Power Integrity Workshop
Debug and characterization using an oscilloscope.

Speaker Name Bold Arial
All Else Regular Arial

KEYSIGHT TECHNOLOGIES

Power Integrity Workshop

Debug and characterization using an oscilloscope.

Workshop goals or outcome.

- Debug and test PDN's (power distribution networks) with more precision, accuracy and confidence.
- More easily isolate root cause.
- Avoid false negative (or positive) test results.
- Know what specialized tools will make your job easier.

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Debug and characterization using an oscilloscope.

Agenda

- Introduction: The need for PI measurements. (15 min)
- Hands-on labs:
  - Get to know the S-Series and new UI (15 min)
  - Noise—minimize unwanted scope noise (20 min)
  - Break, Questions or Buffer (20 min)
  - Measuring common power rails (15 min)
  - Reducing scope and probe loading (10 min)
  - Maximizing BW when needed (10 min)
  - Frequency domain for noise source analysis and triggering for noise components (15 min)

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Agenda

– Hands-on lab: Noise—minimize unwanted scope noise.
  - Lowest noise oscilloscope path.
  - BW limit to reduce measurement system noise.
  - The affects of attenuation ratio.
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Agenda

– Hands-on lab: Lowest noise oscilloscope path.

- Hardware: S-Series
- Set-up file : “50ohm 1meg compare.set” (BW 500MHz, 5us/, 1mV/)
- Composite file: “50ohm 1meg noise compare.osc”
- Default set-up, recall set-up
- Add Vpp and Vrms meas to Ch1
- Open Ch1 dialogue and move to upper right.
- Select between 50 ohm and 1M ohm and compare meas. (this is a null meas. Good idea to do with whole set-up, scope/probe to be sure they are up to the task).

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Agenda

– Hands-on lab: BW limit to reduce measurement system noise

- Hardware: S-Series
- Set-up file : “50ohm 1meg compare.set” (BW 500MHz, 5us/, 1mV/)
- Composite file: none
- Continue from previous example (low noise path)
- Add FFT to CH1
- Open CH1 dialogue box (if not already) and change BW 500MHz at a time up to max and back down to 500MHz.
- Select Analog BW limit 200Mhz and 20Mhz

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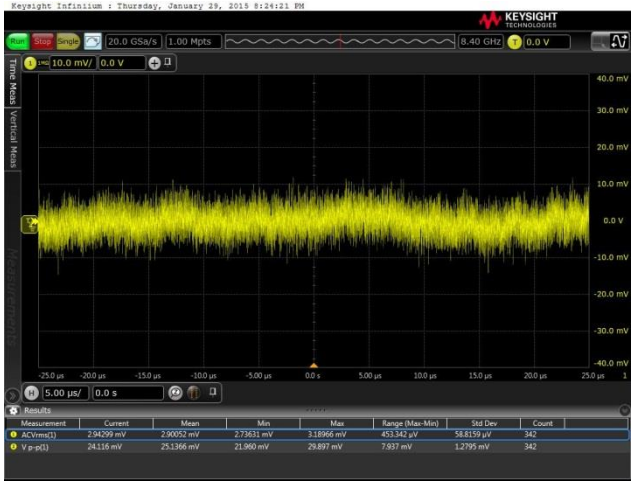
– Hands-on lab: The affects of attenuation ratio

- Hardware: S-Series
- Set-up file : “50ohm 1meg compare.set” (BW 500MHz, 5us/, 1mV/)
- Composite file: “50ohm 1meg noise compare.osc”
- Continue from previous example (BW limit to reduce noise)
- Set analog BW limit to “Off”, Set input impedance to 1M
- Turn-off FFT (Function 1)
- Close CH1 dialogue box
- Set CH1 vertical to 1mV/
- Note Vpp and Vrms
- Plug-in 10:1 passive probe and note Vpp and Vrms



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– Hands-on lab: Extra Credit—50ohms into 1M

- Hardware: S-Series and demo board
- Set-up file : none
- Composite file: “50ohm into 50 and 1M noise.osc”
- Plug USB cable into demo board, SEL left, S401 pos2 left.
- Set vert to 1V/
- Open Ch1 dialogue and set to 50 ohm
- Connect BNC-SMA to 10MHz clock and Ch1
- Set Ch1 to 1M (impedance mis-match causes reflections and amplitude errors—2 out of 3)
- Optional—connect 10:1 passive to ch2, clip alligator ground to probe, ground on adjacent SMA and probe signal. Now remove alligator and attach short ground spring and probe (better quality)
  - Have a discussion about return currents and ground lead inductance.

