Increasing voltmeter input impedance to 10^{12} ohms

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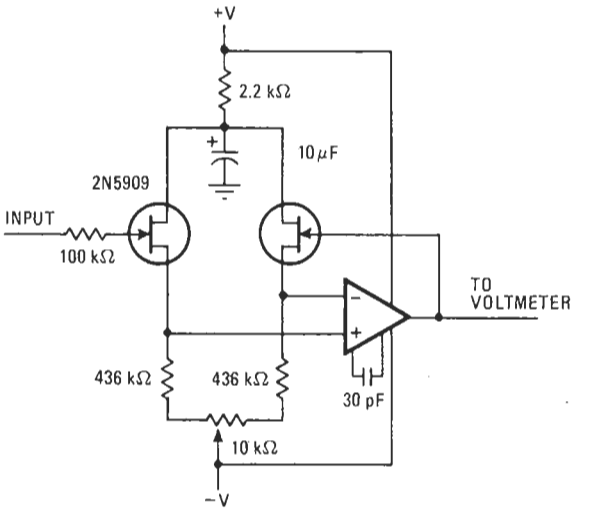
Most commercial voltmeters, whether they have analog or digital readouts, provide relatively low input impedances, only on the order of 10 megohms, which makes accurate voltage measurements difficult for many circuits. But, by combining a couple of low-leakage field-effect transistors with an operational amplifier, you can raise the input resistance of your voltmeter to approximately 1,000,000 megohms.

Any dc voltage applied to the gate of the input FET will be reproduced at the circuit's output with sufficient amplitude to drive any type of voltmeter. If Motorola's type MC1436 op amp is used with a 35-volt supply, the circuit can handle input voltages as high as 30 V without an attenuator. If a wide frequency response is desired, Signetics' type 531 op amp can be used with a lower supply voltage. And, because of its low current drain, National's type LM308 op amp is best for battery-operated voltmeters.

A voltage divider to ground at the circuit's input permits higher voltage measurements to be made, but significantly lowers the circuit's input resistance. However,



OP AMP:
FOR LOW CURRENT DRAIN – NATIONAL LM308
FOR HIGH FREQUENCY – SIGNETICS 531
FOR HIGH VOLTAGE – MOTOROLA MC1436

since FET gate-leakage current is in the low-picoampere range, the resistors used for the voltage divider can have values that are quite large without introducing significant errors. For example, a 1,000-megohm resistor to ground, along with another resistor having the appropriate value to obtain the desired ranging, will still provide an unusually high input resistance of several thousand megohms.

Great care must be taken to prevent extraneous leakage paths to ground. You will invariably degrade the circuit's input resistance considerably by using standard binding posts, or by providing a switching arrangement for the voltage divider, or by terminating the input FET's gate lead on a circuit board.

The circuit will handle ac voltages, although its input impedance will be reduced somewhat by stray capacitance. However, even this lowered input impedance will be much higher than what is usually available from commercial instruments.

The 10-kilohm potentiometer can be used to counteract op-amp offset and drift or to zero whatever offset voltage may result when very high resistance values are used for a voltage divider. □

High-impedance input. FET circuit lets you raise the input resistance of any voltmeter to 1,000,000 megohms, a factor of 10^5.