Six-range FET dc voltmeter has 11M input impedance

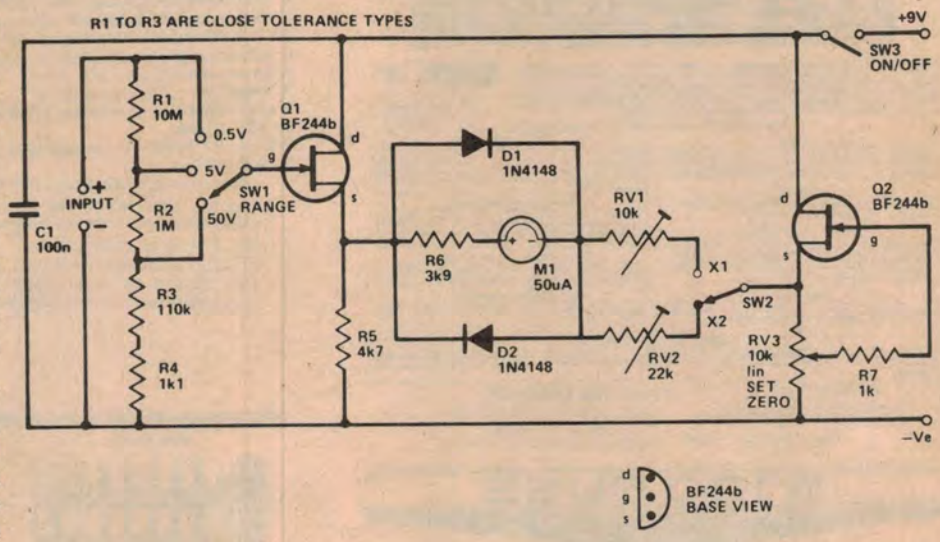
This circuit can be made as a handy add-on unit for a multimeter or as a stand-alone test instrument.

ALTHOUGH an ordinary multimeter is suitable for most dc voltage measurements, it can occasionally prove to be inadequate — usually just when you need it most! This is the case when making measurements on high impedance circuits which cannot supply the input current required to operate even a very sensitive moving coil meter of the type normally employed in a multimeter. The loading effect of the meter then causes the voltage at the test point to fall substantially, resulting in a misleading reading.

The problem is overcome by this FET voltmeter circuit which has six ranges, from 0.5 V (500 mV) to 100 volts full scale deflection (FSD). The circuit features an input impedance of a little over 11M on all ranges. This provides a sensitivity of more than 22M/volt on the half-volt (lowest) range, falling to a little over 110k/volt on the 100 V range. Most common multimeters have a sensitivity of 20k/volt, good quality types 50k/V and top-line models 100k/V, so this unit should compare quite favourably by the time you want to measure high voltages.

The high input impedance is achieved by using Q1 as a unity voltage gain buffer (source-follower). The FET has an inherently high input impedance. The actual input impedance is really set by the value of the series combination of the input attenuator consisting of resistors R1, R2, R3 and R4.

A simple voltmeter circuit is driven from the source of Q1. Ignoring the two diodes, D1 and D2, for the moment, the meter (M1) is arranged with several 'range' resistors in series: R6, RV1 and RV2. The latter two are switched to provide 'x1' and 'x2' ranges. In the x1 range, M1 has a full scale deflection sensitivity of 0.5 V, while in the x2 range it has an FSD sensitivity of 1 V. The unit is set up by adjusting RV1 and RV2 to give the appropriate full scale readings.



As the input FET develops a small bias voltage across R5, the negative side of the meter circuit has to be 'biased up' to counteract a permanent meter deflection. This is provided by another FET connected as a source-follower, Q2. Its gate is returned to the source bias, a potentiometer, so that the 'zero point' on the meter may be adjusted. This arrangement also provides a measure of stability, and little 'drift' in the meter reading is noticeable.

Diodes D1 and D2 protect the meter against serious overloads. When the voltage drop across R6 and M1 exceeds about 550 - 600 mV, of either polarity, one diode or the other will conduct, shunting the meter with a low impedance, reducing any further increase in current flow through the meter. A high reverse voltage at the input may destroy Q2, but the meter will be protected.

A simple input attenuator is arranged to provide three basic ranges of 0.5 V, 5 V and 50 V full scale, in the x1 range, these double to 1 V, 10 V and 100 V respectively.

The circuit is not critical as to layout, apart from the usual precautions to avoid possible accidental shorts, but a good quality switch having excellent insulation resistance impervious to humidity variations should be employed for the RANGE switch, SW1. A switch with ordinary bakelite insulation would be unsatisfactory. The circuit need not be built as a stand-alone unit, but makes an excellent add-on for a multimeter that has a 50 uA current range. Alternatively, if your meter has a 0.5 V range and is protected, delete D1, D2 and R6, connecting the meter between R5 and the junction of RV1 and RV2.

If building it as a stand-alone unit, buy a meter with a good-sized face (80 mm wide, for example). If you can get a mirror-scale type, so much the better. ●