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Agenda

– Hands-on lab: Ground lead length—shorter is better

- Set-up file: none
- Composite file: “ground lead length compare.osc”
- Continuer from previous lab.
- connect 10:1 passive to ch2, clip alligator ground to probe, ground on adjacent SMA and probe signal.
- Now remove alligator and attach short ground spring and probe (better quality)
  - Have a discussion about return currents and ground lead inductance.

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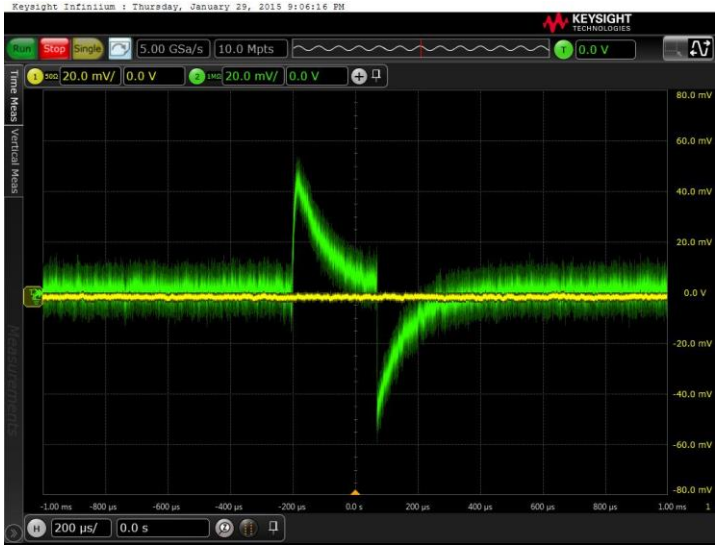

Agenda

– Hands-on lab: High Impedance antennae

- Set-up file: none
- Composite file: “high imp antennae.osc”
- Default set-up
- Connect Kona browser to SMA-BNC adapter and connect to CH1

– **OR**

- Connect Kona browse to Kona and Kona to Ch1
- Connect 10:1 passive to Ch2
- Turn-on Touch Screen (if not already)
- Set vertical to 20mV/ and horizontal to 200uS
- Hold both probes close and observe noise coupling into high impedance path
  - Have a discussion switchers and other things coupling into passive probes when making PI measurements..

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– Hands-on lab: measuring common power rails.
  - Maximize dynamic range.
  - Know the limits of dc blocks.

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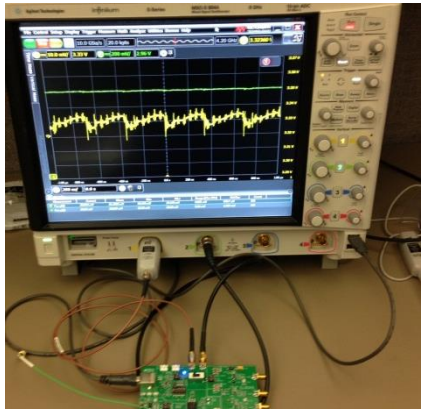
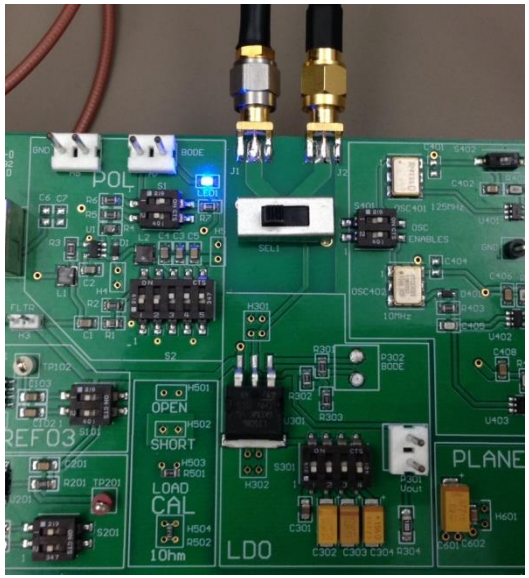


