AC CURRENT MEASUREMENTS

When electronic circuits are evaluated, ac voltage is usually measured instead of ac current because it can be done without changing or loading the circuitry. Yet in many cases, transistor circuits for example, current is really the measurement that is desired to best understand the circuit.

Since measurement of currents directly is rather difficult, other methods for determining current have been devised. For example, it is common to measure voltage across current monitoring resistance; but this method has several disadvantages.

1. It may be necessary to break the circuit.
2. The resistor may add enough inductance to be a problem.
3. The added resistance itself might disturb normal circuit operation.
4. A differential voltage amplifier is required in some cases to sense only the voltage change across the resistor.
5. Common mode voltage may make measurements difficult.

To overcome these disadvantages, hp has designed the Model 154A Voltage / Current amplifier. The 154A plugs into a standard Model 150A Oscilloscope. It contains a probe which clips around a wire to make visible on the cathode ray tube ac currents up to 10 amperes in amplitude and at frequencies from 50 cps to 8 mc. In addition, you may view a voltage waveform simultaneously.

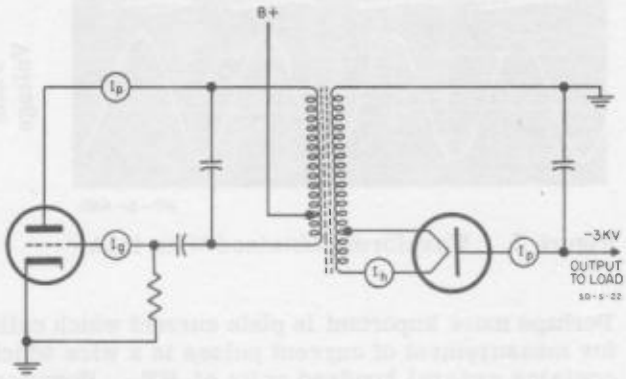

Figure 1. Typical RF Oscillator Used for an Oscilloscope Beam Supply

In addition to obvious applications such as transistor circuits, there are many current measuring applications in which we usually think of voltage, where the 154A will save time and increase confidence in circuit performance. For example, a typical circuit is shown in Figure 1. This circuit is an oscilloscope beam supply which contains a grounded cathode class C 100 KC oscillator, a resonant transformer with a secondary that delivers several thousand volts to a small TV type rectifier. At the output we obtain rectified dc voltage. For best circuit design we should see the grid current pulse to obtain proper operating conditions. Figure 2 shows the current (and grid voltage) waveforms obtained with the 154A probe and displayed on the 150A oscilloscope screen.

