GPRS pulses with cap-XX Supercapacitors

The Problem – Battery devices

- **GPRS pulses require high power for longer durations**
- **Consequences**

  ® **Battery voltage droop during transmission resulting in premature low voltage shutdown**

  ®**Run time too short**

  ®**but plenty of energy left in the battery!**

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The Problem – PC, CF Cards

- **GPRS pulses require high power for longer durations**
- **Consequences**

  - ® **Average power drawn from host within specification**
  - ® **But peak current too high ($\approx$2A)**

    PC Card Max = 1.0A, CF Card Max = 0.5A

    ®**Break specification**

    ®**Non compliant device**

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The Solution

Local Energy Storage device to provide Hi Power delivery for as long as needed

- **Hi Power** **+** **Hi Energy Storage**
- **Low ESR** **+** **Very Hi C**

cap-XX supercapacitors solve this problem

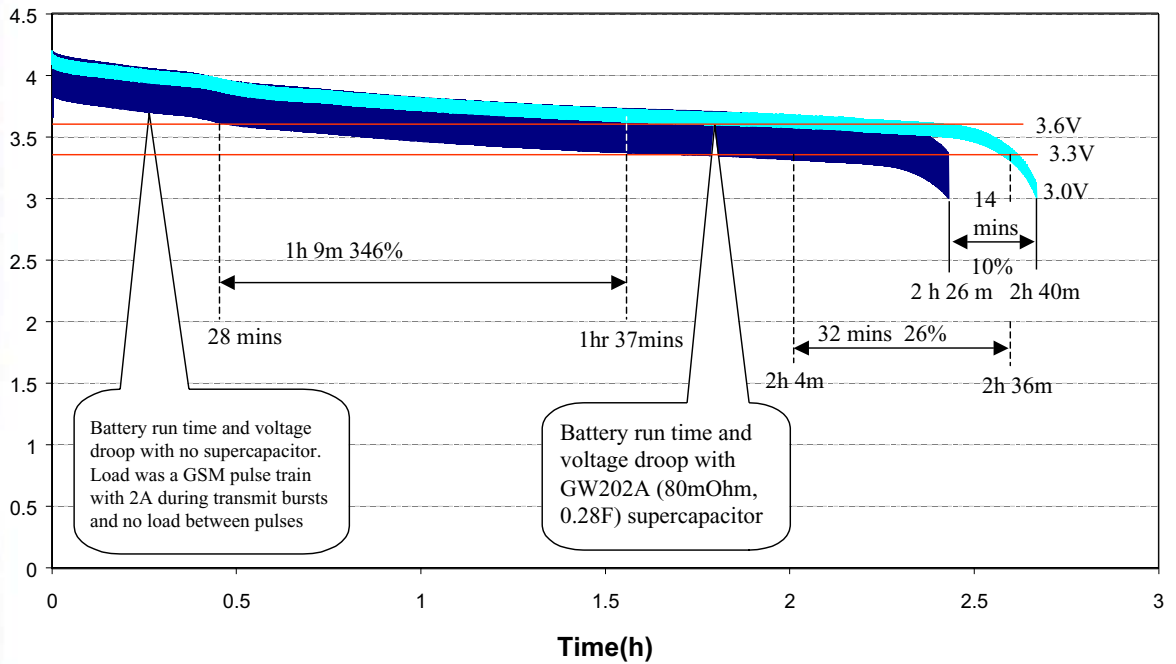- **50-100m_** **100 – 800mF**

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cap-XX

Some demonstrations

- **Extended battery life**
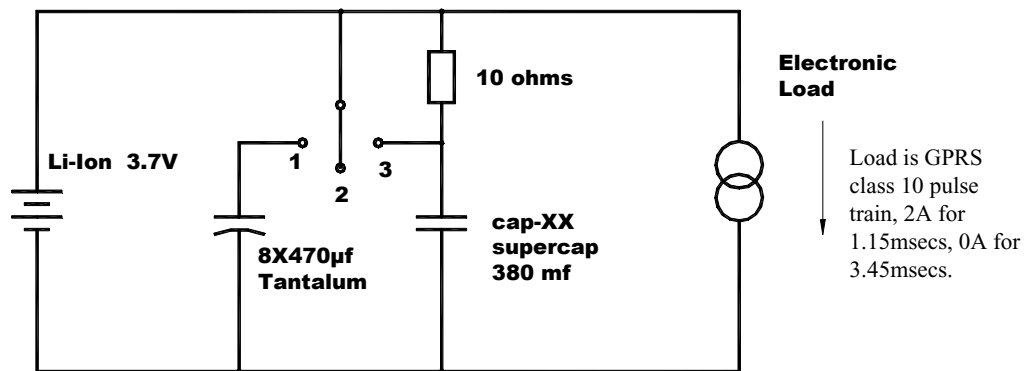- **Reduced voltage droop**
- **Power Averaging**

