The Secret Life of Capacitors

This collection of some rarely mentioned characteristics of the capacitor was inspired by an account of some capacitor voltage readings collected around 2001 by a fellow contributor to the overunity.com website – a certain 'Nerzh Dishual'**

It was also Mr 'Dishual' (ND) who suggested this title – so i think it would be appropriate to dedicate this informal report to him

A couple of years ago ND mentioned that he'd taken some long-term voltage measurements on a capacitor and he was interested that it could show a 'spontaneous' fluctuating voltage

Isn't this just 'Dielectric Adsorption'?

The term 'Dielectric Adsorption' is usually applied to the ***off-load*** self-recharging effect seen on some capacitors after being discharged by a load

This collection of information is mainly involved with the 'spontaneous' charge and then discharge of voltage on a capacitor which is ***still on-load*** (albeit high-impedance)

In any case, just giving something a label (eg. 'Dielectric Adsorption') isn't the same as understanding more about what is involved in an effect

Just how long a 'memory' is Dielectric Adsorption supposed to have?

The following graph shows a 'spontaneous' voltage increase on a 6800uF capacitor (enclosed in an aluminium case); the capacitor was previously shunted by a 1 Mohm resistor for approx. 8 months and then on 15 Jan 2010 the shunt was shorted and then removed

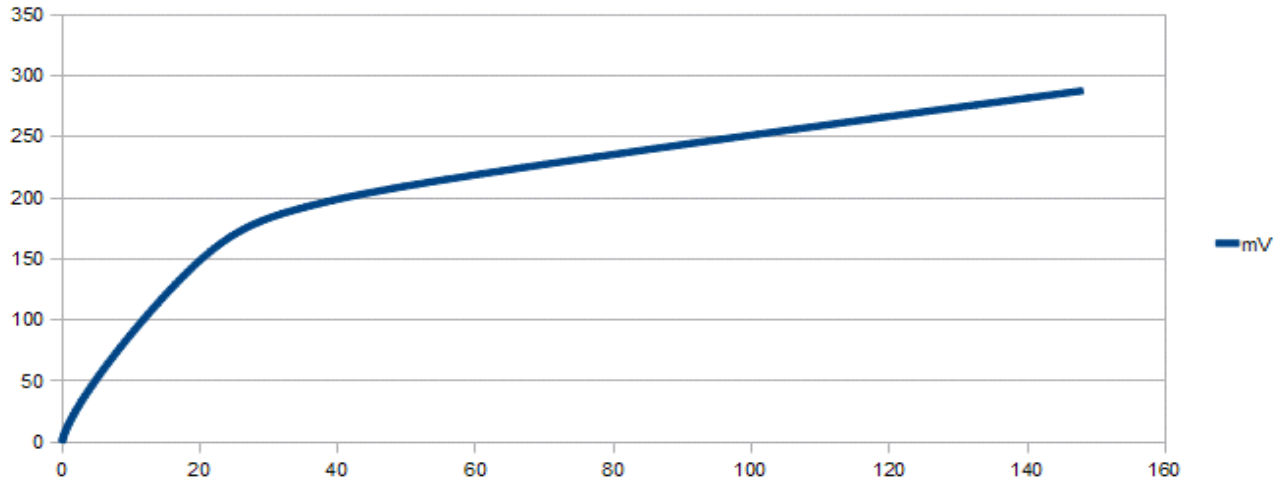

Fig 1. 'spontaneous' voltage on capacitor vs. days since 1Mohm shunt removed

In the few months since the shunt was removed, the 'spontaneous' voltage has increased to a few hundred millivolts

What was happening to the capacitor for several months before the shunt was applied? It was undergoing the datalogging tests, where the voltage was in the range 0 – 10mV max for many months – so Dielectric Adsorption cannot explain the spontaneous 'regeneration' of several hundred millivolts when the previous voltage history was just millivolts

There is something 'going on' with capacitors that the unhelpful label 'Dielectric Adsorption' does not begin to explain!

So – the first question about what might be involved in generating this 'spontaneous' voltage effect is this:

Could a familiar environmental condition be involved this effect?

Here is ND's graph of capacitor voltage readings taken in October '01:

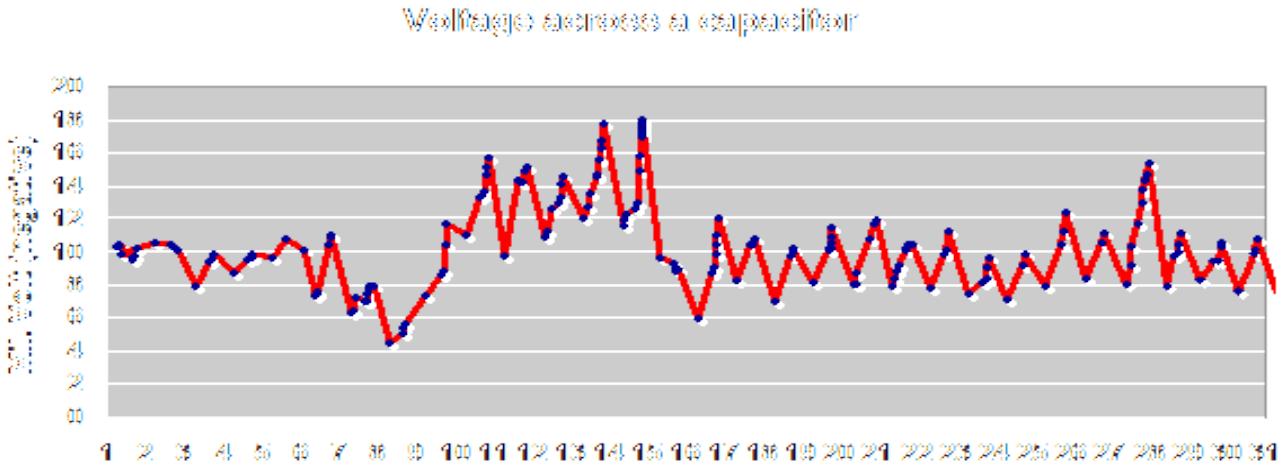

Fig.2 mV charge on capacitor vs. day of month

The first thing to notice is that there is obviously a daily variation in the voltage

I did a web search for various environmental data collected in the same geographic area for the same period:

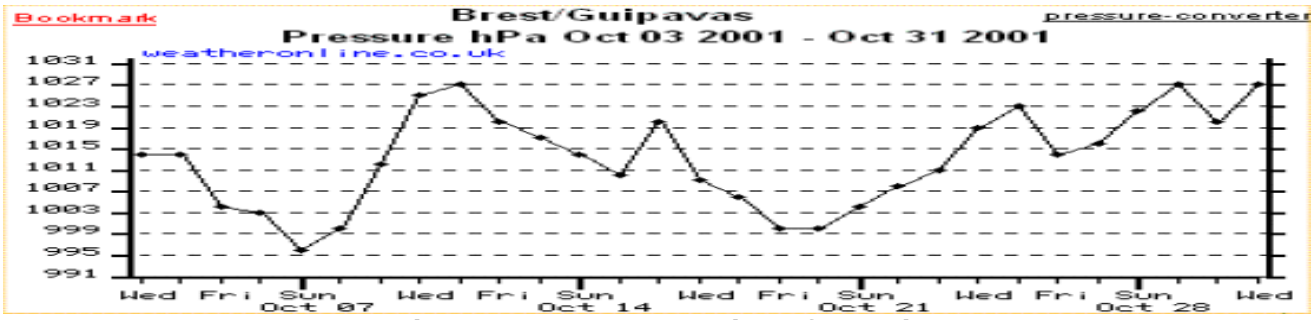

Fig. 3 Pressure vs. day of month

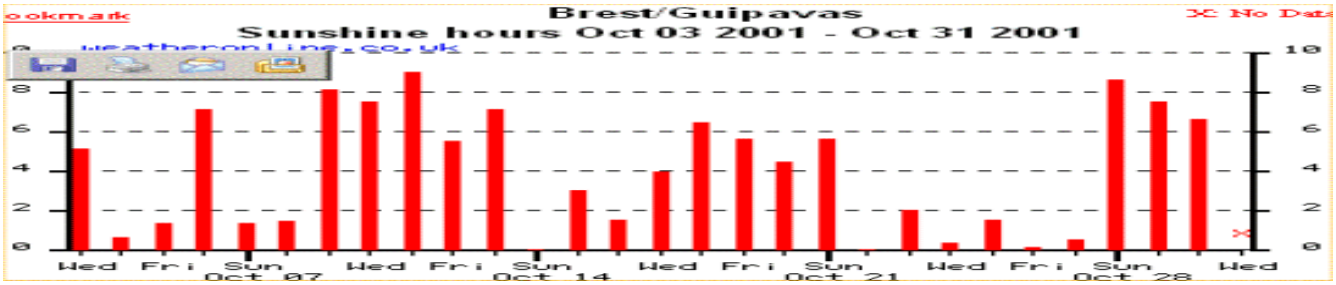

Fig. 4 Number of Sunshine hours vs. day of month

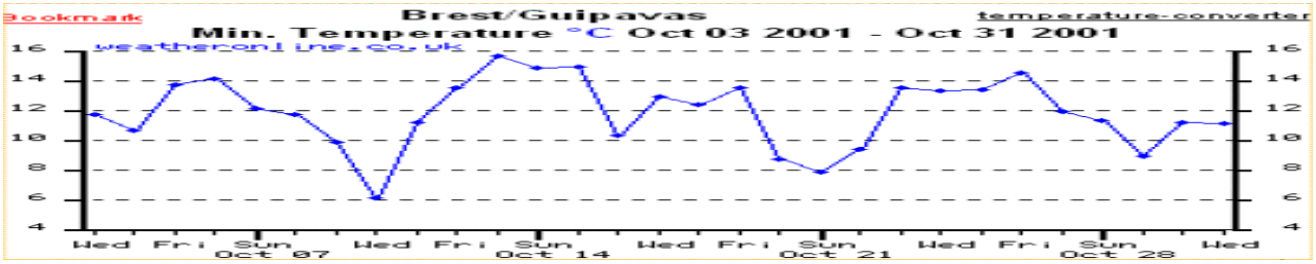

Fig. 5 Min. temperature vs. day of month

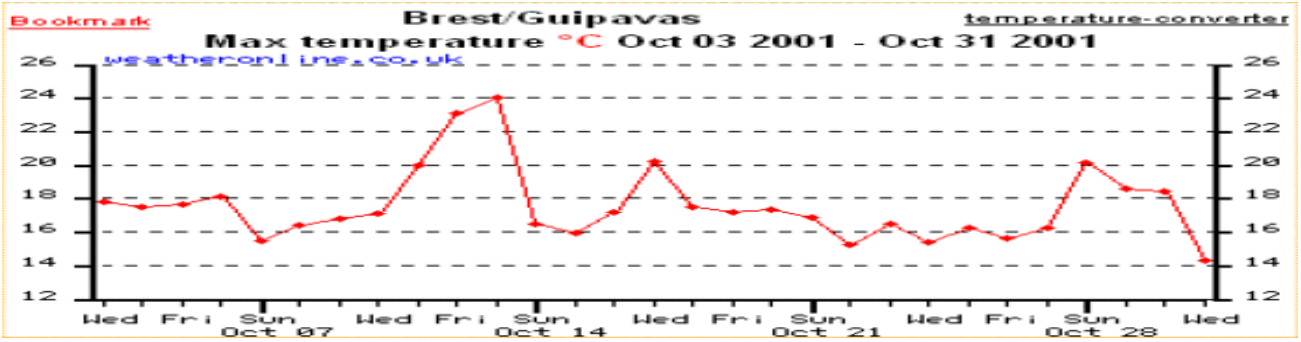

Fig. 6 Max. temperature vs. day of month

It appeared that the closest correlation to the spontaneous voltage on the capacitor was given by the temperature readings

I combined the separate data for maximum & minimum temperatures for the month of Oct '01 and this gave the following 'match' to ND's data – you can compare his measurements and the combined min. max. temperature readings below:-

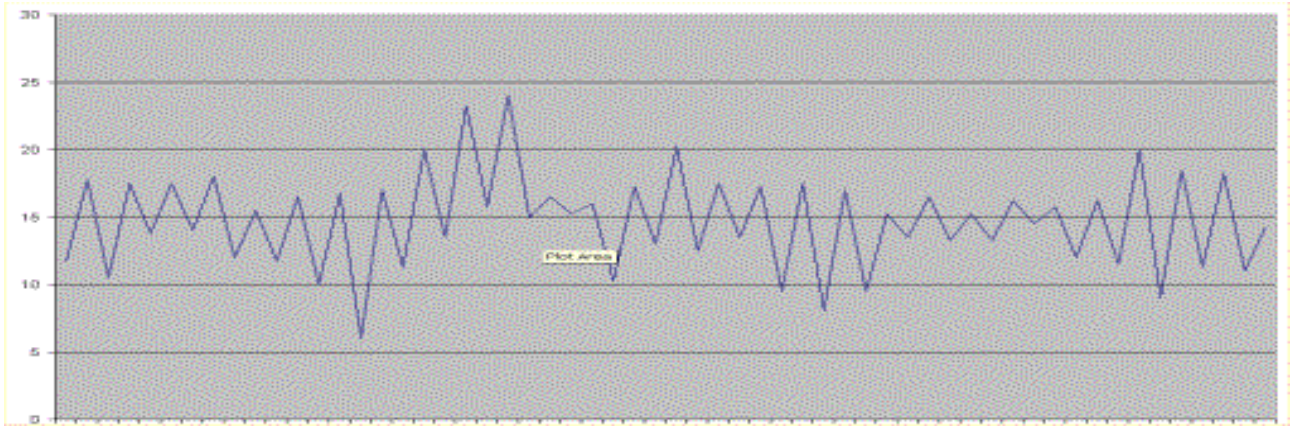

Fig. 7 combined min. & max. local temperature readings (Oct '01)

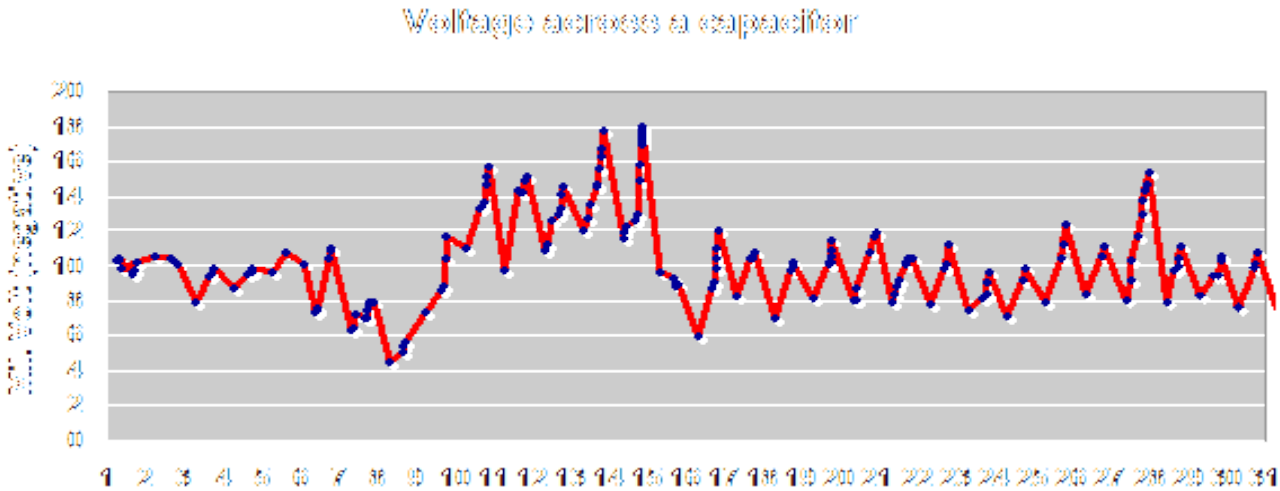

Fig. 8 ND's data for 'spontaneous' voltage on a capacitor (Oct. '01)

