$$K = \frac{R_2}{R} = R_2 = R_1 \quad (= R)$$

$$R = \frac{1}{\omega_c^2 \cdot C_1 \cdot C_2 \cdot R_3}$$

$$R = \frac{2}{\left(\frac{\omega_c}{Q} \cdot C_2\right) - \frac{1}{R_3}}$$

croisé

$$2 = \frac{\left(\frac{\omega_c}{Q} \cdot C_2\right) - \frac{1}{R_3}}{\omega_c^2 \cdot C_1 \cdot C_2 \cdot R_3} = \frac{\frac{\omega_c}{Q} \cdot C_2 R_3 - 1}{\omega_c^2 \cdot C_1 \cdot C_2}$$

$$\frac{2\omega_c^2 \cdot C_1 \cdot C_2 + 1}{\frac{\omega_c}{Q} \cdot C_2} = R_3$$

On sait
C_2
ω_c^2
ω_c / Q
K
} Q, ω_c

$$C_1 = \frac{C_2}{\left(Q \cdot \left(\sqrt{\frac{R \cdot R_3}{R}} + \sqrt{\frac{R_3}{R}} + \sqrt{\frac{R}{R_3}}\right)\right)^2}$$

$$R_3 = \frac{2 \cdot \omega_c^2 \cdot \frac{C_2}{\left(Q \cdot \left(\sqrt{\frac{R \cdot R}{R}} + \sqrt{\frac{R}{R}} + \sqrt{\frac{R}{R_3}}\right)\right)^2} \cdot C_2 + 1}{\frac{\omega_c}{Q} \cdot C_2}$$

$R_2 = R_1$

$\frac{1}{\omega_c^2 \cdot C_2 \cdot R_2 C_1} = R_3$

C_2
K
ω_c^2
ω_c/Q

$\frac{\omega_c}{Q} = \frac{1}{C_2} \cdot \left(\frac{2}{R} + \omega_c^2 \cdot C_2 \cdot R_2 \cdot C_1 \right)$

R_2

$R_3 C_1$

R_3

C_1

$$R_1 \cdot R = R_2$$

$$\frac{1}{\omega_c^2 \cdot R_2 \cdot C_2} = R_3 C_1$$

$$\frac{1}{\left(\frac{\omega_c}{Q} \cdot C_2\right) - \frac{1}{R_1} - \frac{1}{R_2}} = R_3$$

R_1

1) $S^{Q}_{R_1} = \frac{R_1}{Q} \cdot \frac{\partial Q}{\partial R_1}$

$$\frac{\left(\sqrt{\frac{R_2R_3}{R_1}} + \sqrt{\frac{R_1}{R_2}} + \sqrt{\frac{R_2}{R_3}}\right)R_1}{\sqrt{\frac{C_2}{C_1}}} \cdot \frac{\sqrt{\frac{C_2}{C_1}} \cdot \left(\sqrt{\frac{R_2R_3}{R_1}} + \sqrt{\frac{R_3}{R_2}} + \sqrt{\frac{R_2}{R_3}}\right)^{-1}}{2Q}$$

2) $\left(\sqrt{\frac{R_2R_3}{R_1}} + \sqrt{\frac{R_1}{R_2}} + \sqrt{\frac{R_2}{R_3}}\right)R_1 \cdot -1 \cdot \left(\sqrt{\frac{R_2R_3}{R_1}} + \sqrt{\frac{R_3}{R_2}} + \sqrt{\frac{R_2}{R_3}}\right)^{-2} \cdot \left(\sqrt{R_2R_3} \cdot -1\frac{1}{R_1^2}\right)$

$$S^{Q}_{R_1} = \frac{\sqrt{R_2R_3}}{R_1\left(\sqrt{\frac{R_2R_3}{R_1}} + \sqrt{\frac{R_1}{R_2}} + \sqrt{\frac{R_2}{R_3}}\right)}$$

R_2

$$\left(\sqrt{\frac{R_2R_3}{R_1}} + \sqrt{\frac{R_1}{R_2}} + \sqrt{\frac{R_2}{R_3}}\right)R_2 \cdot -1 \cdot \left(\sqrt{\frac{R_2R_3}{R_1}} + \sqrt{\frac{R_3}{R_2}} + \sqrt{\frac{R_2}{R_3}}\right)^{-2}$$

$$\frac{1}{R_1}\left(\tfrac{1}{2}(R_2R_3)^{-1/2} \cdot R_3\right) + \tfrac{1}{2}(R_3/R_2)^{-1/2} \cdot R_3 \cdot R_2^{-2} + \tfrac{1}{2}(R_2/R_3)^{-1/2} \cdot \tfrac{1}{R_3}$$

$$\frac{R_3}{2R_1\sqrt{R_2R_3}} + \frac{R_3}{2\sqrt{\frac{R_3}{R_2}}\,R_2^2} + \frac{1}{2R_3\sqrt{R_2/R_3}}$$