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cap-XX

Extended Battery Run Time

Chart: Voltage (V) vs Time(h). Y-axis from 0 to 4.5, X-axis from 0 to 3.

Reference lines: 3.6V, 3.3V, 3.0V

- 1h 9m 346%
- 28 mins
- 1hr 37mins
- 14 mins
- 10%
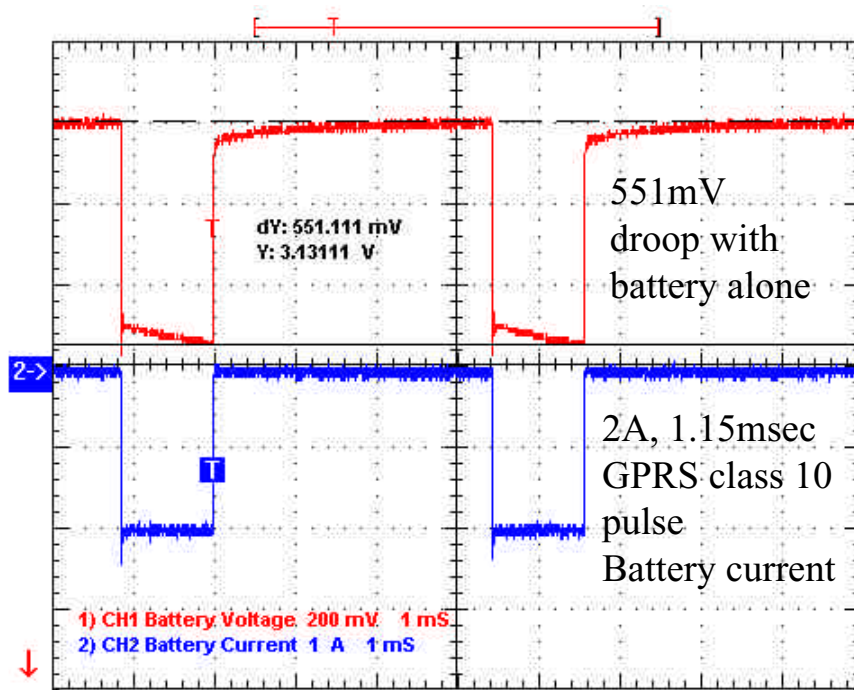- 2 h 26 m   2h 40m
- 32 mins 26%
- 2h 4m
- 2h 36m

Battery run time and voltage droop with no supercapacitor. Load was a GSM pulse train with 2A during transmit bursts and no load between pulses

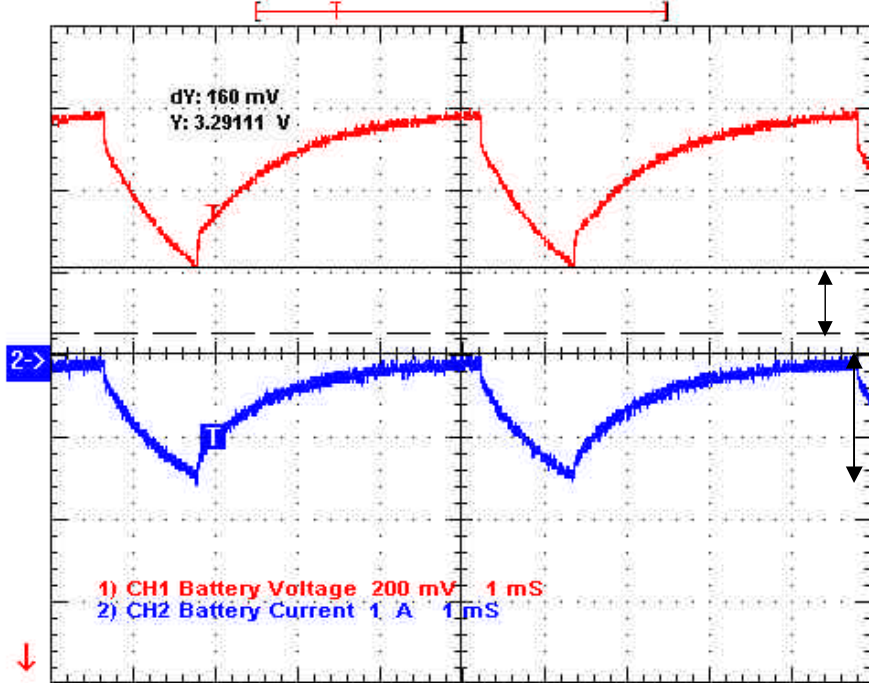Battery run time and voltage droop with GW202A (80mOhm, 0.28F) supercapacitor

