

CurrentRF

Dynamic Power and SWaP Reduction in CubeSat Systems

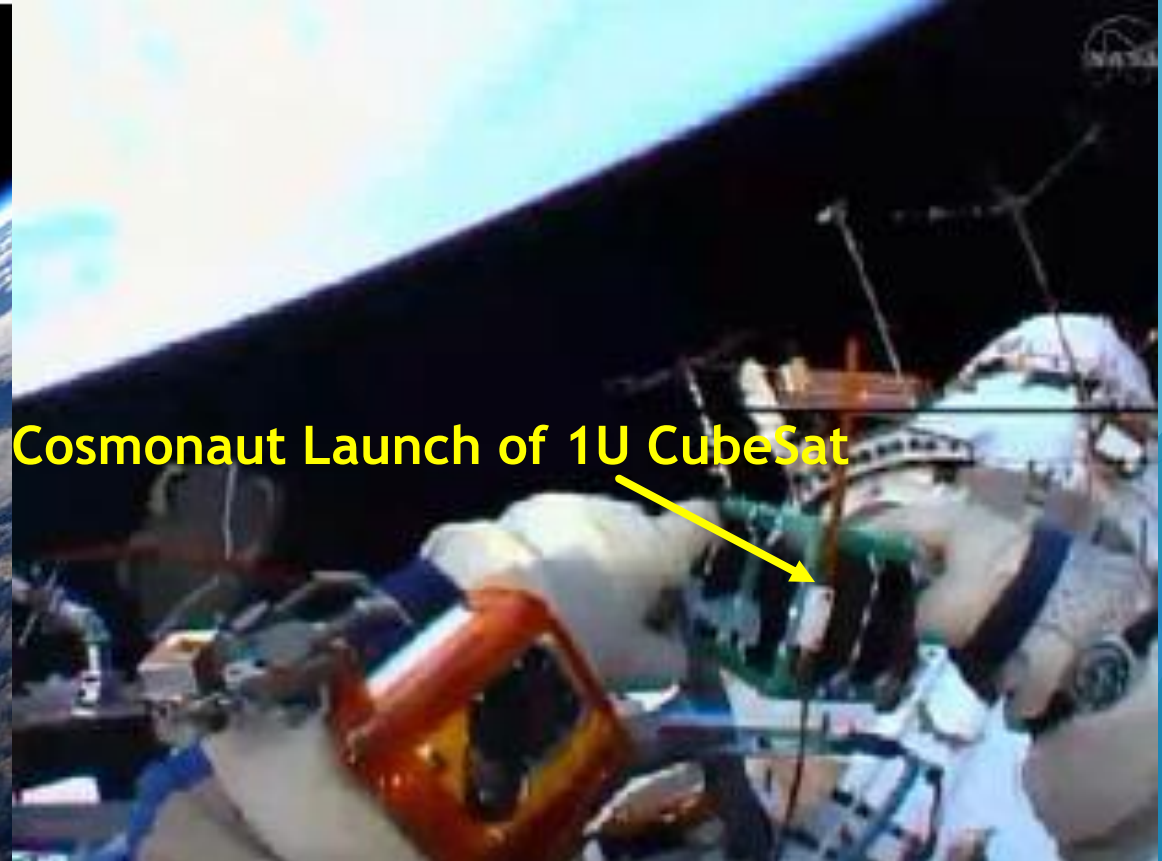
(The Noise Activated, CC_100 Power Optimizer/Silicon Super Capacitor)

Michael Hopkins
Founder and CEO



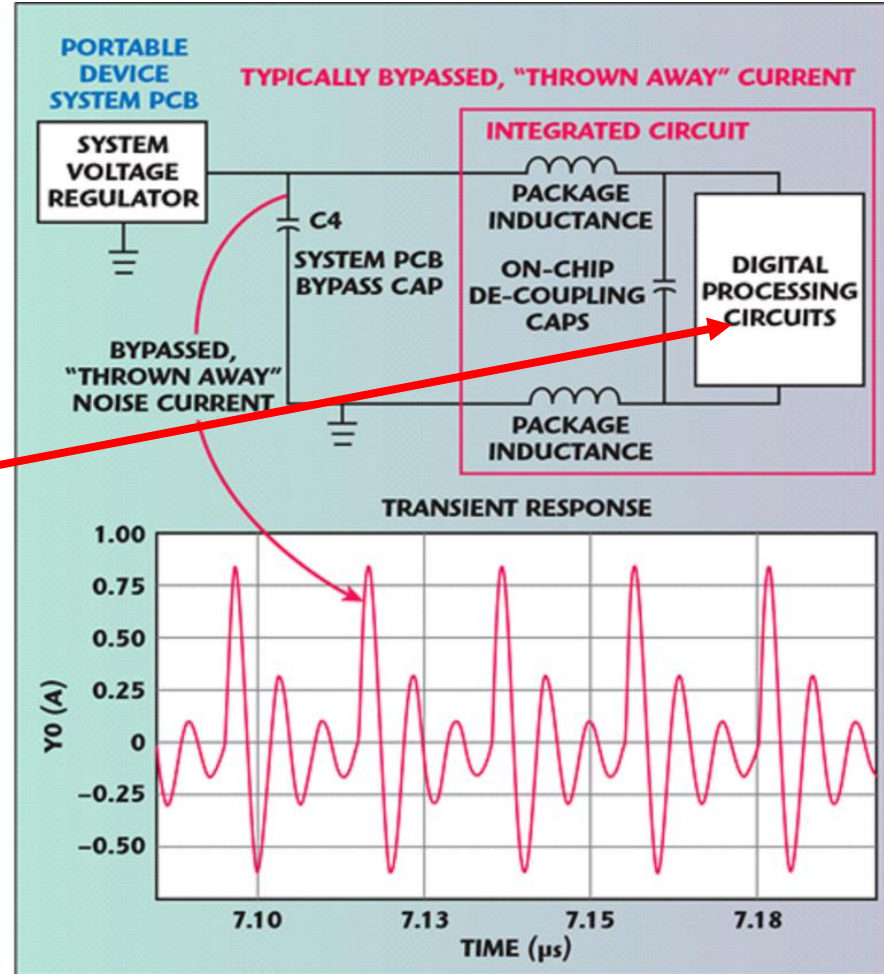
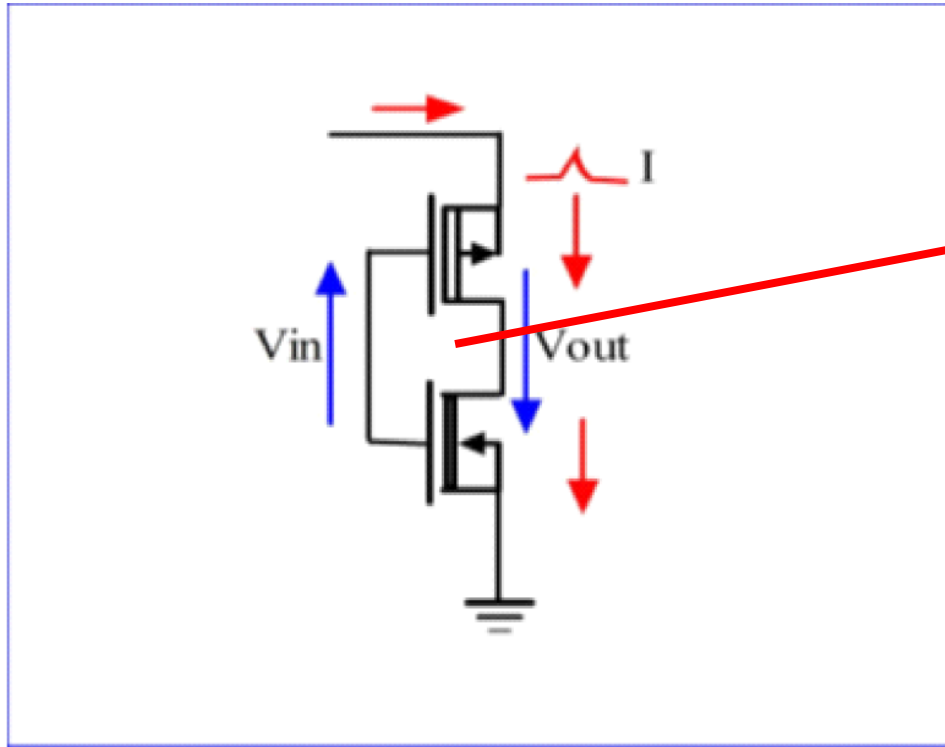
The Problem:

CubeSat Embedded DSP Increases System Dynamic Power Dissipation and Injects High Frequency Noise into Sensitive Analog and RF Systems, Decreasing System Sensitivity

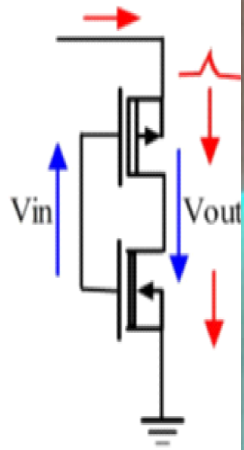


Dynamic Power Dissipation— What is It and Why is It Important?

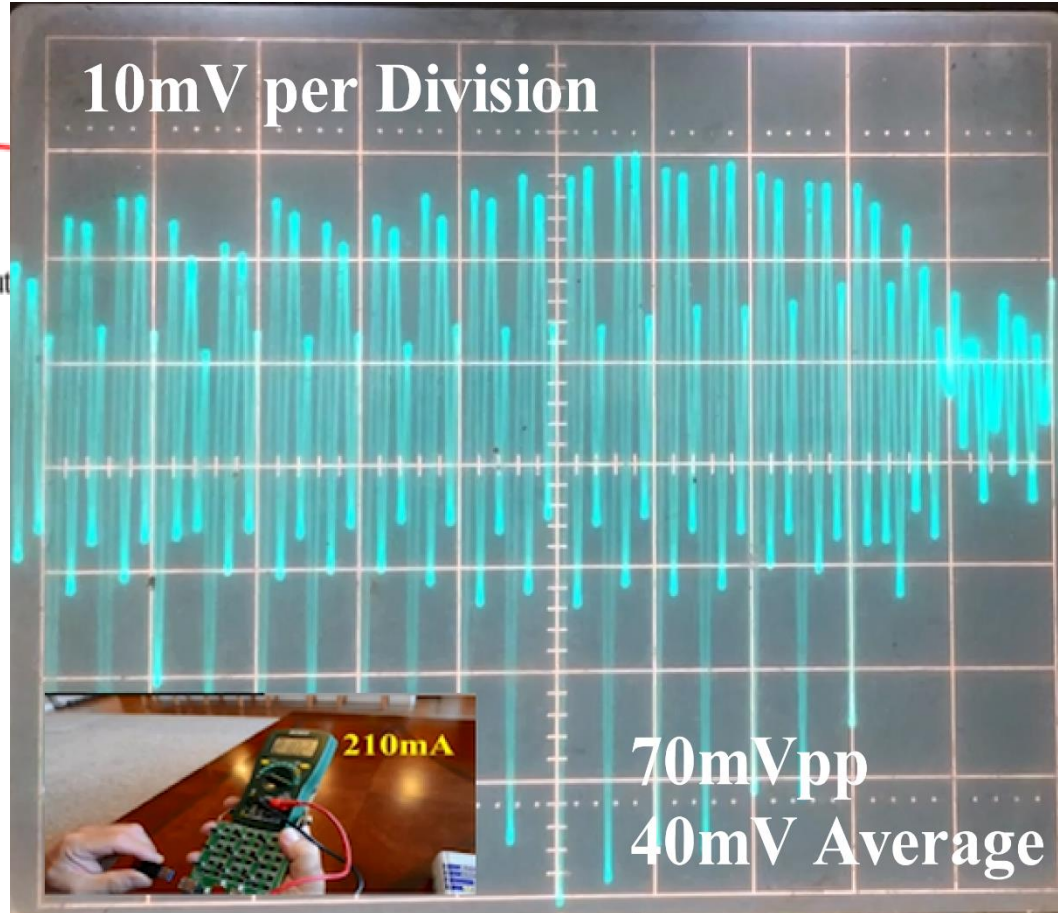
CMOS Inverter Based Overlap Current
The Primary Source of Digital Power
Dissipation



