PORTABLE ATMOSPHERIC CHARGE DETECTOR

http://alancordwell.co.uk/electronics/lightning.html
Not Found

Electrometer Method

An electrometer is essentially a meter for measuring electrostatic charges. There is a constant electric field in the air which rises from zero at ground level and goes upwards - in fact we live in a soup of electric charges, as you will see if you experiment with this little circuit. Any construction technique will do, but the gate lead of the FET should be extremely well insulated; you can use the teflon insulator here from an old N-type RF connector. The antenna consists of a small piece of copper clad board about 3in square, mounted up in the air on about 6in of stiff wire, with the copper connected to the FET gate via the 10 meg resistor. The circuit should be grounded for best results. The FET should ideally be an Insulated Gate device, however JFETS of the 2N3819/BF244 variety seem to work. The meter is a 100uA meter movement.

To check it out, set the sensitivity control to maximum resistance, and switch on. Set the meter to center zero with the set zero control. It will probably drift a bit after initial switch on. Now get a plastic rod such as bic pen and rub it in your sleeve a couple of times to charge it. You will see that the meter responds with deflections first one way and then the other, as you move the rod toward or away. Increase the sensitivity as necessary, try just walking around near the meter... If you take it out of doors, notice how the meter reading changes as clouds go by. If a storm brews, you will see a huge build up of charge, and violent movement of the needle - frequently from end-stop to end-stop - when lightning occurs.

Just a couple of things to note about the (very basic) circuit above;
1. there is nothing stopping you setting the sensitivity pot to zero resistance and maybe damaging the meter movement. You could put a 1K resistor in series which would both protect the meter and set the maximum to something sensible.
2. The FET is protected only by the 10M resistor and will die if you put a static charge from any seriously charged up object on it.
The following circuit is an electronic approximation of the ‘gold leaf electroscope’, except that this electroscope indicates polarity as well as electric field magnitude. It is incredibly sensitive! It will detect a television or an electrostatically charged comb from the other side of a room. It can even ‘see’ people moving about!

The neon bulb serves two purposes. It provides leakage at the FET gate and also helps to defend the FET against an electrostatic discharge. Do not omit the neon bulb – the FET won’t get the proper biasing without it. Ideally, the neon bulb should be in darkness, though the circuit seems to work okay with the neon bulb illuminated. The only effect is that the meter ‘autozero’ has a much shorter time constant when the neon bulb is illuminated.

The meter can be of the ‘VU’ variety though meters in the range 100 μA to 1 mA can be made to work. You may need to change the value of the adjustable resistor if a meter of widely different FSD to that specified is employed. A source of small, cheap meter movements is those cheap battery testers – their meters tend to be in the range 0.5 mA to 1 mA.

You won’t be able to walk around with this electroscope – the needle will just kick between its end stops if you try. Instead, it should be operated on a firm surface and left to settle for a minute or two. Adjustment of the METER CENTRE adjustment is inevitably a trial and error affair, as bringing your hand near the electrometer will probably alter its reading.

The probe can be just a few inches of wire. The impressive looking probe on my meter is nothing more than a redundant adapter from an emergency mobile phone battery! I provided an earth connection through the body of the switch in anticipation that I might need to use my hand to remove excessive charge from the probe, but I haven’t actually needed to do that yet.
PORTABLE ATMOSPHERIC CHARGE DETECTOR

High Voltage Detector

http://blog.arduino.cc/2011/06/15/high-voltage-detector/

This circuit is a simple electric field detector. It can detect very faint electric fields present around powered electric lines.

Nothing really new: a JFET is used to sense the electric field generated by high voltage electric line; the JFET amplifies the signal very little, but it lowers the impedance and provide current to a level suitable for transistor amplification. The two transistor can be any low power NPN scavenged from anywhere. The two-transistor are configured as a sort of threshold amplifier: when the voltage at R2 rises at above 3V circa, Q1 starts pumping current into the LED with a step curve providing a better go-no/go response. The circuit is the same as the one used in the Korg Monotron to drive the LFO LED.