So the answer to this question is 'yes, there does appear to be a reasonably close correlation between the local temperature and the 'spontaneous' voltage on the loaded capacitor'

Isn't a capacitor under resistive load supposed to follow an exponential discharge rate?

Before looking at more detailed data for 'spontaneous' voltage on a capacitor there's another characteristic we need to observe first: if you zoom in on the data readings you can see that capacitors do not discharge and charge smoothly – there is a very obvious 'step' function occurring

It appears that, like the '2nd Law' of thermodynamics at macro levels, the exponential 'rule' for a capacitor when charged/discharged through a resistor is only a statistical approximation of the physical reality which is occurring at a micro level

I've observed occasions when the voltage on a capacitor under light load has actually increased for a while before continuing with the usual 'exponential' discharge trend

If we zoom in on the discharge data at the ringed position on the graph below:

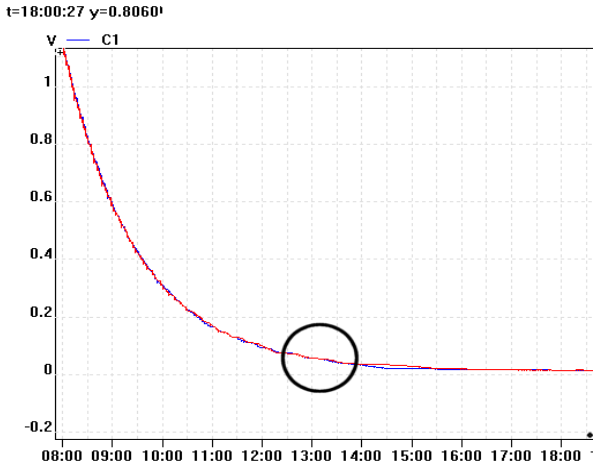

Fig. 9 Capacitor discharge voltage under load

we find this:

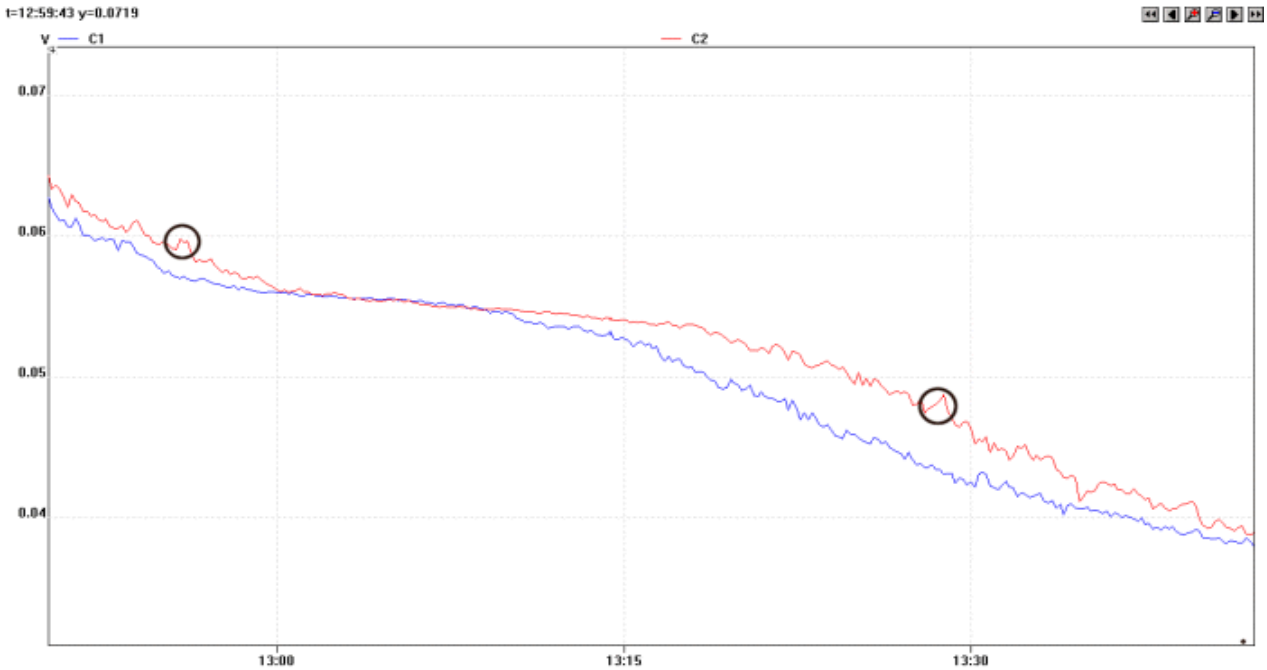

Fig. 10 detail of capacitor discharge voltage under load

First of all, we can clearly see the 'step' nature of the capacitor discharge waveform – for approx. 20 minute sections the slope of the voltage discharge is almost horizontal, before continuing its downward trend