Time(h)

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cap-XX

Test Circuit for next 3 slides

Li-Ion 3.7V

8X470µf Tantalum

1 **2** **3**

10 ohms

cap-XX supercap 380 mf

Electronic Load

Load is GPRS class 10 pulse train, 2A for 1.15msecs, 0A for 3.45msecs.

cap-XX

600 mAh Battery, 2A GPRS Pulse

dY: 551.111 mV
Y: 3.13111 V

551mV droop with battery alone

2A, 1.15msec GPRS class 10 pulse
Battery current

1) CH1 Battery Voltage 200 mV 1 mS
2) CH2 Battery Current 1 A 1 mS

Referring to test circuit on slide 7 (previous slide) Switch in position 2

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cap-XX

8 x Ta Capacitors, 2A GPRS Pulse

Ta capacitors (470μF ea) have inadequate energy storage

dY: 160 mV
Y: 3.29111 V

1) CH1 Battery Voltage 200 mV 1 mS
2) CH2 Battery Current 1 A 1 mS

Referring to test circuit on slide 7 Switch in position 1

Min voltage improved by 160mV

Peak Battery current ≈ 1.5A

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cap-XX

cap-XX Supercapacitor

Supercapacitor enables the battery to be discharged a further 300mV ®
Significant increase in run time

dY: 302.222 mV
Y: 3.13111 V

2->

1) CH1 Battery Voltage 200 mV 1 mS
2) CH2 Battery Current 1 A   1 mS

Min Voltage improved by 302mV

Supercapacitor averages load current.

Peak battery current reduced to ≈ 0.9A

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cap-XX

Summary

- **Hi peak power requirements cause power problems for both battery devices**
  - **Short run time**
- **and hosted devices (PC, CF cards)**
  - **Break max current spec**
- **Simple solution to both problems is a cap-xx supercapacitor**
  - ® **Load averaging: Battery, host do not see peaks**
  - ® **Hi energy storage and hi power delivery**
  - ® **Very Hi C   +   Very low ESR**

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cap-XX

Power Delivery for Notebooks with cap-XX Supercapacitors

The Problem – Notebooks

- **Latest CPU's can draw 100W transients**

- **Consequences**

  ® **10A load at the battery**
  ®**I^{2}R losses in battery, 5%-10%**

  ® **Battery voltage droop of ≈ 1.5V**

  ® **Premature low voltage shutdown**

  ®**Run time too short**
  ®**but plenty of energy left in the battery!**

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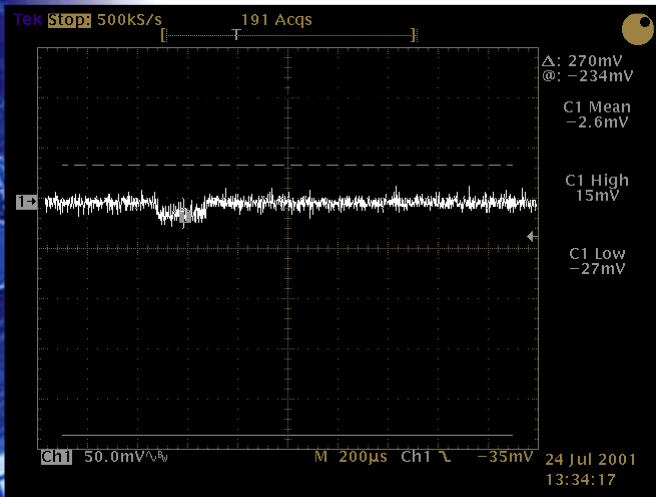cap-XX