– Hands-on lab: measuring common power rails.
  - **Maximize dynamic range.**
  - Hardware: Kona, BNC-to-SMA cable, USB-A-B cable, Kona demo board.
  - Set-up file : “offset on 3,3 demo board.set” (5GSa/s, 1ms/, 5.0V offset, 20mV/)
  - Composite file : “offset on 3,3 demo board.osc” (ch 1 10mV, 3.33V offset, ch2 200mV, 2.96V offset, trigger ch1 3.324V, 200ns/div)
    - Connect Kona and BNC-SMA cable to demo board sma connectors. Connect usb to demo board and to scope.
    - Default set-up. Recall set-up. Connect Kona. Connect BNC cable.
    - Hit run.
    - Add a Vpp measurement to ch2
    - Turn-on channel 1 (after a while press stop—optional)
    - Add Vpp meas to ch1
    - Notice ch2, overstates the answer by about 25%.



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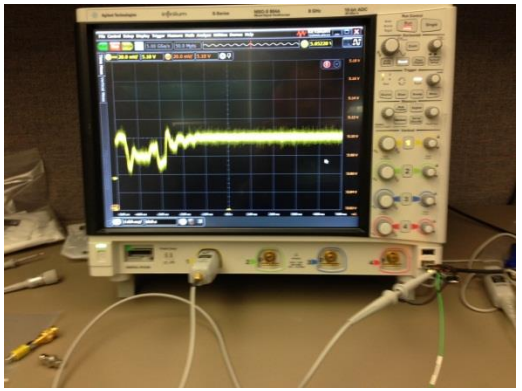
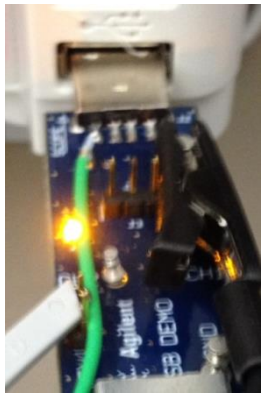


– Hands-on lab: measuring common power rails.
  - **Know the limits of dc blocks.**
  - Hardware: Kona, Kona Browser, USB demo board (ignore green wire in photo), dc block, sma to bnc adapter, passive probe ground lead, passive probe grabber.
  - Set-up file : “dc block on usb.set” (5GSa/s, 1ms/, 5.0V offset, 20mV/)
  - Composite file: “dc block on usb kona.osc” (traces trying to capture below—Kona mem1, dc block mem2)
    - Grabber and ground lead on browser and attach to Kona. Grabber to header pin +5V (pin by J4 on board) and grabber to ground stud on USB board.
    - Default set-up. Recall set-up, attach Kona, plug-in usb, hit “run”.
    - Kona on, let it run and see drop-outs.
    - “Stop” (or set trigger) to capture a drop-out.
    - Save waveform to waveform memory 1.
    - Remove Kona, remove browser from Kona, attach dc block and BNC adapter to browser.
    - Change ch1 to 50ohms if not already (scope may kick it into 1M when removing Kona).
    - Attach browser/block/adapter and press “run”
    - Set ch1 offset to 0V (type it in or press knob).
    - Observe that no drop-outs are seen.



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– Hands-on labs: Reducing scope and probe loading