A low current LED could have been connected directly between V+ and the Drain of the JFET and removing TR1, TR2 and R3 through R7: in this case the LED would light up in a linear way, no threshold. See bottom of post for a description of what TR2 is there for.

Stray charge may escape from the tip of R1 for tip-effect letting the intrinsic capacitance at the gate of the JFET charge positively giving a positive read after a little while. So, a curled tip and a very high resistance path to ground in the form of a few turns of thin wire around resistor R1, help keep things in balance. In case, a very very high resistor can be connected between gate and ground (R8), but this will limit sensitivity very much.

Resistor R1 is there to provide a protection to the delicate gate of the JFET and the delicate heart of the operator in case of contact to a live line. Here, the higher the value of the resistor, the better. R1 also provides for the sensing tip.
Atmospheric Charge Monitor circuit
Posted by P. Marian in DIY
http://electroschematics.com/5751/atmospheric-charge-monitor/

This circuit is designed to monitor the atmospheric charge. By observing the increase in the atmospheric charge, it is possible to predict a nearby lightning. The sudden electric discharge during a lightning may cause the flow of excessive current to earth which may be detrimental to the appliances connected to mains lines.
Normal atmospheric charge on a sunny day will be around 100 milli volts with negligible current and may increase to many volts as the clouds accumulate in the sky. This may go up to thousands of volts before the lightning strikes. The circuit described here monitors the atmospheric condition and display the same through LED indications.
The front end of the Atmospheric Charge circuit has a Op Amp comparator built around IC TL071. It is a JFET input op amp with an open loop voltage gain of 100dB. Its inverting input is connected to the positive rail through two presets VR1 and VR2 while the non inverting input is connected to the antenna. Resistor R2 protects the input of IC from excessive charge while R1 keeps the non inverting input stable. TL071 has very high gain, so R3 is provided to give some negative feedback.
Output from IC1 is around 2.5 to 5 volts which passes to the input pin 5 of IC2 through VR3. Resistor R4 protects VR3 if its wiper is turned fully. IC2 LM3914 is a monolithic integrated circuit that can sense analogue voltage levels to drive the LEDs and provide a linear analogue display. Current through the LEDs is self regulated by the IC eliminating the need of current limiting LED resistors. Its low bias current input pin 5 receives signals down to 0.5 volts and its outputs 18 to 10 sinks current one by one as its input receives an increment of 125 milli volts. The LEDs can give a DOT mode display if pin 9 of IC2 is unconnected. If it is connected to positive rail, bar mode display can be obtained.D1 lights when the input pin 5 gets 1.7 volts andD5 light up when the input gets 4.2 volts.

Adjustments
Before applying power to the circuit, turn the wiper of VR1 to the extreme anti clock position and keep the wiper of VR3 in the middle position. When the wiper of VR2 turns to clock wise direction, D2 to D5 light up one by one. Adjust VR3 till D4 turns on. Wait for some time and see that D5 is glowing. This shows that the circuit is responding to changes in atmospheric charge. It is necessary to make adjustments on a sunny day with clear sky. Adjust VR2 till D1 glows. This indicates normal atmospheric charge. As the charge in the atmosphere increases due to the accumulation of clouds, D2 through D5 lights.
Antenna can be 3 meters plastic coated wire. The negative rail of the circuit should be earth grounded since the circuit is monitoring the atmospheric potential with reference to ground. Earth grounding can be done by driving an iron rod into the earth. Connect the circuits negative to this iron rod. Keep the unit inside a room near the window. Do not try adjustments if there is lighting.
PORTABLE ATMOSPHERIC CHARGE DETECTOR
STATIC CHARGE MONITOR

Static Charge Monitor
Posted by P. Marian

Here is a circuit that can sense the static electricity level in the atmosphere. It gives LED indications for both positive and negative atmosphere charges. The circuit uses a low noise JFET input Op Amp TLO 71 to detect the atmospheric charge.