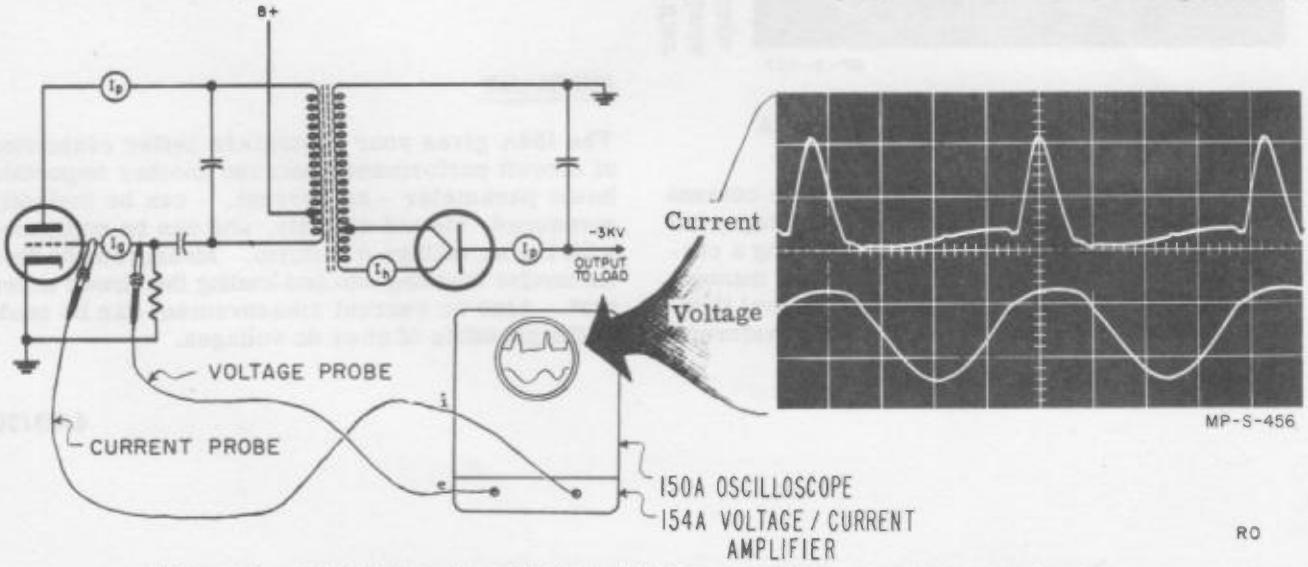

Figure 2. Grid Current and Voltage Waveforms Obtained with the Model 154A

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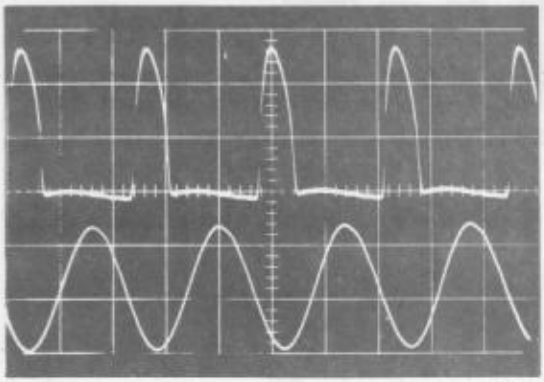


Figure 3. Waveforms Obtained With 154A

Perhaps more important is plate current which calls for measurement of current pulses in a wire which contains several hundred volts of RF. However, since the 154A probe clamps around the wire, no direct connection to the circuit is necessary and you obtain the waveforms shown in Figure 3. You can easily determine conduction angle of plate current for efficiency considerations, and peak amplitude is obvious to help you choose a tube with the required emission capability.

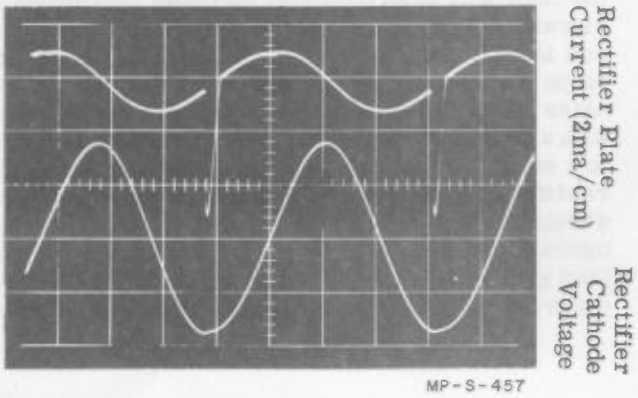


Figure 4. Waveforms Obtained With 154A

On the secondary side, peak rectifier plate current is of interest. This point has little ac voltage, but has several thousand volts of dc. So by using a current monitoring resistor in the conventional manner, you would have to float an oscilloscope several thousand volts off ground to see the current waveform - a difficult and hazardous method at best. The 154A, however, responds only to current and is insensitive to the presence of dc voltages. Waveforms taken with the 154A are shown in Figure 4.

The display shows the 90^{o} phase difference between the sine wave component of plate current and the cathode voltage which results from the tube plate-cathode capacity. More important, the sharp spikes in the current waveform show the rectifier conduction current.

