

EECS290Y

Wednesday, Feb 22, 1995

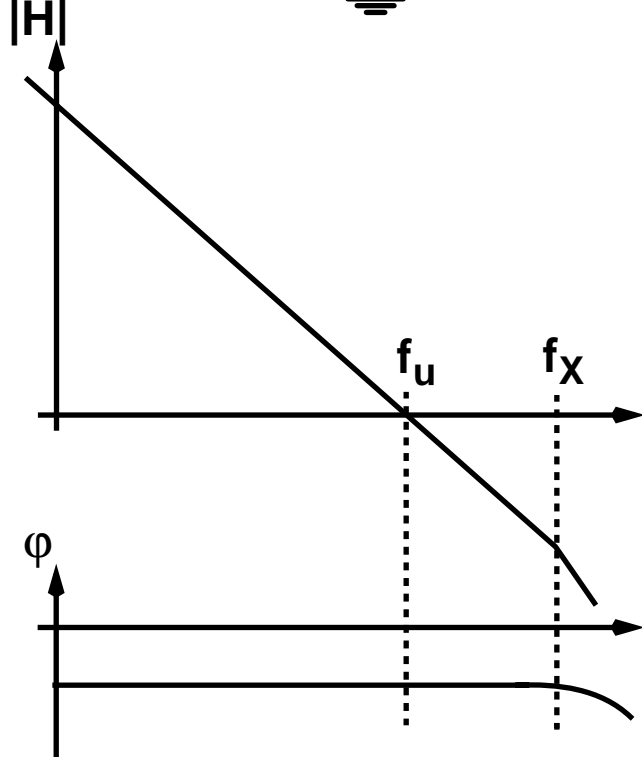
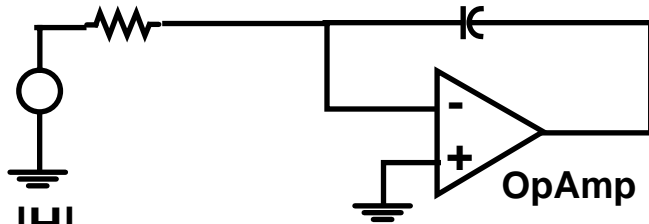
Today:

- 1) Speed Limitations in SCF's**
- 2) Accuracy Limitations**
- 3) Power Limits**

NEW TOPIC - A/D Conversion

Speed Limitations in SCF's

Contiuous Filter

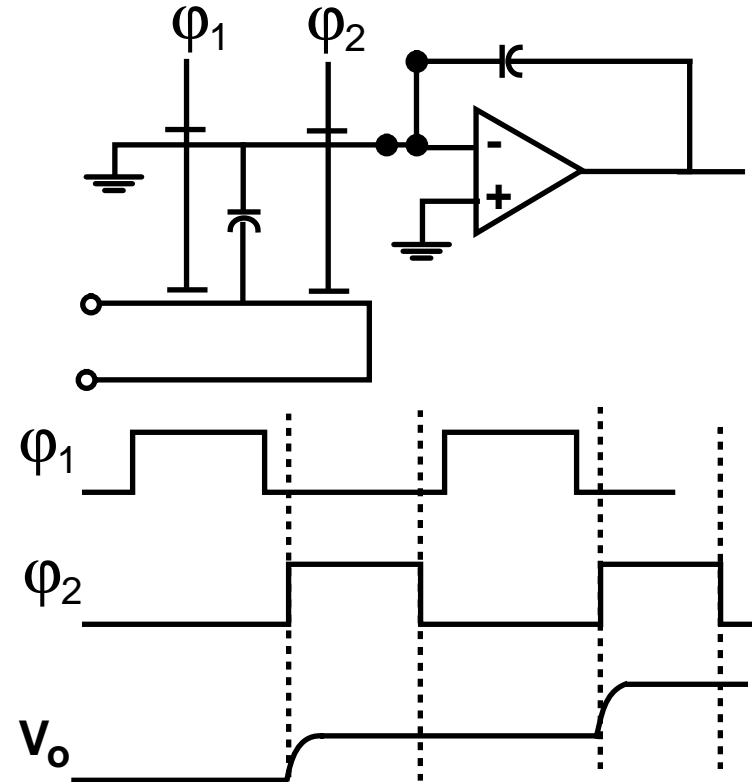


Example:

$$f_u = 10\text{kHz}, f_x = 1\text{MEG}$$

$$\phi_{\epsilon}|_{f=f_u} = -0.5^\circ \sim f_u/f_x \text{ (radians)}$$

S. C. Filter



Example:

