Using thin prismatic supercapacitors to support 3 Volt coin cell batteries

IDTechEx, Berlin

12th April 2018

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3 key points to remember

1. In general supercapacitors are an ideal buffer between a low power energy source and a load with high peak power

2. Supercapacitors enable 3 Volt coin cell batteries to be used where:

   - a 3V coin cell battery alone could not work (e.g. Spire) or
   - greatly extend battery run time (e.g. BLE SensorPuk)

3. CAP-XX's new 3V thin prismatic cells offer significant extra benefits over current options

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About CAP-XX

- Global supercapacitor supplier
- Market leader in prismatic, high power supercapacitors
- Dual strategies of IP licencing and product sales
- Strong IP licensed to multinational suppliers Murata and AVX
- Target applications are high growth markets – US$100m +p.a.
- 25+ million CAP-XX supercapacitors sold to date

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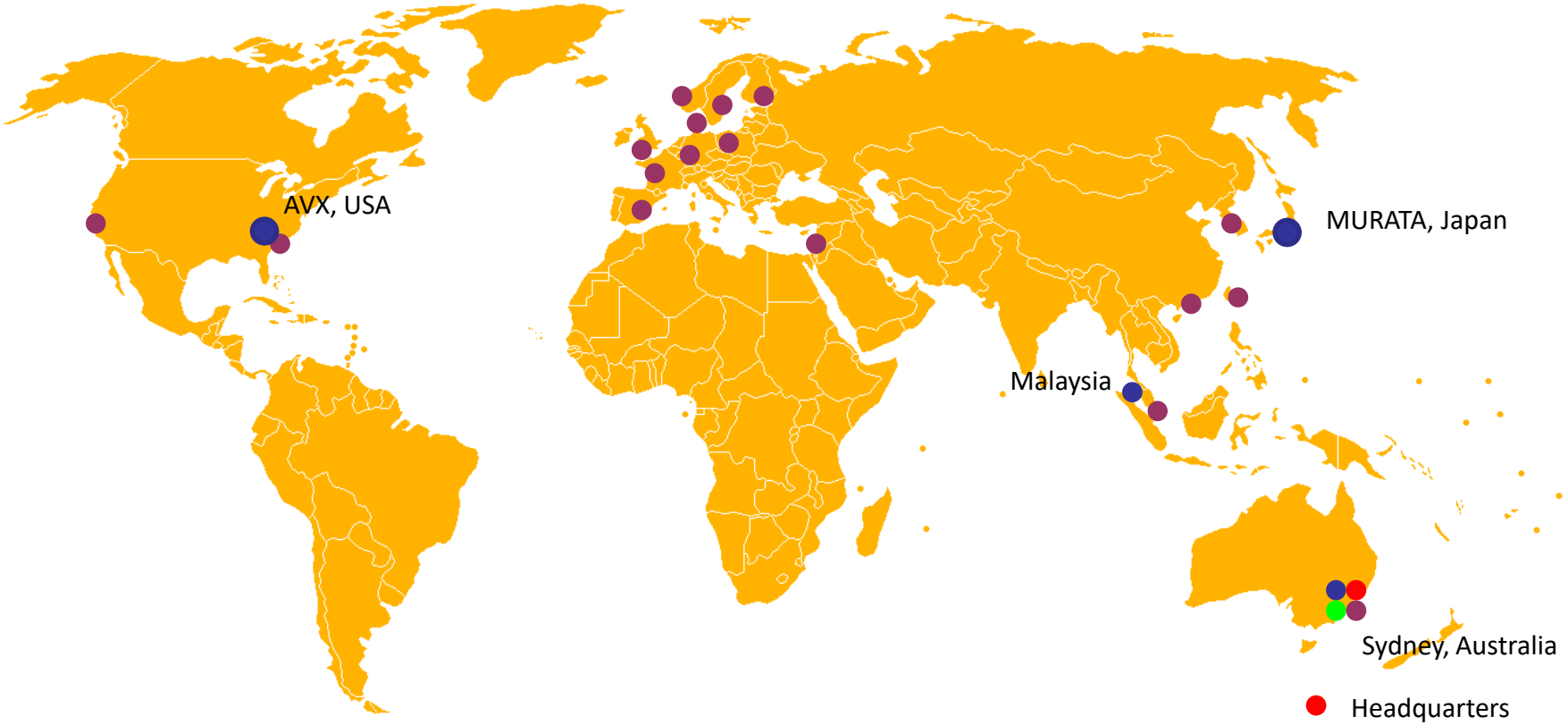
About CAP-XX



