

## 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 firingThe digital crosstalk in particular was  $\sim$ independent of distance
- Literature studied (particularly Verghese *et al*)

HP 0.5u process: heavily-doped substrate:

500u thick, 50 mohm-cm  $\rightarrow$  1 ohms/square

lightly-doped epi layer:

6u thick, 20ohm-cm  $\rightarrow$  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):

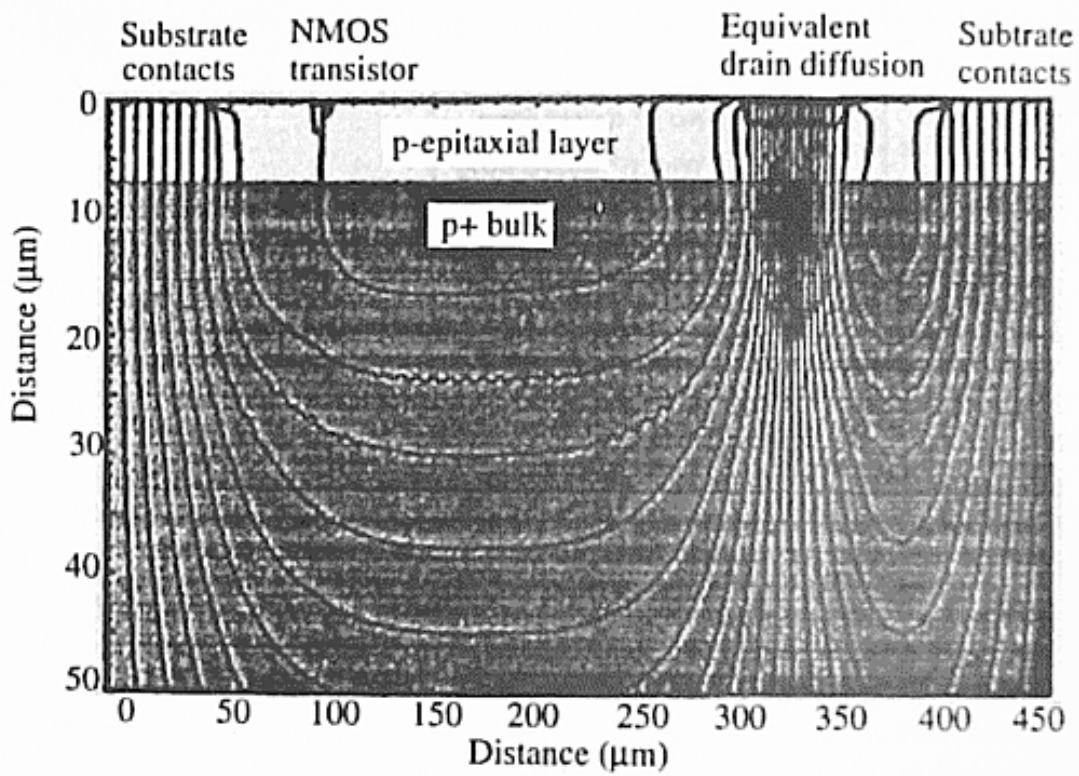
### REDUCING NOISE GENERATION

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

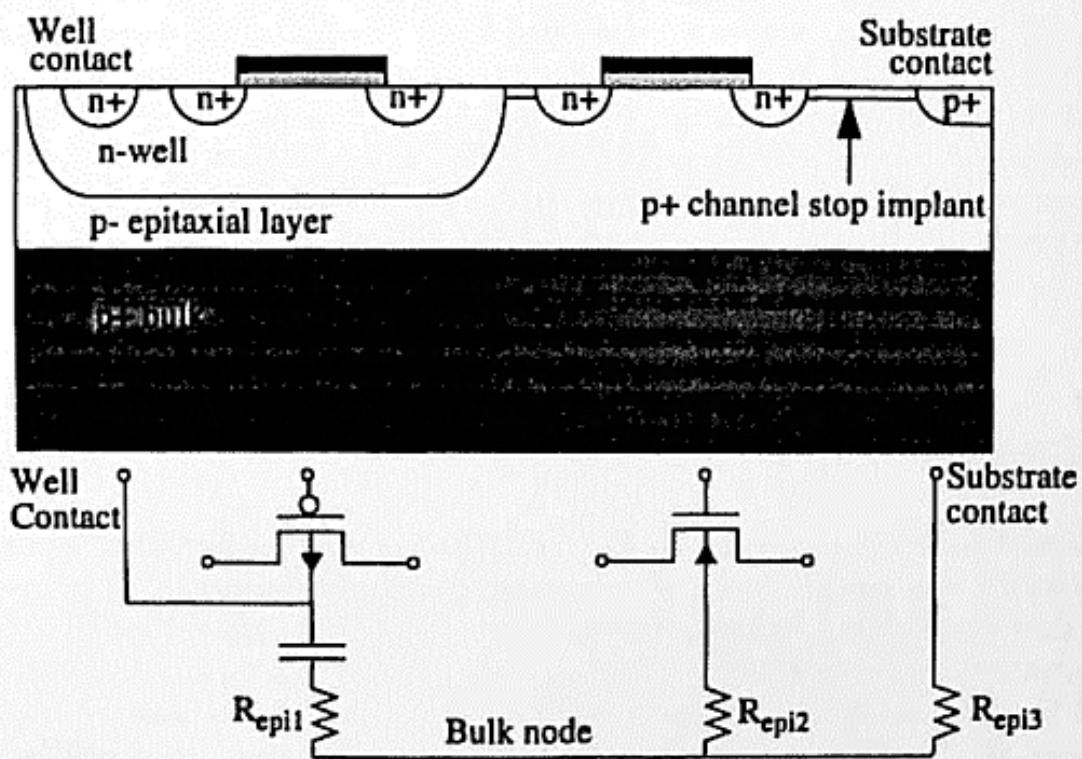
### ISOLATING SENSITIVE CIRCUITS

- 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

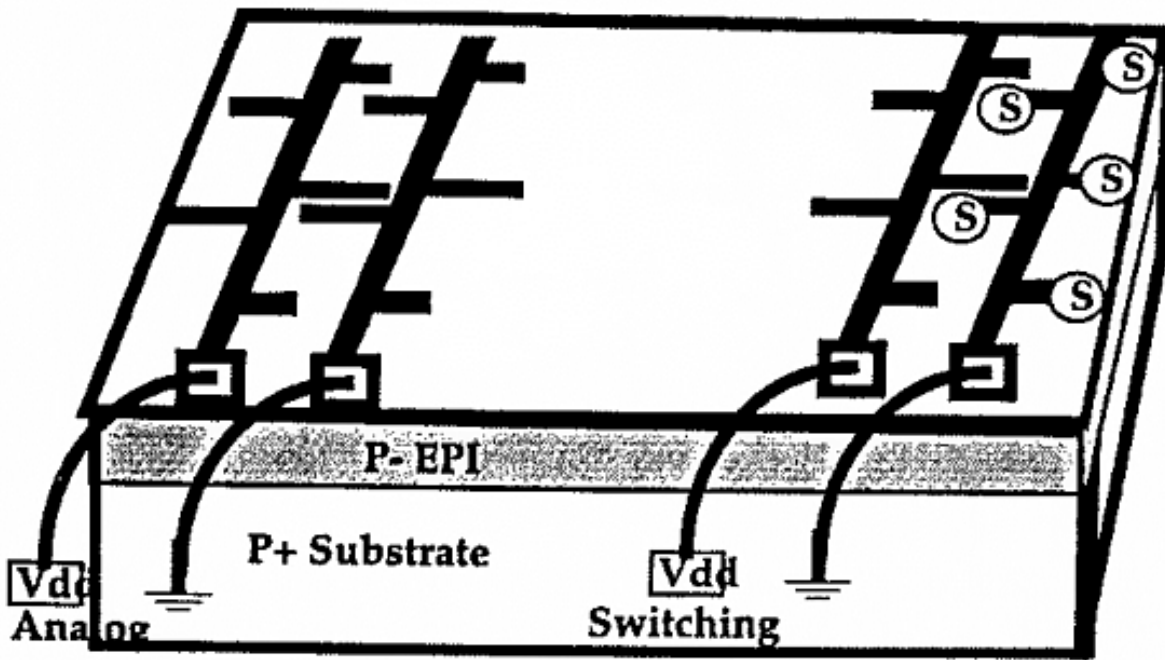
- Results: Analog crosstalk < 0.3%.  
Digital crosstalk: not measurable



