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Constructional Project

ATMOSPHERIC ELECTRICITY DETECTOR by KEITH GARWELL - PART 2

Investigate Nature's power-house with this intriguing experimental design.

Last month we dealt with the Meter Interface Buffer and Dual-Voltage Power Supply circuits together with suggested stripboard constructional details. We conclude this month with meter switching, module interconnections and probe details.

SYSTEM METERING

Moving coil meters are the favorite for this application as they show more clearly the activity that is taking place. Digital voltmeters (DVMs) are fine in some respects but when the voltage is changing rapidly (as it often is in this caper) the digits just whirl about and it

can be very difficult to make head or tail of them.

A pair of moving coil meters are required with a full scale of 0.1 milliamps. These are usually around 1000 ohms or less in resistance, which is small enough to be ignored for this exercise. The scale will normally be marked with 0 to 10 with 0.2 intervals.

Meter ME1 in Fig.8 is used with a 10 volt scale to show the output of the high resistance meter and is provided with a center zero facility, and a reversing facility. Included along with the meter and its switches is a 2-cell AA size battery pack which is switched into effect by S2 to give half scale deflection i.e. center zero. Preset VR2 is used to adjust the reading to 5, the half-way mark.

This means that the meter unit's output of +5V or -5V can be read and is very helpful when trying to back off the plate voltage with the high voltage supply. When voltages of greater than 5V are present at the meter output, S2 can be turned off so that the full range (10V) of the meter is available. Switch S1 is used to reverse the meter connections if necessary.

Meter ME2 is also a 0.1 milliamp meter which is used to measure the high voltage supply output. It is very helpful if this meter is marked 0 to 3, and there are some meters about which have two scales 0 to 10 and 0 to 3. The alternative is to do the arithmetic, i.e. multiply the reading by 30 if it is calibrated 0 to 10.

It is entirely up to the user how the "metering" is arranged. In the prototype, the meters are separate, but it could be more convenient to build them into a

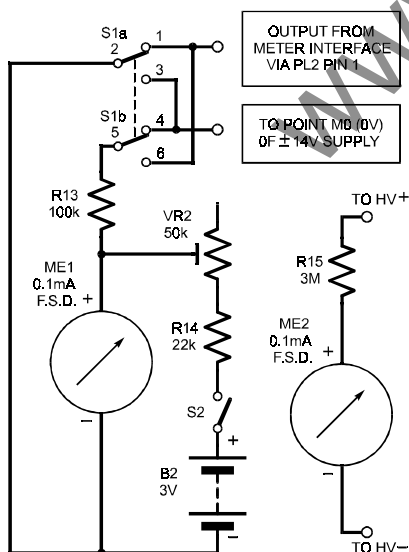


Fig.8. Circuit diagram for the twin meters.

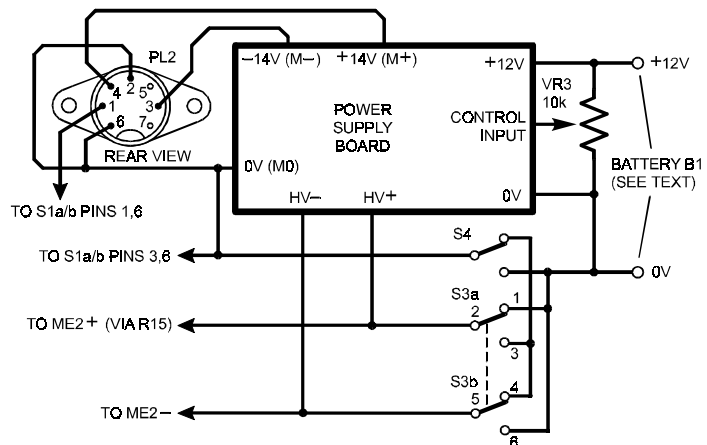


Fig.9. Schematic illustrating the connections distributed from the power supply.

dedicated unit. It depends whether you have other uses for them, and they do require the largest capital outlay of the whole project.

INTERCONNECTIONS

So far we have discussed the various units in isolation, and they must be brought together to implement Fig.1 (last month).