- HQ, R&D, product & manufacturing development in Australia
- Volume manufacturing in Malaysia
- Global market coverage via local sales agents

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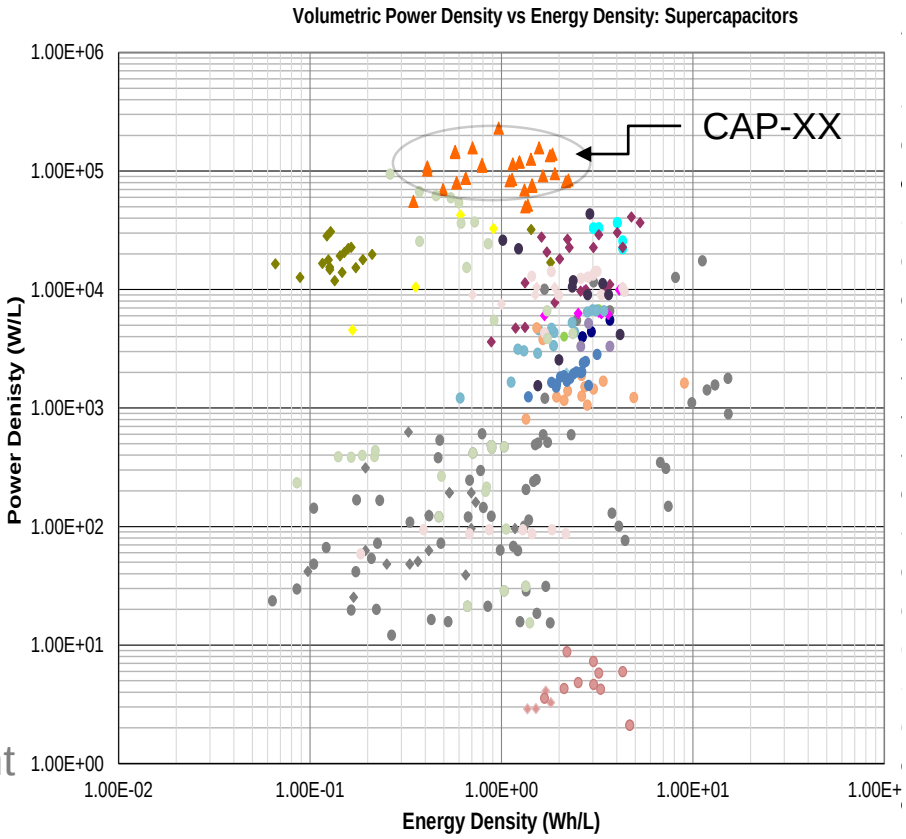
CAP-XX's competitive advantages

- Nanotech materials
- Efficient packaging
- Clever electrochemistry
- Smart electronics
- Strong Patent Portfolio

Yields products which are:

- Thinner, flatter, smaller & lighter
- Very high power (low ESR)
  - best in class (110KW/L)
- High energy (high capacitance)
- High voltage & High peak temp
- Very low leakage current/charge current
- Very good frequency response
- Safe, reliable & long lasting