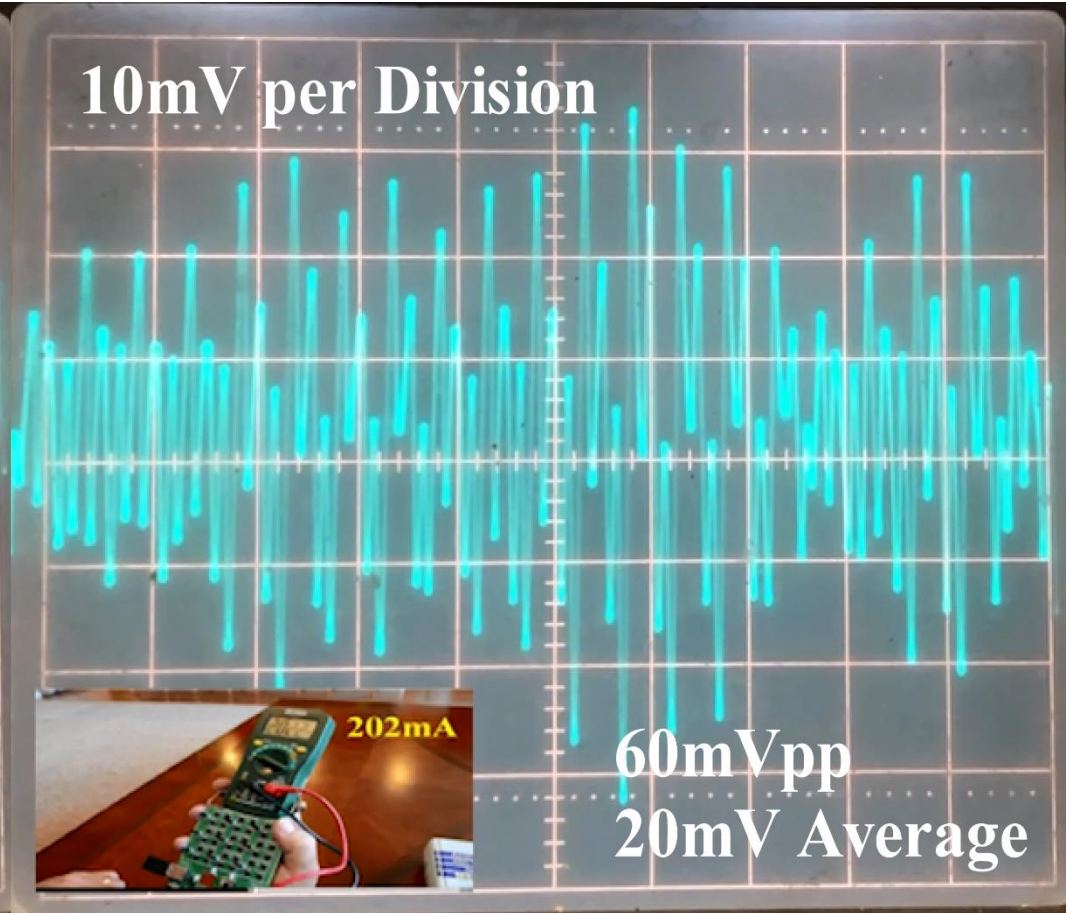
Our Solution: Reduction in Dynamic Power- Dynamic Power-The Source of Processor Power Dissipation



Supply
Line
Time
Domain
Plots



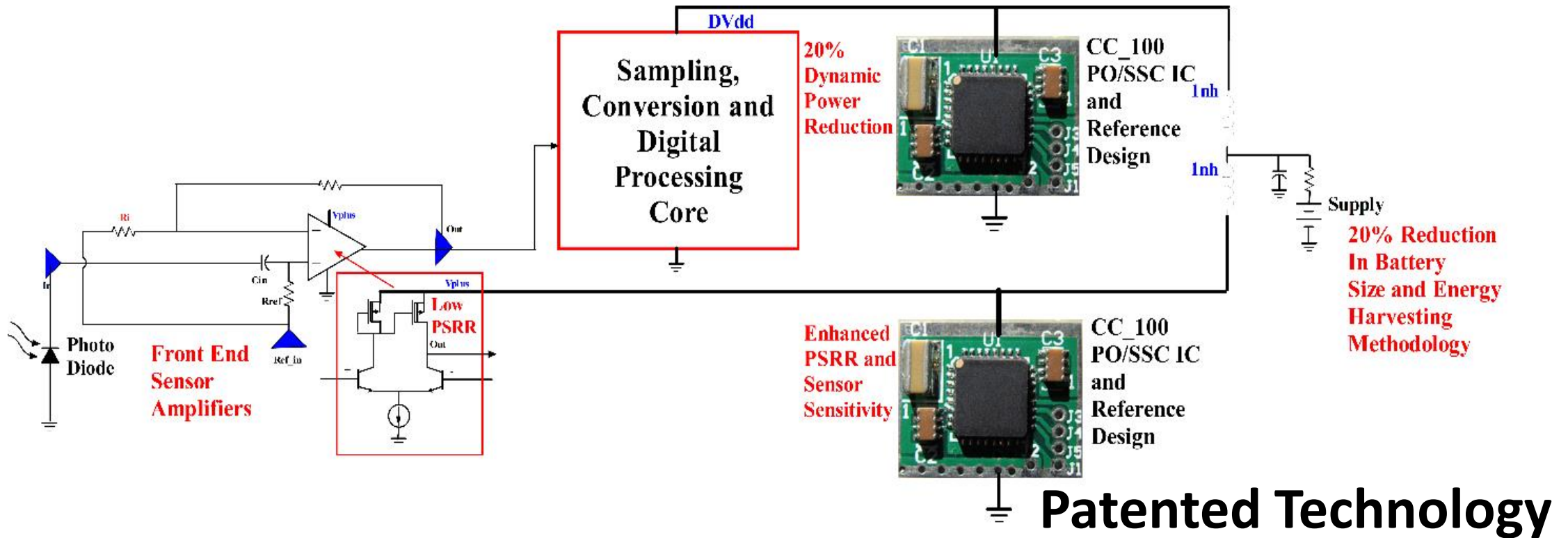
Dynamic Power-CC_100 Disengaged



Dynamic Power-CC_100 Engaged

Our Solution:

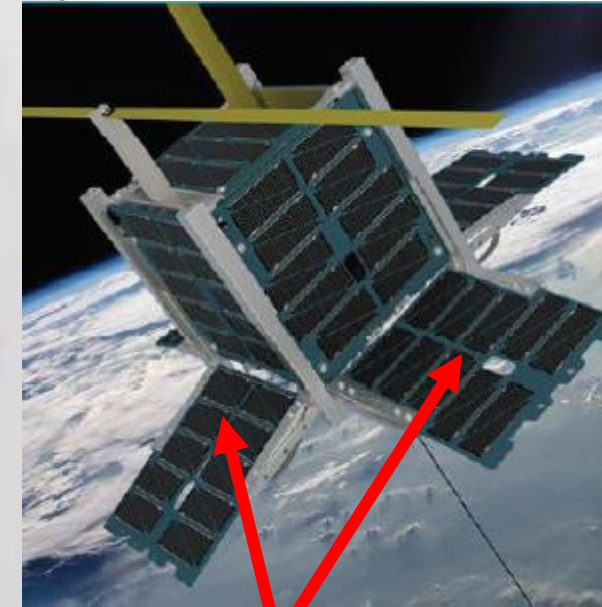
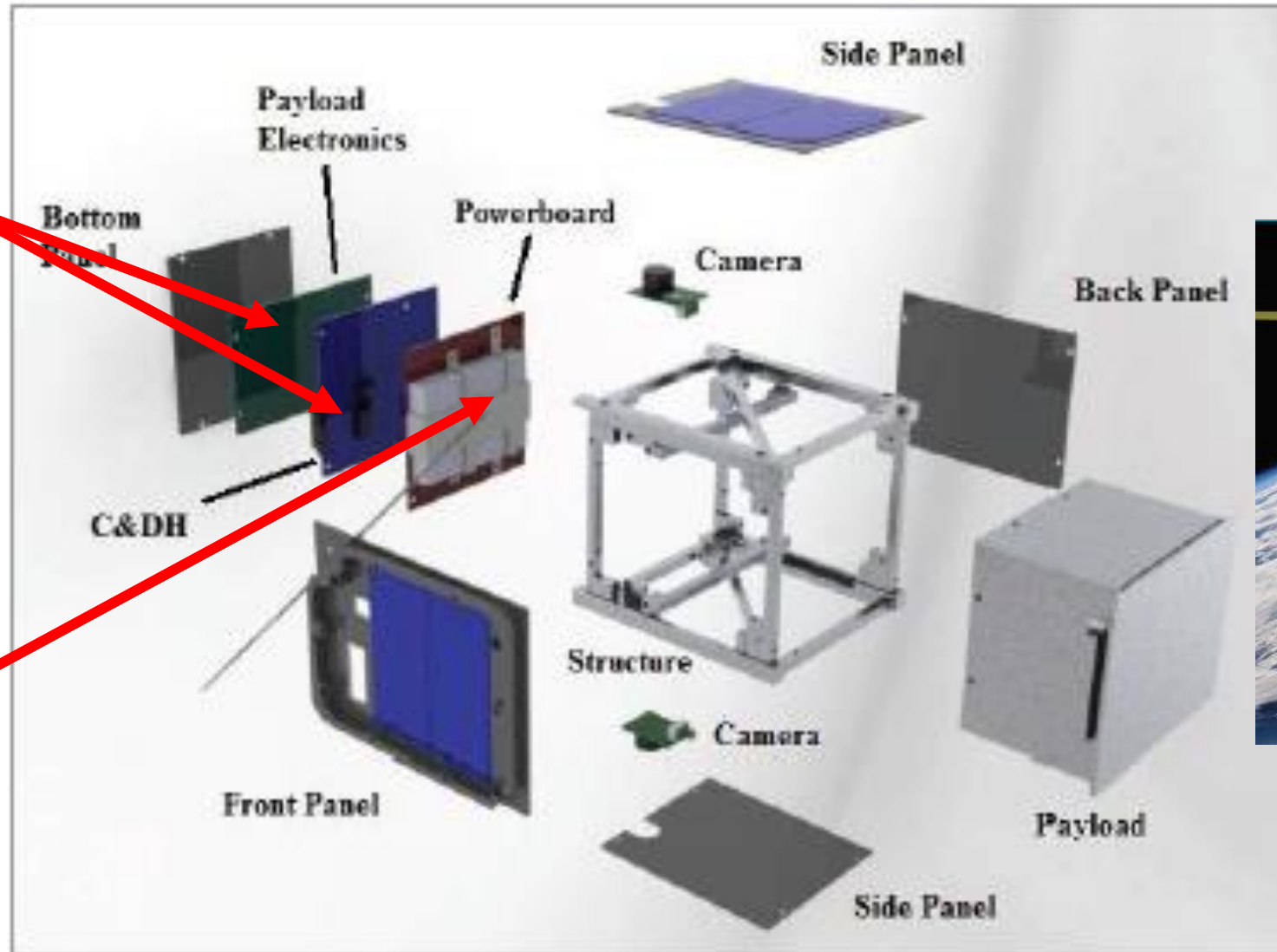
Embedded DSP Dynamic Power Dissipation is Decreased with the CC_100 PO/SSC IC (36% SWaP Reduction), Resulting in Cleaner, More Sensitive CubeSat Sensor Electronics