The interconnections between the various system components are shown in Fig.9. There are three controls, an on/off switch (S4) and a reversing switch (S3) to change the potentials of the high voltage supply, plus a rotary control (VR3) to adjust the voltage supplied to the monitoring system. There are also the two moving coil meters, ME1 and ME2, connected as shown earlier in Fig.8.

Switches S3 and S4 must be rated at least at 250V AC. The current involved is only a few microamps.

A 6-way cable (low voltage) with a 7-pin DIN plug at either end connects this unit with the meter interface unit and needs to be long enough to enable the user to be well away from the plate when it is being used for atmospheric measurements, 15 meters for example.

It must be pointed out that the sensitivity of the meter unit allows it to detect the static on the author's clothes at 10 meters, and don't try using the unit if there's any washing hanging on the line – the pinging noise made by the meter becomes quite audible! Arrange to share the good days with wife and family!

The author has not tried screening the system between himself and the probe (he doesn't think he's really cut out

to be the monkey in the cage!), but he has noticed that walls seem to provide protection, whether glazed or brick.

The 0V line of the 12V power supply source and the case **MUST BE CONNECTED TO GROUND**. If the 12V supply is derived from a mains power supply rather than a battery, then the mains earth will be sufficient, but check that there is no significant voltage between this and true ground. If a battery is being used for the 12V supply then an earth connection must be made to the 0V line. If no other is available an earth spike must be used, driven into the ground beside the unit. **DO NOT** earth the 0V line of the $\pm 14V$ supply.

CONSTRUCTION

An aluminum box about 120mm x 120mm x 50mm deep was used for the prototype power supply, its controls and connectors.

The panel layout is open to the constructor's preference and no layout is offered. In the prototype the connectors are at the top of the panel and the controls below.

For a portable unit perhaps a 12V lead acid battery, meters

and the dual supply should all be in the same box, with just the controls and the 7-pin DIN connector to connect to the meter circuit showing, plus some means of easily removing the battery (or connecting to it) for charging.

Sealed versions of lead acid batteries are available which can be mounted in any position. A whole range is available from about 0.5Ah upwards (YUASA range). If such a battery is used, it must be provided with a suitably rated fuse (100mA) as they are capable of very high currents under fault conditions.

The author has two separate power supplies available, a mains only unit, and a battery powered unit which can also be connected to the mains (the latter is effectively a no-break 12V supply), with the option for supplying 12V at 100mA or 500mA.

There are various aluminum boxes available and one convenient form is a two-part unit where the top (lid) is formed into a U-section and fits over the base, which has sides formed and an edging with fixing holes to fasten the top. One of these was used for the meter unit, and another for the high voltage power supply and controls.

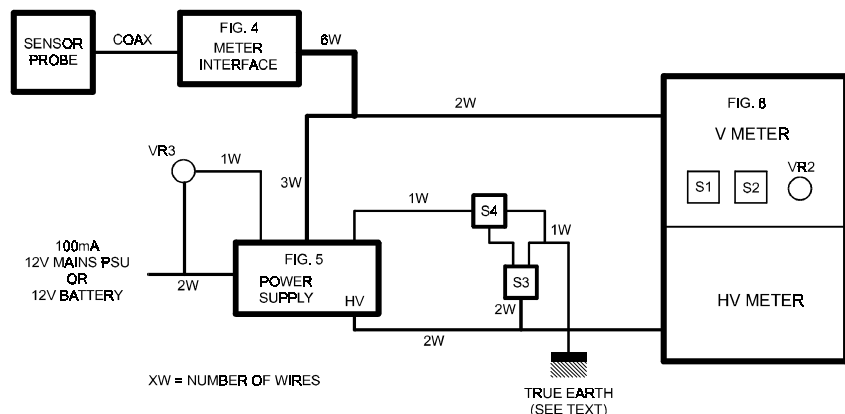
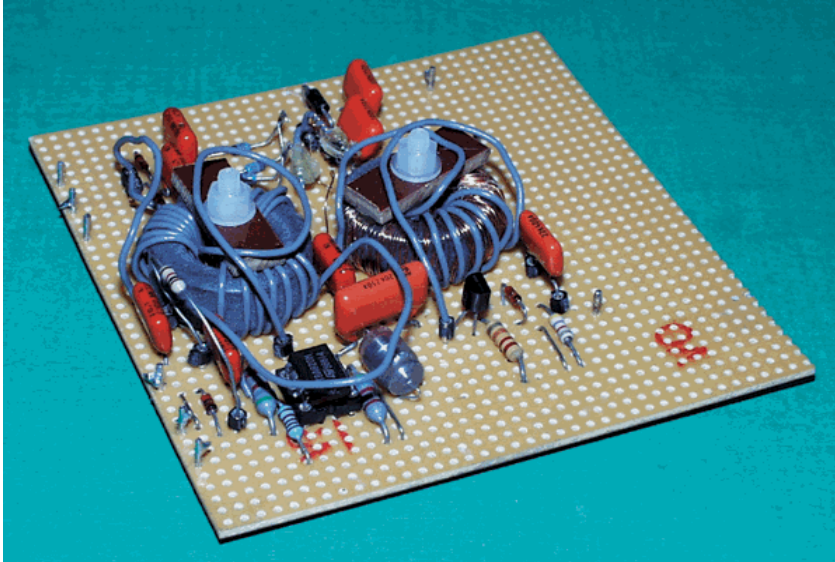


