Powering the DUT

DUT Power Supply Challenges for SSD Test.

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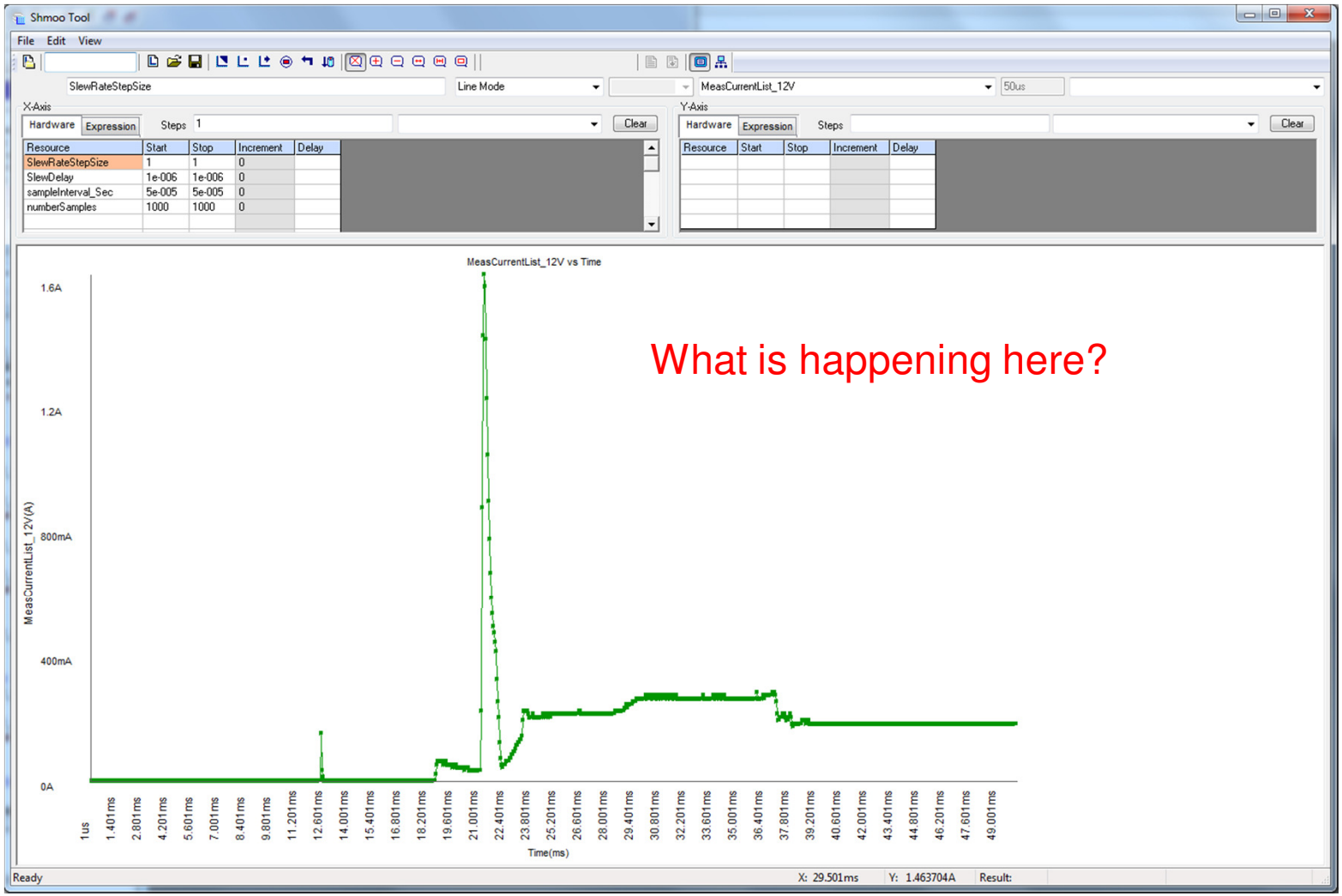
Outline