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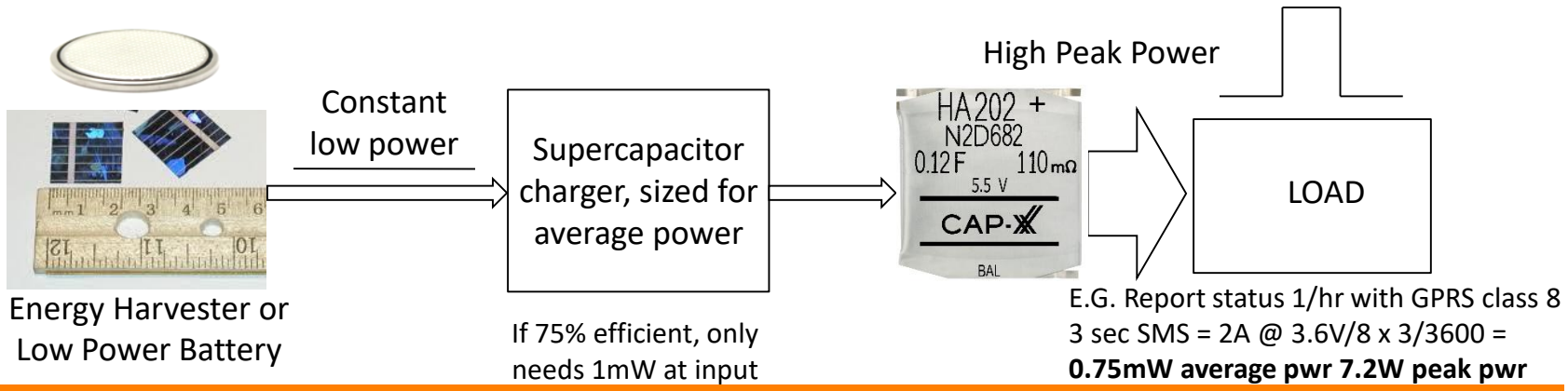
When to use supercapacitors

- Use supercapacitors when peak power exceeds the limits of the primary energy source
  - Supercapacitors offer peak load support either as a power buffer or back-up energy reservoir
  - While the source (battery or energy harvester) provides a constant, low power charge current at peak efficiency
  - The average load power must be < the average source power available



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Powering the IoT

Many IoT applications use low power energy sources (small batteries & energy harvesters)

- Wearable electronics (activity/fitness bands, watches, healthcare)
- Portable electronics (smart cards, smart tags, key FOBs, handhelds)
- Connected electronics (smart home, wireless sensor networks)

… but need to support peak power loads

- RF transmissions
- E-Ink and OLED displays
- Haptic feedback & vibration alerts (with electric motors)
- GPS acquisition
- Data acquisition, storage, MCU start-up etc

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Supercapacitor options today

If you are using a 3V coin cell battery then your supercapacitor options today are typically:

1. Use a low-drop out voltage regulator (LDO):
   - Drops voltage from 3V to the maximum rated voltage of a single supercapacitor cell (typically 2.5V or 2.7V)
   - Typical extra cost of US$0.27 to $0.31 and over 30% of the battery energy wasted over 5 years, over 22% over 3 years
2. Use a buck convertor
   - Drops voltage from 3V to the maximum rated voltage of a single supercapacitor cell of 2.5V or 2.7V.
   - Typical extra cost of US$1.50 and over 20% of the battery energy wasted over 5 years, over 16% over 3 years
3. Use 2 supercapacitor cells
   - Increases rated voltage of the supercapacitor module to 5V or 5.5V
   - Typical extra cost of US$1 to $1.50 and 12% energy wasted over 3 years