The op amp has well matched high voltage JFET input device for low input offset voltage. The BIFET technology provides wide bandwidth and fast slew rate with two input bias currents. IC1 (TLO71) is designed as a voltage sensor cum signal amplifier. Its Non INV input is connected to the aerial (1 meter plastic wire) through R2. R1 maintains the input impedance of IC1 to make the input sensitivity normal. VR1 and VR2 adjust the voltage level at the INV input of IC1. Resistor R3 and R4 determines the gain of the inverting amplifier and with the shown values it is 1000. That is, a difference of 1 milli volt at the input gives 1 volt output. Output from IC1 is used to switch on T1 and T2 at different output states. When there is positive charge in the atmosphere, output of IC1 becomes high and T1 conducts to light Red LED. If the atmospheric charge is negative, output of IC1 remains low and T1 off. This causes T2 to conduct and Green LED lights. These states of LEDs change as the atmospheric charge changes.

Adjust VR1 and VR2 for IC’s input sensitivity and VR3 for the threshold level of T1. Adjustments should be done in a sunny day so that atmospheric charge will be around 100 milli volts.

ORIGINAL SCHEMATIC

[Image of the circuit diagram]
PORTABLE ATMOSPHERIC CHARGE DETECTOR

http://www.techlib.com/electronics/cloud.htm

One-Transistor Cloud Charge Monitor
(AUTO-ZERO CLOUD CHARGE MONITOR)

Do not stand where lightning might strike you when using this device! Stay under cover. The fields are plenty strong and will even go through windows.

Some comments about this project:
This is really a toy that detects changing fields. It cannot make measurements of static fields. Investigate "field mills" for more serious applications.
The plastic can accumulate a charge on its surface and a metal package may be more desirable but the antenna insulation becomes critical.
Stand perfectly still when watching clouds; lifting a foot will create a big meter response!

Here is a simple electrostatic charge monitor that may be used to detect any slowly changing electric field including charges swirling around in a thunderstorm or the charge on a moving pocket comb from across a room. The heart of the circuit is an electrometer-grade JFET marked “SPF3059” which is like those found in many smoke detectors, similar to the PN4117 or 2N4117. The plastic PN4117 is the better choice because the plastic package leaks less than the glass/metal package.

The antenna connection is very critical and if you don't have a teflon terminal, just float the wires in the air, making sure they don't touch anything except the zero switch. You might suspect that the zero switch and 150pF capacitor would be a problem but normally there is little voltage across these parts and, consequently, leakage is not as serious. In fact, a little leakage here tends to help "auto-zero" the circuit. Use a low leakage polystyrene, plastic or glass capacitor of 100 to 1000pF. A ceramic capacitor may have too much leakage. Use a good, clean switch, too. (If too much leakage occurs here, the capacitor will discharge too quickly and the meter will drift back to center a little too quickly.) A bolt was added as a finger pad to bring the circuit ground to the same potential as the person's body holding the meter. Touch this bolt while holding the jar to stabilize the readings a bit.

Here is how to set it up:
Clean everything with a good degreaser (circuit wash, alcohol, acetone, etc) and dry thoroughly with a hair dryer. Take care not to damage the plastics if you are using something aggressive like lacquer thinner!

Temporarily disconnect the 2,200 uF capacitor, turn on the power and wait several minutes. Press the zero button and, while holding it, adjust the pot until the meter reads half scale. This adjustment should be permanent unless you have leakage problems or the 2,200 uF capacitor is unusually leaky. Reconnect the 2,200 uF capacitor and wait several minutes again. Press the zero button several times until the meter settles near half scale.

Now lift your foot off the ground and you should see a change. Try running a comb through your hair then waving it near the antenna. A properly operating meter should respond to the comb from yards away. Push the zero button occasionally to center the meter. Sometimes a static charge can build up on the plastic. Simply run your fingers over the surface of the plastic while touching the ground screw with the other hand to discharge the plastic.