Another interesting feature of the 'horizontal step' section is that the voltage slope appears relatively 'smooth' – whereas in the steeper slope sections there is a significant increase of fluctuations

There are several instances where the voltage on the loaded capacitors are actually rising for at least 30 seconds – two examples above are shown ringed - the capacitors obviously don't realise that this is in direct violation of the so-called '2nd Law' of thermodynamics and that what they are doing is supposedly quite impossible! (in some people's view)

Does this 'step' function occur elsewhere?

Compare the voltage 'step' characteristic below, on a discharging capacitor:

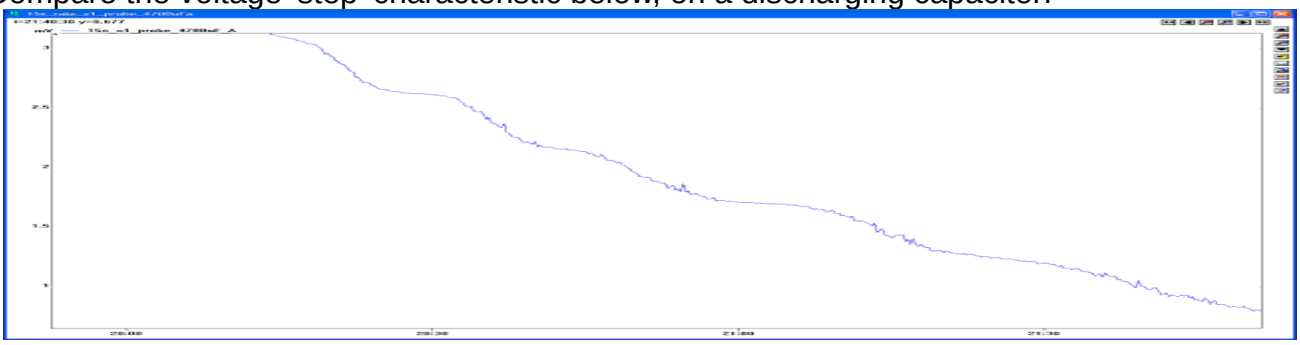

Fig 11. voltage 'step' function of capacitor discharge under load

with result data shown below from 2 NiMh batteries discharging under loads:

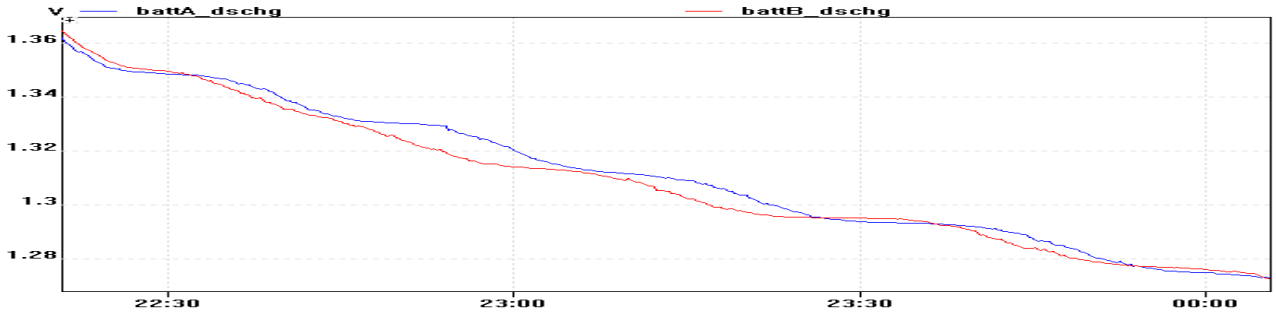

Fig 12. voltage 'step' function of NiMH battery discharge under load

An interesting similarity of behaviour

The voltage levels of each 'step' appear to be fixed for each capacitor or battery – the same levels of step voltage appear when charging or discharging (cf. April 16 graph in the Appendix data) - so it is a physical characteristic of that component

Are we observing the macro effect of some Quantum operation in releasing & storing energy which is common to capacitors and batteries?

The load doesn't change in either of these cases – so at the micro level, capacitors and batteries can have two different rates of converting energy, not one

This suggests that the energy conversion process has two distinct phases or type of function

What we see at the macro level is only an approximation of these different phases or functions – an 'averaging' of the two rates

How were the result data listed below obtained?

A 6800uF electrolytic capacitor was shunted with a 1Mohm 0.5W carbon resistor and enclosed in an aluminium case

Fig. 13 a) & b) side & top views of test capacitor // magnet arrangement

several Neo magnets were fixed around the capacitor, parallel to the can, all with the same pole pointing towards the top of the capacitor – this created a magnetic field within the capacitor which was at right-angles to the voltage field across the internal spiral arrangement of the capacitor 'plates'

The graphical results in the Appendix below were obtained using a PC datalogger to take a voltage reading every 15s

The initial voltage on the capacitor was allowed to discharge by means of the shunt resistor

When the voltage had discharged to somewhere in the region of a millivolt it started to increase again and the 'spontaneous' voltage profile started to appear, as shown in the Appendix data (the pk-pk voltage was only a few mV – dependent on the shunt resistance)

Is there a general pattern of the daily fluctuation?