$$\frac{-R_2\left(\frac{R_3}{2R_1\sqrt{R_2R_3}} + \frac{R_3}{2\sqrt{\frac{R_3}{R_2}}\,R_2^2} + \frac{1}{2R_3\sqrt{R_2/R_3}}\right)}{\sqrt{\frac{R_2R_3}{R_1}} + \sqrt{\frac{R_3}{R_2}} + \sqrt{\frac{R_2}{R_3}}}$$

$$S_{C_1}^{Q} = \frac{C_1}{Q} \cdot \frac{\partial Q}{\partial C_1}$$

C_1

$$= \frac{C_1 \cdot \left(\frac{\sqrt{R_2 R_3}}{R_1} + \sqrt{\frac{R_2}{R_3}} + \sqrt{\frac{R_3}{R_2}}\right)}{\sqrt{\frac{C_2}{C_1}}} \cdot \frac{\sqrt{\frac{C_2}{C_1}}\left(\frac{\sqrt{R_2 R_3}}{R_1} + \sqrt{\frac{R_2}{R_3}} + \sqrt{\frac{R_3}{R_2}}\right)^{-1}}{\partial C_1}$$

$$= \frac{C_1 \cdot R}{\sqrt{\frac{C_2}{C_1}} \cdot R} \cdot \frac{\sqrt{\frac{C_2}{C_1}}}{\partial C_1} \Rightarrow -\frac{1}{2}(C_1)^{-3/2} \cdot 1 \cdot \sqrt{C_2} \Rightarrow \frac{C_1\sqrt{C_1}}{\sqrt{C_2}} \cdot \sqrt{C_2} \cdot -\frac{1}{2} \cdot \frac{1}{\sqrt{C_1^3}}$$

$$\Rightarrow \frac{-C_1 \cdot}{2\sqrt{C_1^3}} = -\frac{1}{2}$$

$$S_{C_1}^{Q} = -\frac{1}{2}$$

R_3

$$S_{R_3}^{Q} = \frac{R_3}{Q} \cdot \frac{\partial Q}{\partial R_3}$$

$$= \frac{\left(\frac{\sqrt{R_2 R_3}}{R_1} + \sqrt{\frac{R_2}{R_3}} + \sqrt{\frac{R_3}{R_2}}\right) \cdot R_3}{\sqrt{\frac{C_2}{C_1}}} \cdot \frac{\sqrt{\frac{C_2}{C_1}}\left(\frac{\sqrt{R_2 R_3}}{R_1} + \sqrt{\frac{R_2}{R_3}} + \sqrt{\frac{R_3}{R_2}}\right)^{-1}}{\partial R_3}$$

$$\cdot \left(\frac{1}{R_1} \cdot \frac{1}{2}(R_2 R_3)^{-1/2} \cdot R_2 + \frac{1}{2}(R_3/R_2)^{-1/2} \frac{1}{R_2} + \frac{1}{2}(R_2/R_3)^{-1/2} \frac{R_2}{R_3^2}\right)$$

$$S_{R_3}^{Q} = -R_3 \left(\frac{R_2}{2R_1\sqrt{R_2 R_3}} + \frac{1}{2R_2\sqrt{R_3/R_2}} + \frac{R_2}{2R_3^2\sqrt{R_2/R_3}}\right)$$

$$\frac{\sqrt{R_2 R_3}}{R_1} + \sqrt{\frac{R_3}{R_2}} + \sqrt{\frac{R_2}{R_3}}$$

C_2

$$S^{Q}_{C_2} = \frac{C_2}{Q} \cdot \frac{dQ}{dC_2}$$

$$= \frac{C_2 \cdot \left(\sqrt{\frac{R_2 R_3}{R_1}} + \sqrt{\frac{R_2}{R_3}} + \sqrt{\frac{R_2}{R_3}}\right)}{\sqrt{\frac{C_2}{C_1}}^{-1}} \cdot \frac{\sqrt{\frac{C_2}{C_1}}\left(\sqrt{\frac{R_2 R_3}{R_1}} + \sqrt{\frac{R_3}{R_2}} + \sqrt{\frac{R_2}{R_3}}\right)^{-1}}{\partial C_2}$$

$$= \frac{C_2 \cdot R}{\sqrt{\frac{C_2}{C_1}} \cdot R} \cdot \frac{\sqrt{C_2}}{\frac{\sqrt{C_1}}{\partial C_1}} \Rightarrow \frac{(C_2)^{-1/2}}{2\sqrt{C_1}^{-1}} \cdot \frac{C_2 R \sqrt{C_1}}{\sqrt{C_2} \cdot R}$$

$$\Rightarrow \frac{C_2 R \sqrt{C_1}}{2\sqrt{C_1}\sqrt{C_2}\sqrt{C_2} R} = \frac{1}{2}$$

$$S^{Q}_{C_2} = \frac{1}{2}$$