

## EECS240 – Spring 2010

### Lecture 20: Comparators



Elad Alon  
Dept. of EECS

## Comparator Gain-Bandwidth

### Example:

- 4Gb/s link
- Minimum  $\Delta V$ : 1mV
- $V_{dd} = 1V$

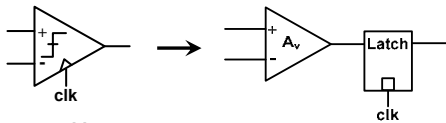
$$\rightarrow A_v > 1V / 1mV = 1000 \text{ in } < 250ps!$$

EECS240

Lecture 20

4

## Comparator



### Specs and issues:

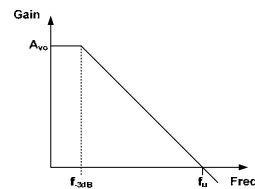
- Clock rate  $f_s$
- Offset
- Resolution
- Hysteresis
- Input cap
- Power dissipation
- CM rejection
- Kickback noise
- ...

EECS240

Lecture 20

2

## Operational Amplifier?



$$f_{-3dB} = \frac{f_u}{A_{vo}} = \frac{2}{3} \frac{1}{T_{bt}}$$

$$f_u = \frac{2A_{vo}}{3T_{bt}} = \frac{1000}{3 \times 250ps} = 1.33THz$$

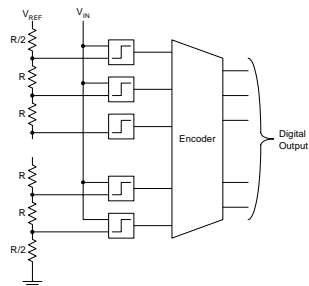
EECS240

Lecture 20

5

## Flash Converter

- Fast: one clock cycle per conversion
- High complexity:  $2^B - 1$  comparators
- High input capacitance

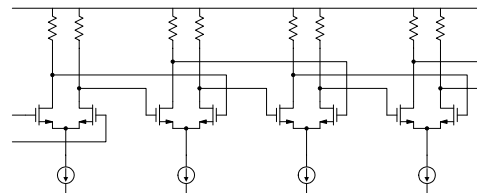


EECS240

Lecture 20

3

## Open-Loop Amplifier Cascade



EECS240

Lecture 20

6

## **Cascaded Amplifier**

---

- Simplified bandwidth analysis:
  - Open-circuit time constants
  - (Not most accurate, but leads to nearly the right answer for design optimization)

## **Power Consumption**

---

## **Bandwidth/Gain Optimization**

---

## **Regenerative Latch**

---

## **Bandwidth/Gain Optimization**

---

## **CML Comparator (Latch)**

---

## **StrongArm Latch**

---

## **Kickback**

---

## **Hysteresis**

---

## **Kickback cont'd**

---

## **Overdrive Recovery**

---

## **Kickback cont'd**

---