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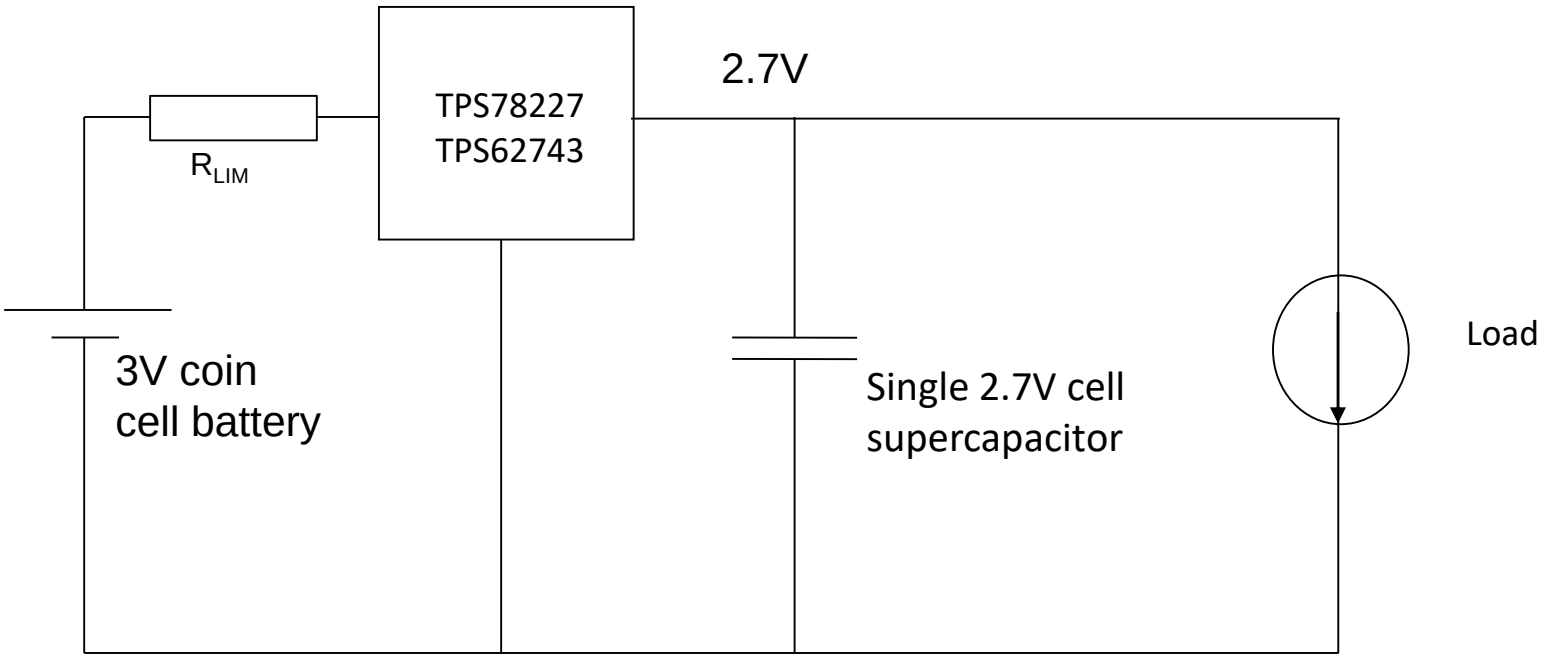
Typical coin cell, supercapacitor & LDO



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Coin cell battery with an LDO + single 2.7V supercapacitor solution

2 Case Studies

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#1 Spire eHealth tag

- Wearable - monitors breathing to monitor stress, sleep and activity.
- Gives a vibration alert to the wearer as needed.
- Vibration motor requires ~150mA peak current, and ~40mA average for ~500ms
- Coin cell cannot drive the vibration motor. With 10Ω R_{BATT} the voltage would drop ~1.5V as the motor starts, turning the unit off.
- CAP-XX HA114T (thinline 0.8mm thick) supports the battery with a regulator reducing the voltage to 2.5V.