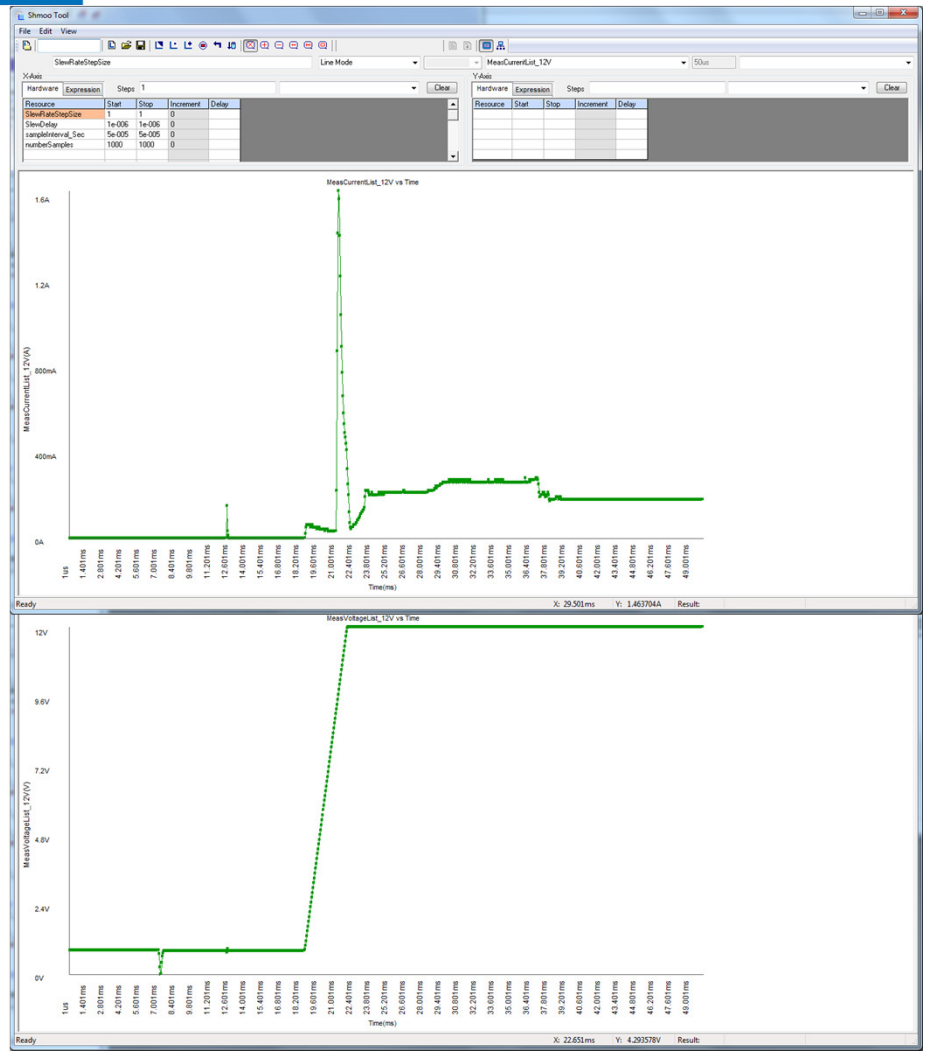
- Power On Power Profile
- Active Power Profile
- Unplanned Power Off
- DEV Sleep Measurement Requirements
- Conclusions