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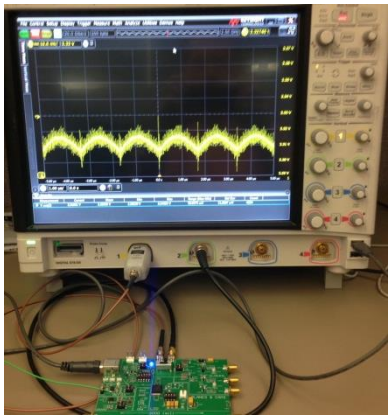
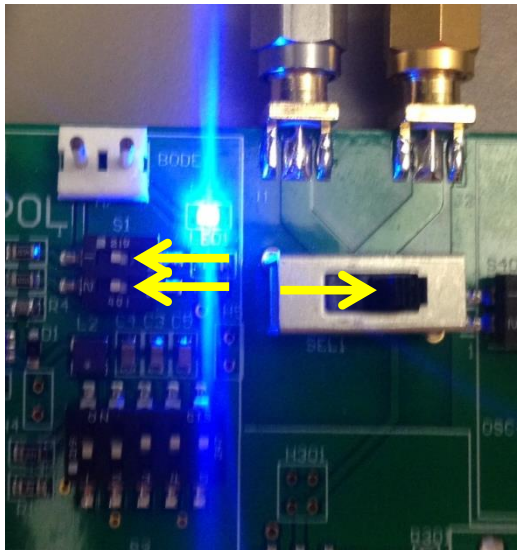


- Hands-on lab: Reducing scope and probe loading
  - Hardware: Kona, Kona demo board, BNC-to-SMA cable
  - Set-up file : “50ohm loading.set” (BW 500MHz, 1us/, 3.33V offset, 10mV/)
  - Composite file: “50ohm loading.osc” (Before connecting 50ohm Mem1, after Mem2)
    - Be sure to set switches as shown on demo board (this is different from default state)—all the way to right and all the way to the left.
    - Connect demo board to USB and plug USB into scope
    - Connect Kona to sma on demo board, connect BNC/SMA cable to demo board but DO NOT connect it to the scope yet.
    - Default set-up, recall set-up
    - Connect Kona to scope
    - “Run”
    - Add Vave meas to Ch1
    - Note the Vave reading.
    - Now connect the BNC/SMA cable to ch2.
    - notice the waveform moved and decrease of Vave (~25mV).



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– Hands-on lab: Maximizing BW when needed.
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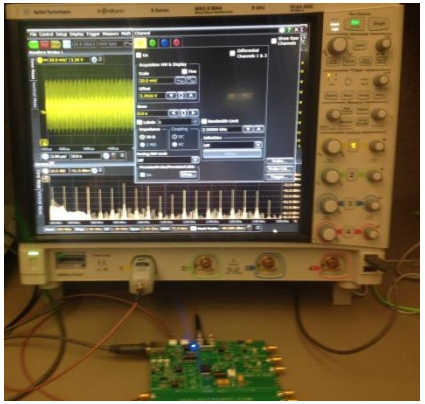

- Hands-on lab: Maximizing BW when needed
- Hardware: Kona, Kona demo board
  - Set-up file : “BW example.set” (BW 500MHz, 2us/, 3.33V offset, 20mV/, fft 100Mhz start—2.5GHz stop)
  - Composite file: “BW example.osc”
    - Set demo board switches as shown (see following slide)
    - Connect Kona to sma on demo board
    - Factory default set-up, recall set-up.
    - Connect Kona to scope
    - “Run”
    - Move Switch S401, position 1 to left—notice the extra noise on the supply. We turned on a 125MHz clock.
    - Grab top of spectral window and pull it up
    - Open Ch1 dialog and move to upper right
    - Begin increasing Ch1 BW limit 500MHz at a time to 2.5GHz pausing each time—notice how the noise spikes continue in BW.