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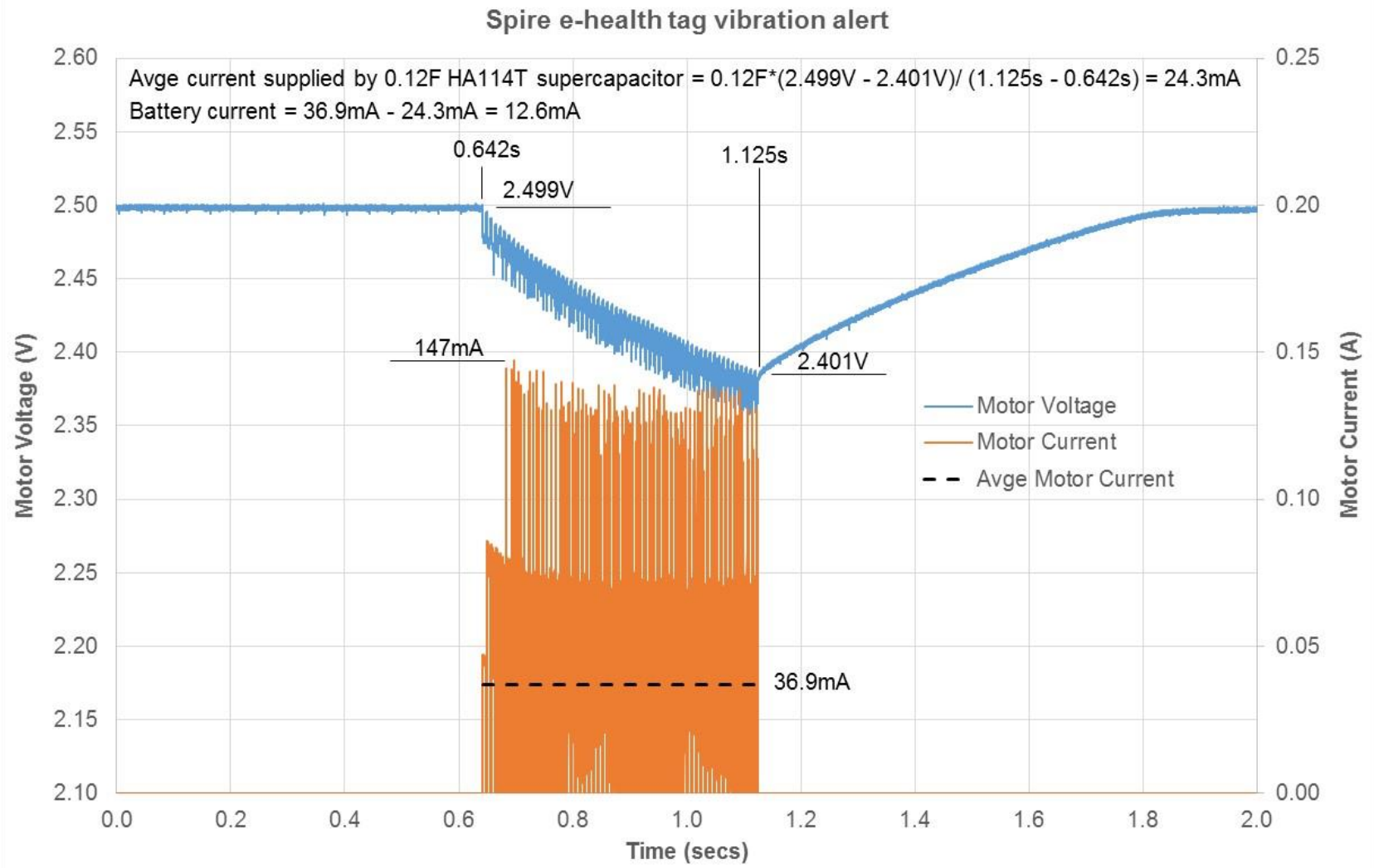
Spire Vibration Alert Current & Voltage