Power On Power Profile



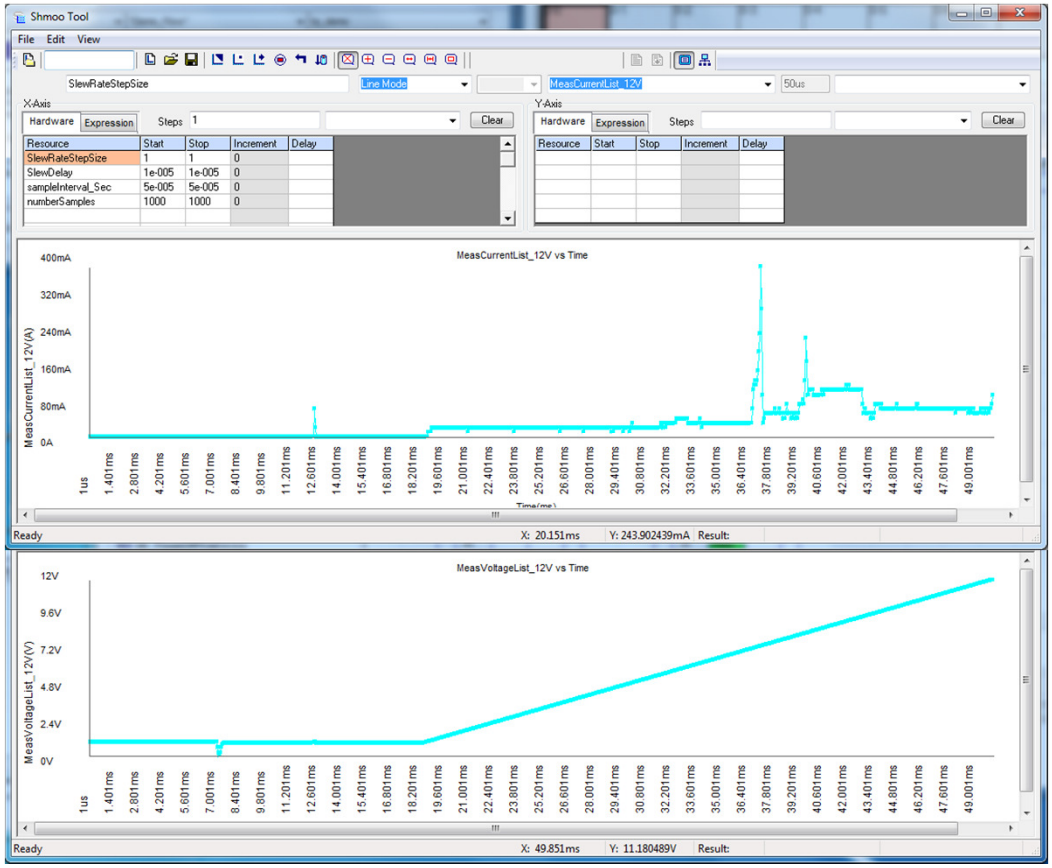
What is happening here?

Power On



- Transient Response
  - DPS + Layout
- Peak Current
  - > 6A available
- Sampling rate
  - 50us

Power On (2)



- SATA drive on PCIe adapter
- Slower Slew Rate Input
  - 0.34V / ms
- I = C*dV/dt
  - 50 – 60 uF