The Solution

Energy Storage device to provide Hi Power delivery for as long as needed

Takes the power strain off the battery

- **Hi Power + Hi Energy Storage**
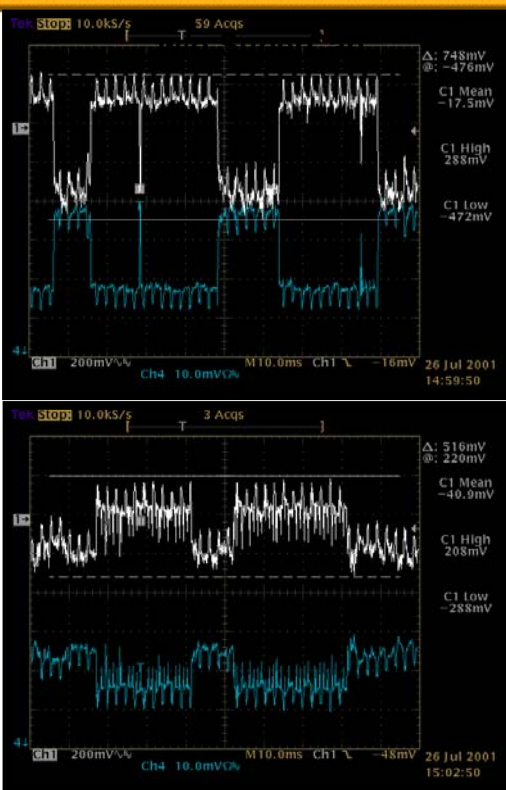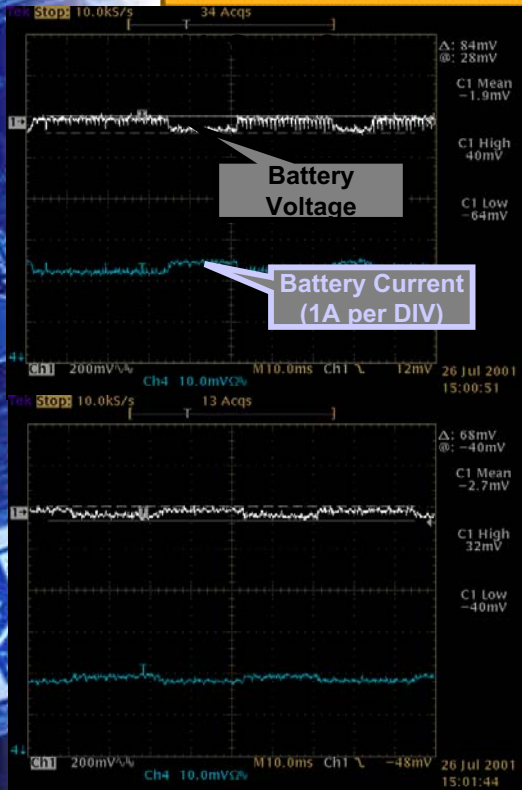- **Low ESR + Very Hi C**

cap-XX supercapacitors solve this problem

- **30m_ 3F**

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Supercapacitor – transient suppressor
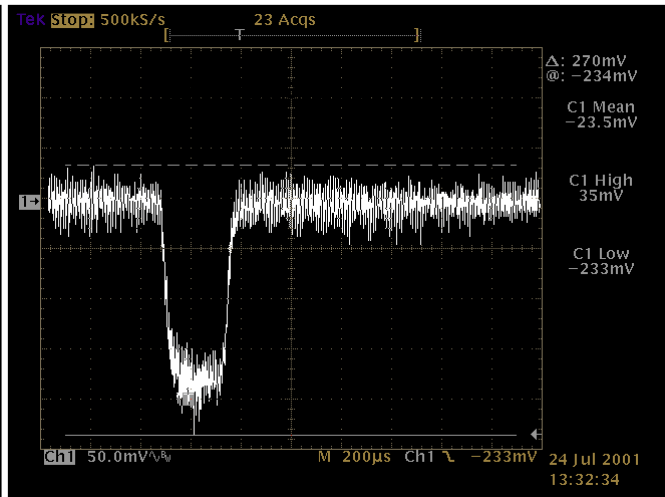
SuperCap Reduces Battery Transient by 7x

Supercapacitor – DVD Application

Battery Voltage

Battery Current (1A per DIV)