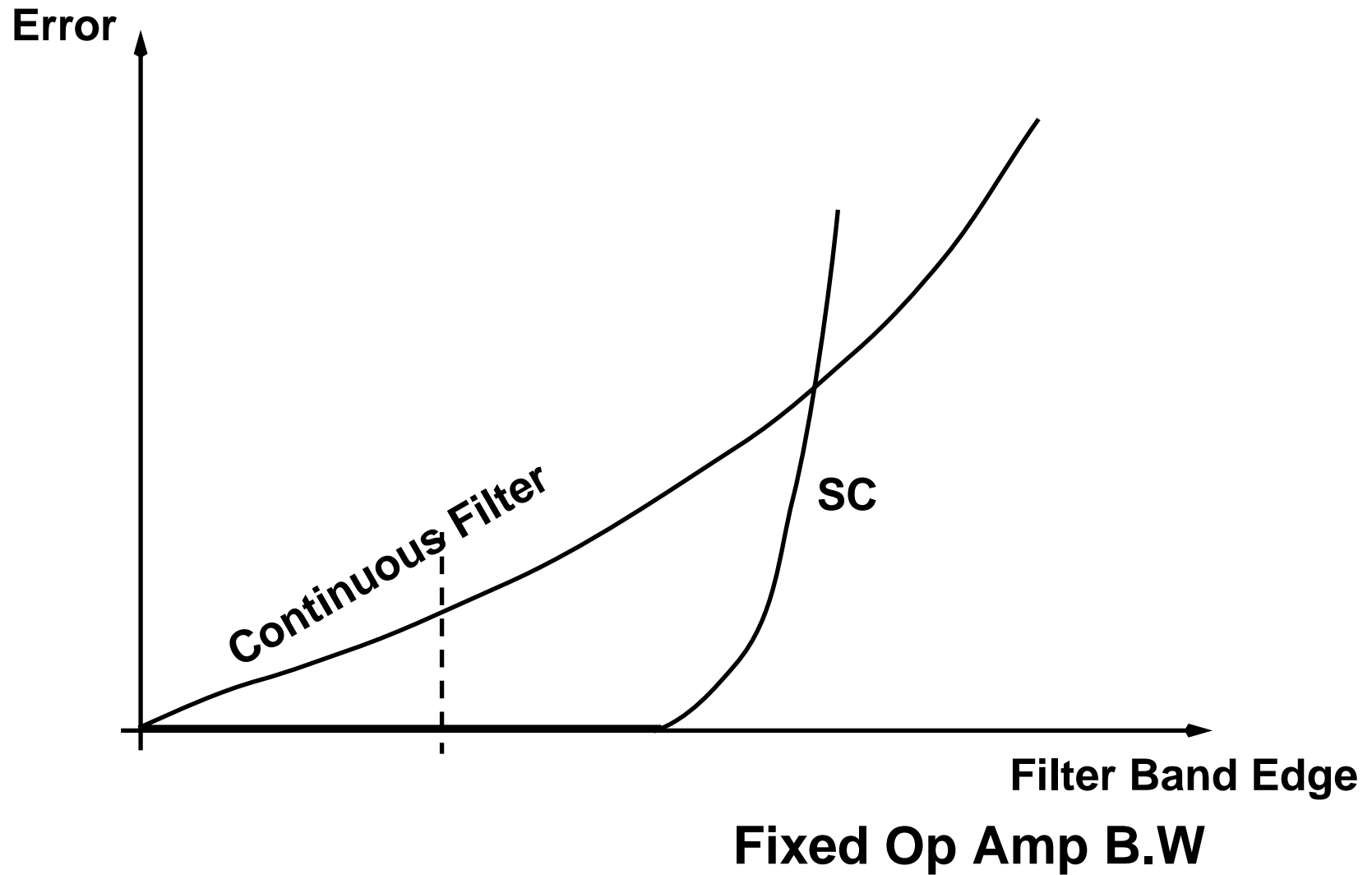
$$f_u = 10\text{kHz}, f_{\text{CLK}} = 128\text{kHz}$$