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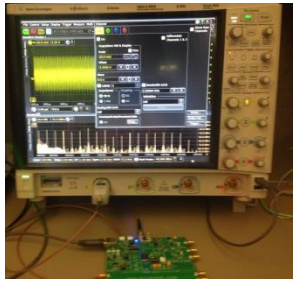
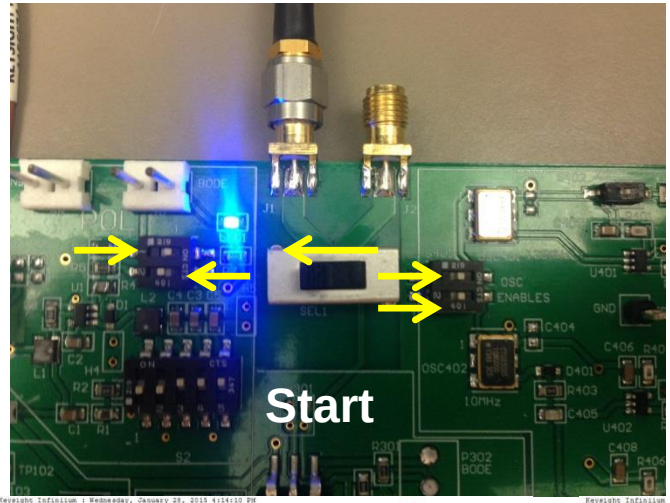
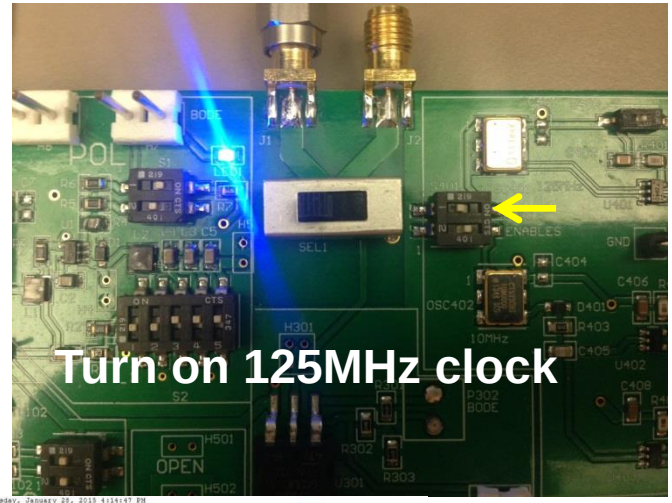
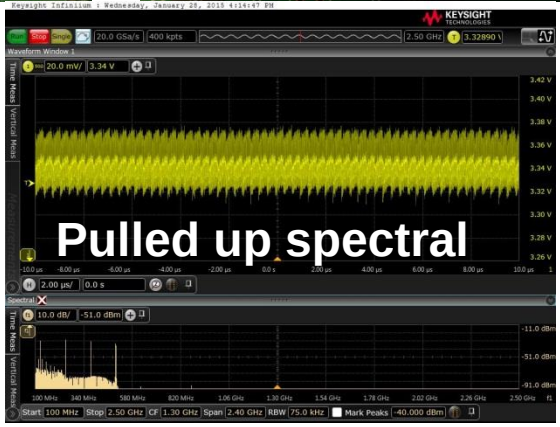


– Hands-on lab: Maximizing BW when needed







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– Hands-on lab: Frequency domain for noise source analysis and triggering for noise components

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- Hands-on lab: Frequency domain for noise source analysis and triggering for noise components

- Hardware: Kona, Kona demo board, BNC-SMA cable
  - Set-up file : “fft.set” (BW 200MHz, 10GSa/s, 500ns/, 3.34V offset, 20mV/, trigger ch1 3.311V fft1 1Mhz start—15MHz stop, fft2 10Mhz—200MHz both on Ch1)
  - Composite file: multiple
    - Set demo board switches as shown (see following slide)
    - Connect Kona to sma on demo board, connect BNC-SMA to 10MHz clock
    - Factory default set-up, recall set-up.
    - Connect Kona and BNC-SMA cable to scope
    - “Run” (looking at output of 2.8MHz switcher—POL)
    - Grab top of spectral window and pull it up (notice some spikes but RBW is wide—need longer aqc)
    - Change time base to 20us/ (notice 2.8 spike, 10MHz spike and 125MHz spike)
    - Move SEL1 switch all the way to the right (now looking a the LDO, notice 10MHz is bigger)
    - Create 2 Grids, turn on channel 2 (be sure it’s in grid 2)

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- "Stop" and change time base to 50ns/, move FFT down out of way (see any correlation?)
- Trigger on Ch2 and run.
- Turn-on averaging (this is the noise correlated to the 10MHz clock).
- Save CH1 to Memory1 and move up/down out of the way.
- Turn off averaging and then "Stop" (you can kind of see similarities between correlated and supply)
- Move BNC-SMA cable to 125MHz clk . "Run" and then after a while "Stop" (correlation?)
- "Run" and turn on averaging.
- "Stop", CH1 to Memory2 and move up/down out of the way.
- Turn averaging off, "Run" then "Stop". (can kind of see both saved traces in live trace).