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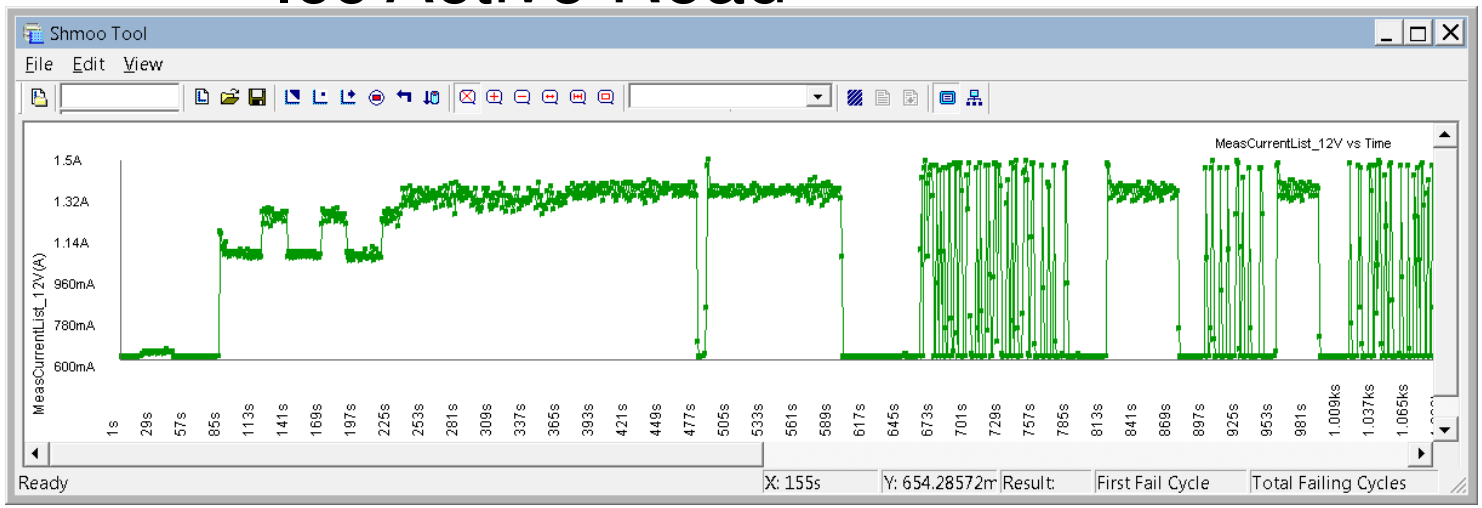
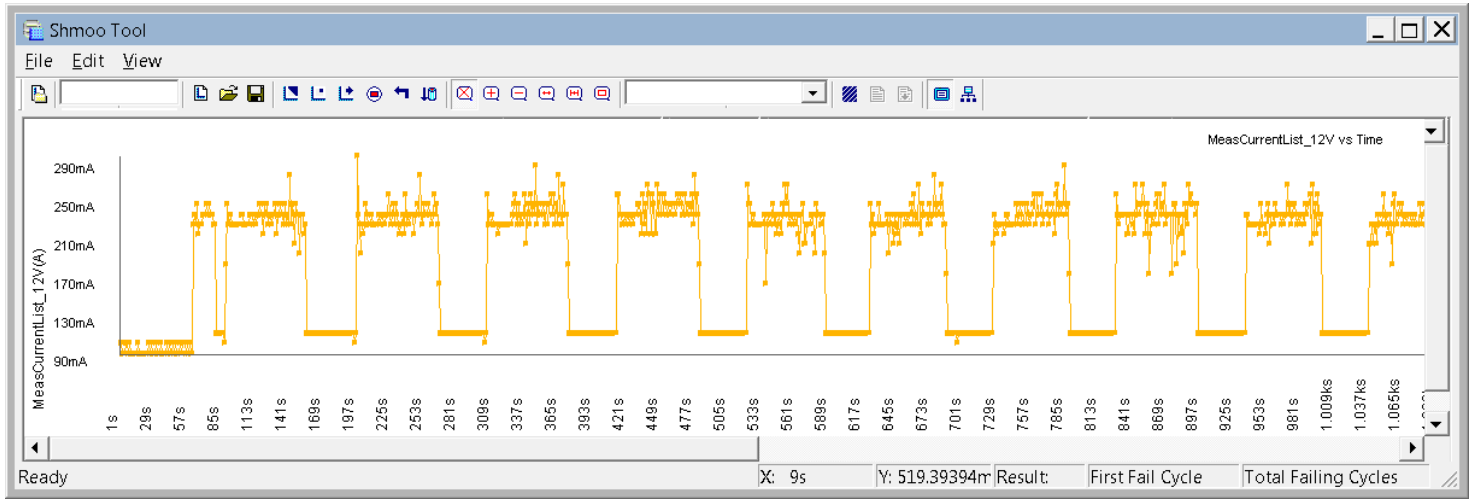
Active Power Profile