First of all, we have to ignore the 'step' function which we've already seen is common to capacitors and batteries – this is an artifact of general capacitor behaviour (regardless of what method is used to charge/discharge it), it's not related to the cause of the 'spontaneous' voltage

The voltage profile changes each day, sometimes slightly, sometimes extensively, but there are some recognisable pattern groups

The most common feature is a voltage minima at approx. 06:00 – 07:00 UTC

There are peaks around 10:00, 20:00 and 00:00 UTC which occur fairly often in the results

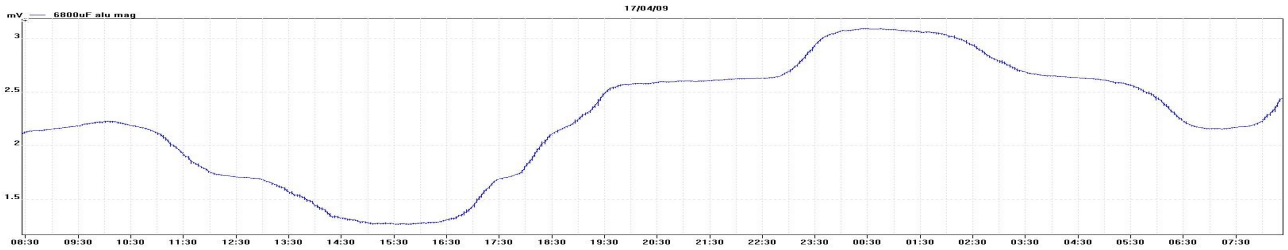

Fig. 14 basic daily pattern of 'spontaneous' voltage profile on shunted stand-alone capacitor

Is the capacitor influenced by magnetic field?

Some Neo magnets were arranged around the circumference of the the capacitor under test; the magnets were arranged with like poles facing up towards the top of the can, ie, the resulting magnetic field within the capacitor was parallel to the capacitor can and at right angles to the voltage gradient across the internal spiral arrangement of the capacitor 'plates'

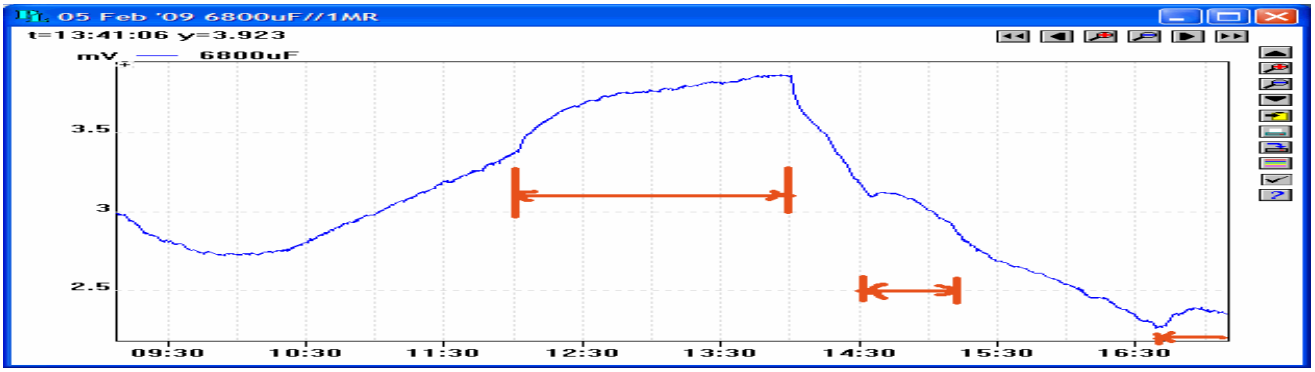

Fig. 15 influence of static magnetic field on 'spontaneous' voltage of capacitor

The sections of the waveform marked with red extent lines show that the 'spontaneous' voltage on the capacitor exhibited an increase when a magnetic field was induced within the capacitor

Does the 'spontaneous' voltage occur inside a 'Faraday cage'?

The test arrangement was moved into a microwave oven (which was powered off obviously, but still grounded)
Datalog readings of the 'spontaneous' voltage were recorded for a few minutes then the probe was disconnected for a few minutes with the MWO door closed

This cycle was repeated approx. ten times

The outline of the graph below shows that the 'spontaneous' voltage fluctuations continued regardless of whether the capacitor was completely enclosed by the Faraday cage or not

It also shows, incidentally, that the effect was independent of the datalog recording equipment