Advantages of the CC_100 PO/SSC IC in CubeSats

Increased RF and Analog Sensor Signal Sensitivity

20% to 36% Reduction In Size, Weight, and Power (SWaP) (Batteries, Solar Panels)

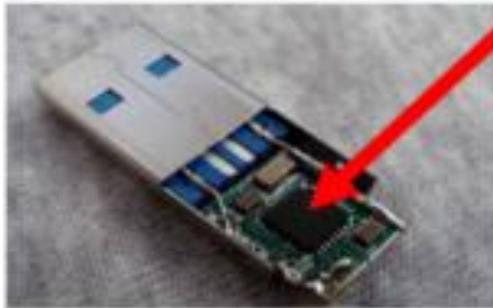
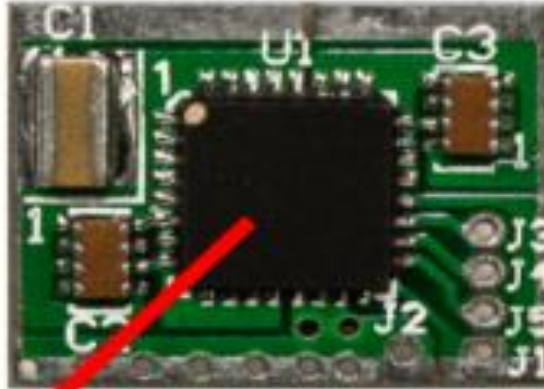


20% to 36% Reduction In SWaP (Solar Panels)

Additional Advantages of Using the CC_100 PO/SSC IC & IP in CubeSat Systems

- **Internal Energy Harvesting (Up to a 36% Reduction in Dynamic Current and Power)**
- **RF Emissions Reduction(Up to a 36% Reduction over Standard DCAPs)**
- **Power Integrity Enhancement**
- **EMI Reduction-EMC Improvement**
- **2X Small Signal Effective Capacitance increase over Standard Capacitors**
- **600X Large Signal Reservoir Capacitance Increase over Standard Capacitors**
- **A 25% reduction in Effective Series Inductance (ESL)**
- **Enhanced System PSRR(Cleaner System Spectral Outputs)**
- **Draws No Operational DC Power**
- **CC_100 IC and IP can be shaped into any form factor**
- **CC_100 IC and IP used as a standard Capacitor**
- **Customizable Design**

Power Op/Silicon Super Capacitor IC Equals PowerStic/Exodus



CC_100 IP in USB PowerStic Packaging



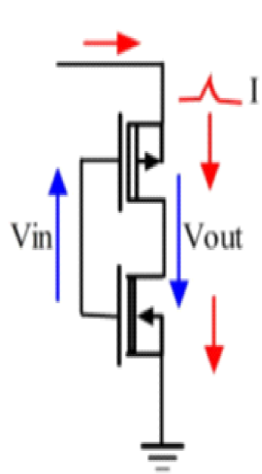
Just Different Packaging

Power Op/Silicon Super Capacitors Packaged as PowerStic and Exodus

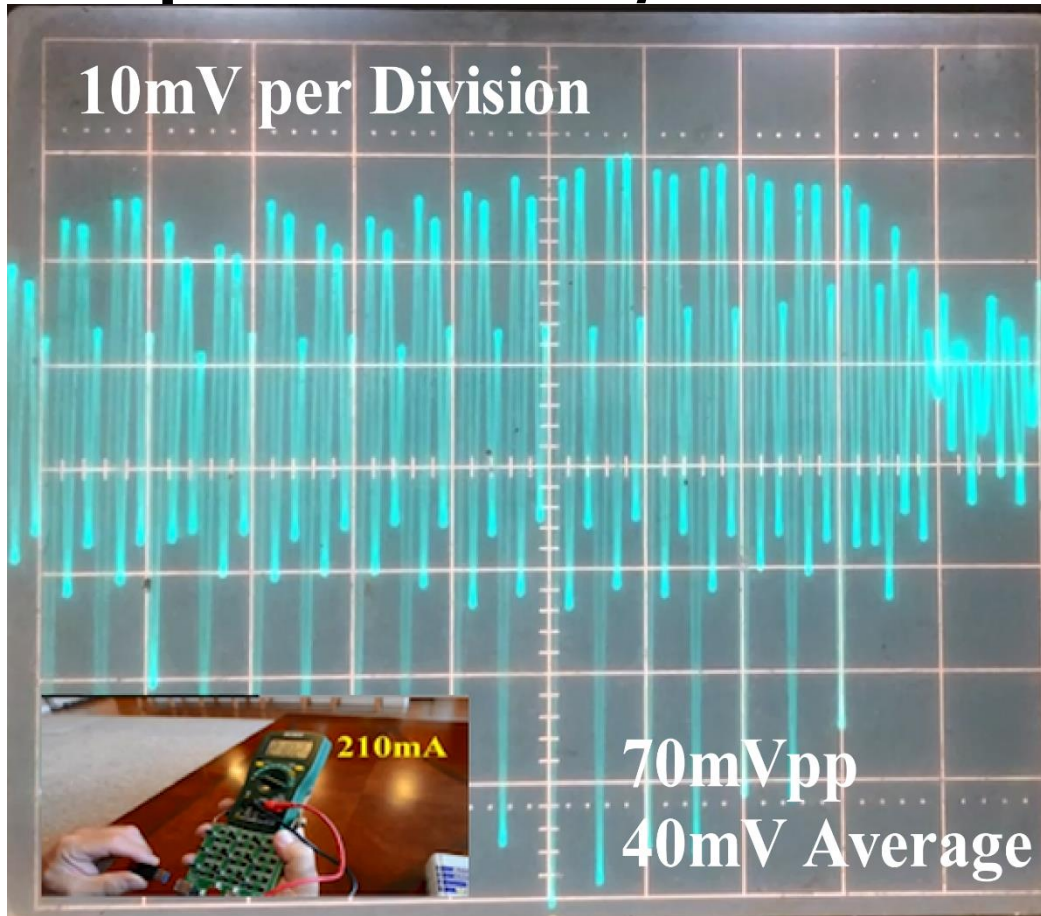
Performance-Time Domain Dynamic Power Reduction— (SWaP Reduction in CubeSats)

Power Op/Silicon Super Capacitor IC

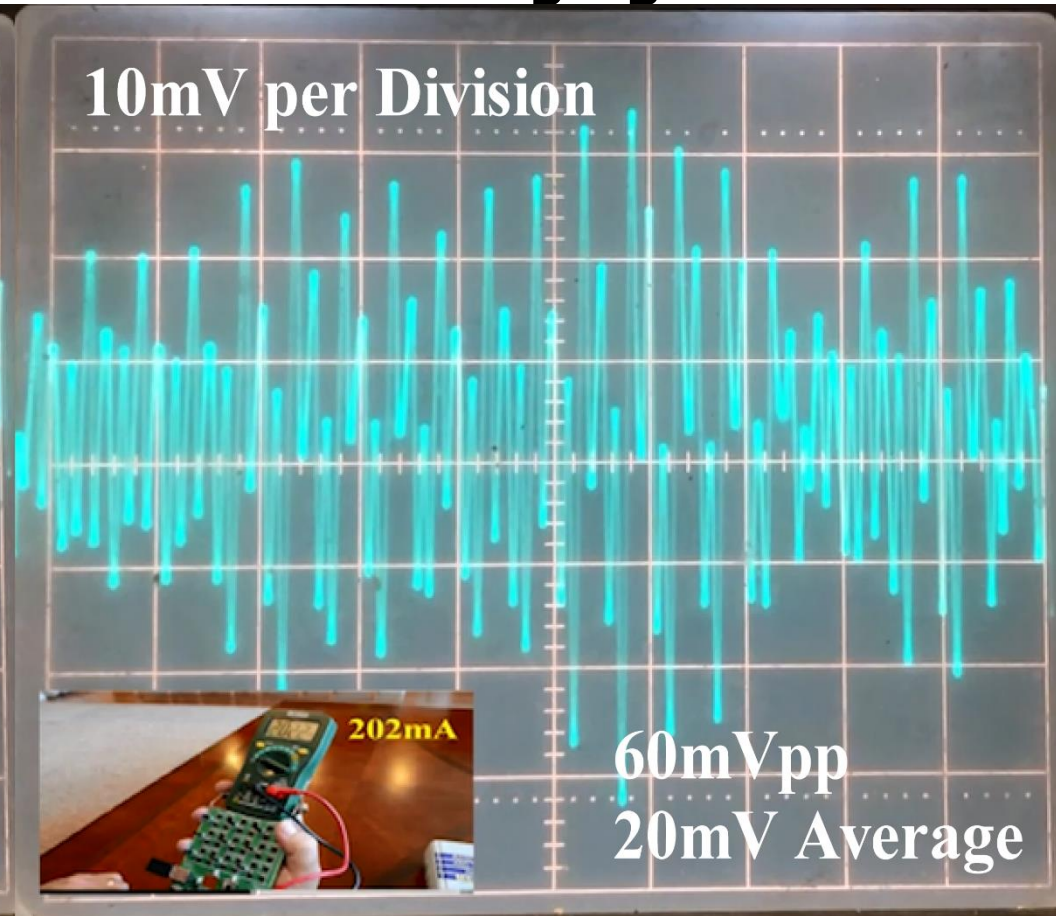
Equals PowerStic/Exodus—Just Different Packaging



