EE 435

Lecture 37

DAC Design
  Current Steering DACs
  Charge Redistribution DACs
Current Steering DACs

Inherently Insensitive to Nonlinearities in Switches and Resistors
Smaller ON resistance and less phase-shift from clock edges

- Termed "bottom plate switching"
- Thermometer coded
Review from last lecture

Current Steering DACs

Transistor Implementation of Switches

\[ \beta = \frac{R_{\text{CELL}}}{R_{\text{CELL}} + R_F} = \frac{R_{\text{CELL}}}{R_{\text{CELL}} + kR_F} \]

If \( V_{\text{OUTFS}} = V_{\text{REF}} \), \( R_{\text{CELL}} = NR_F \)

\[ 0.5 < \beta \leq 1 \]
Current Steering DACs

Binary-Weighted Resistor Arrays

- Need for decoder eliminated!
- DNL may be a major problem
- INL performance about same as thermometer coded if same unit resistors used
- Sizing and layout of switches is critical

Observe thermometer coding and binary weighted both offer some major advantages and some major limitations
Review from last lecture

Current Steering DACs

Binary-Weighted Resistor Arrays

Actual layout of resistors is very important
Current Steering DACs

- Combines two types of architectures
- Inherits advantages of both thermometer and binary approach
- Minimizes limitations of both thermometer and binary approach
R-2R Resistor Arrays

- 4 bit-slices shown
- Can be extended to arbitrary number of bit slices
- Conceptually, area goes up linearly with number of bit slices
Current Steering DACs

R-2R Resistor Arrays
Current Steering DACs

R-2R Resistor Arrays

V_{REF} \quad R \quad 2R \quad \frac{1}{2} \quad 2R \quad \frac{1}{2^2} \quad 2R \quad R

b_3 \quad b_2 \quad b_1

V_{OUT} \quad R_F
R-2R Implementation

- Unit cell widely used
- Switch included in cell even if not switched!
- Code dependence of switch impedance of concern
Another R-2R DAC
End of Lecture 37