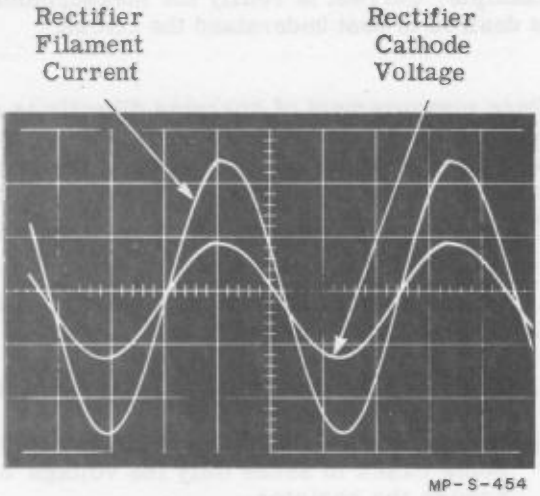


Figure 5. Waveforms Obtained With 154A

Rectifier Filament current is shown in Figure 5. Here, the 154A really saves time and increases reliability. Previous methods such as thermocouple and filament light comparison were only approximate and involved considerable hazard because of the high voltages present.

SUMMARY

The 154A gives your customers better evaluation of circuit performance because another important basic parameter - ac current, - can be instantly measured, viewed directly, and can be compared with the ac voltage waveform. Measurement does not involve breaking into and loading the circuit under test. Also ac current measurement can be made in the presence of ac or dc voltages.

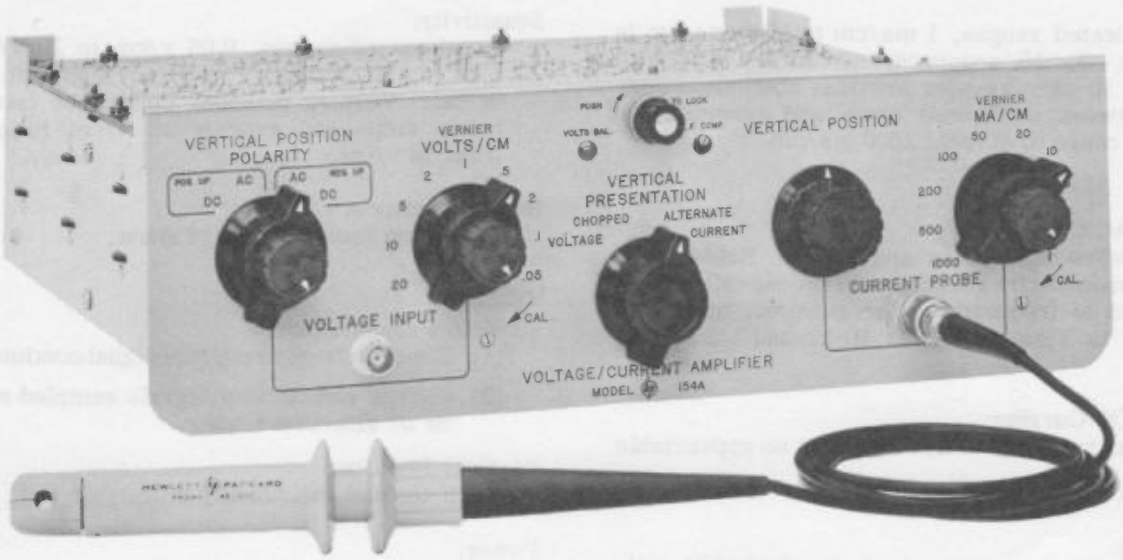
4/23/59

TECHNICAL DATA

HEWLETT-PACKARD COMPANY · 1501 PAGE MILL ROAD · PALO ALTO, CALIFORNIA, U.S.A.
CABLE "HEWPACK" TELEPHONE DAVENPORT 6-7000

MODEL 154A VOLTAGE/CURRENT DUAL CHANNEL AMPLIFIER

for use with Model 150A Oscilloscope



ADVANTAGES

- Observe current waveforms quickly, conveniently
- Easy to use, just clamp and read
- Observe current and voltage waveforms simultaneously
- Reliable, convenient measurements reducing engineering, test time

USES

- Investigating computer and transistor circuitry
- Measure phase angle between voltage and current
- Laboratory or production line measurements
- Clip-on ac ammeter 50 cps to 8 mc