Supply
Line
Time
Domain
Plots



Dynamic Power-CC_100 Disengaged

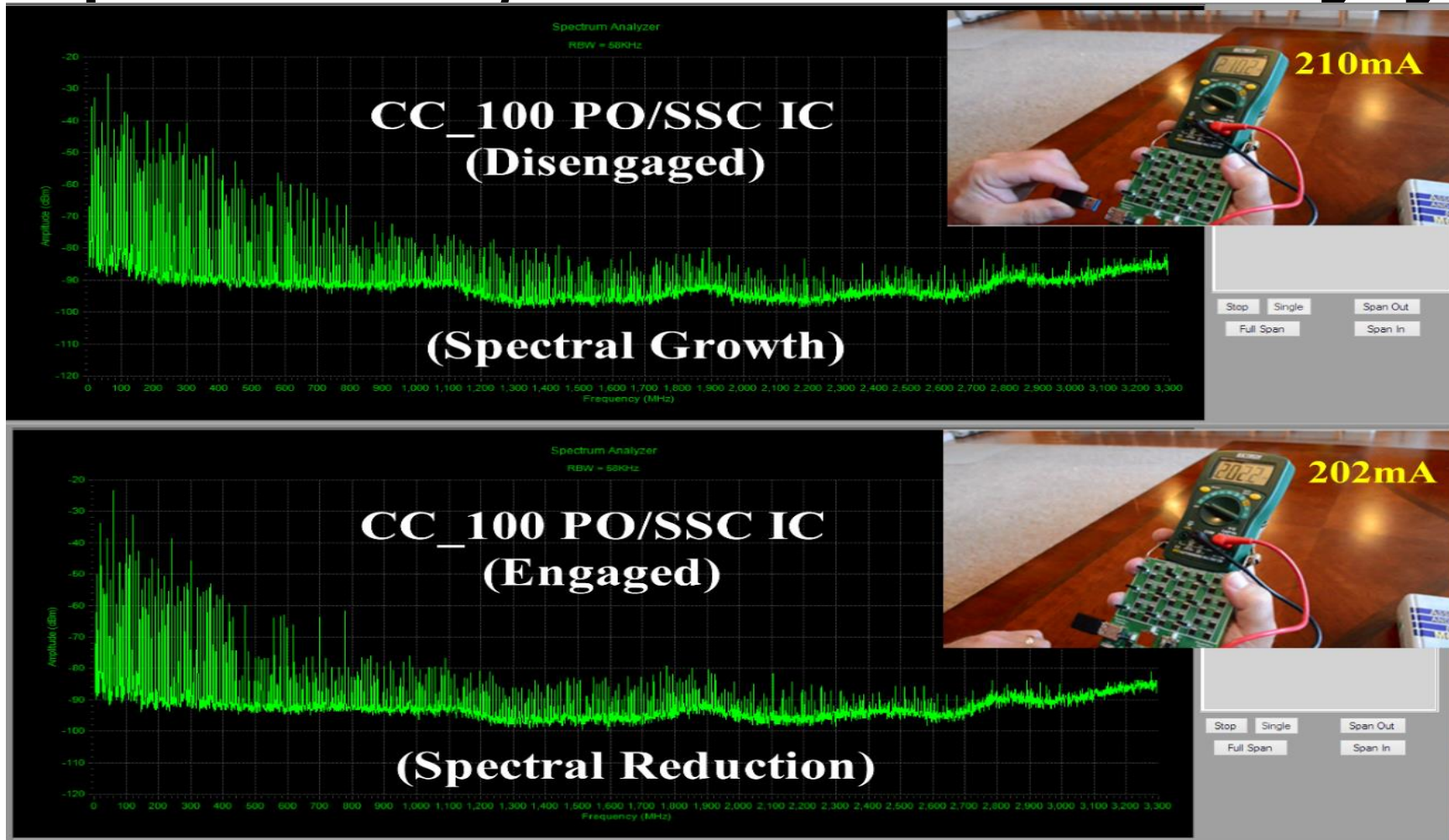


Dynamic Power-CC_100 Engaged

Performance-Dynamic Spectral and DC Power Reduction (SWaP Reduction in CubeSats)

Power Op/Silicon Super Capacitor IC Equals PowerStic/Exodus—Just Different Packaging