Icc Active Read

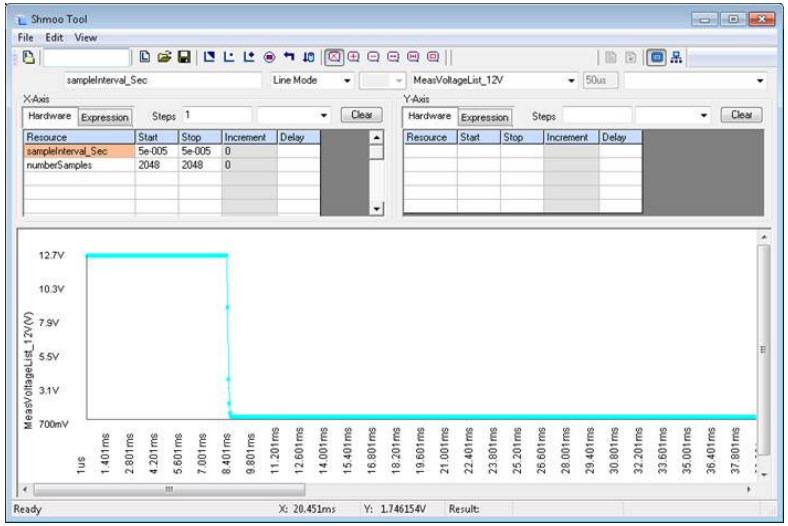
Drive “A”



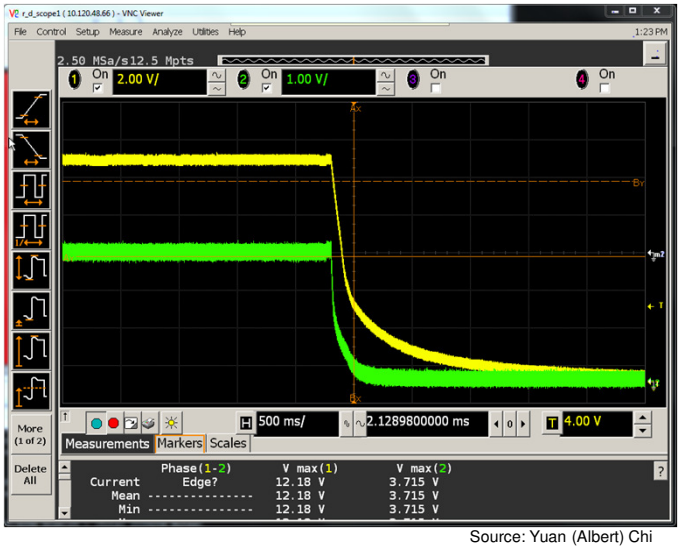
Drive “B”



Unplanned Power Off



One choice in the tester.



Source: Yuan (Albert) Chi

Measured in a typical PC.

- "#1 Failure Mode".
  - Device must retain all acknowledged data.
- Slew Rate and Connect/Disconnect.
  - Can emulate many waveforms.

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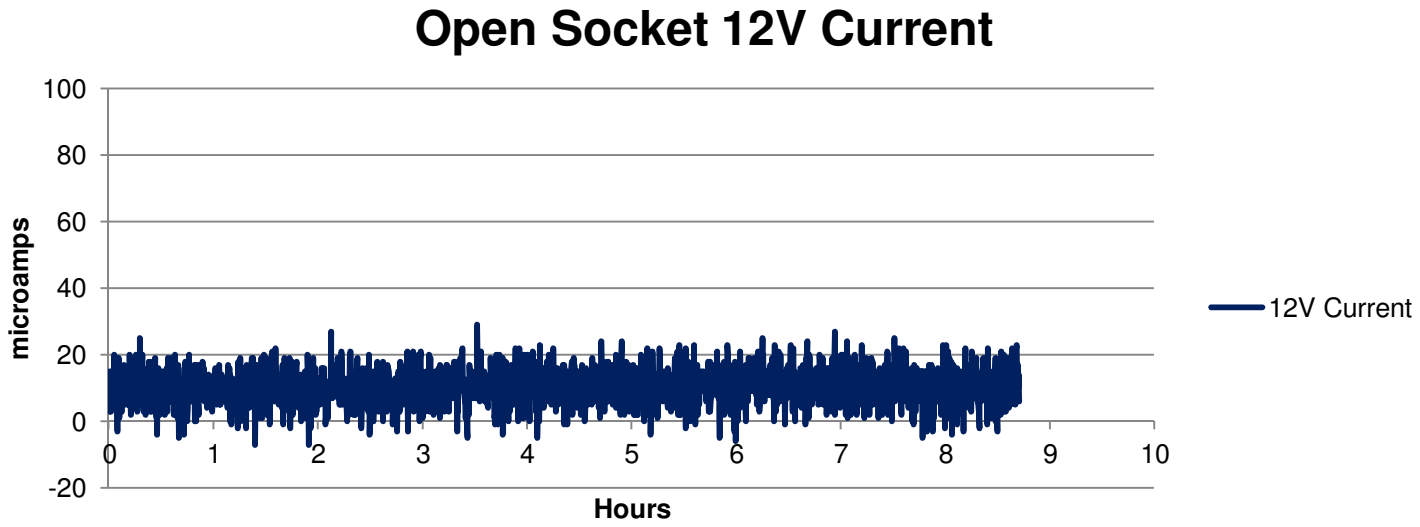
DEV Sleep Measurement Requirements