DESCRIPTION

Now, for the first time, you can have an oscilloscope to view alternating current waveforms directly without breaking leads, having a voltage drop caused by inserting a series resistor and without circuit loading or disturbance. Just clamp the probe of the Model 154A around the current carrying wire to observe current waveforms from 50 cps to 8 mc. In addition, Model 154A Voltage/Current Amplifier permits you to measure and observe simultaneously both voltage and current waveforms with your Model 150A Oscilloscope. Electronic switching between channels, either by alternate sweeps or by 100 kc chopping, allows direct comparison of voltage and current relationships within a circuit. For instance, you can study transfer admittance and impedance by comparing input voltage with output current or vice versa. Of course, either the current channel or voltage channel may be used separately. The current channel, equipped with a unique current sensing probe, allows direct presentation of current waveforms simply by clamping the probe around a wire. It is therefore possible, without breaking into a circuit, to measure and observe alternating currents from 1 ma peak-to-peak to 15 amperes peak-to-peak. Being able to measure and current conveniently brings a new dimension to the investigation of transistors, logic circuits, or wherever current is the most important parameter. Engineering as well as production and test time will be materially reduced since measurement is simple, quick and convenient. Further by having simultaneous presentation of both current and voltage it is possible to make phase comparisons between the two, keeping in mind that the time delay through the current channel is approximately 0.02 microseconds longer than the delay through the voltage channel. Current probe can be relied upon for accurate measurements and is little affected by stray fields and by wire position within the probe, since the current probe is electro-statically and magnetically shielded.*

* See "A Clip-On Oscilloscope Probe for Measuring and Viewing Current Waveforms", Hewlett-Packard Journal Vol., 10, No. 9-10, May-June 1959.

Model 154A EEM 2900

SPECIFICATIONS

When plugged into Ⓗ Model 150A Oscilloscope

CURRENT CHANNEL

Band Pass:
50 cps to 8 mc

Sensitivity:
10 calibrated ranges, 1 ma/cm to 1000 ma/cm in a 1, 2, 5, 10 sequence. Accuracy ±5% with vernier in cal. Vernier provides continuous control between calibrated steps and extends 1000 ma/cm range to at least 2500 ma/cm.

Maximum AC Current:
10 amperes rms 20 kc and above. Below 20 kc core non-linearity reduces current capability proportional to frequency. For example, maximum current is 5 amps rms at 10 kc and 1/2 amp at 1 kc.

Maximum DC Current:
Direct current up to 1/2 amp has no appreciable effect.

Calibration:
Calibrate at 5 ma with short circuited 150A calibrator output on the 0.2v position.

Input Impedance:
(Impedance added to circuit by probe) approximately 0.01 ohm shunted by 1 μhenry.

Phase Shift:
Sinusoidal Input: Insignificant above 400 cps; may exceed 20^{o} at lower frequencies (with respect to voltage channel).

VOLTAGE CHANNEL

Band Pass:
DC Coupled: dc to 10 mc, 0.035 μsec rise time
AC Coupled: 2 cps to 10 mc, 0.035 μsec rise time

Sensitivity:
9 calibrated ranges, 0.05 v/cm to 20 v/cm in a 1, 2, 5, 10 sequence. Accuracy ±5% with vernier in cal. Vernier provides continuous control between steps and extends 20 v/cm range to at least 50 v/cm.

Input Impedance:
1 megohm (nominal), 30 pf shunt.

GENERAL

Vertical Presentation:
(1) Either voltage or current signal continuously or
(2) voltage and current signals sampled at 100 kc or on alternate traces.

Vertical Position:
Each channel individually adjustable

Power:
Supplied by Model 150A Oscilloscope

Weight:
Net 5 lbs., shipping 10 lbs.

►Accessories Available:
AC-21A Probe (10:1 voltage division), $30.00
AC-21C Probe (50:1 voltage division), $30.00

Price:
Ⓗ Model 154A Voltage/Current Amplifier with AC-21F Current Probe, $430.00

Prices f.o.b. factory 6/15/59
6/1/61

DATA SUBJECT TO CHANGE WITHOUT NOTICE