

# Super Capacitor

What it can do for the Ham

Presented to SPARC, February 2015

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# What “SPARC’ed” me to investigate Super Capacitors?

- MFJ introduced a 12V Voltage Conditioner, 4403
  - Sale price ~ \$120
  - What does it do?
    - Transient Suppression
    - Reverse Polarity Protection
    - Short Circuit protection
    - Outstanding Noise and Ripple Filtering
    - 100w rig with 10 amp supply?
- I also found my Weather Station’s wireless anemometer uses a solar cell to charge a super capacitor, not a rechargeable battery.





# An example of a Super Capacitor

- Super Capacitors – low voltage cells in series
- Made with Activated Carbon or Graphene
  - Nobel Prize awarded in 2010 for ground breaking experiments
  - Graphene first produced in a lab in 2003
- Multiple Farads
- Typically low voltage cells wound in spiral layers.

$$C_{\text{total}} =$$

$$\frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4} + \frac{1}{C_5} + \dots}$$

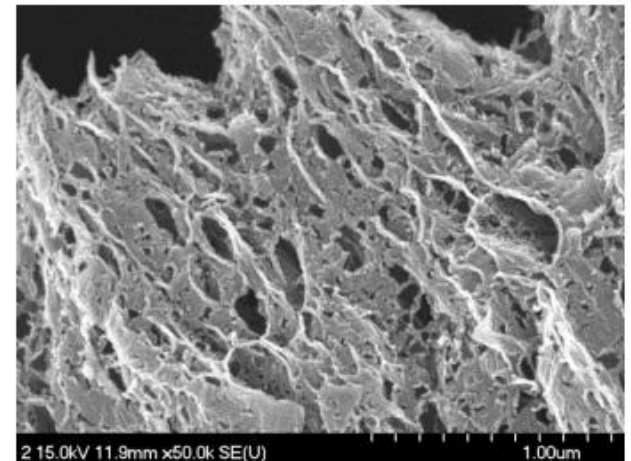
and, for only two capacitors in series,

$$C_{\text{total}} = \frac{C_1 \times C_2}{C_1 + C_2}$$

# Super Capacitor construction



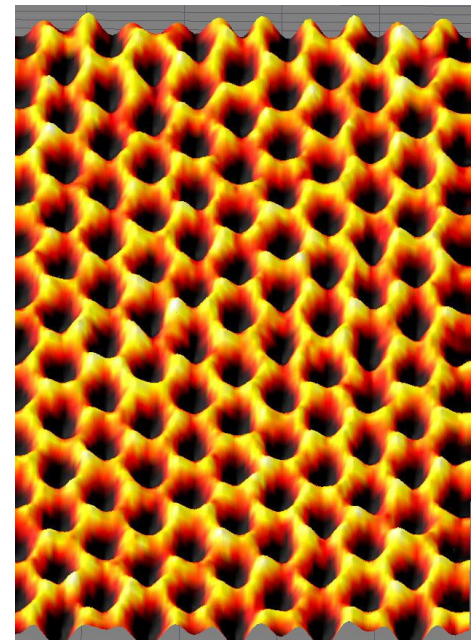
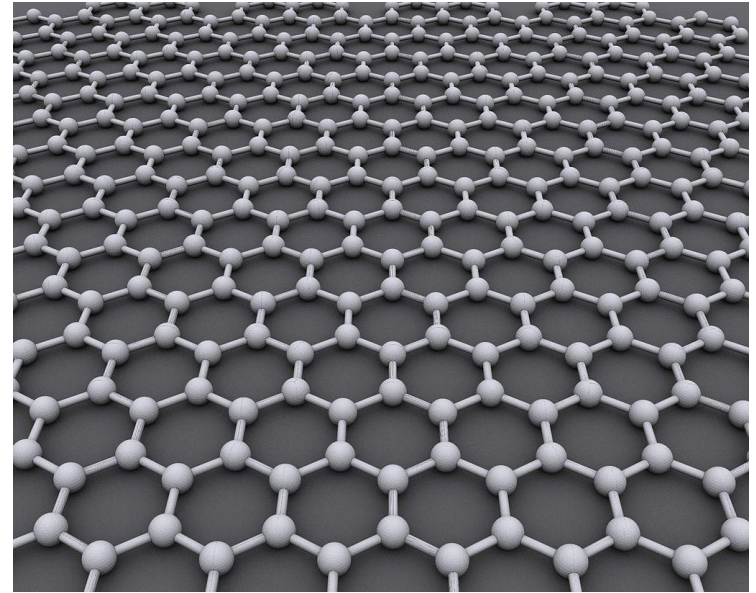
- 2.7 V 500 Farad
- Activated carbon “sponge like” material.
- Electrolyte (alkylammonium)
- Separator material.
- High current electrode connections.