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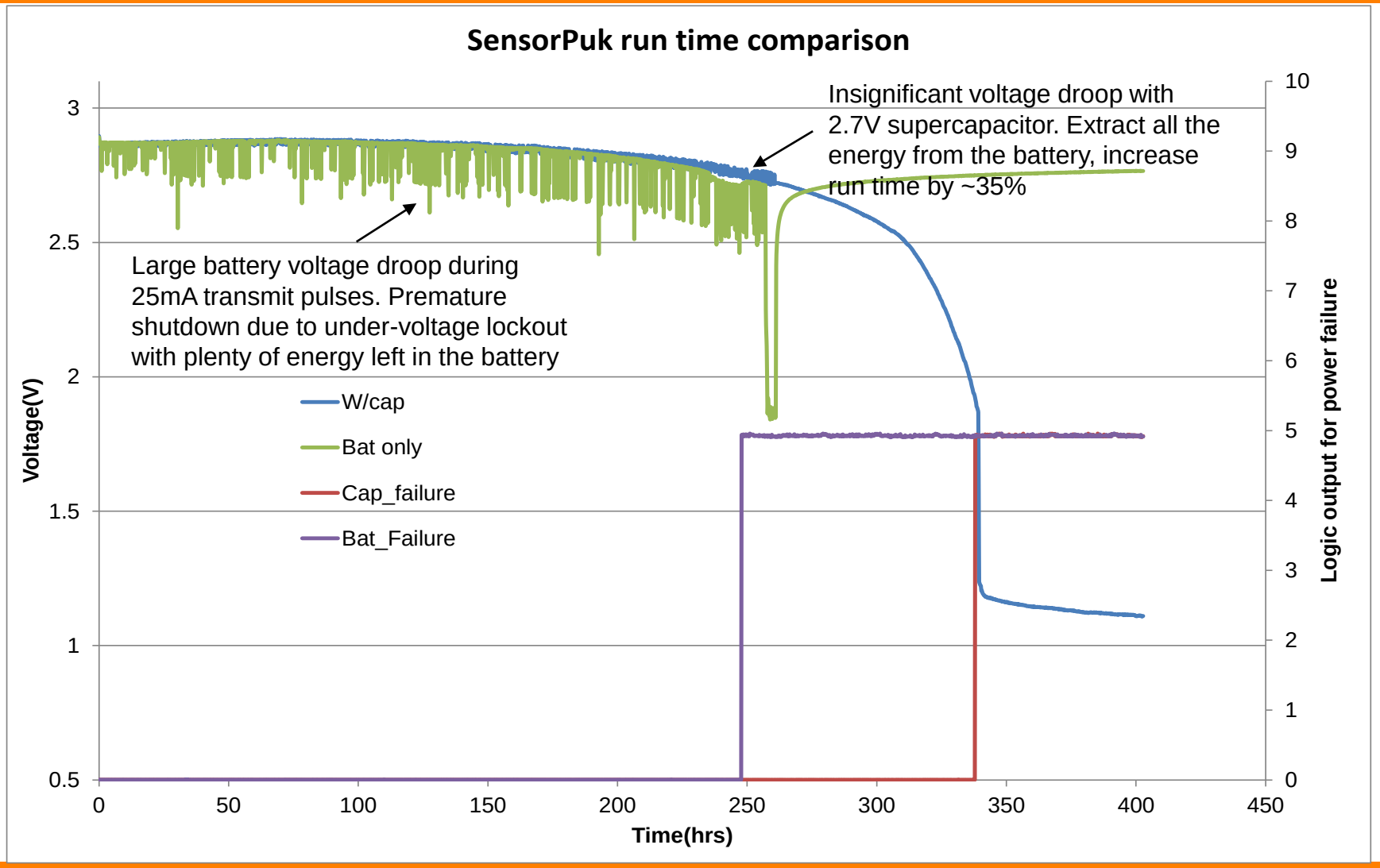
#2 Runtime comparison supplying a BLE sensor transmitting once per sec



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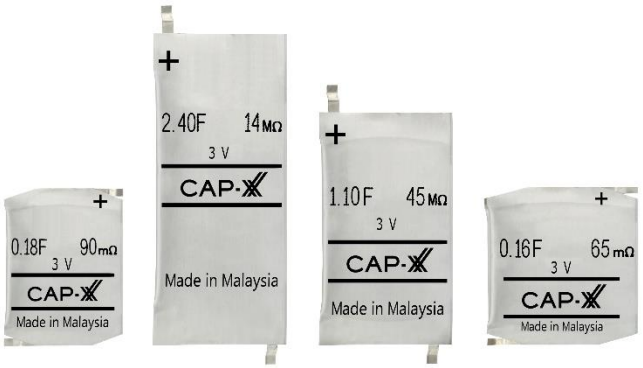
CAP-XX has developed the world's first 3V thin prismatic supercapacitor

Key points:

- **Samples available August 2018 in S package**
- **Followed by W, A and Z**
- **Production Q2 2019**
- **pricing less than US$1 per cell in large quantities**
- **Will then roll out to Thinline, truckStart and large cells**



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3V prismatic cell advantages

Can be connected directly across 3 Volt coin cell battery with:

- Cost savings - no need for an LDO (up to US$0.31) or buck US$1.50
- Battery energy savings - if constant power & using LDO of 30% over 5 years ∴ $up\ to\ 43\%\ longer\ battery\ run\ time$
- Space savings – reduced number of components
- Very low leakage current - does not excessively drain battery energy
- Stores more energy - If the application runs down to 1.8V then a 3V supercapacitor stores 42% more useable energy than a 2.7V supercapacitor with 23% more power