Supply
Line
Spectral
Plots

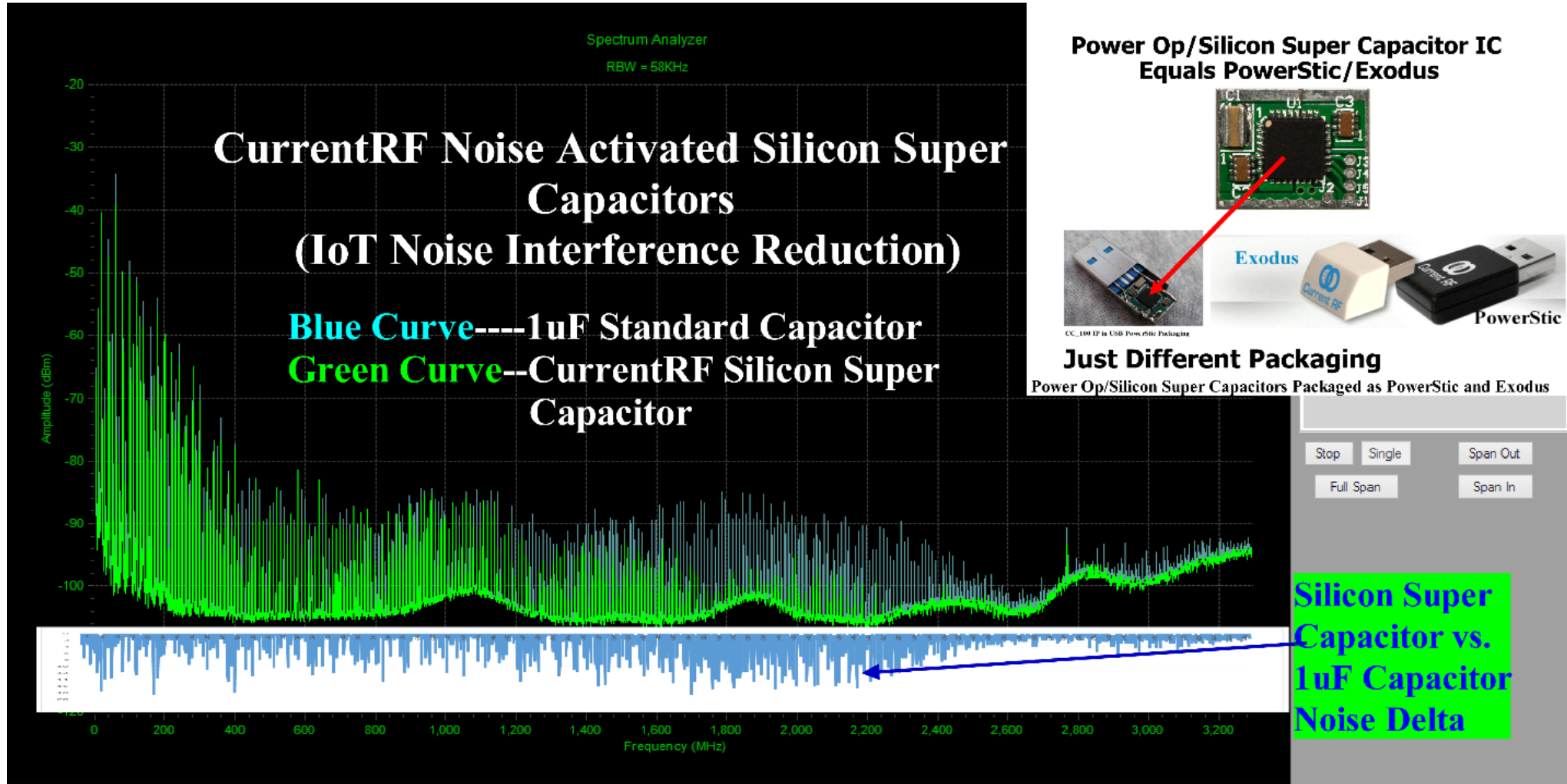


Performance-System RF and Analog Sensitivity Enhancement

Power Op/Silicon Super Capacitor IC

Equals PowerStic/Exodus—Just Different Packaging

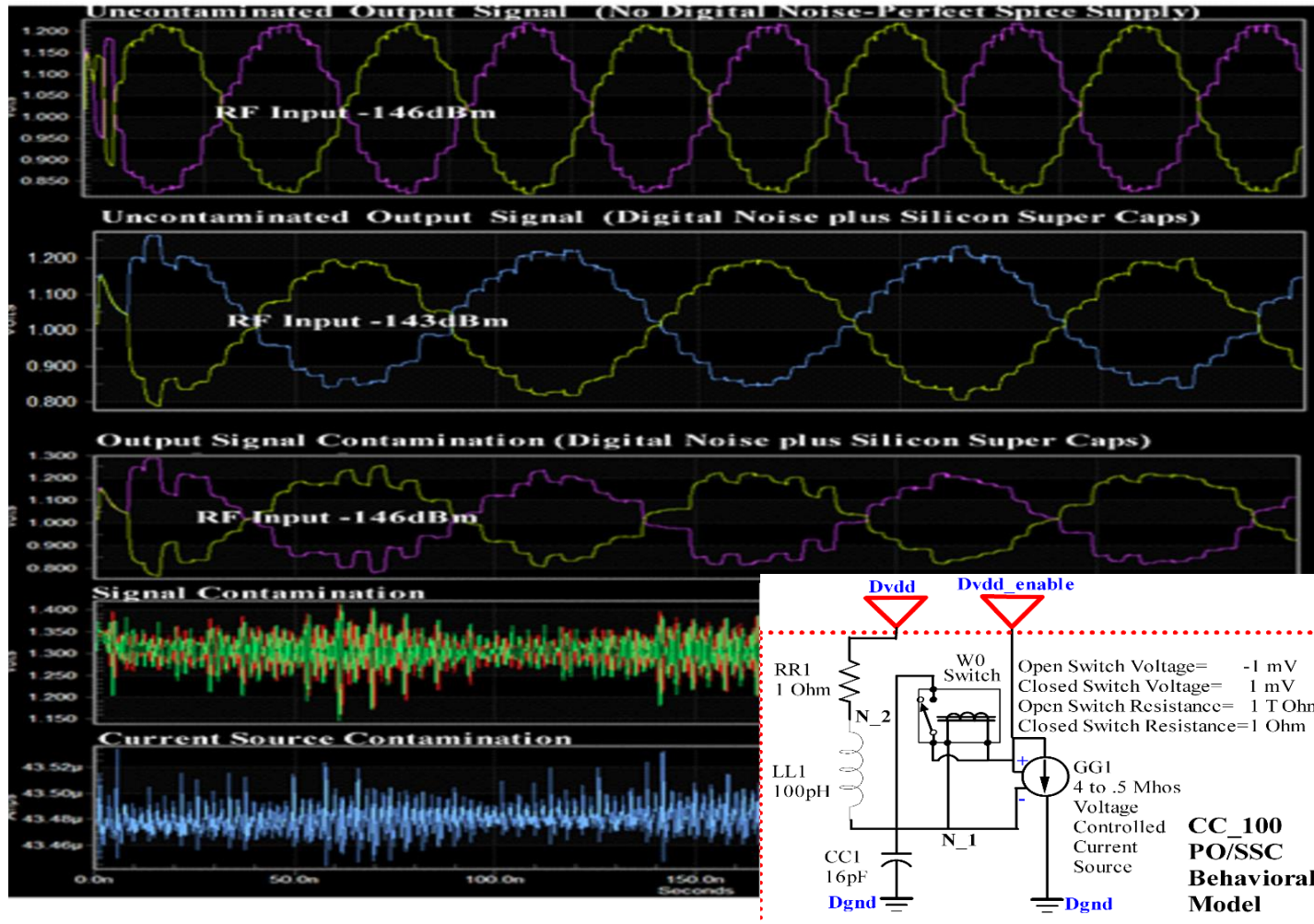
Supply
Line
Spectral
Plots



Performance-System RF and Analog Sensitivity Enhancement

Power Op/Silicon Super Capacitor Design Increases RF Amplifier Sensitivity

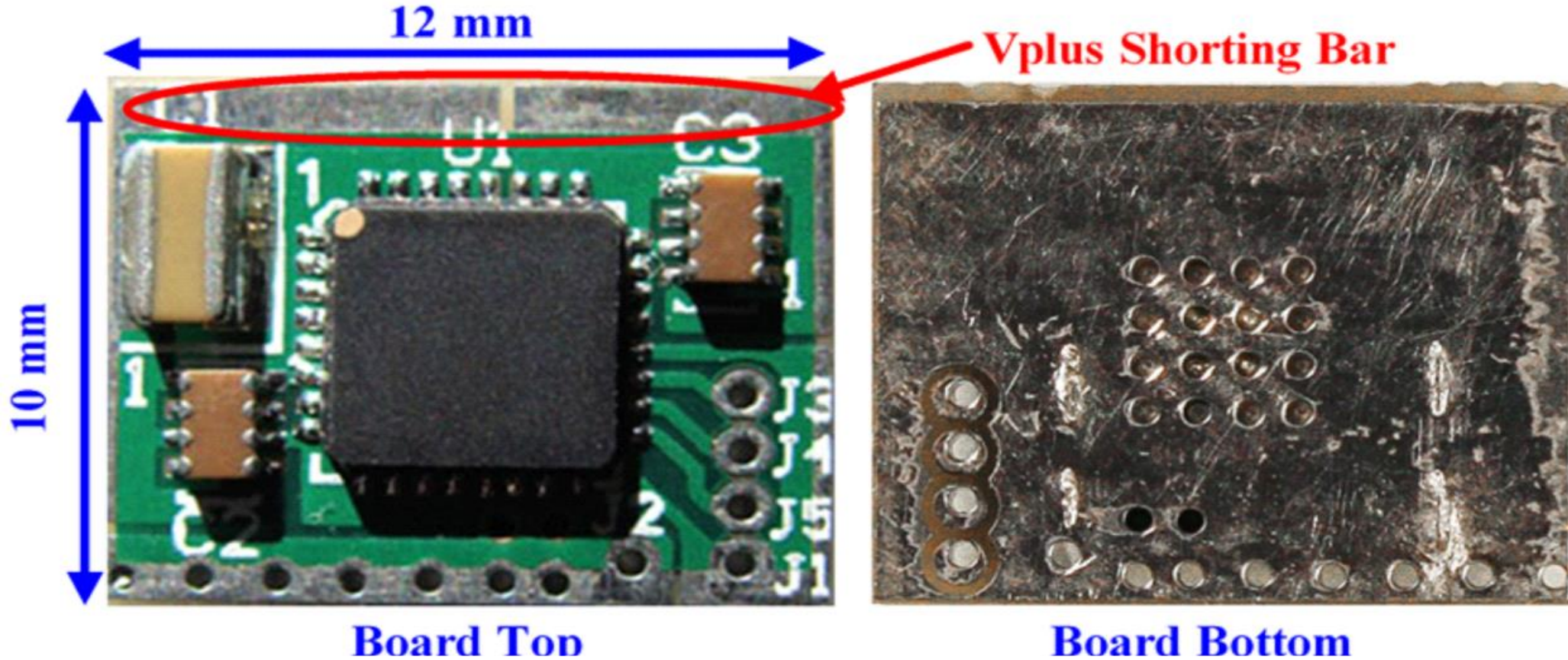
ADC
Time
Domain
Plots



Integration into Existing CubeSat Designs

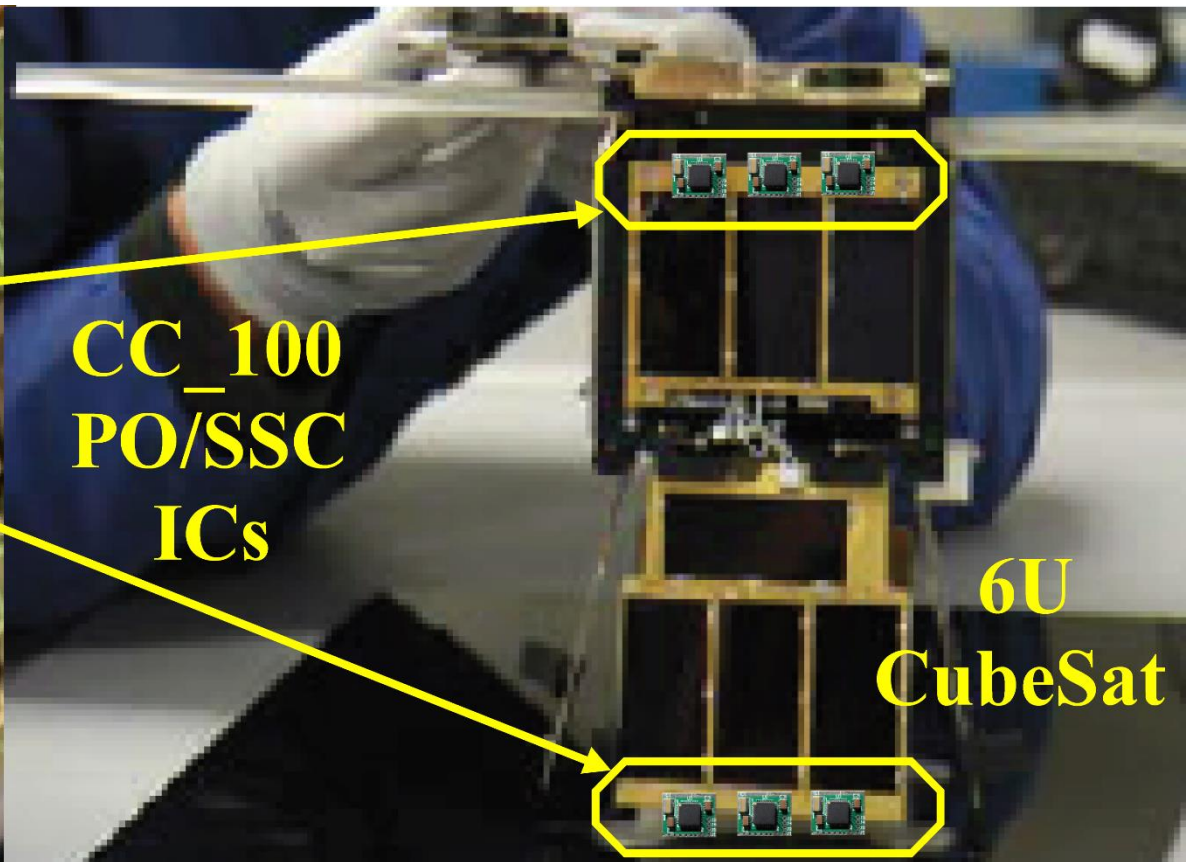
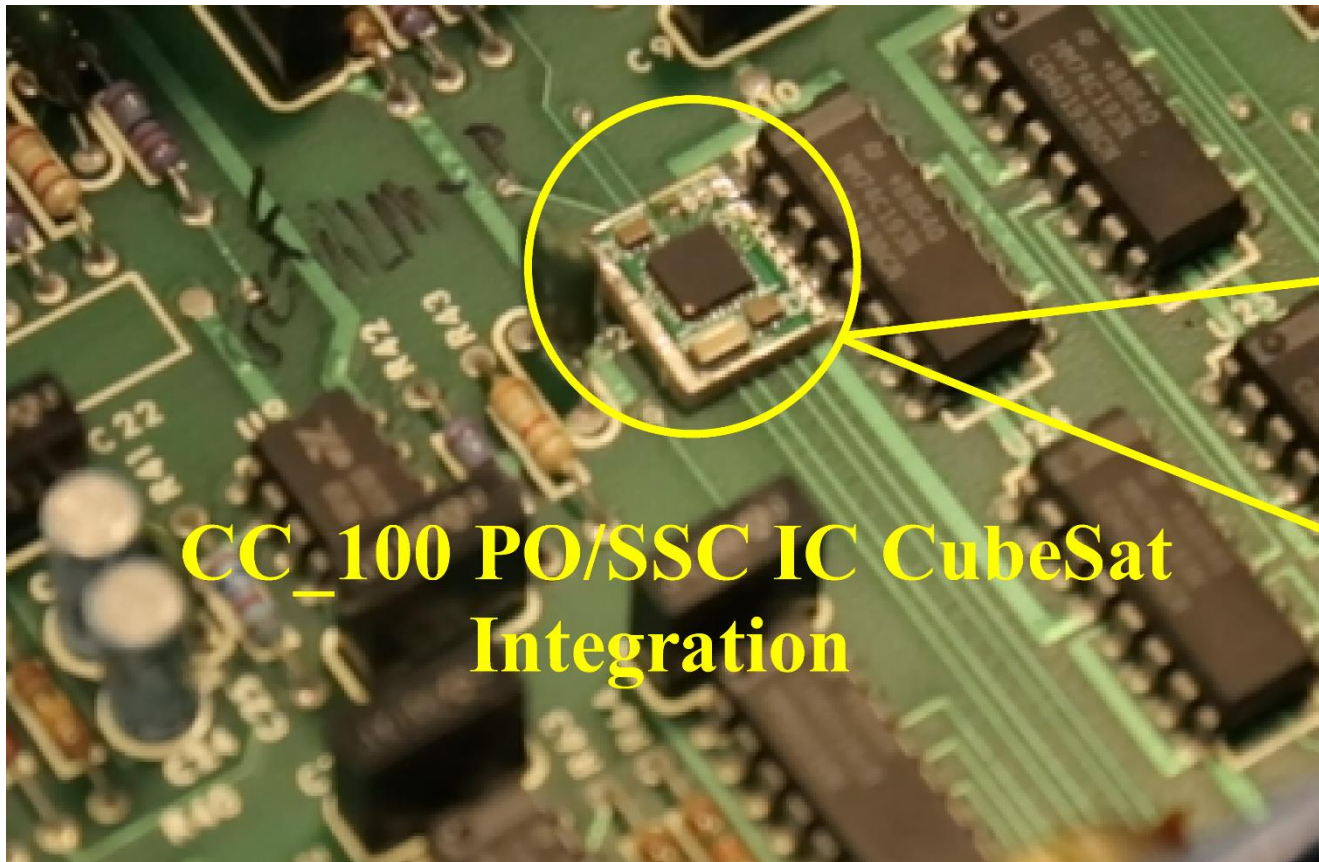
The CC_100 PO/SSC IC and Reference Design Module

2 Connections- Power (Vplus Shorting Bar) and Ground
(Board Bottom onto an existing Ground Plane)



Easy to Integrate into Existing CubeSat Designs

2 Connections- Power and Ground anywhere in the System



CubeSat Probing & Post Processing Capabilities for CC_100 PO/SSC IC Integration into Existing CubeSat Design & Placement Optimization

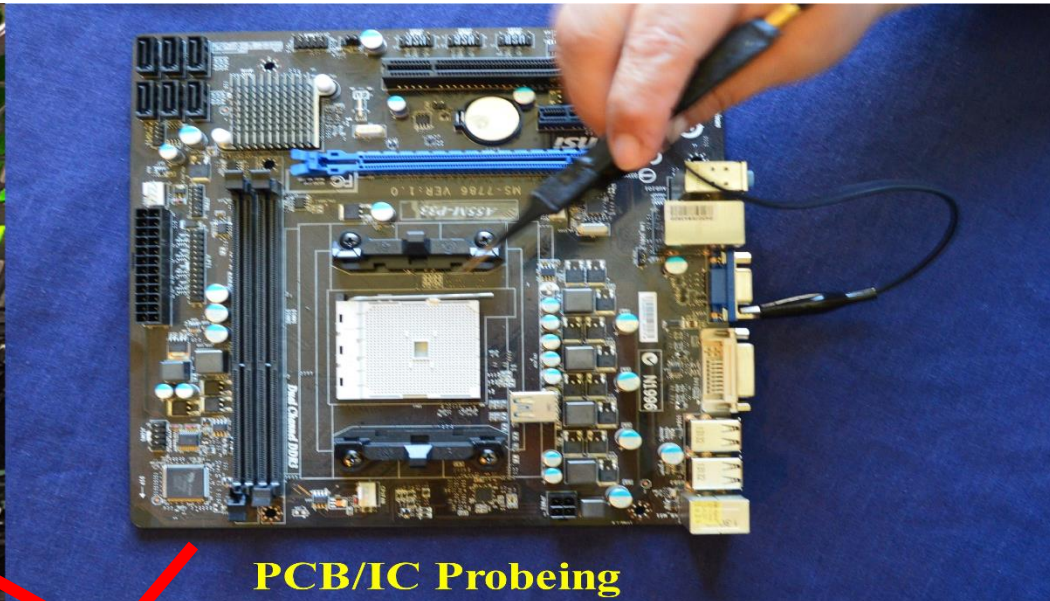
Software Enabling Precision Detection of CC_100 PO/SSC Power Deltas

| | | | | | | | | | | |
|------|-----------|---------|---------|----------|-------------|-------------|-------------|-------------|-------------|--|
| 3583 | 3308.186 | -88.96 | -88.96 | 0 | 1.27057E-12 | 1.27057E-12 | 0 | 0 | 0 | |
| 3584 | 3307.109 | -90.473 | -92.473 | 2 | 8.96809E-13 | 5.65848E-13 | 3.30961E-13 | 8.13586E-08 | | |
| 3585 | 3308.032 | -88.485 | -88.485 | 0 | 1.41742E-12 | 1.41742E-12 | 0 | 0 | | |
| 3586 | | | | | | | 2.21484E-06 | 0.001435877 | 0.000861526 | approx. delta measurement of the dc meter (dc) |
| 3587 | Frequency | without | with | subtract | without | with | summation | total | multiply | |
| 3588 | [MHz] | dBm | dBm | dBm | power | power | power | power | by the | |
| 3589 | | | | | (W) | (W) | (W) | (W) | approx | |
| 3590 | | | | | | | | | input Z | |
| | | | | | | | | | ratio | |
| | | | | | | | | | spec an | |
| | | | | | | | | | input to | |
| | | | | | | | | | CC_100 | |
| | | | | | | | | | input Z | |
| | | | | | | | | | ratio(6:1) | |
| | | | | | | | | | (saved | |
| | | | | | | | | | Current) | |
| | | | | | | | | | I(rms) | |