Here is how it works:
When the zero pushbutton is held in, the gate of the FET is connected directly to the variable voltage provided by the potentiometer. This voltage sets the source voltage to a value that gives 50uA drain current giving a half-scale meter reading. When the zero switch is released, the 150 pF capacitor holds the DC voltage constant as long as there is no significant leakage current. The capacitor forms a divider with the antenna capacitance and any electric field the antenna experiences induces a voltage at the gate, changing the meter reading. The 2,200uF capacitor grounds the source of the FET for AC signals giving the circuit much more gain for changing signals. The time constant is long so the meter has good sensitivity for even slowly changing fields. The leakage is so low that the voltage will stay constant on the 150pF capacitor for long periods! The prototype works well with no capacitor except the capacitance of the antenna!
PORTABLE ATMOSPHERIC CHARGE DETECTOR

Auto-zero Cloud Charge Monitor V2

ALTERNATE: Use a panel push button switch for a hand-held unit.
Use a jumper on the PCB for an external (Pizza Pan) antenna.

TROUBLE SHOOTING
Unsteady needle at idle
Low idle setting
Faulty Tank Capacitor
Faulty JFET

Troubleshooting:

- Unsteady needle at idle
- Low idle setting
- Faulty Tank Capacitor
- Faulty JFET
PORTABLE ATMOSPHERIC CHARGE DETECTOR

Auto-Zero Cloud Charge Monitor V1.4

Auto-Zero Cloud Charge Monitor V1.4B

Auto-Zero Cloud Charge Monitor V1.5

R2 47K
Q1 2N3819
N CHANNEL JFET
TRIM1 100K
ZERO G S D
C2 2200mF 35V
C1 100-1000pF
J1
R1 1M
J2
ANT - METER
SW
R3 4K7
+9V GND SW
+METER
R3 4K7
+9V

9V Batt

R2 47K
Q1 2N3819
N CHANNEL JFET
TRIM1 100K
ZERO G S D
C2 2200mF 35V
C1 100-1000pF
J1
R1 1M
J2
ANT - METER
SW
R3 4K7
+9V GND SW
+METER

ALTERNATE: Use a panel push button switch for a hand-held unit.
Use a jumper on the PCB for an external (Pizza Pan) antenna.

R1 4K7
2N3819
N CHANNEL JFET
TRIM1 100K
BALANCE R3 VALUE TO REACH ZERO G S D
J2 J1
PB1

TROUBLE SHOOTING

Unsteady needle at idle
Low idle setting
Faulty Tank Capacitor
Faulty JFET

Auto-zero Cloud Charge Monitor V2

SW1
METAL BAT HANDLE TOGGLE CASE TO GROUND

R1 4K7
R2 1M
C2 2200mF
C1 100-1000pF
SW1
R3 4K7
GND

GND

GND

GND

SUPPORT BRACKET

COOKIE TIN LID
or PIZZA PAN ANTENNA

TROUBLE SHOOTING

Unsteady needle at idle
Low idle setting
Faulty Tank Capacitor
Faulty JFET

R1 4K7
2N3819
N CHANNEL JFET
TRIM1 100K
BALANCE R3 VALUE TO REACH ZERO G S D
J2 J1
PB1
PORTABLE ATMOSPHERIC CHARGE DETECTOR

AUTO-ZERO CLOUD CHARGE MONITOR
(PLASTIC JAR VERSION)
PARTS LAYOUT

TROUBLE SHOOTING
Unsteady needle at idle
Low idle setting
Faulty Tank Capacitor
Faulty JFET

Auto-zero Cloud Charge Monitor V2
ALTERNATE: Use a panel push button switch for a hand-held unit.
Use a jumper on the PCB for an external (Pizza Pan) antenna.

AUTO-ZERO CLOUD CHARGE MONITOR V3
PORTABLE ATMOSPHERIC CHARGE DETECTOR

RIDICULOUSLY SENSITIVE CHARGE DETECTOR

This simple circuit can detect the invisible fields of voltage which surround all electrified objects. It acts as an electronic "electroscope."