& ~ 2 Billion 3 V coin cell batteries sold in 2017

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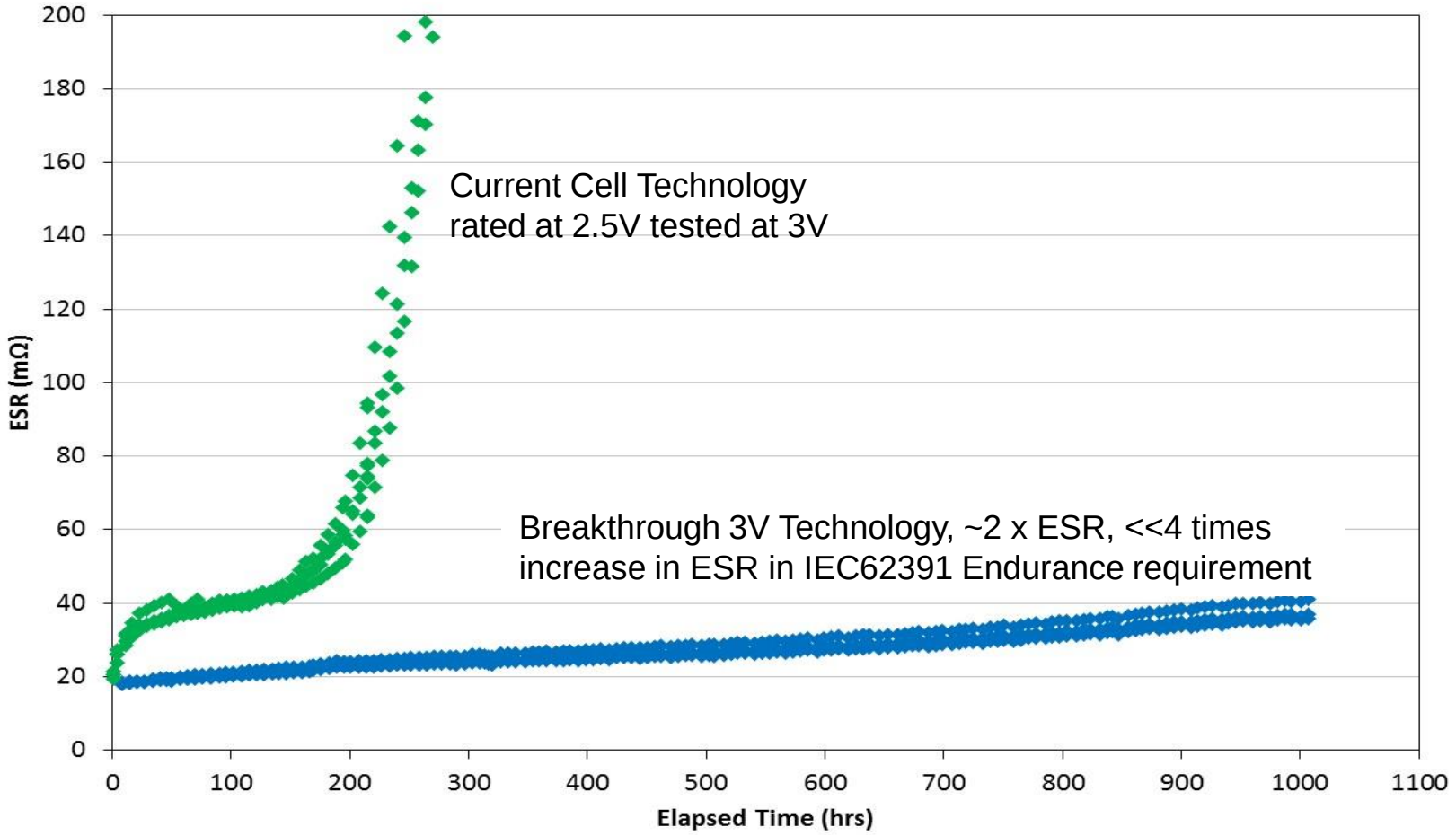
3V Device : ESR Rise Rate