- Stable open socket calibration.
  - Compensates for leakage and zero errors.
- Avoid measurement range changes.
  - May cause glitches.
  - Single range allows DUT to wake up and draw full current at any time.
- Use DSP (Averaging) for resolution and noise improvement.
  - DSP allows simpler hardware.
  - Watch out for 1/f noise in your tester hardware.

Stable Open Socket Calibration



- Measured every 15 seconds.

Averaging - Resolution

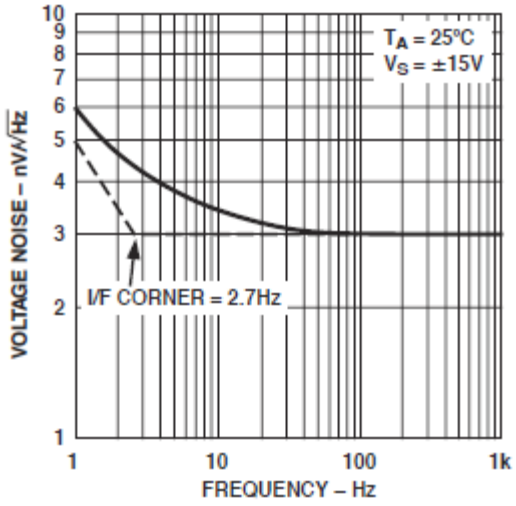
- Averaging N measurement samples improves the measurement resolution by 1/N
  - For example:
    -Hardware resolution = 95uA,
    -Average 4096 samples,
    -Effective resolution = 95uA/4096 = 23nA

Averaging - Noise

- Averaging N measurement samples improves the resultant measurement standard deviation (i.e. noise, or repeatability) by 1/sqrt(N).
  - For example:
    -Standard deviation of a sequence of single measurements = 0.25mA,
    -Average 4096 samples,
    -Standard deviation of a sequence of 4096 point averages = 0.25mA / sqrt(4096) = 3.9uA

Averaging - 1/f noise

- 1/f noise increases in amplitude as the frequency decreases.
  - 1/f noise breaks the noise improvement of averaging.



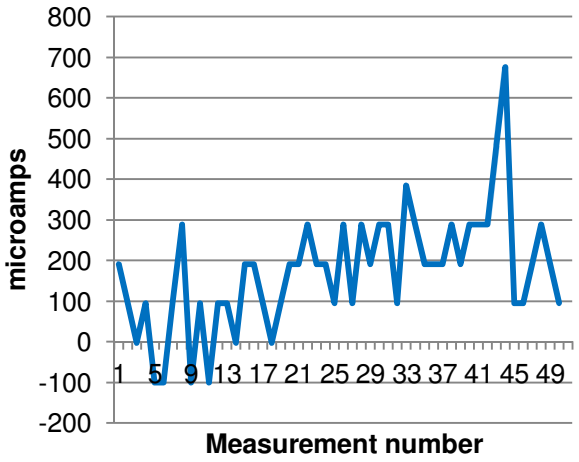
TPC 2. Voltage Noise Density vs. Frequency OP37 Source: Analog Devices

- Example: OP37 – Noise increases for averaging times longer than ~100ms.
- Advantest uses special amplifiers (called chopper-stabilized) that move the 1/f noise to high frequencies where it can be filtered out.