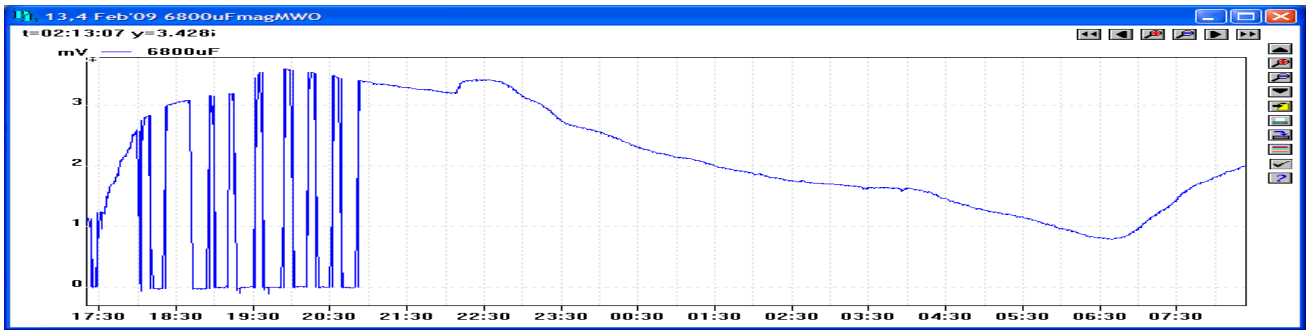

Fig. 16 'spontaneous' voltage on capacitor inside Faraday cage

Is the capacitor influenced by either cosmic events or gravity effect?

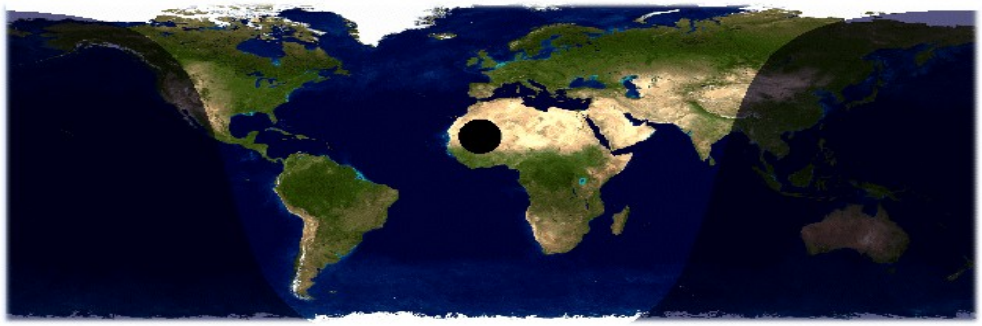

Fig. 17 Longitude of moon inline with sun over UK, 12:30 UTC 25th April 2009

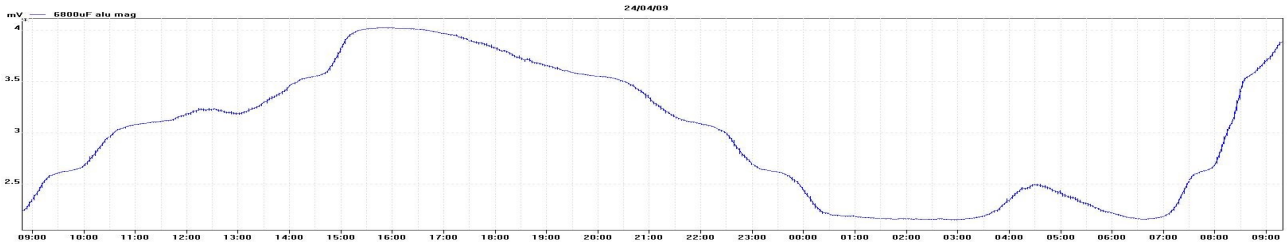

Fig. 18 'spontaneous' voltage profile for 24th April 2009

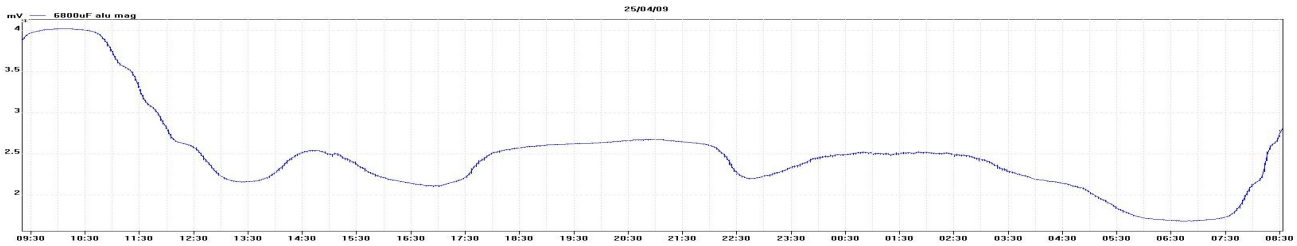

Fig. 19 'spontaneous' voltage profile for 25th April 2009

If we look at the graphs for April 24 & 25th 2009 around midday when the moon was approximately in line between the UK longitude and the sun, the voltage profiles for the two days are very different which suggests that the main driver for the fluctuation of the 'spontaneous' voltage is ***not*** a gravity effect of the moon ***nor*** the position of the moon obstructing solar emissions to the earth

Has there been any other influence seen on the capacitor?

Tesla mentioned a relationship between capacitance and altitude – i don't have any definite indication of this in these results, but on several occasions when the capacitor under test was moved between different floors of buildings there was a noticeable change in the DC levels of the voltage waveform

What's the verdict?