Fig. 10. Block diagram illustrating the cabled interconnections between the various units.



Close up details of the constructed power supply board.

However you decide to house it, once the building work is finished it is time for testing. Thoroughly check all connections, particularly the 0V line. At this stage don't connect the meter unit or its cable.

It is recommended that a regulated and current-protected (at about 100mA) 12V power supply should be used while testing the units.

With power switched on, the output of the high voltage meter should be adjustable (using VR3) between about 0V and 300V. Note that 0V might not be reached and that the minimum might be nearer to 5V.

If this is OK so far, check the low voltage (nominally $\pm 14V$) outputs at pins 2, 3 and 4 of the 7-pin connector SK2.

Fit the two AA cells to the low voltage meter ME1 and switch on S2. Adjust VR2 to give exactly half scale (5V).

Connect the meter interface unit and open the case just enough to get at its off-set balance adjustment preset VR1 and adjust it to give zero output, i.e. the meter needle on the 5V

mark. Refit the cover.

Now fit the short coaxial connector with about 6cm of coax cable attached to it, and a crocodile clip at the far end of the cable. The screening is removed for about 30mm to allow the clip to be fitted.

The meter needle should wander back and forth as you move around the unit. The next step is to check the calibration, which requires another meter, preferably a DVM, and two or three test voltages of between 0V and 5V. The latter can be achieved by using three single cells or a battery with a potentiometer across it.

By this means apply voltages between the meter unit input and the 0V line of the 12V supply. Check on both polarities and on the agreement between meter ME1 and the DVM. Don't be surprised by slight irregularities, moving coil meters are not perfect.

To make checks above 5V up to 10V, the meter's center zero will have to be switched off and the full scale used.

If this is OK, you can now

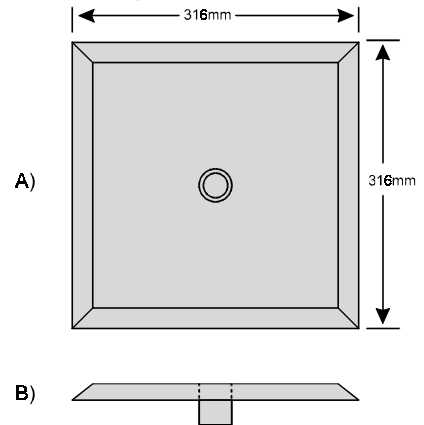


Fig.11. Details of the suggested sensor probe plate.

prepare the probes.

PROBES

The probe suggested in Fig.1 last month is the author's principal tool. As the illustration suggests, it is nothing more than a piece of aluminum 316mm square, which gives one tenth of a square meter in area.

The corners are just nicked with tin snips or a fine saw from the corner towards the center for about a centimeter and then the four edges are just dressed down a little way. This both stiffens the plate and prevents it fluttering in the wind, see Fig.11.