Averaging Results

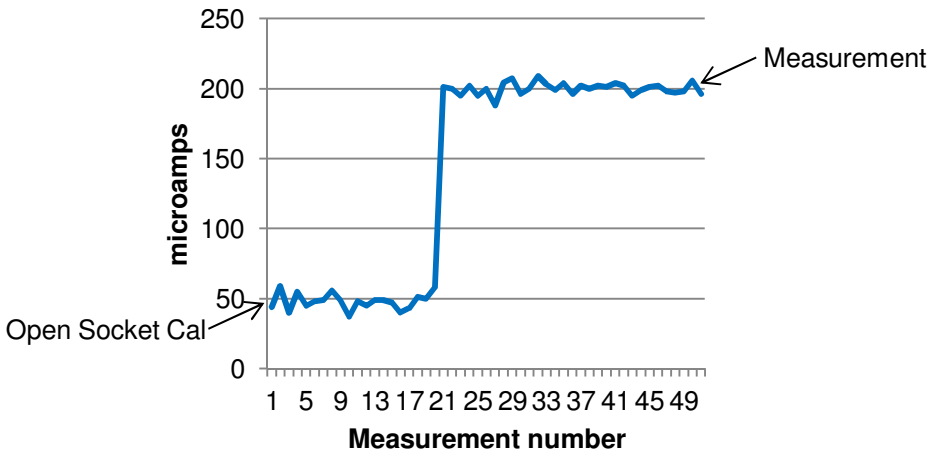
- Measured current drawn by a 21.65K resistor connected to the 3.3V supply.

Measured 21.65K Resistor with No Averaging



Not measurable.

Measured 21.65K Resistor with 64K Averages



Measured: 153.3uA.
Calculated: 152.8uA
Error: 0.3%

Conclusions

- Powering up an SSD requires carefully designed DPS characteristics.
- The Power Profile is an excellent tool for understanding the power aspects of DUT operation.
- DSP (Averaging) can tremendously increase measurement capability.

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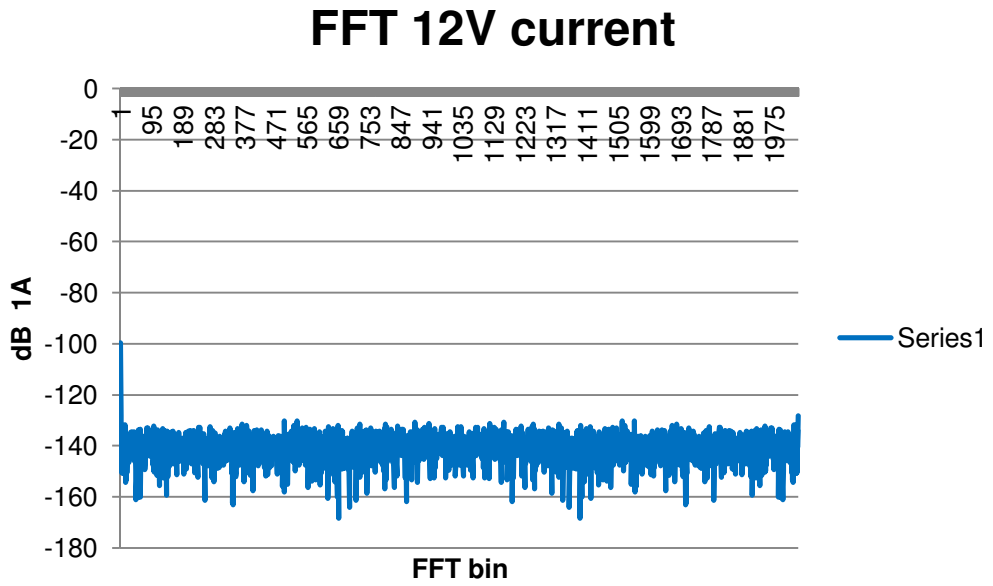
Backup

Noise Spectrum is flat past 32 microHz !



Bin 1 => DC

Bin 2 => 32.568 microHz

Bin 1024 => 33.34 milliHz