$dBm = 10 \log\left(\frac{P}{.001}\right)$ $i^2 * R = P$
 $inv \log\left(\frac{dBm}{10}\right) * .001 = P$ $i = \sqrt{\frac{P}{R}}$

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USB Port Probing



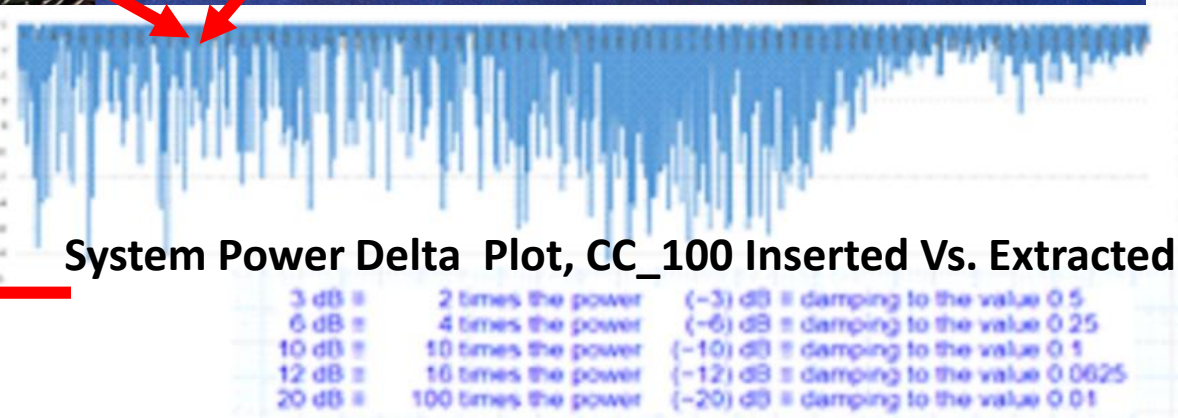
PCB/IC Probing

Post Processing Delta (Power Sensitivity)

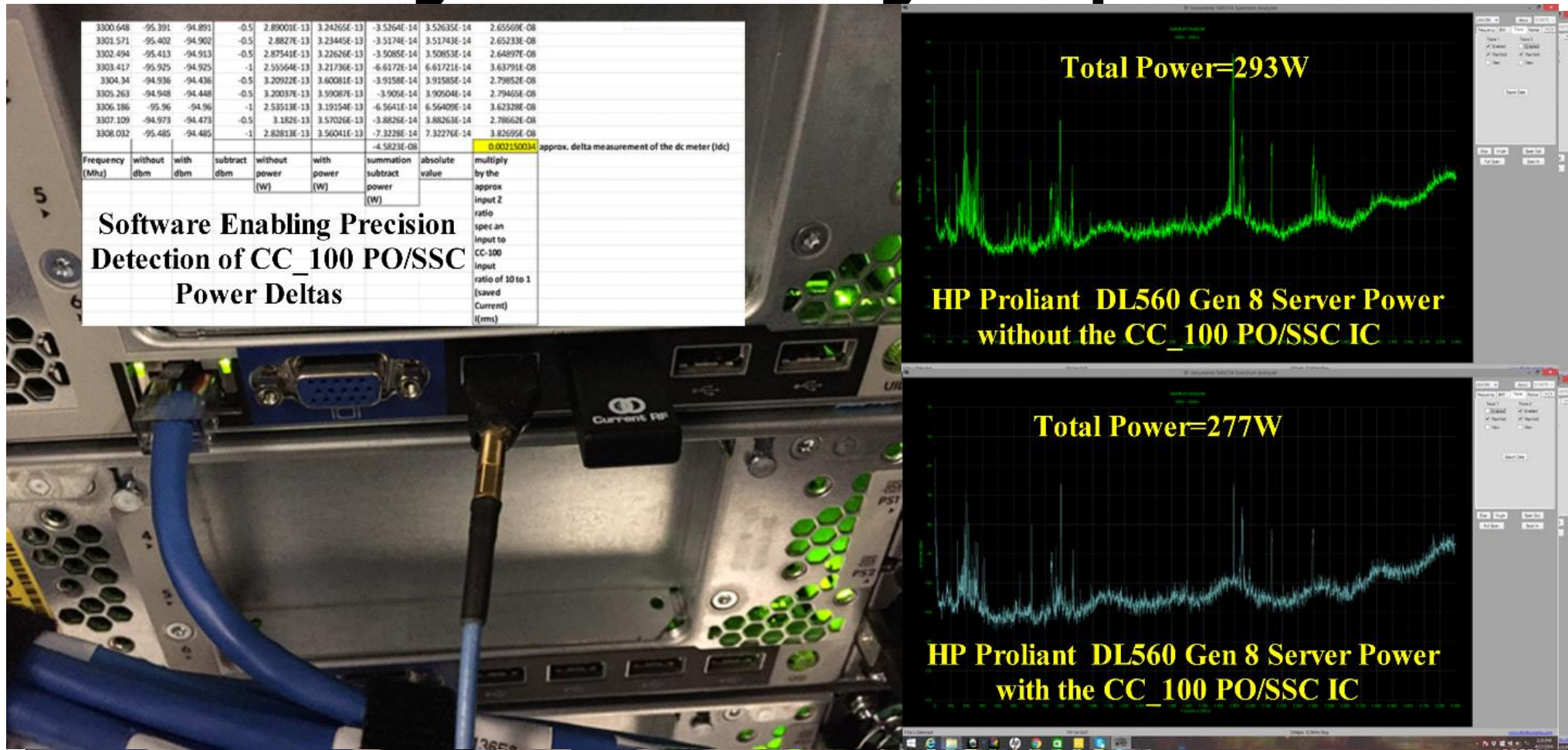
| | | | | | | | | | | |
|------|-----------|---------|---------|----------|-------------|-------------|-------------|-------------|-------------|--|
| 3583 | 3308.186 | -88.96 | -88.96 | 0 | 1.27057E-12 | 1.27057E-12 | 0 | 0 | 0 | |
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| 3585 | 3308.032 | -88.485 | -88.485 | 0 | 1.41742E-12 | 1.41742E-12 | 0 | 0 | | |
| 3586 | | | | | | | 2.21484E-06 | 0.001435877 | 0.000861526 | approx. delta measurement of the dc meter (dc) |
| 3587 | Frequency | without | with | subtract | without | with | summation | total | multiply | |
| 3588 | [MHz] | dBm | dBm | dBm | power | power | power | power | by the | |
| 3589 | | | | | (W) | (W) | (W) | (W) | approx | |
| 3590 | | | | | | | | | input Z | |
| | | | | | | | | | ratio | |
| | | | | | | | | | spec an | |
| | | | | | | | | | input to | |
| | | | | | | | | | CC_100 | |
| | | | | | | | | | input Z | |
| | | | | | | | | | ratio(6:1) | |
| | | | | | | | | | (saved | |
| | | | | | | | | | Current) | |
| | | | | | | | | | I(rms) | |

$dBm = 10 \log\left(\frac{P}{.001}\right)$ $i^2 * R = P$
 $inv \log\left(\frac{dBm}{10}\right) * .001 = P$ $i = \sqrt{\frac{P}{R}}$

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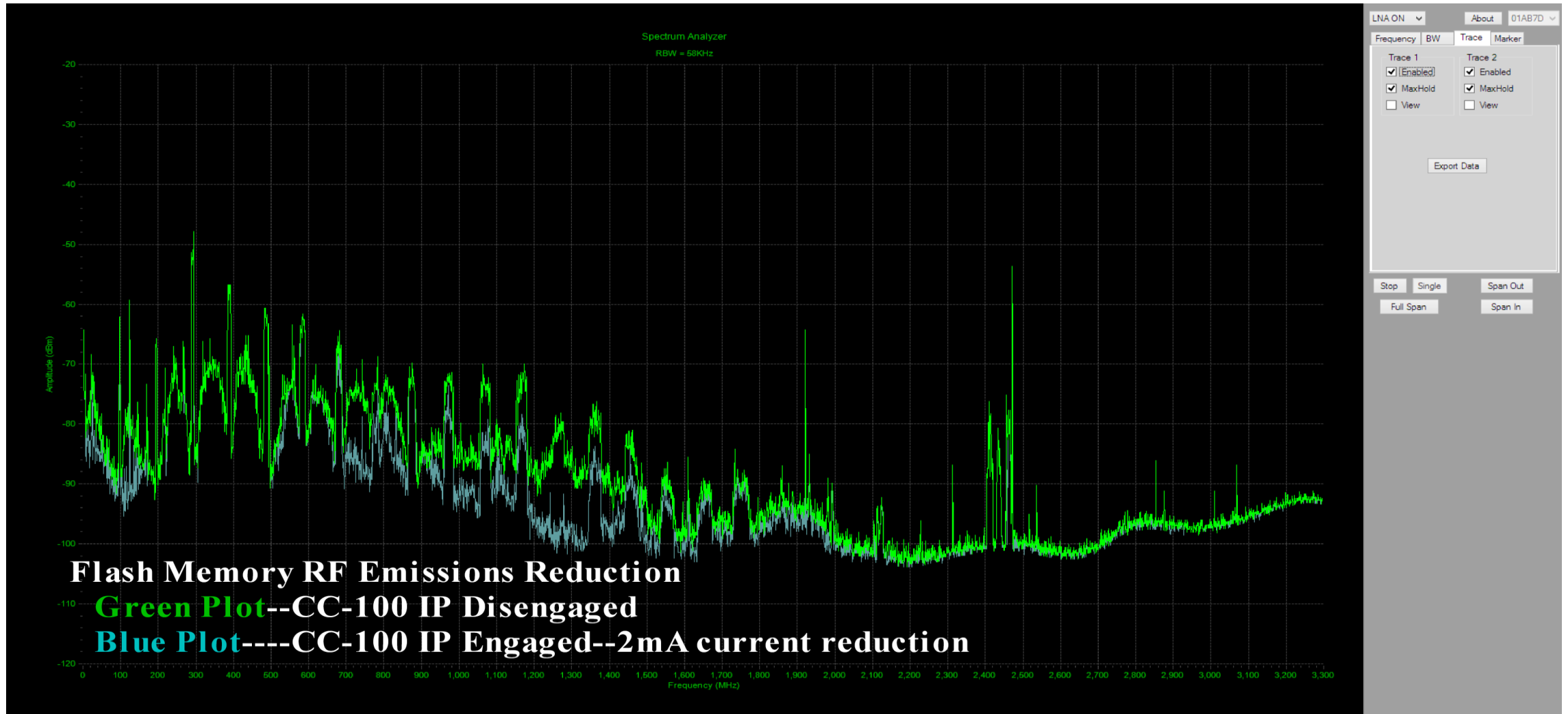