Regular foil-leaf electrosopes deal with electrostatic potentials in the range of many hundreds or thousands of volts. This device can detect one volt. Its sensitivity is ridiculously high. Since "static electricity" in our environment is actually a matter of high voltage, this device can sense those high-voltage charged objects at a great distance. On a low-humidity day and with a 1/2 meter antenna wire, its little LED-light will respond strongly when someone combs their hair at a distance of five meters or more. If a metal object is lifted up upon a non-conductive support and touched to the sensor wire, the sensor can detect whether that object has an electrostatic potential of as little as one volt!

Note: I use the term "electrification" rather than "charging", in order to avoid confusion between charge and net-charge. Charge is the stuff on the negative electrons and positive protons, while net-charge is the imbalance between positive and negative particles which appears on everyday objects. Real-world objects become "electrified" whenever their pre-existing + and - charges are not equal.

PARTS LIST:
1 - Standard 9-volt battery 1 - MPF-102 N-channel Field Effect Transistor (FET) Radio Shack #276-2062 1 - Red Light Emitting Diode (LED) Radio Shack #276-041 MISC: ·Battery connector (#270-325) ·Alligator Clip Leads (#278-1156) ·solder, if desired ·1-meg resistor (not required) ·plastic, fur, foil, comb, tape dispenser, plastic cup (Tiny version built atop a 9v battery connector)

CONSTRUCTION HINTS
Warning: Avoid touching the Gate wire of the FET. Any small sparks jumping from your finger to the Gate wire can damage the transistor internally.

The 1-meg resistor helps protect the FET from being harmed by any accidental sparks to its Gate lead. The circuit will work fine without this resistor. Just don't intentionally "zap" the Gate wire.

To test the circuit, charge up a pen or a comb on your hair, then wave it close to the little "antenna" wire. The LED should go dark. When you remove the electrified pen or comb, the LED should light up again.

IF IT DOESN'T WORK, the humidity might be too high. Or, your LED might be wired backwards, or the transistor is connected wrong, or maybe your transistor is burned out. Make sure that the transistor is connected similar to the little drawing above. Also, if the polarity of the LED is reversed, the LED will not light up. Try changing the connections to your LED to reverse their order, then connect the battery and test the circuit again. If you suspect that humidity is very high, test this by rubbing a balloon or a plastic object upon your arm. If the balloon does not attract your arm hairs, humidity is too high.

SENSE E-FIELDS
Connect the circuit to its battery, and the LED will turn on. Comb your hair, then hold the comb near the Field Effect Transistor (FET) gate wire. The LED will go dark. This indicates that the comb has an excess of negative charge, and the FET responds to the electrostatic field surrounding the comb. It acts as a switch and turns off. Remove the comb and the LED brightens again. Wiggle the comb, and find at how great a distance the circuit still detects it. It's amazing how far an e-field extends around an electrified object. (But then, e-fields should extend to infinity, no?)
PORTABLE ATMOSPHERIC CHARGE DETECTOR

Electroscope (BALANCED BRIDGE ELECTROSCOPE)
http://electronicidea.blogspot.com/2008/09/electroscope.html

The electroscope pictured in Fig. 1 can be used to display static energy charges from sources such as TV sets, electrostatic generators, carpet cruising, and hair combing. The electroscope is the sophisticated cousin of the static-electricity detector shown in Fig. 1-9. The electroscope would make an excellent science-fair project or addition to your electronics bench. The heart of the electroscope circuit is the two FETs, Q1 and Q2, connected in a balanced bridge configuration. The gate of Q1 is connected to the wire pick-up antenna via a 1.5k resistor, and the gate of Q2 is tied to the circuit's common ground through the other 1.5k resistor. This type of bridge circuit offers excellent temperature stability. Q1 operates in an open-gate configuration. The 500-Ω potentiometer balances the null bridge circuit. The 5-kΩ potentiometer and capacitors C1 and C2 help reduce stray 60-Hz pickup and increase the stability of the circuit. The 1-mA meter connected between the drain pins of Q1 and Q2 indicates an electrostatic field. The electroscope requires little current consumption, and therefore, it can be operated from a 9-V transistor-radio battery.