POM 9x Ripple Reduction

BOM 7x Ripple Reduction
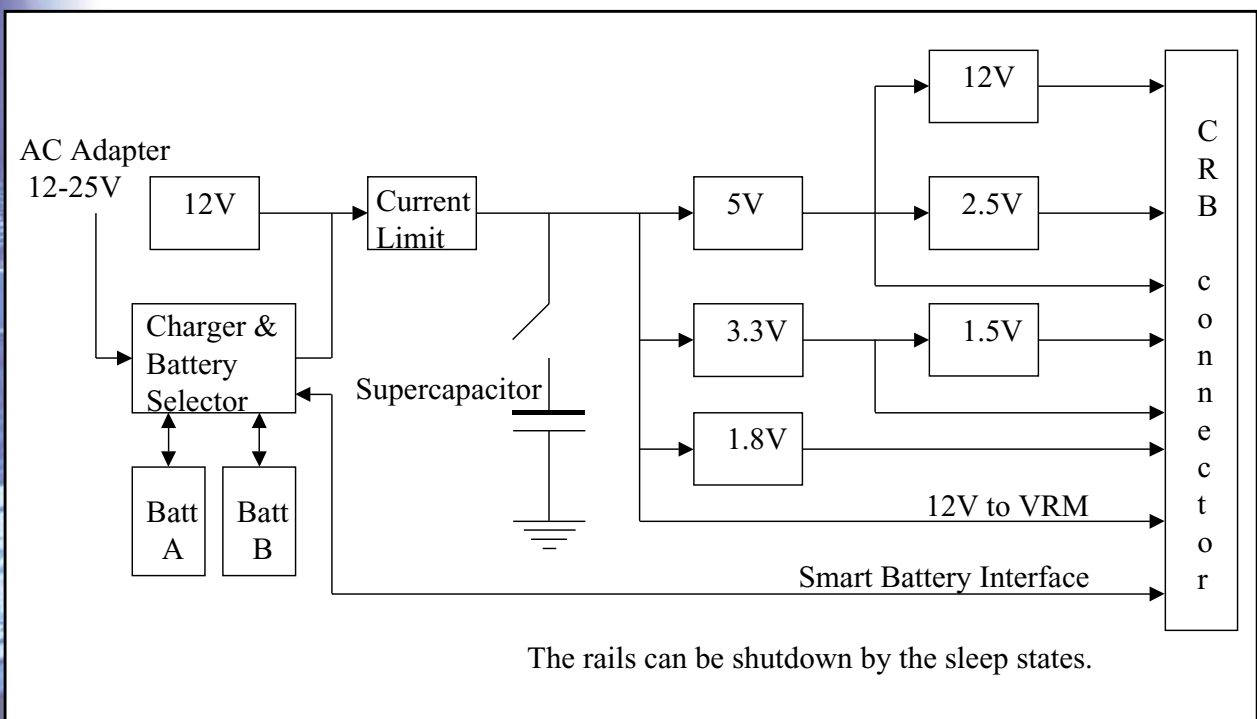
cap-XX

Banias Program

- **cap-XX is working with Intel to evaluate the performance of supercapacitors with the next generation of high power CPU's, starting with Banias**

- **cap-XX will have available a daughter board for the Banias CRB to evaluate battery run time and supercapacitor performance**

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cap-XX battery evaluation PCB

AC Adapter
12-25V

| 12V |

| Current Limit |

| Charger & Battery Selector |

Supercapacitor

| Batt A | Batt B |

| 5V |

| 3.3V |

| 1.8V |

| 12V |

| 2.5V |

| 1.5V |

12V to VRM

Smart Battery Interface

C R B   c o n n e c t o r

The rails can be shutdown by the sleep states.