CubeSat Probing & Post Processing Capabilities for CC_100 PO/SSC IC and PowerStic Integration into Existing CubeSat Design & Optimization



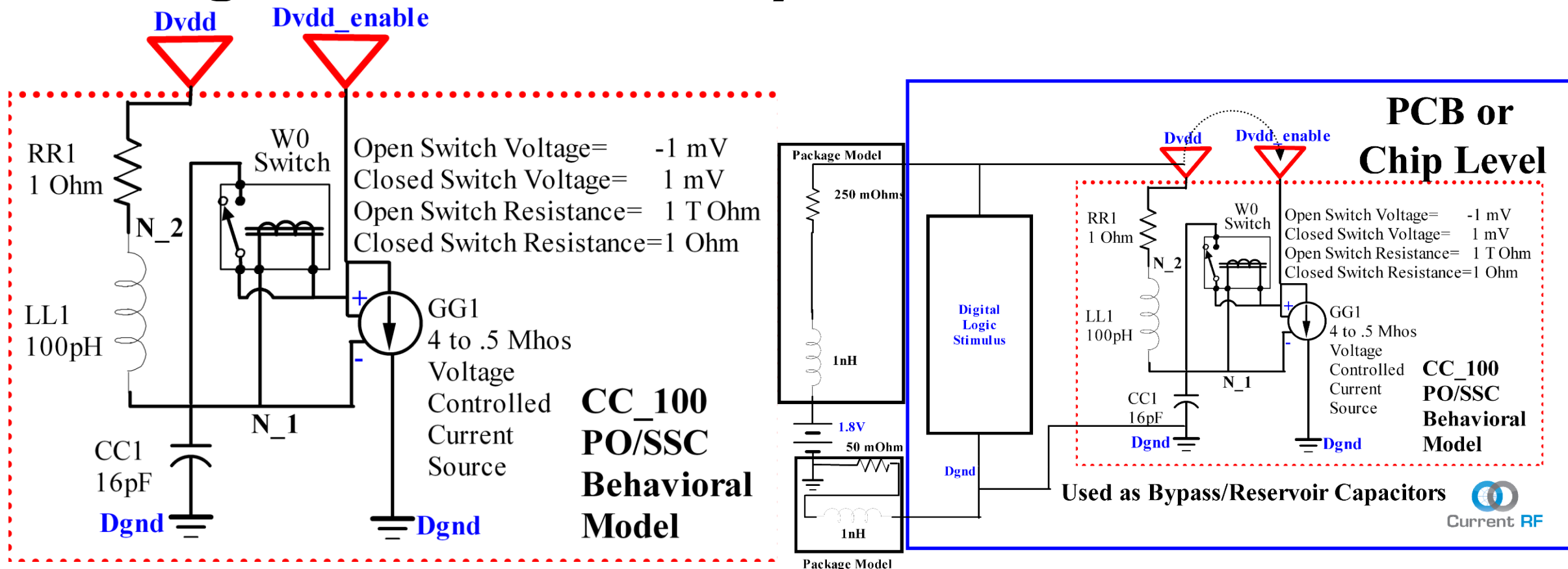
Integration into New System Designs

CC_100 PO/SSC IC Flash Memory Power and Emissions Reduction



Integration into New CubeSat Designs

CC_100 PO/SSC IC Behavioral Model and Testbench for CubeSat Simulation--Saving up to 36% in Dynamic Power & Enhancing CubeSat Sensitivity with the CC_100 PO/SSC IC

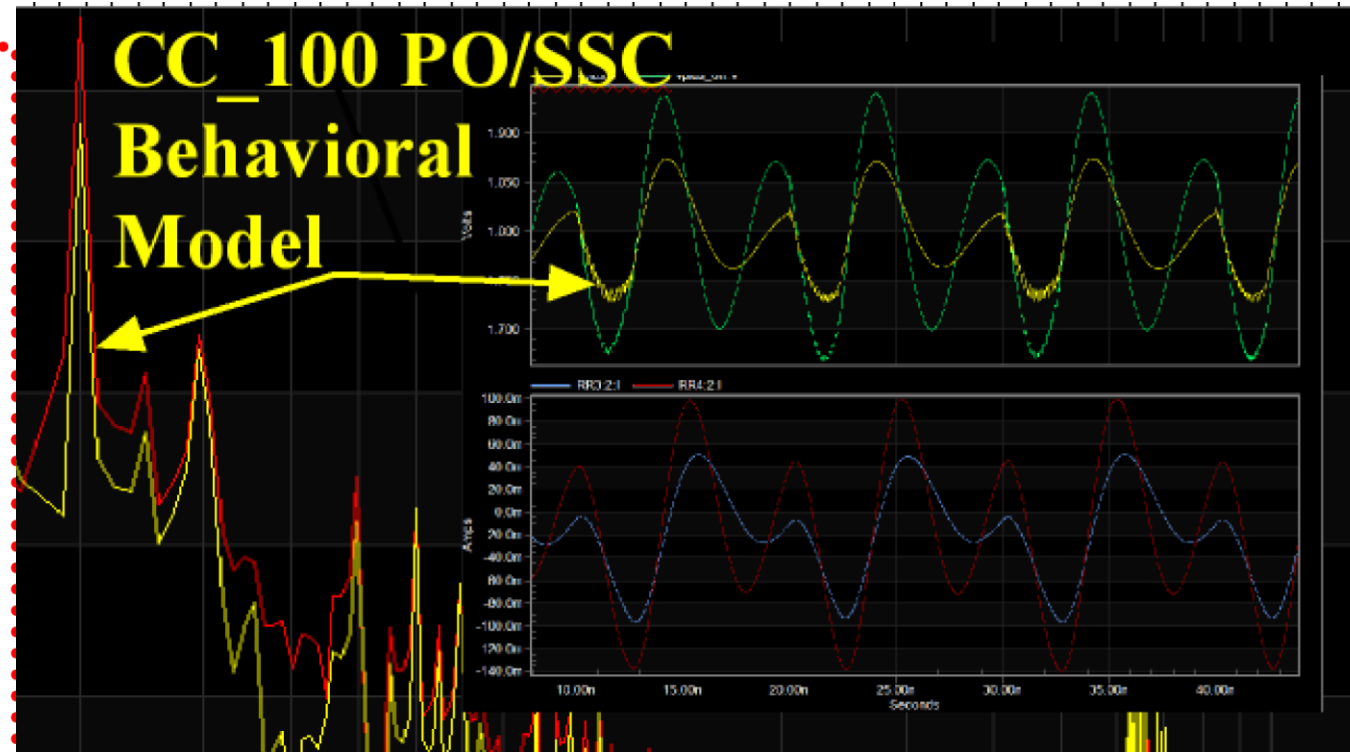
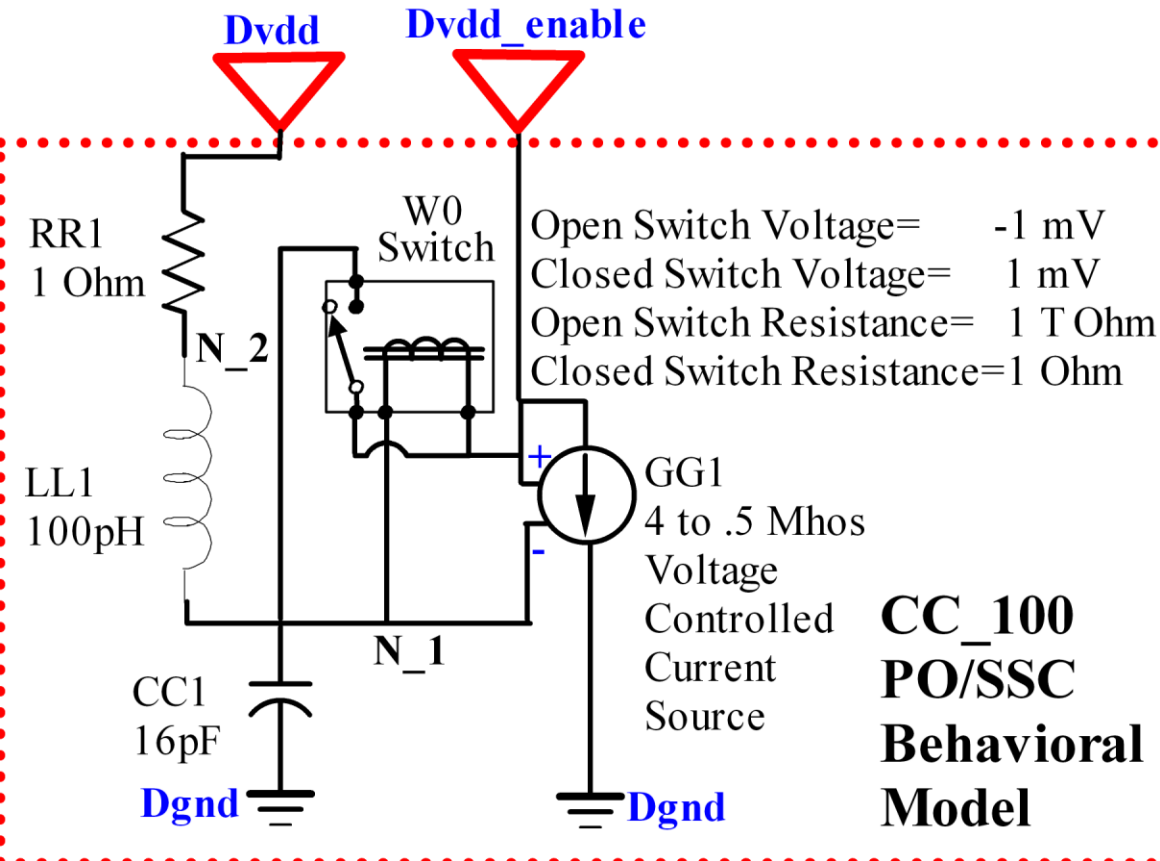