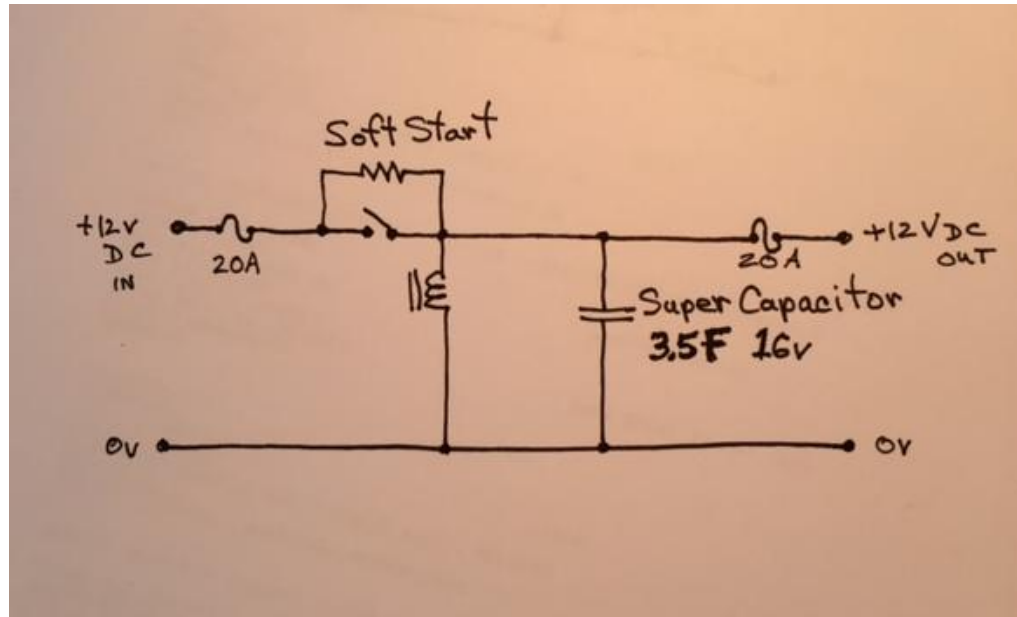


# What is Graphene?

- Graphene is remarkably strong for its very low weight (about 100 times stronger than steel) and it conducts heat and electricity with great efficiency. While scientists had theorized about graphene for decades, it was first produced in the lab in 2003. It is virtually two-dimensional.
- In graphene, carbon atoms are densely packed in a regular atomic-scale chicken wire (hexagonal) pattern. Graphene can be described as a one-atom thick layer of graphite. It is the basic structural element of graphite, charcoal, carbon nanotubes and fullerenes (buckyballs).



# A Simple Demonstration Circuit



- The Soft Start circuit is used to initially charge the capacitor. Inrush current can be in the 100A range if not limited.

# An interesting side effect

- It is commonly accepted that a 100W rig requires at least a 20A power supply.
- The typical auto accessory socket is rated at 10A max.
- However, SSB and CW modes require less average power although rig peak power may approach 20A.
- The Super Capacitor with its large energy storage provides the extra current required for the peak demands of SSB and CW.
- The SuperCap offers a solution for running a 100w SSB transmitter in a mobile or portable application.

# Does the Super Capacitor have an application in my shack?

- The 3 storage batteries charged by solar panels have plenty of power to supply the HF and VHF rigs plus accessories.
- However, when the batteries are near depletion, the internal resistance comes into play to further drop the terminal voltage during current peaks.
- However, with several connecting wires, fuses, distribution panel and changing loads, adding the Super Cap close to the HF rig stabilizes the rig's power during full power SSB and CW operation.



# Resources – links to more detail

- Super Cap Pros and Cons
  - <http://supercapacitors.org/>
- Super Cap ready for electric vehicles
  - <http://www.technologyreview.com/view/521651/graphene-supercapacitors-ready-for-electric-vehicle-energy-storage-say-korean-engineers/>
- Super Cap as an auto battery replacement
  - <http://2600f-supercapacitor.blogspot.com/2013/03/super-capacitor-vs-car-battery.html>
- ARRL review of MFJ 4403
  - [http://www.nxtbook.com/nxtbooks/arrl/qst\\_201412/index.php#/50](http://www.nxtbook.com/nxtbooks/arrl/qst_201412/index.php#/50)
- MFJ Voltage Conditioner
  - <http://www.mfjenterprises.com/Product.php?productid=MFJ-4403>
- Inside the Super Capacitor
  - <https://www.youtube.com/watch?v=ljeF-I5FpOI&list=LLSRPikmy8lxmFVsN-b5HNIQ&index=4>