$$f_x \sim 1\text{MHz}$$

$$\tau \sim \frac{1}{2\pi(1\text{MHz})} \sim 160\text{ns}$$

$$\epsilon \sim e^{-\frac{4}{0.16}} \sim 0$$

Speed Limitations in SCF's



Estimate Speed Capability in Terms of Op Amp Bandwidth

Assume $f_{clk} \sim 8f_{Bandedge}$

$$t_s \sim \frac{1}{2f_{clk}} = \frac{1}{16f_{Bandedge}}$$

Allow 10 Time Constants for settling

$$\tau_{opamp} = \frac{1}{160f_{Bandedge}}$$

Assume Feedback Factor ~ 1

$$2\pi f_{Unit} \approx \frac{1}{\tau_{OpAmp}}$$

$$f_{Unity} \approx \frac{160}{2\pi} f_{BandEdge} \approx 30X$$

For 10MHz Filter, $\sim 300\text{MHz } f_u$

Speed Limitations in SCF's

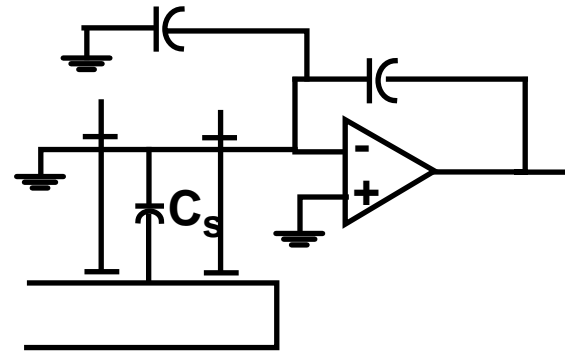
Actual Behavior Worse

R_{on} of Switches

Slew Rate Limit

Parasitics

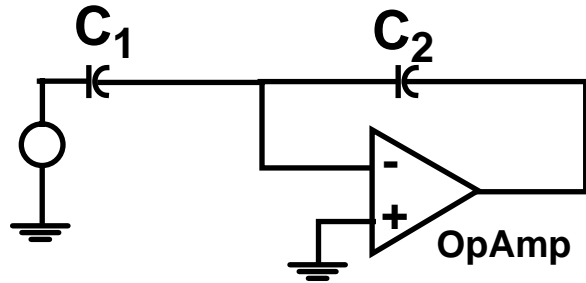
Feedback Factor $\ll 1$



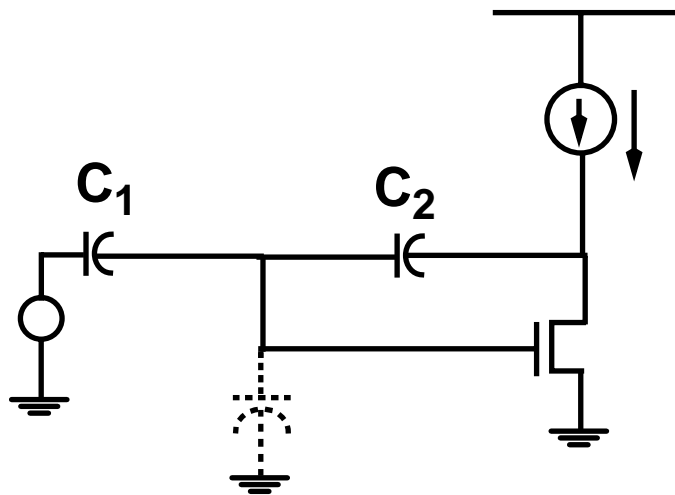
Bottom Line

$$\underline{f_{unity}} \sim 100-200 \times \underline{f_{bandedge}}$$

What Limits τ ?

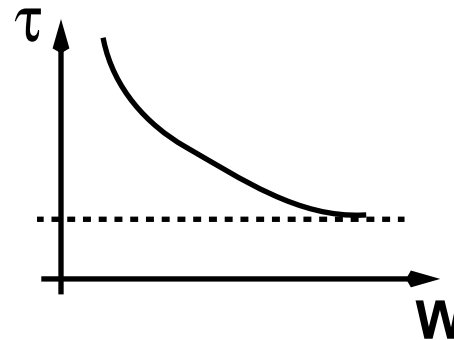


Approximate w/ Simplest Op Amp



IF $C_2 \gg C_1$

$$\tau = (C_1 + C_{gs})/g_m$$

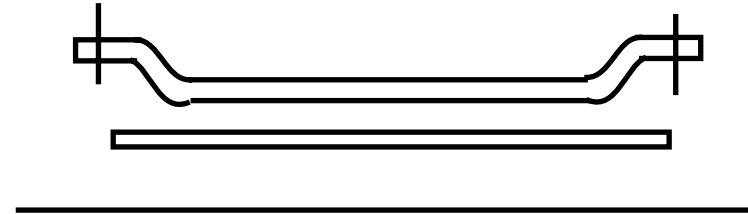
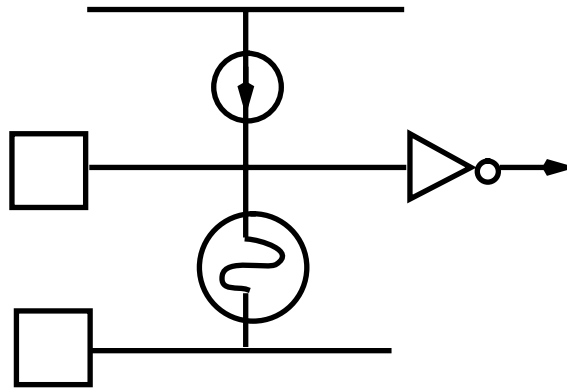


