# Solid State OP-AMP Measures Kilovolts With 0.05% Accuracy

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Current drawn by an electrostatic voltmeter in high-voltage tests lowers the measured voltage and consequently limits the accuracy of the measurement. The 2% accuracy of a conventional electrostatic voltmeter causes a significant 200-volt error in a 10-kilovolt measurement. A charge transfer circuit that precisely divides the high voltage and protects the divided voltage from current drain during test keeps measurement error within .05%.

The voltage division is accomplished by transferring the charge on a small, high-voltage capacitor to a large, low-voltage capacitor. The large capacitor is the feedback capacitor of an operational amplifier. Any current drawn by the voltmeter during test is replaced on the capacitor by the amplifier.

The voltage to be measured, $V_1$, charges capacitor $C_1$ when the switch $S_1$, is moved to position A. Corona losses are avoided with rounded contacts on both the swinger and position A. By using a glass, oil-filled capacitor for $C_1$, the error introduced by dielectric losses is eliminated.

To measure the voltage under load conditions switch $S_2$ is moved to the load position. The value of $R_1$ is determined by a calculation when the desired load current is known.

When $S_1$ is moved to position B, the charge on $C_1$ is completely discharged into the input of the operational amplifier. The resistor $R_2$, is placed in series with amplifier to slow the current flow and insure response of the amplifier. The output current of the operational amplifier — equal to the input current — accumulates on $C_2$ and charges it to a voltage, $V_2$, that is related to $V_1$ by

$$V_1 = V_2 \frac{C_2}{C_1}$$

The voltage, $V_2$, is measured by a digital voltmeter. Since the discharge of $C_2$ during the measurement is replenished by the operational amplifier, $V_2$ remains permanently accurate. The voltage $V_2$ is removed from the capacitor by closing switch $S_3$, thus allowing the engineer to make further measurements.

Since the $C_2/C_1$ ratio is involved in the calculation of $V_1$, it is precisely determined by placing a standard voltage on $C_1$ and measuring the voltage on $C_2$ after current transfer.
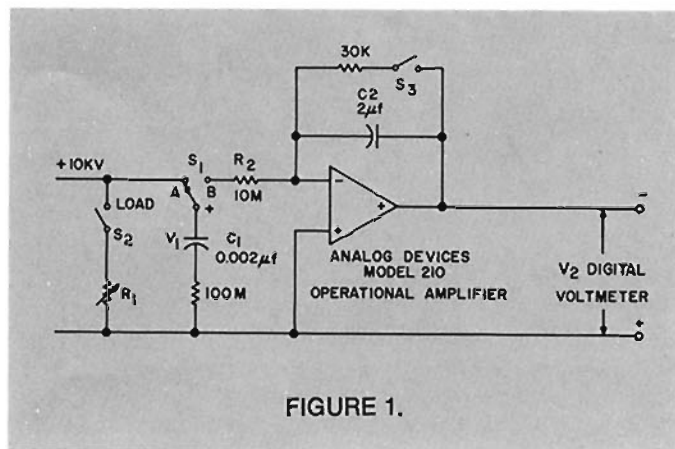


FIGURE 1.