Integration into New CubeSat Designs

CC_100 PO/SSC IC Behavioral Model for System Simulation

Saving up to 36% in Dynamic Power and

Enhancing CubeSat Sensitivity with the CC_100 PO/SSC IC

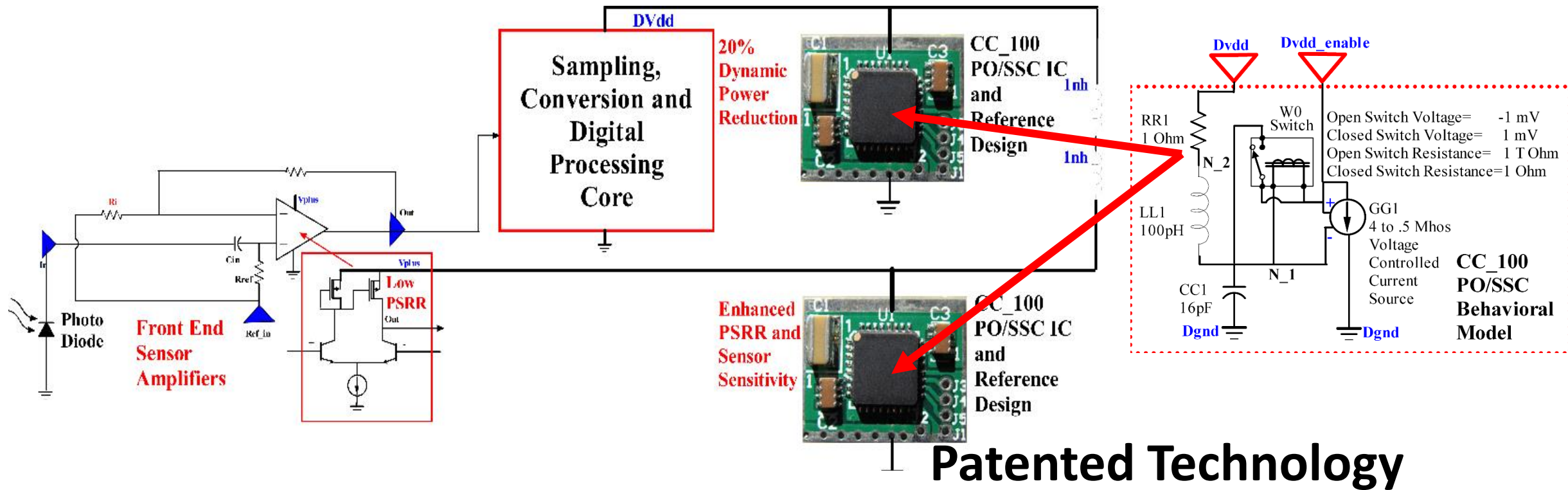


Integration into New CubeSat Designs

CC_100 PO/SSC IC Behavioral Model for CubeSat Simulation

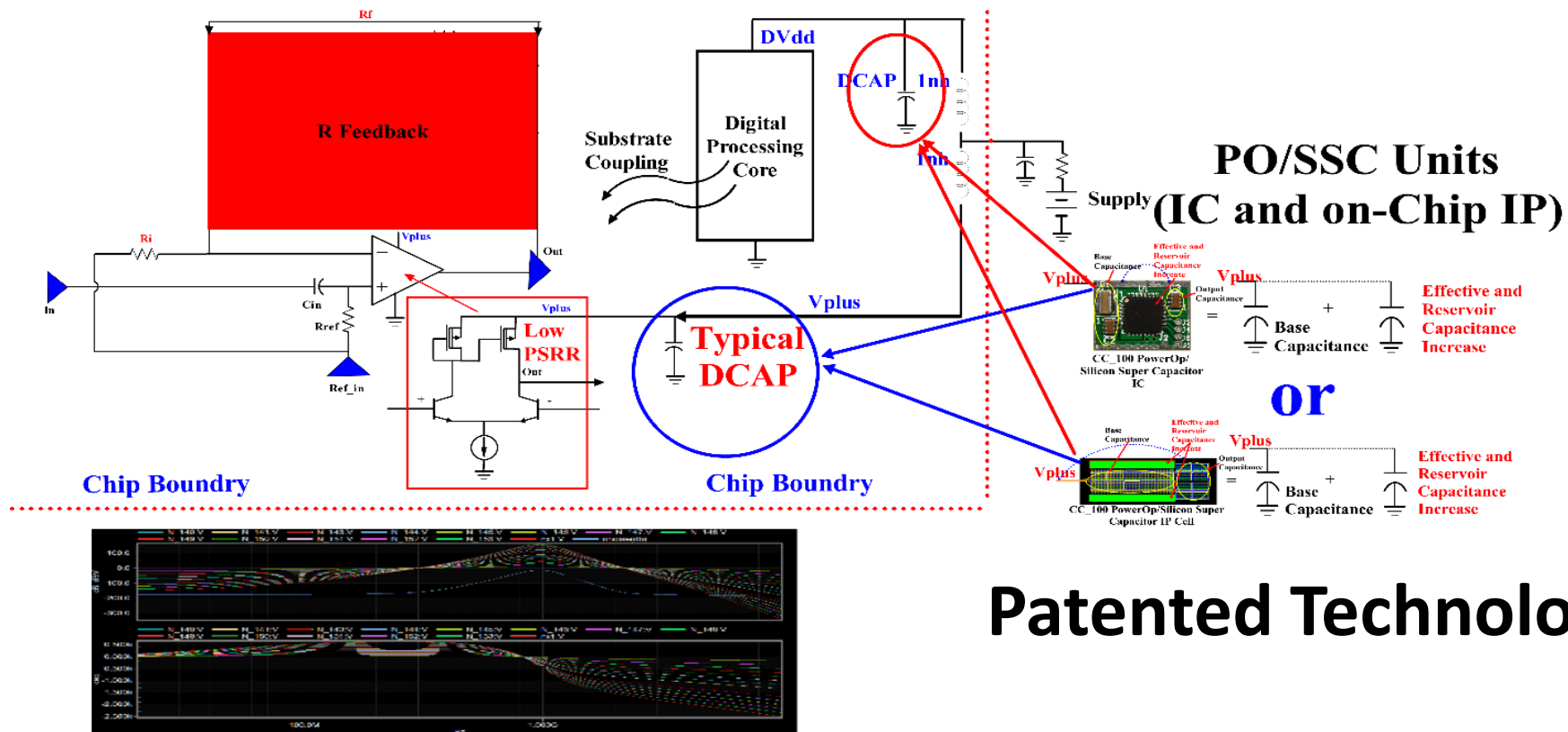
Saving up to 36% in Dynamic Power and

Enhancing CubeSat Sensitivity with the CC_100 PO/SSC IC



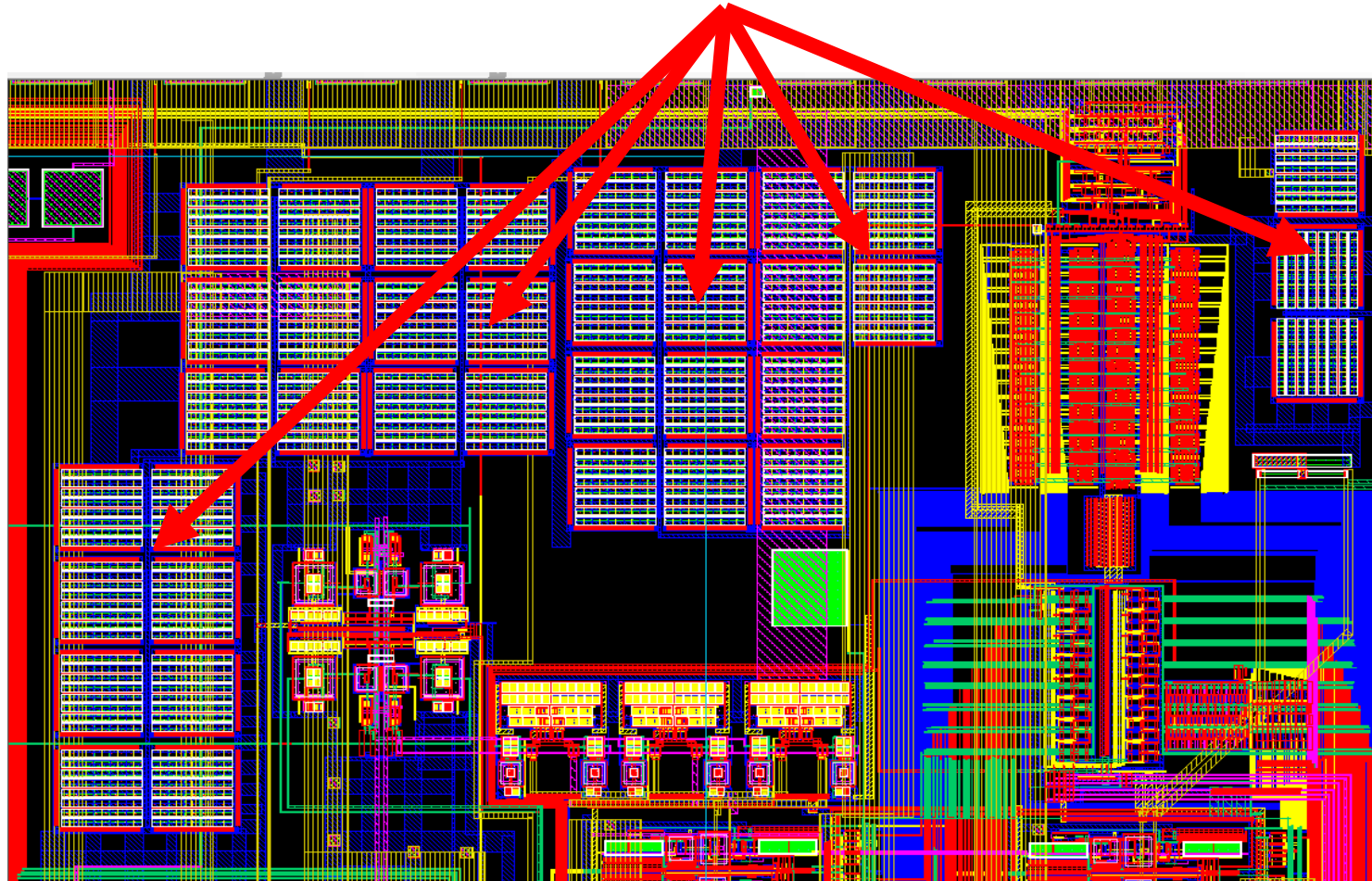
Integration into New CubeSat Designs

System Capacitor->Silicon Super Capacitor Replacement (Same Form Factor/Size)



Integration into New CubeSat Designs

Silicon Super Capacitor->On-Chip DCAP Replacement (Same Form Factor/Size)



Commercialization Expertise & Strategy

Using a Design Services and IP Strategy Targeted at Both Military and Commercial Entities:

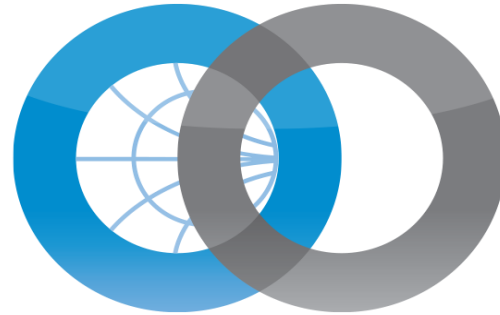
- Promote the use of the CC-100 PO/SSC IC in Power Saving and Sensitivity Enhancement Applications.
- Present the CC_100 PO/SSC IC Power Saving and Sensitivity Enhancement Applications at Trade Shows and Conferences.
- Promote and Design the CC_100 PO/SSC IC Devices into PCB efforts at the System Level (CubeSats, etc.).
- Promote and Design the CC_100 PO/SSC IC and IP Devices into IC efforts at the Integrated Circuit Level.



CurrentRF Logistics

- **Key Personnel:**
- **Mr. Michael Hopkins: PI and CurrentRF CEO**
- **Ms. Tami Hopkins: CurrentRF CFO**
- **Dr. Peter Gize: PhD Advisor and Sales/Marketing**
- **Mr. Jonathan Hopkins: IT Manager– CurrentRF**
- **Ms. Savannah Ford: Media Specialist—CurrentRF**
- **MidStreet Marketing: Sales and Marketing**
- **No Foreign Citizens**
- **No Sub-Contractors/Consultants**
- **No Prior, Present, or Pending Support**
- **Facilities: Office, Development, and Testing Facilities—Huntington Beach, Ca.**





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