$$\tau_{opt} \sim \frac{2C_1}{g_m} \sim \left(\frac{2}{2\pi f_T} \right)$$

500MHz \sim 30ps for 0.6um $V_{gs} - V_t = 0.5V$

Limitations to Accuracy

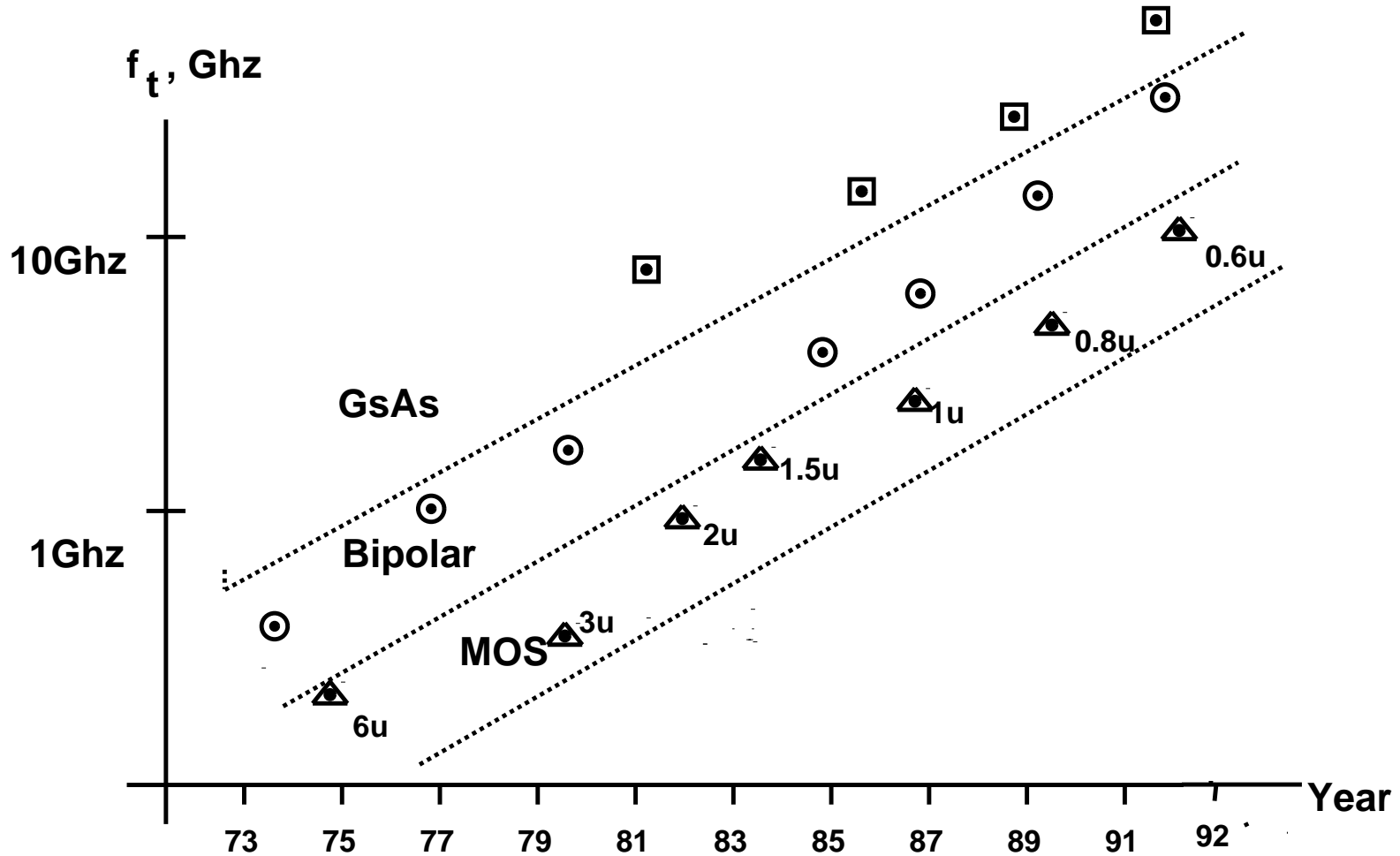
$$H(Z) = f(C_a/C_b)$$



Power

- 1) Costs 4X in Power to get 1 bit of D.R.
- 2) Lowering V_{dd} tends to Increase Power

MOS, Bipolar, and GaAs f_t vs. Year



MOS, Bipolar, and GaAs f_t vs Year

(For MOS, $(V_{gs}-V_T) = 0.5V$)