Obviously, local temperature has an important influence on the voltage

could there be any other contributory factors?

i found data for another naturally occurring phenomenon which appears to produce a remarkably similar profile to the voltage fluctuations on a shunted capacitor

here is some data from a completely different source:

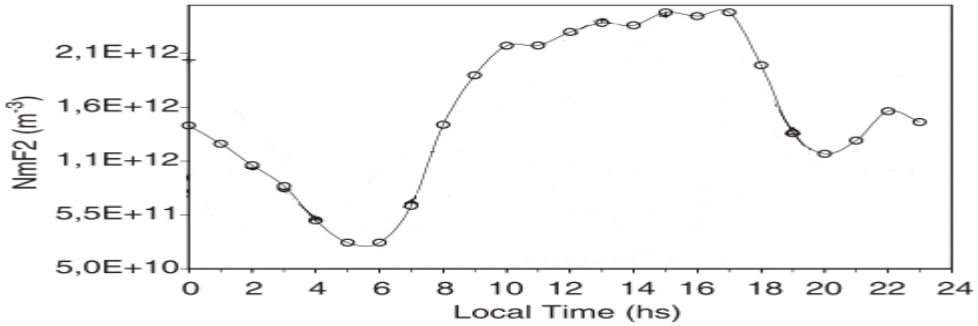

Fig. 20 a 'voltage' profile caused by solar emissions

It's not the 'spontaneous' voltage on a electronic component capacitor – it's an example of 'spontaneous' voltage on the planet Earth's capacitor

the graph in Fig 20 shows some sample data for the maximum free electron density in the 'F-region' of the ionosphere recorded above one particular location by ionosonde (the detail will vary to some extent, according to latitude of the sampling location)

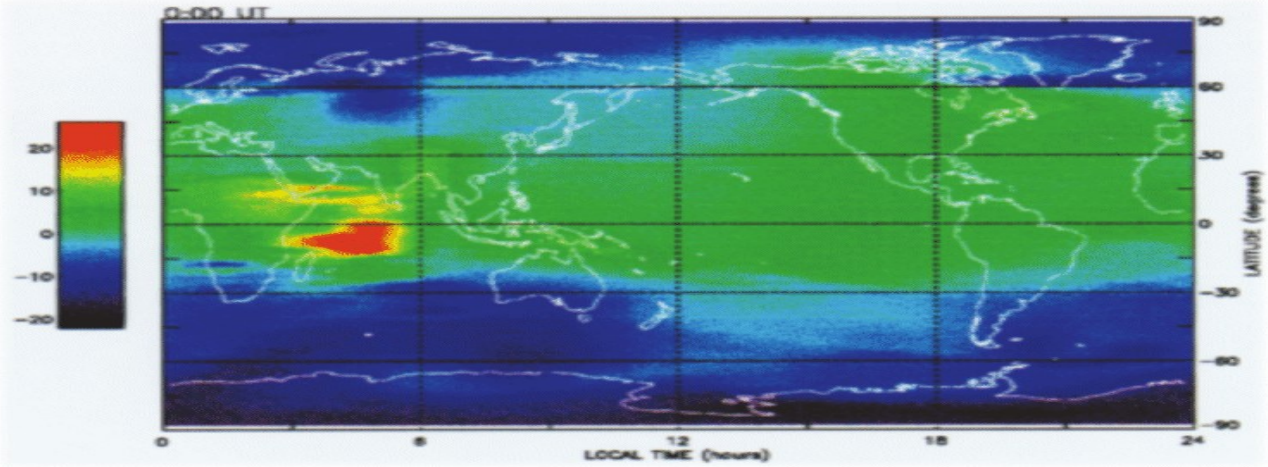

Fig. 22 Winter NmF2 scan

Fig. 22 is a 24 hr global scan of the F2 ionospheric electron density – the data in Fig. 20 above represents a horizontal cross-section (ie. at a single Latitude) of the global scan

As the earth revolves beneath the ionosphere (which is getting charged by the solar wind) the ionosonde data provides an electron density profile for a 'latitude' strip across the charged area

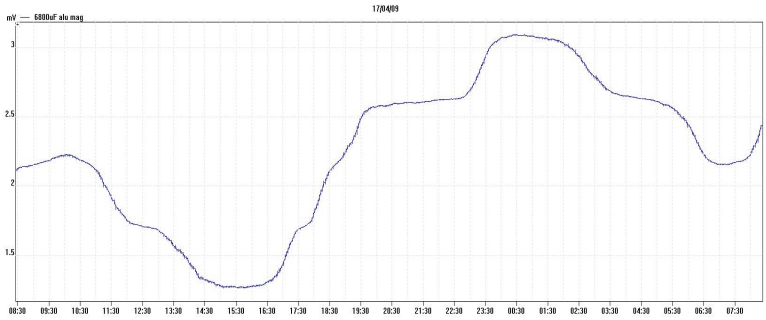

Fig. 21 sample 'spontaneous' voltage profile from a capacitor (17 Apr '09)

so – my interpretation (at present) of what is happening in a small scale on our electronic capacitors is that the main factor is the ambient temperature around the capacitor – and an additional factor could be due to the atmospheric charge in the ionosphere – or to the particles which cause it

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4th July 2010 (revised 3rd April 2011)
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** i understand that the phrase 'Nerzh Dishual' in the Breton dialect either sounds like, or has a similar meaning to, 'Free Energy'