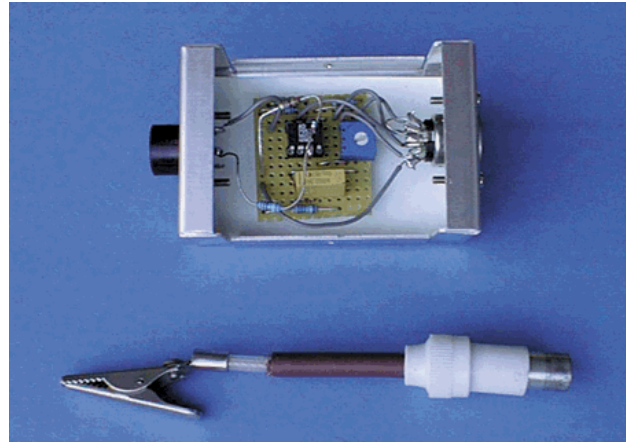
It is supported on 41mm, outside diameter, standard plastic waste pipe and connector, both obtainable at any DIY store.

The connector was first cut in half, the sealing rings removed, and then glued to the center of the metal plate using hot-melt glue. The pipe was then pushed into the connector.

In a very similar way, the base for the pipe was made from a piece of chipboard, 380mm x 280mm x 20mm. This was just a scrap found in the workshop and its thickness makes it heavy enough to be a firm support. Screwed to the



Meter interface unit connected to the sensor probe plate.



Details of the meter interface unit and the interconnecting probe clip.

center of this is a “socket” made from another scrap of wood about 100mm x 100mm x 45mm.

A 41mm diameter hole was drilled into this block, which was then screwed to the chipboard. It provides a firm fit when the pipe is pushed in and there is no tendency to wobble.

The pipe can be cut to length as required – the “standard” length is one meter, the length used for reference readings, but experiments may

require alternative lengths of perhaps 0.5 and 1.5 meters.

Connection between the plate and the meter unit is made by means of the short length of coaxial cable with its plug at one end and a crocodile clip at the other, the latter clips on to a small screw on the underside of the plate.

This arrangement works well and the pieces (plate, pipe and base) need only to be connected together as and when required. Several lengths of pipe allow measurements to be taken at different heights.

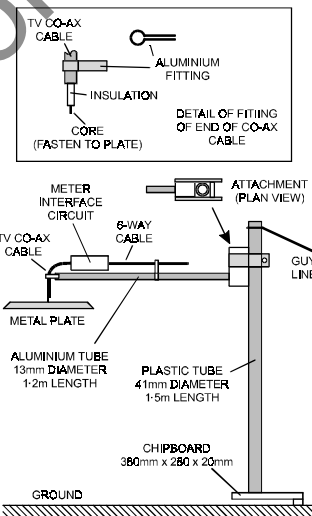


Fig. 12. Alternative sensor plate support construction.



The author's prototype single-plate atmospheric detection platform

ALTERNATIVE SUPPORT

The simple arrangement described has two shortcomings. A change in height requires a change in the supporting pipe and, as the values being measured can change quite quickly, it would be nice to be able to change the height quickly.

Secondly, it is necessary to be aware of the possibility of condensation on the surfaces of the pipe. On one occasion when the readings didn't make sense it was realized that condensation

was taking place. A quick wave of a hair drier warmed the pipe enough to stop the condensation, but the readings were still nonsense. It eventually became apparent that condensation was taking place on the inside of the pipe as well!

In a sense, these are trivial problems, one of which only occurs when it's cold and damp, but it was still thought desirable to avoid the support problem altogether. As a consequence, the arrangement shown in Fig.12 was invented.

No support is used as the

plate is suspended and can be raised or lowered by shortening or lengthening the guy line when the whole affair tips backwards or forwards on its foot. It all works like a charm – until there is a breeze when the plate waves around like a mad thing!

So do the meter needles!

Ah well, there are times when you can't win them all, but it otherwise does the job it's meant to. Do any readers have any bright ideas to steady the plate?

We will be happy to published any feedback from readers through our Readout column. Ed.

AUTHOR'S WEB SITE

This equipment is referred to on the author's web site under Atmospheric Electricity, and which is kept updated with developments:

<http://members.tripod.co.uk/GarwellK>

The author would also be pleased hear from you via his E-mail address at: **kgarwell@hotmail.com**

There are many other sites dealing with Atmospheric Electricity which are well worth a browse –

in particular the meteorological site at Reading University: www.met.reading.a.c.uk

The UK Meteorological Office site is at www.met.gov.uk

The equivalent US site (National Oceanic and Atmospheric administration) is at www.noaa.gov

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