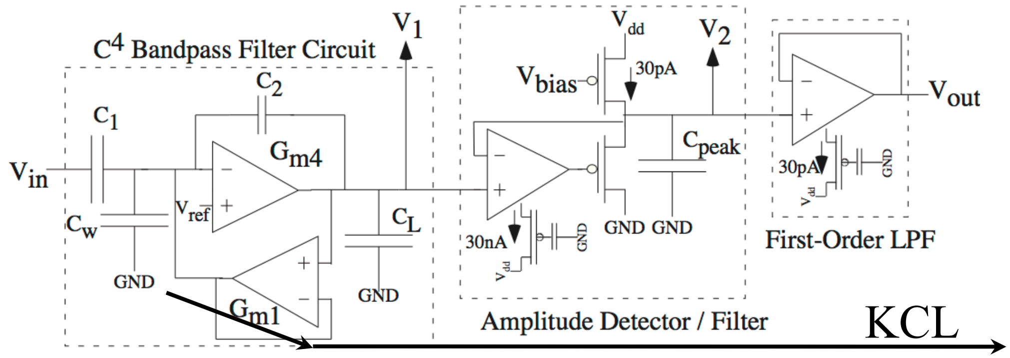
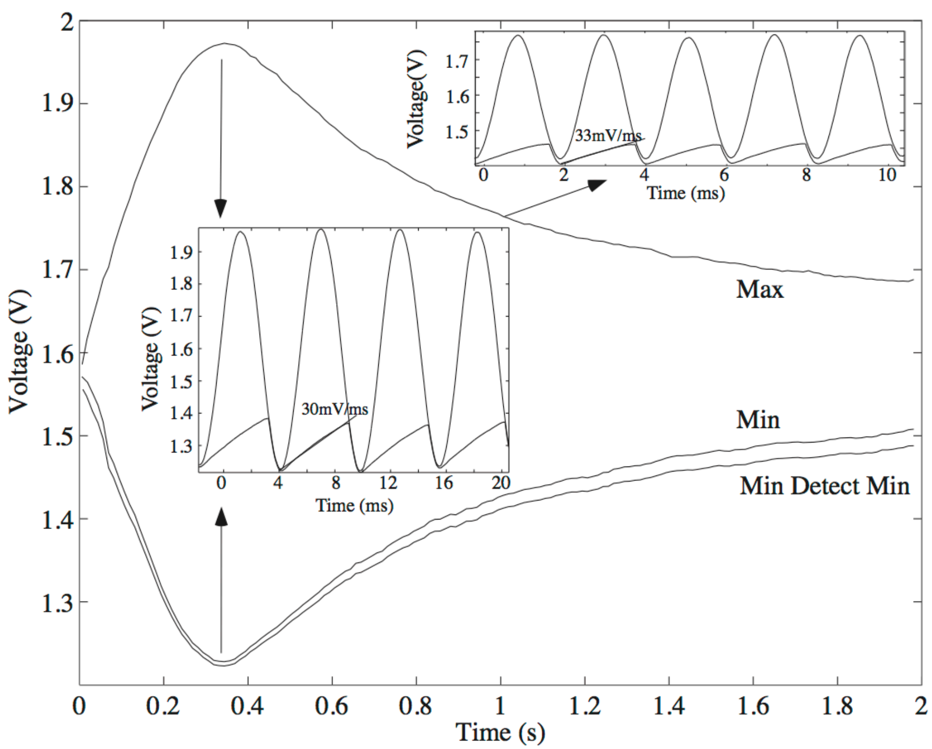
C^4 Bandpass Filter Structure





Building a sim model (macromodel)

$$\frac{d\mathbf{V}}{dt} = \mathbf{f}(\mathbf{V}, \mathbf{V}_{in})$$

$$(C_1 + C_2 + C_w)\frac{dV_1}{dt} = C_1\frac{dV_{in}}{dt} + C_2\frac{dV_{out}}{dt} + I_{bias2}\tanh\left(\frac{V_{out} - V1}{V_L}\right)$$

$$(C_L + C_2)\frac{dV_{out}}{dt} = C_2\frac{dV_1}{dt} + I_{bias1}\tanh\left(-\frac{\kappa V_1}{2U_T}\right)$$