**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!)

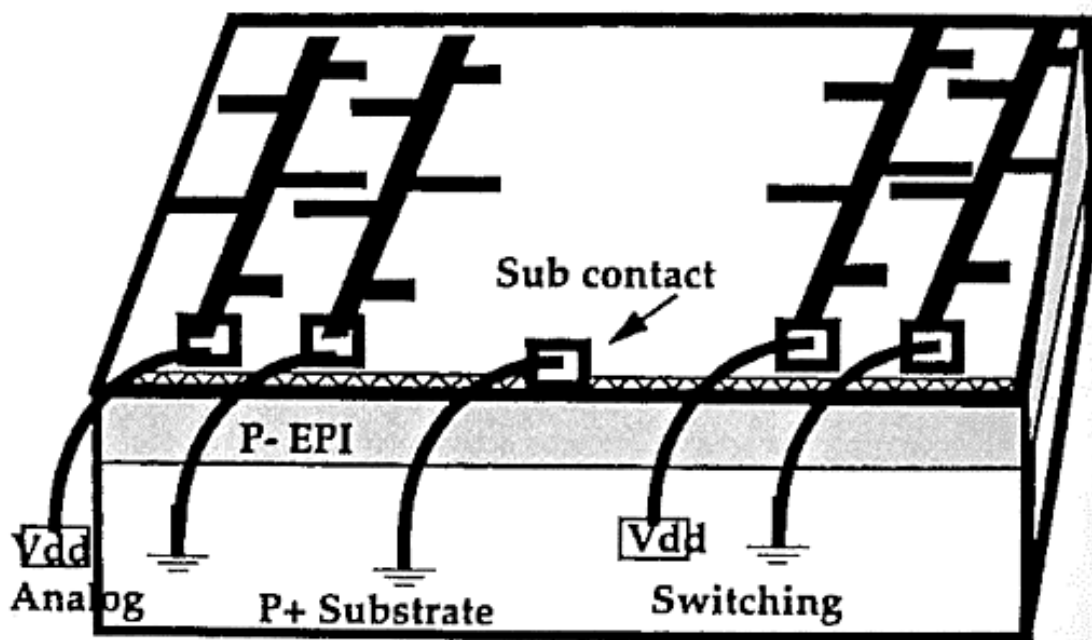
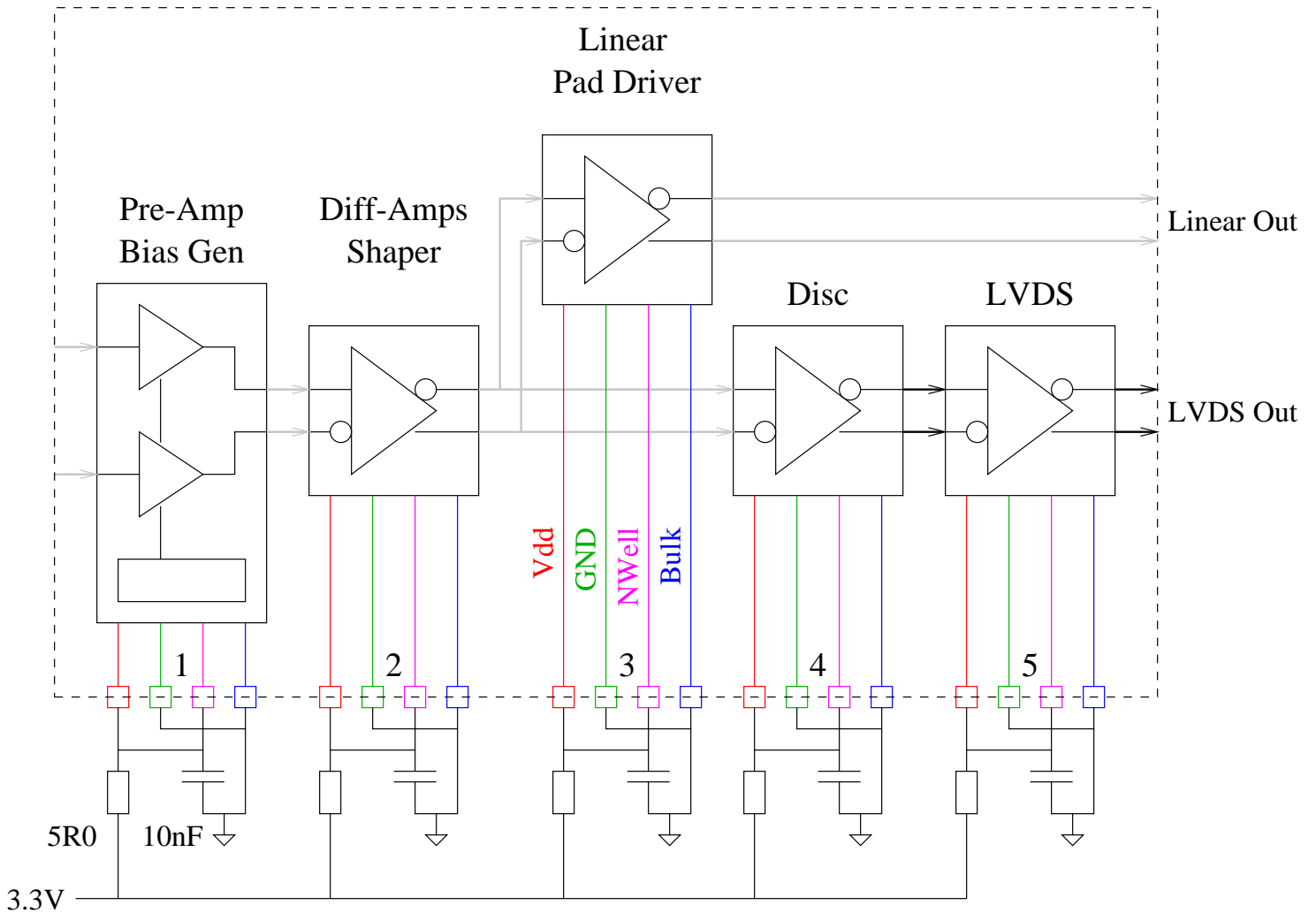


FIGURE 9.10 Substrate Contact to Kelvin Top-Side Ground. (good!)

