

P. Lay

This circuit can precisely measure electrostatic charge. The charge to be measured is stored on C1 (a high quality MKT capacitor with a value of 1-2 μF). The voltage (U) across the capacitor (C1) is related to its charge (Q) by the equation $U = Q/C1$. Operational amplifier IC2 buffers this very high impedance source. An input lead is connected to one side of capacitor C1 and terminated with a test probe. The other side is connected to an earth lead and to a convenient earth point. IC3 amplifies the low voltage level at the output of IC2 and drives the moving coil meter M1 ($\pm 100 \mu\text{A}$ to $\pm 1 \text{ mA}$ centre zero). Switch S2 allows selection between two measurement ranges. With S2 closed the amplification factor is 5 and when open the amplification factor is 10. The internal impedance of P1 is 2.2 k Ω . Alternatively a digital multimeter can be used in place of P1, in this case resistor R7 (2-20 K Ω) can be omitted. Low Current LED D2 indicates that the electroscope is on.

The operational amplifiers used here are MAX4322 from Maxim. The common mode input voltage for these devices can go to the supply rails; likewise the outputs will drive from rail to rail. The maximum supply voltage is 6.2 V, hence the need for zener diode D1 to limit the supply voltage. A full data sheet can be obtained from www.maxim-ic.com.

The operational amplifier IC1 produces a symmetrical supply with a centre rail (earth) from the 9-V battery. The supply current for the electroscope is in the order of 5 mA, most of which is used by the zener diode D1. Alternatively, the operational amplifiers can be replaced by a type that can operate at a higher supply voltage. For example IC2 and IC3 can be replaced by a single (dual op-amp) TLC272 (see the DIL outline for this device to assign the new pins). IC1 can be replaced by a TLC271 (pin 8 should in this case be connected to earth and pins 1 & 5 left unconnected). The maximum supply voltage for these IC's is 16 V so zener diode D1 can be omitted which will bring the supply current down to 3 mA.

Operation of the precision electroscope is simple:

1. Switch on S1, LED D2 lights.
2. The test probe is touched to the earth lead to discharge capacitor C1 before a measurement is made. Alternatively a small push button switch can be wired in parallel to C1 to discharge it.
3. The test probe is now touched onto the charged part.
4. The meter will show any charge, its polarity and its value.
5. After use, turn off to save the batteries.

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