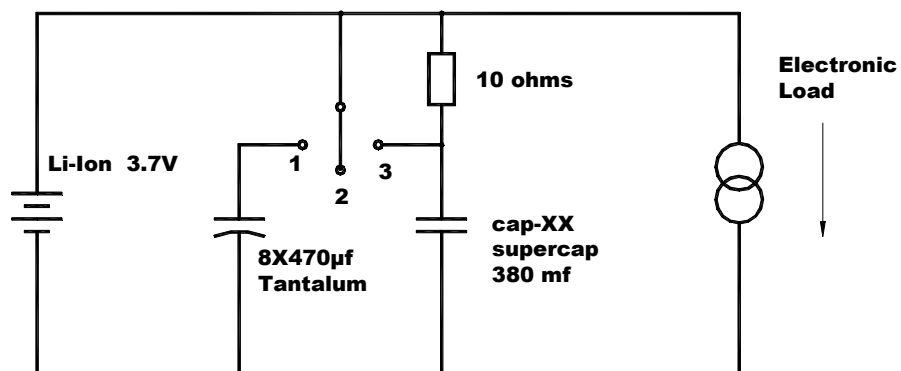**18**

cap-XX

Summary and Next Steps

- **Latest CPU's cause hi current transients and voltage droop at the battery**
  - ® **Shortens run time**
    - • **Premature Low Voltage Shutdown**
    - • **Energy losses in battery impedance**
  - ® **Very low impedance energy storage & power delivery device solves these problems**
    - ® **Cap-XX supercapacitor**
  - ® **Use cap-XX evaluation board to see what improvements a cap-XX supercapacitor can make to your power architecture**

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Back Up Slides

cap-XX

Test Circuit

Li-Ion 3.7V

8X470µf
Tantalum

1   3
2

10 ohms

cap-XX
supercap
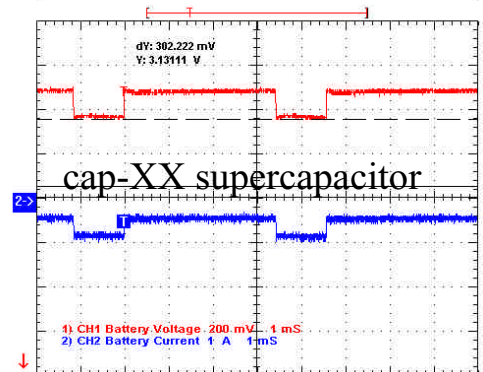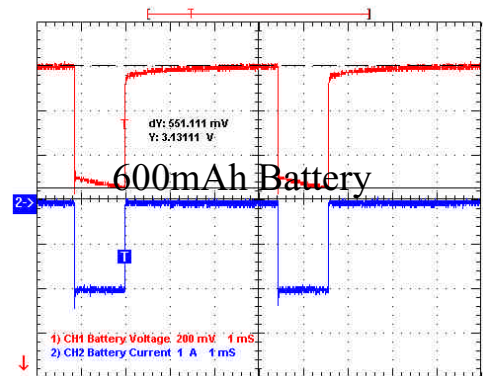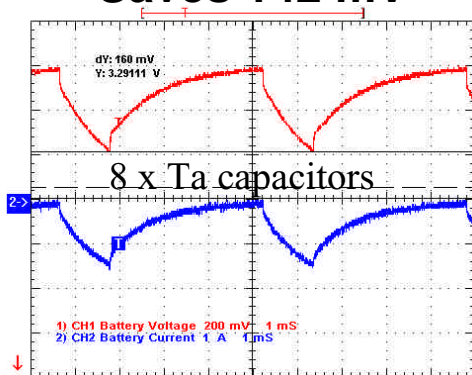380 mf

Electronic
Load

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Demonstration details

- **We apply a 2A pulsed load with three different time specifications:**
  - **GSM, 2 slot GPRS and 4 slot GPRS**

- **To three different power sources:**
  - **A 600 mAh Li ion battery**
  - **The 600 mAh battery and 8 Ta capacitors, each 470 µF, 50 mΩ**
  - **The 600 mAh battery and a cap-XX supercapacitor of 300 mF, 100 mΩ**

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Supercapacitor 1.9 x better than Ta in voltage cutoff

Results for 2A GPRS 2 Slot pulses

- **1/4 duty cycle**
- **Voltage droop:**
  - **Battery 551 mV**
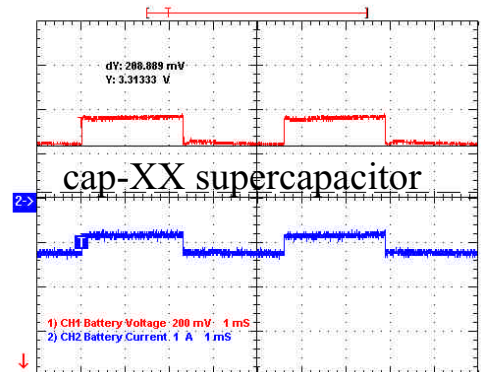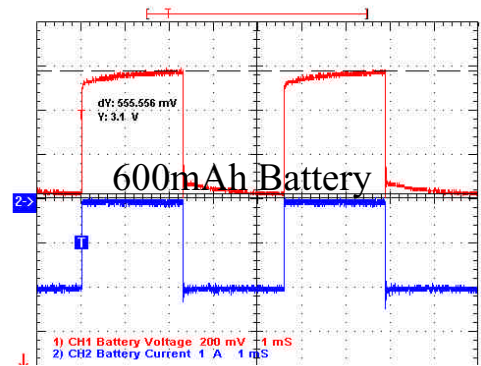 - **Ta cap 160 mV less**
  - **cap-XX 302 mV less**
  - **Saves 142 mV**