Electroscope parts list
Quantity Part Description
2 R1,R7 1.5-Ω, ¼-W resistor
2 R2,R5 2.2-kΩ, ¼-W resistor
1 R3 5-kΩ, ¼-12-Watt potentiometer
1 R4 680-Ω, ¼-W resistor
1 R6 500-Ω, ¼-Watt potentiometer
2 C1,C3 39-pF, 25-V capacitor
1 C2 100-μF, 25-V electrolytic capacitor
2 Q1,Q2 2N4342 FET
1 M 0-1-mA panel meter
1 SW-1 SPST toggle switch
1 ANT Telescoping whip antenna
1 BATT 9-V transistor-radio battery

BALANCED BRIDGE ELECTROSCOPE

Drawn by Jochlerius Mangkasa
PORTABLE ATMOSPHERIC CHARGE DETECTOR

BALANCED BRIDGE ELECTROSCOPE

by Jochtorius Mangkasa
PORTABLE ATMOSPHERIC CHARGE DETECTOR

MOVING CHARGE SENSOR
http://www.ece.rochester.edu/~jones/demos/ahern.html
Thomas B. Jones
Professor of Electrical Engineering
University of Rochester

DESCRIPTION
What distinguishes Ahern's instrument from other charge detection and measurement apparatuses used in electrostatics demonstrations, such as the conventional leaf electroscope and the tonal electrostatic voltmeter, is that Ahern's device responds to the movement of positive (+) and negative (-) electric charge toward or away from a sensing electrode. As such, the instrument is probably most closely akin to some of the electrostatic charge monitors now commercially available and routinely installed in electronics assembly areas to detect conditions that might cause damage to sensitive electronics components during assembly.

The instrument is small and portable, it operates on a 9 volt battery, and the output is visual. Furthermore, its construction requires only minimal skills with a soldering iron and other simple tools, and it can be packaged very conveniently in a small, shielded box. Refer to the photo at the left. A short, telescoping cellular telephone antenna mounted so that it retracts into the box when not in use, serves as a sensing electrode.

USE OF THE MOVING CHARGE SENSOR
The instrument is sensitive primarily to the movement of charge rather than to its presence. Thus, when the approach of negative charge is sensed, the green LED comes on, while the red LED lights if positive charge is approaching. As negative charge starts to recede from the sensing electrode, the green changes to red, while red changes to green as positive charge recedes. If a condition of balance can be achieved between positive and negative, then both LED's can be made to light up; this balance is exquisitely delicate due to the very high input impedance of the CMOS gates. In the absence of any charge, neither LED lights up.

Table 1 summarizes the instrument's responses to various charge conditions.

<table>
<thead>
<tr>
<th>Charge Condition</th>
<th>LED Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>Red</td>
</tr>
<tr>
<td>Negative</td>
<td>Green</td>
</tr>
<tr>
<td>Balanced</td>
<td>Both</td>
</tr>
</tbody>
</table>

The instrument is much more sensitive than most hand-held charge detectors. During demonstrations of electrostatic phenomena -- for example, triboelectrification -- the moving charge sensor can be used to sense the charge and to determine its sign. The circuit draws very little current, so the instrument can be operated for extended periods of time without draining the battery.