Life testing at 3V and 70°C continuous



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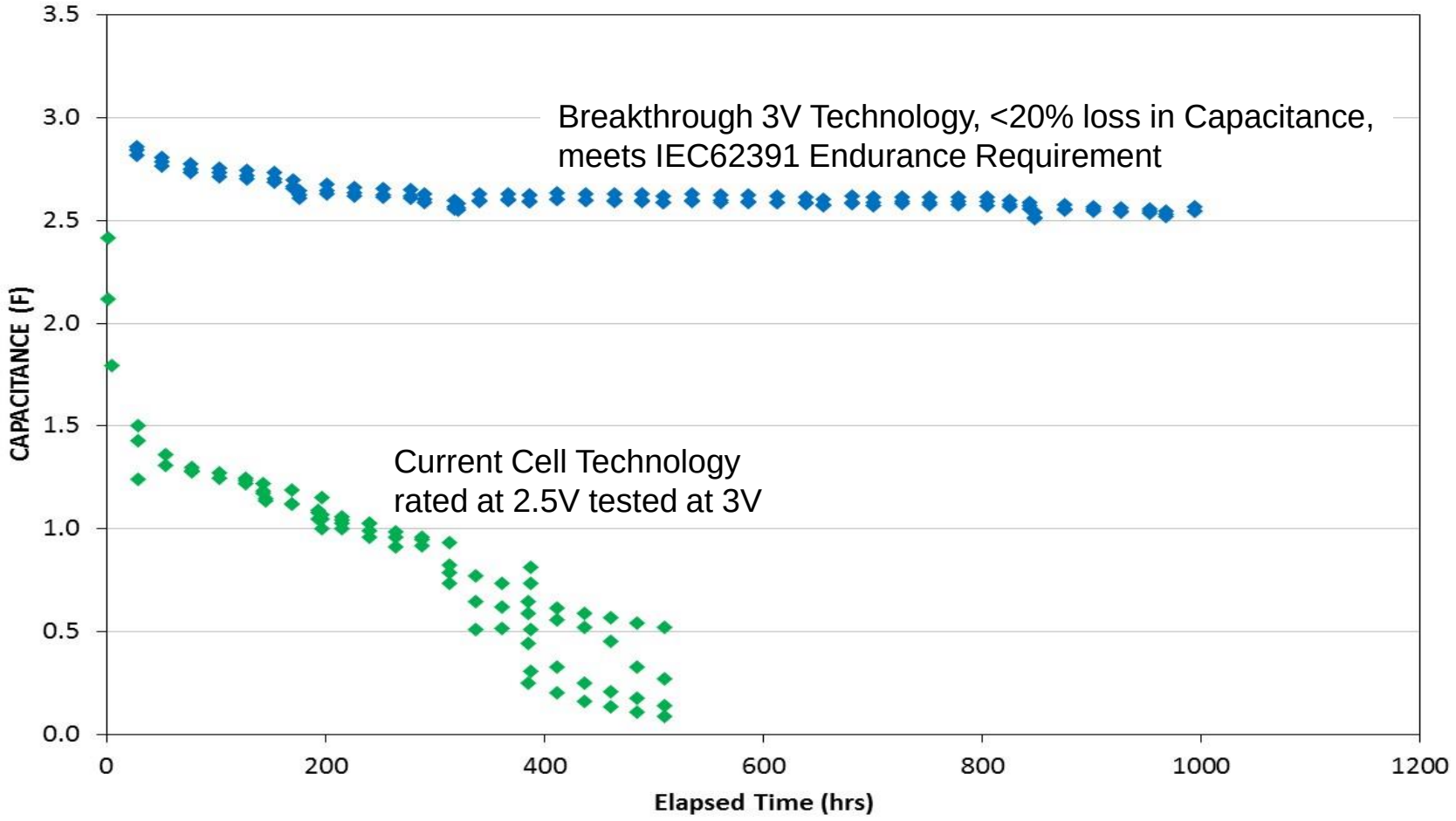
3V Device : Capacitance Loss

Life testing at 3V and 70°C continuous



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Summary

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