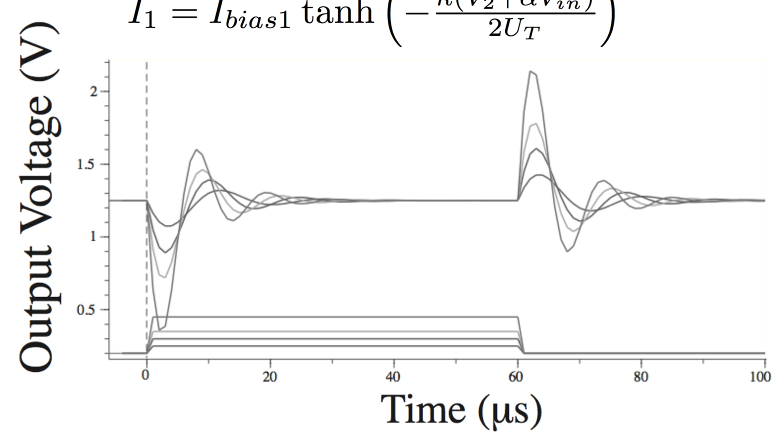
Convert Form

$$C_{eq}\frac{dV_1}{dt} = \frac{C_L + C_2}{C_2} I_2 + I_1$$

$$C_{eq}\frac{dV_{out}}{dt} = I_2 + \frac{C_1 + C_2 + C_w}{C_2} I_1$$

$$I_2 = I_{bias2}\tanh\left(\frac{V_{outa} - V2 + (\beta - \alpha)V_{in}}{V_L}\right)$$