THE CIRCUIT
The heart of this inexpensive circuit, the schematic of which is shown below, is a quad CMOS NAND gate integrated circuit (4011). Experienced circuit designers will smile when they recognize that this circuit beneficially exploits the notorious static sensitivity of CMOS IC devices. Only three of the four NAND gates in the IC are actually used in the instrument; the input of the fourth gate should be grounded. The 3 MW series resistor protects the chip from ESD damage, while the capacitors serve the primary function of biasing the gates to a quiescent state. Resistors in the ~10 GW range may be used instead, but the capacitors -- Ahern specifies tubular ceramics -- with their very small but not negligible leakage current, work just as well and are definitely cheaper and more readily available. In addition, the charge storage feature of the capacitors introduces some incidental phase lag between the two detection circuits that permits both LEDs to remained lighted when both signs of charge are detected simultaneously.

A small, inexpensive telescoping antenna -- of the type used in cell phones and available at electronics supply stores -- serves the function of the input charge-sensing electrode. But an even cheaper solution for the sensing electrode is a length of rigid wire formed into a loop so as not to present a hazard. One must make sure to remove the insulation from this wire. If the circuit is packaged in a plastic box, shielding is crucial. Aluminum or copper foil taped or glued to at least one side of the box and connected to the circuit ground is essential. In addition, if the telescoping antenna is used, it may be a good idea to shield it from the circuit on the inside of the box.

Note: The 4th gate in the 4011 (not shown) should be disabled by connecting both inputs to ground.
PORTABLE ATMOSPHERIC CHARGE DETECTOR

Electroscope – Measure electrostatic charge
PRECISION ELECTROSCOPE
Posted by P. Marian


This DIY electroscope circuit can precisely measure electrostatic charge. The charge to be measured is stored on C1 (a high quality MKT (Metallized Polyester Film) 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 IC1 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 (±100 μA to ±1 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 M1 is 2.2 kΩ. Alternatively a digital multimeter can be used in place of M1, in this case resistor R7 (2-20 kΩ) 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 IC3 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 IC1 and IC2 can be replaced by a single (dual op-amp) TLC272 (see the DIL outline for this device to assign the new pins). IC3 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.
Voltage (U) across the capacitor (C1) is related to its charge (Q) by the equation $U = \frac{Q}{C_1}$. 
Notes:
This tester is designed to locate stray electromagnetic (EM) fields. It will easily detect both audio and RF signals up to frequencies of around 100kHz. Note, however that this circuit is NOT a metal detector, but will detect metal wiring if it conducting ac current. Frequency response is from 50Hz to about 100kHz gain being rolled off by the 150p capacitor, the gain of the op-amp and input capacitance of the probe cable. Stereo headphones may be used to monitor audio frequencies at the socket, SK1.

Probe Construction:
I used a radial type inductor with 50cm of screened cable threaded through a pen tube. The cable may be used with a plug and socket if desired. A layer of insulating tape or glue is used to secure the pen body to the inductor.

Meter Circuit:
The output signal from the op-amp is an ac voltage at the frequency of the electro-magnetic field. This voltage is further amplified by the BC109C transistor, before being full wave rectified and fed to the meter circuit. The meter is a small dc panel meter with a FSD of 250uA. Rectification takes place via the diodes, meter and capacitor.

Testing:
If you have access to an audio signal generator you can apply an audio signal to the windings of a small transformer. This will set up an electromagnetic field which will be easily detected by the probe. Without a signal generator, just place the probe near a power supply, mains wiring or other electrical device. There will be a deflection on the meter and sound in the headphones if the frequency is below 15KHz.

In Use:
Switch on, plug in headphones (optional) and move the probe around. Any electrical equipment should produce a hum and indicate on the meter. I remember once building a high gain preamp (for audio use). I made a power supply in the same enclosure. The preamp worked, but suffered from an awful mains hum. This was not directly from ripple on the power supply as it was regulated and well smoothed. What I had done was built the audio circuit on a small piece of veroboard, and placed it within a distance that was less than the diameter of the transformer. The transformers own electromagnetic field was responsible for the induced noise and hum. I should however note, that this was when I was new to electronics with very little practical experience. You can now buy toroidal transformers which have a much reduced hum field.
PORTABLE ATMOSPHERIC CHARGE DETECTOR

ELECTROMAGNETIC FIELD PROBE WITH METER