ASD Lite has 5 sets of power/substrate connections



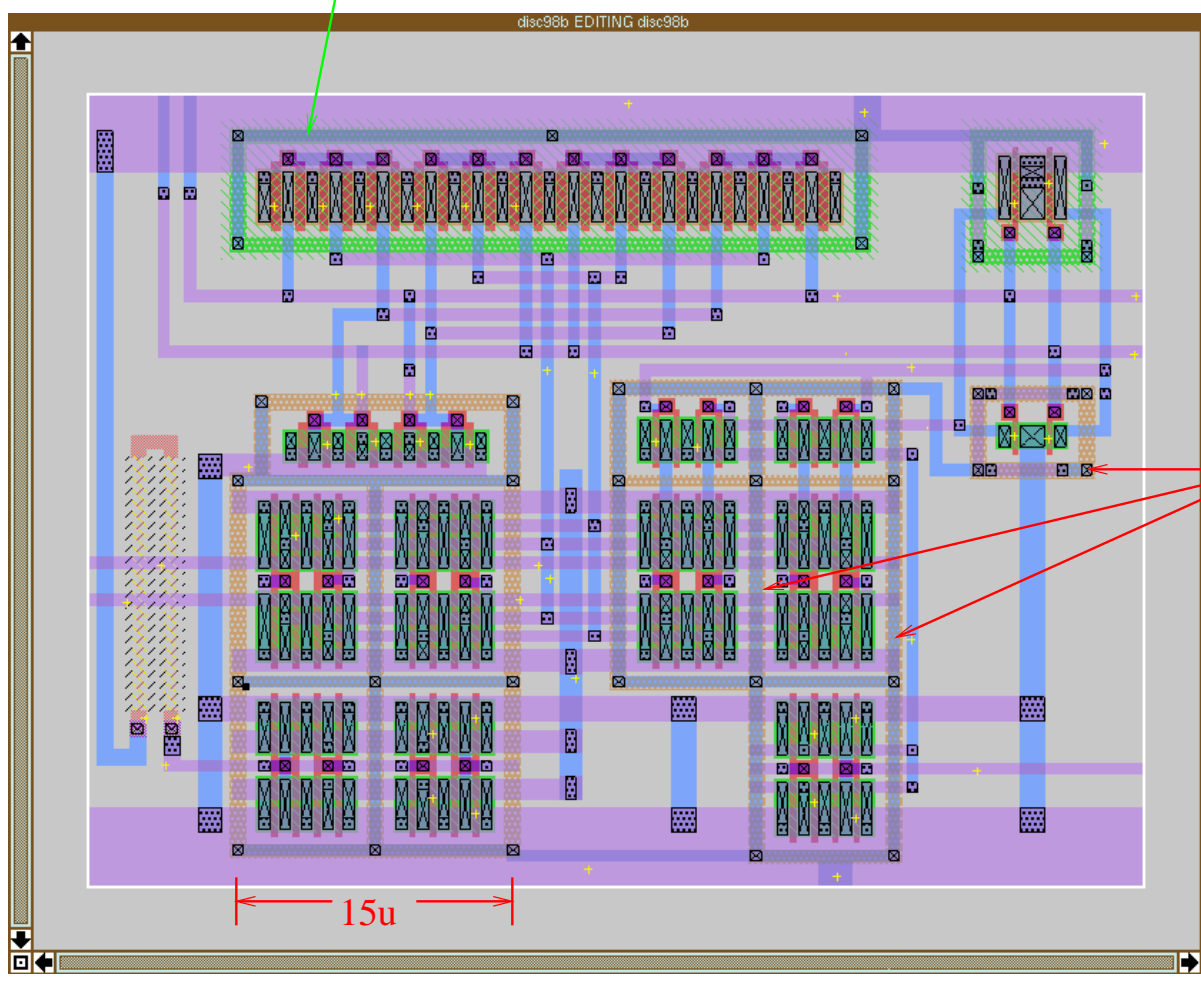
Test results:

crosstalk <0.3% with Nwell[1:5] <- Vdd[1:5] and GND[1:5] <- Bulk[1:5]

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

# Disc98b Layout

Guard Rings  
(N-Well)



Guard Rings  
(substrate)