$$I_1 = I_{bias1}\tanh\left(-\frac{\kappa(V_2 + \alpha V_{in})}{2U_T}\right)$$

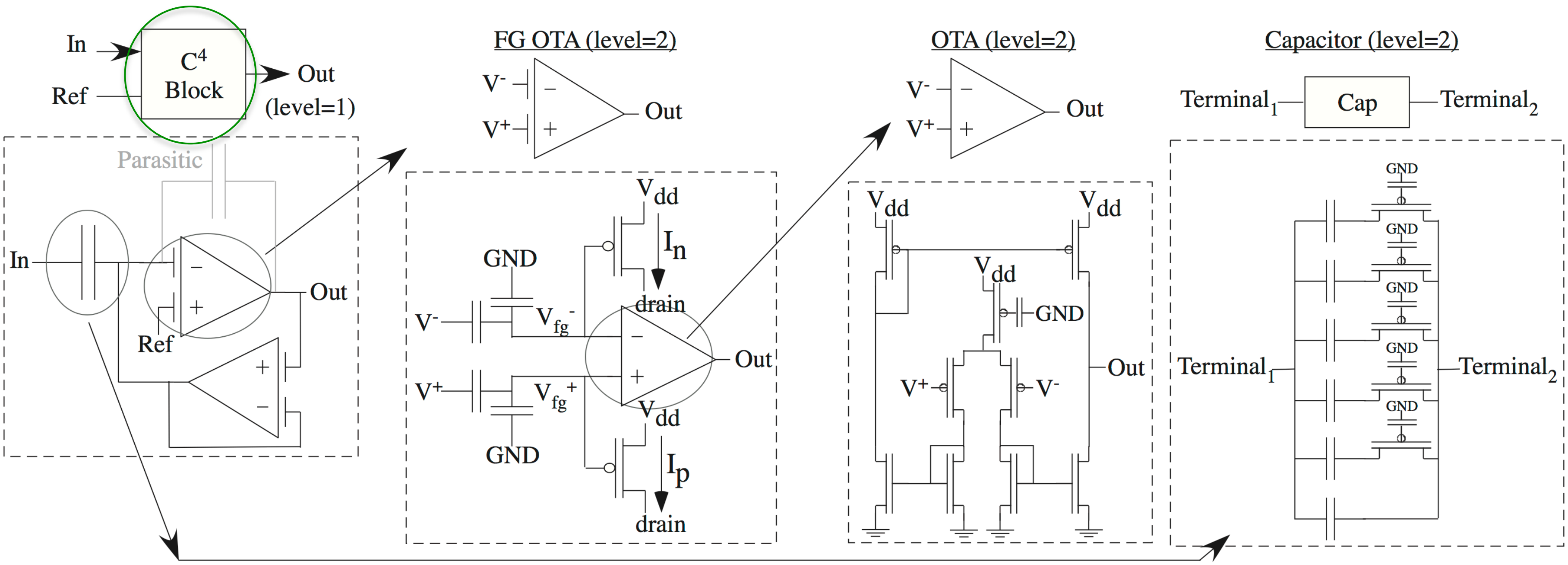


Abstraction in BandPass Filter

BPF → Two FG OTAs + One tunable C

FG OTA → Normal OTA + FG I_{bias}

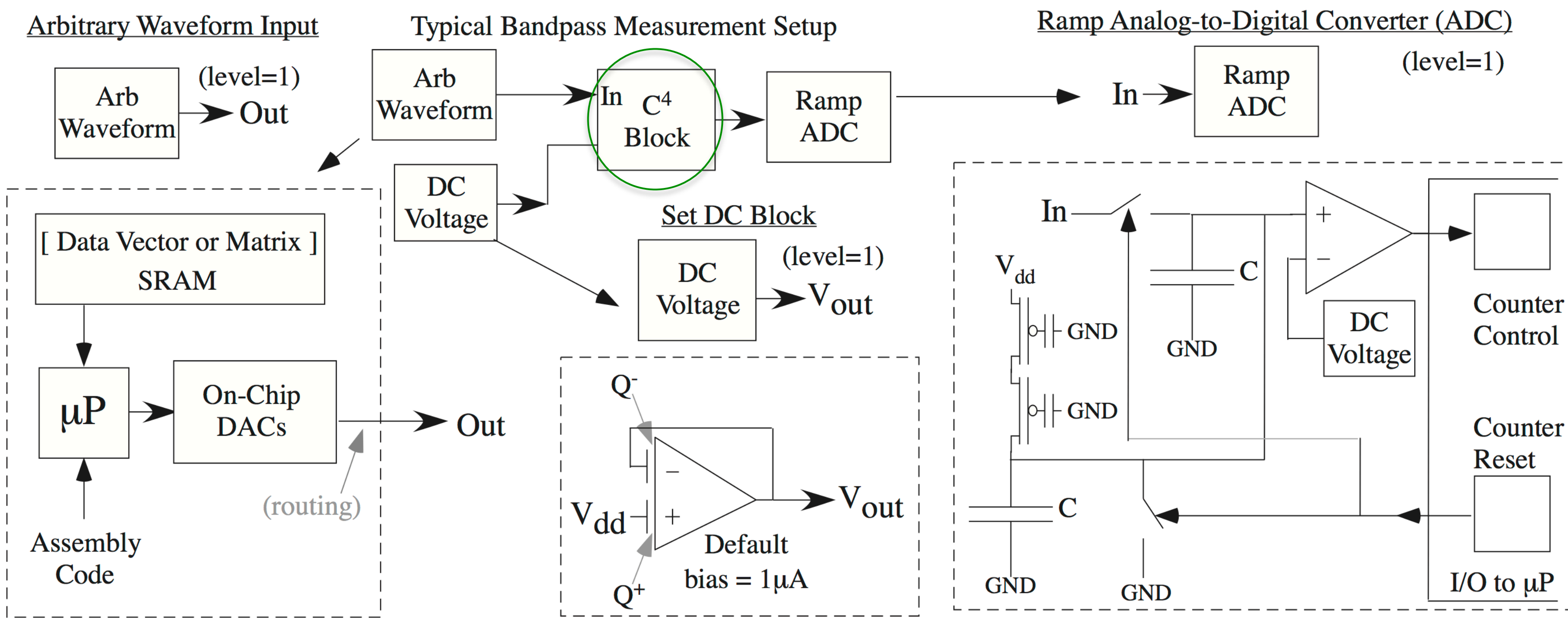
One simple analog block, one simple description, many components



C^4 Measurement

Compiles to:

- routing
- analog blocks
- signal DACs
- digital Blocks
- µP code



Experiment Session

Experimental measurements of
C4 Second-Order Section Block,
a core signal processing function.
and various testing modes.

Example set up for step responses.
Perform the first step response.
Remembering the original values,
try different values for corner freq.
Look at different input signals.