600mAh Battery

dY: 551.111 mV
Y: 3.13111 V

1) CH1 Battery Voltage 200 mV 1 mS
2) CH2 Battery Current 1 A 1 mS

8 x Ta capacitors

dY: 160 mV
Y: 3.29111 V

1) CH1 Battery Voltage 200 mV 1 mS
2) CH2 Battery Current 1 A 1 mS

cap-XX supercapacitor

dY: 302.222 mV
Y: 3.13111 V

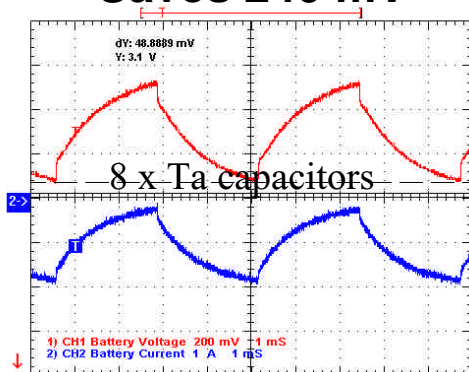1) CH1 Battery Voltage 200 mV 1 mS
2) CH2 Battery Current 1 A 1 mS

cap-XX

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Supercapacitor 5.9 x better than Ta in voltage cutoff

Results for 2A GPRS 4 Slot pulses

- **1/2 duty cycle**
- **Voltage droop:**
  - **Battery 561 mV**
  - **Ta cap 49 mV less**
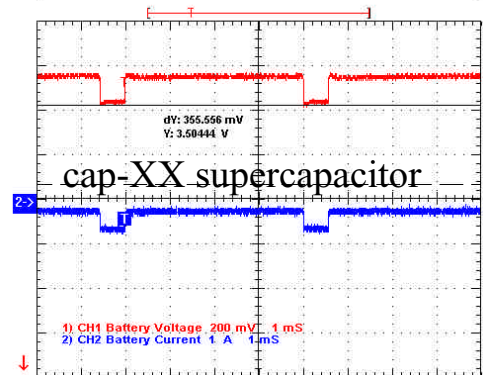 - **cap-XX 289 mV less**
  - **Saves 240 mV**

dY: 555.556 mV
Y: 3.1 V

600mAh Battery

2->

1) CH1 Battery Voltage 200 mV   1 mS
2) CH2 Battery Current 1 A   1 mS

dY: 48.8889 mV
Y: 3.1 V

8 x Ta capacitors

2->

1) CH1 Battery Voltage 200 mV   1 mS
2) CH2 Battery Current 1 A   1 mS

dY: 288.889 mV
Y: 3.31333 V

cap-XX supercapacitor

2->

1) CH1 Battery Voltage 200 mV   1 mS
2) CH2 Battery Current 1 A   1 mS

cap-XX

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Supercapacitor 1.3 x better than Ta in voltage cutoff

Results for 2A GSM pulses

- **1/8 duty cycle**
- **Voltage droop:**
  - **Battery 547 mV**
  - **Ta cap 267 mV less**
  - **cap-XX 356 mV less**
  - **Saves 89 mV**

dY: 546.667 mV
Y: 3.14889 V

600mAh Battery

1) CH1 Battery Voltage 200 mV 1 mS
2) CH2 Battery Current 1 A 1 mS

dY: 266.667 mV
Y: 3.14889 V

8 x Ta capacitors

1) CH1 Battery Voltage 200 mV 1 mS
2) CH2 Battery Current 1 A 1 mS

dY: 355.556 mV
Y: 3.50444 V

cap-XX supercapacitor

1) CH1 Battery Voltage 200 mV 1 mS
2) CH2 Battery Current 1 A 1 mS

cap-XX

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