Classical Sensitivity Examples Bernie H 8/30/2016

$$S_Y^X = \frac{\frac{\Delta X}{X}}{\frac{\Delta Y}{Y}} \approx \frac{Y}{X}\frac{\partial X}{\partial y}$$

Suppose for some filter we have

$$Q = \frac{3R_G}{R}$$

$$S_{R_G}^Q = \frac{R_G}{Q}\frac{\partial}{\partial R_G}\left(3\frac{R_G}{R}\right) = \frac{R_G}{Q}\,\frac{3}{R} = \frac{R_G}{3R_G}R\,\frac{3}{R} = 1$$

% change in $R_G \rightarrow$ <u>same</u> % change in Q <u>good</u>

Suppose also the cutoff freq =

$$\omega_0 = \frac{1}{\sqrt{R_1R_2C_1C_2}}$$

$$S_{R_1}^{\omega_0} = \frac{R_1}{\omega_0}\frac{\partial\omega_0}{\partial R_1} = \frac{R_1}{\omega_0}\frac{\partial}{\partial R_1}\left[R_1R_2C_1C_2\right]^{-1/2}$$

$$= \frac{R_1}{\omega_0}\left[R_2C_1C_2\right]^{-1/2}\frac{\partial}{\partial R_1}\left(R_1^{-1/2}\right)$$

$$= R_1\left[R_1R_2C_1C_2\right]^{1/2}\left[R_2C_1C_2\right]^{1/2}\left(-\frac{1}{2}\right)R_1^{-3/2}$$

$$= -\frac{1}{2}$$ <u>better</u>

Or if $Q = \frac{1}{3-K}$ ("Sallen-Key")

$$S_K^Q = \frac{K}{Q}\frac{\partial}{\partial K}(3-K)^{-1} = \frac{K}{Q}(-1)(3-K)^{-2}(-1)$$

$$= \frac{K}{(3-K)^2}(3-K) = \frac{K}{3-K} = 3Q-1$$

<u>not good</u> as <u>Sensitivity</u> increases with Q

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