Chapter 3

- The Metal Layers
  - Bond Pad
  - Design and Layout
  - Parasitics
  - DRC
  - Cross Talk, Ground Bounce
Bond Pad

**DESCRIPTION**
- **INTERFACE: CHIP TO WORLD**
- **ESD PROTECTION**
  - NECESSARY
  - MORE DETAILS LATER
- **SIZE DEPENDS ON USAGE**
  - **BOND PAD**
    - SIZE SET BY WIRE PROCESS
  - **ETEST PAD**
    - SIZE SET BY PROBE CARD
  - **MICRO PAD**
    - SIZE SET BY MICRO-TIP
- **LOCATION**
  - **BOND PAD**
    - TOP METAL LAYER
  - **ETEST PAD**
    - ALL ROUTING LAYERS
  - **MICRO PAD**
    - ANY ROUTING LAYER
- **PASSIVATION**
  - MUST REMOVE TO PROBE
  - PAD.DG LAYER USED FOR MASK
**Design and Layout**

- **DESCRIPTION**
  - **CONNECTIVITY**
    - METAL1 → VIA1 → METAL2
  - **RULES**
    - VIA1 MUST BE ENCLOSED BY
      - METAL1
      - METAL2
    - VIA1 IS ONE FIXED W/L
  - **CONNECTIVITY**
    - METAL1 → VIA1 → METAL2
    - NWELL IS NOT CONNECTED
    - HOW TO CONNECT TO NWELL?
  - CAN / SHOULD HAVE MANY VIAS
  - HOW MANY VIAS IN A DESIGN?

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**Figure 3.4** Layout and cross-sectional views.

**Figure 3.5** An example layout and cross-sectional view using including the n-well.

**Figure 3.15** The schematics of the contact resistances for the layouts in Fig. 3.14.
Parasitics

**DESCRIPTION**
- SEPARATE DEVICE FROM OTHER
  - WHAT DEVICES ARE HERE?
  - WHAT “OTHER” IS HERE?

**RESISTANCE**
- METAL SHEET RHO
  - WHAT ARE UNITS OF SHEET RHO?
  - HOW IS SHEET RHO FOUND?

- VIA RESISTANCE
  - NO SHEET RHO, WHY?

**CAPACITANCE**
- METAL1 OVER SUBSTRATE
  - WHERE ARE TERMINALS?
  - DISTRIBUTED CAP → LUMPED

- METAL2 OVER METAL 1

**DISTRIBUTIONS**
- RESISTANCES, CAPS DO NOT HAVE ONE VALUE ONLY
**ELECTROMIGRATION, DRC**

- **DESCRIPTION**
  - **ELECTROMIGRATION**
    - LIMITS $I_{\text{max}}$
    - DUE TO BAMBOO FORMATION
    - SEPARATION, FAILURE
  - **DRC RULES**
    - BOOK VALUES ARE NOT TYPICAL
    - NEED DESIGN RULE PRIMER
  - **TERMINOLOGY**
    - ENCLOSURE
    - SPACING
    - WIDTH
    - OVERLAP

**KEY PHRASE, THESE ARE NOT THE RULES THAT YOU USE**

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**Figure 3.11** Design rules for the metal layers using the CMOSEDU rules.
Cross Talk, Ground Bounce

DESCRIPTION

- **CONDUCTORS INTERACT**
  - EM FIELD OVERLAP, V INDUCED

- **CROSS TALK**
  - AC SIGNALS
  - \( I_{\text{mutual}} = C_{\text{mutual}} \frac{dV_{\text{signal}}}{dt} \)

- **GROUND BOUNCE**
  - AC, DC SIGNALS

- **V=IR**
  - CAUSE AND EFFECT
  - V IS FROM POWER SUPPLY
  - I IS FROM V/R
  - R IS FIXED, BASED ON ROUTING

- **DECOUPLING CAP**
  - STORES VDD CHARGE
  - TRANSIENT CURRENT

*Figure 3.16* Conductors used to illustrate crosstalk.

*Figure 3.17* Illustrating problems with incorrectly sized conductors.

*Figure 3.18* Estimating the decoupling capacitance needed in an output buffer.