Crosstalk - Substrate and P.S. Coupling

- Significant (few %) crosstalk/instability observed in previous prototypes:
  "Analog crosstalk" - differentiated, proportional to input Q
  "Digital crosstalk" - response to discriminator firing
  The digital crosstalk in particular was ~independent of distance

- Literature studied (particularly Verghese et al)

  HP 0.5u process: heavily-doped substrate:
  - 500u thick, 50 mohm-cm -> 1 ohms/square
  - lightly-doped epi layer:
    - 6u thick, 20ohm-cm -> 33k ohms/square

  Observations:
  - Substrate can be treated as a single node
  - Nodes with large dV/dt will couple strongly to substrate
  - unless substrate contacts are within one epi thickness
  - of switching FETs

- Remediating Measures (new features in ASD98b underlined):

  REducing Noise Generation

  - Balanced, differential topology adopted throughout
  - LVDS driver p.s. resistively degenerated with ~kohms
  - Separate power pads for output drivers
  - Guard rings around all digital circuits within 8um
  - Nwell/Vdd/Gnd/Substrate all separate (own bond pads)

  Isolating Sensitive Circuits

  - Analog circuits surrounded by guard rings
  - All-differential analog topology
  - Separate power pads for analog circuits
  - Re-design of preamp/bias circuit for better PSRR
  - Separate bond pads for bypass cap in bias circuit

- Results:
  - Analog crosstalk < 0.3%.
  - Digital crosstalk: not measurable
FIGURE 6.2 Current flow lines in a heavily-doped substrate.
FIGURE 6.3 The single node model for a heavily-doped substrate.
FIGURE 9.8 Substrate Contacts on Switching ground. (usually not recommended!)
FIGURE 9.10 Substrate Contact to Kelvin Top-Side Ground. (good!)
ASD Lite has 5 sets of power/substrate connections

Test results:

Local connection between well/Vdd and Bulk/GND has little effect
Disc98b Layout

Guard Rings (N-Well)

Guard Rings (substrate)

15u