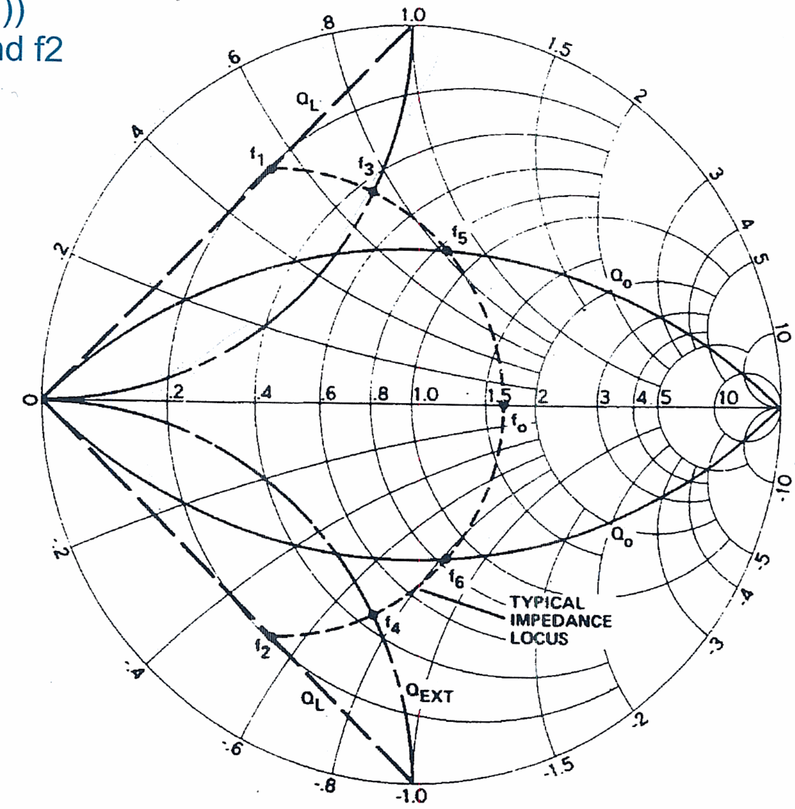
$\mathrm{Im}(Z) = 1$

QE: intersect with Z=j*50 Ohm in detuned open position; equivalent to Y=j1
=> f3 and f4

QL: search for max / min
(Im(S11))
=> f1 and f2

$Q_L \delta = 1$

β



Q0: Re(Z) = Im(Z)
=> f5 and f6

si può fare con la conversione Z from S_{11}

R: read Re(S11) at Min(abs(S11))

Fig. 30 Loci of Q_0, Q_L and Q_{EXT} of a resonator

$Q_{EXT} = \frac{Q_0}{\beta}$

$$\frac{1}{Q_L} = \frac{1}{Q_0} + \frac{1}{Q_{ext}} \tag{42}$$

$$Q = \frac{f_0}{\Delta f} \quad (3\,\mathrm{dB}).$$

Referring to Fig. 30 we obtain

$$\begin{aligned} Q_0 &= f_0/(f_5 - f_6) \\ Q_L &= f_0/(f_1 - f_2) \\ Q_{ext} &= f_0/(f_3 - f_4) \end{aligned} \tag{43}$$

Figure 30 shows the resonator in the "detuned short position", i.e. the impedance of the resonator far from f_0 approaches zero and f_1, f_2 are "half-power" points (intersection with straight lines connecting $\rho = 0$ and $\rho = \pm j$ respectively. For the external Q (f_3, f_4) we must turn the locus of the resonator into "detuned open position" ($\lambda/4$ transformer). This produces an intersection with the constant reactance circle $Z = Y/Z_0 = \pm j$. Finally the points f_5, f_6 (Q_0; $R_{cavity} = \pm X_{cavity}$) are read from the intersection of a cavity with two circles centered at $\pm j$ and having a radius of $\sqrt{2}$.

There are three ranges of the coupling factor β defined by

CALCOLO DI β

$$\frac{Z}{Z_0} = \frac{\beta}{1 + jQ_0\delta} \qquad S_{11} = \frac{\beta-1 - jQ_0\delta}{\beta+1 + jQ_0\delta}$$

$$SWR = \frac{1+|S_{11}|}{1-|S_{11}|}$$

@ RESONANCE ($\delta = 0$) $\quad SWR = \dfrac{|\beta+1| + |\beta-1|}{|\beta+1| - |\beta-1|}$

I MODO

VISUALIZZO LA CARTA DI SMITH E METTO IL CURSORE SULLA RISONANZA ($\delta = 0$, IMPEDENZA REALE)

LEGGO LA RESISTENZA IN Ω DAL CURSORE DELLA C. DI SMITH

$Z(\Omega)$

$$\beta = \frac{Z(\Omega)}{50\,\Omega}$$

II MODO

METTO IL ~~cu~~ CURSORE ALLA RISONANZA ($\delta = 0$) E MISURO LA PARTE REALE DI S_{11}

$$R_e(S_{11}) = \frac{\beta - 1}{\beta + 1}$$

III MODO

MISURO LO SWR ALLA RISONANZA $\delta = 0$

Se $\beta < 1$ $\qquad SWR(\delta = 0) = \dfrac{1}{\beta}$

SE $\beta > 1$ $\qquad SWR(\delta = 0) = \beta$

MISURA DI Q_0

DETUNED SHORT POSITION

$$Z = \frac{\beta}{1+(Q_0\delta)^2} - j\,\frac{\beta Q_0 \delta}{1+(Q_0\delta)^2}$$

δ_1: $\quad Re(Z) = Im(Z) \qquad \beta = -\beta Q_0 \delta_1 \qquad \delta_1 = -\frac{1}{Q_0}$

δ_2: $\quad Re(Z) = -Im(Z) \qquad \beta = +\beta Q_0 \delta_2 \qquad \delta_2 = +\frac{1}{Q_0}$

$$\delta = \left(\frac{f}{f_0} - \frac{f_0}{f}\right) = x - \frac{1}{x} \simeq 2(x-1)$$

$$\delta_2 - \delta_1 \cong 2(x_2 - x_1) \cong \frac{2}{Q_0}$$

$$Q_0 = \frac{1}{x_2 - x_1} = \frac{f_0}{f_2 - f_1}$$

$x_1 = \frac{f_1}{f_0}$ TALE CHE $\quad Re\,Z = Im\,Z$

$x_2 \quad \frac{f_2}{f_0}$ TALE CHE $\quad Re\,Z = -Im\,Z$

- VALE SOLO PER Q_0 ALTI
- FARE LA VERIFICA PER VEDERE FINO A CHE Q_0 VALE CON MATHEMATICA

$\boxed{\text{MISURA DI } Q_L}$

$$S_{11} = \frac{\beta^2 - 1 - (Q_0\delta)^2}{(\beta^2+1)^2 + (Q_0\delta)^2} - j\,\frac{2\beta Q_0\delta}{(\beta+1)^2 + (Q_0\delta)^2}$$

$$Im(S_{11}) = -\frac{2\beta}{\beta+1}\,\frac{Q_L\delta}{1+(Q_L\delta)^2} \qquad Q_L = \frac{Q_0}{\beta+1}$$

$$\frac{d}{d(Q_L\delta)}\left[\frac{Q_L\delta}{1+(Q_L\delta)^2}\right] = \frac{1-(Q_L\delta)^2}{\left[1+(Q_L\delta)^2\right]^2}$$

MAX OF $Im\,S_{11}$ $\Rightarrow$ $\frac{d}{d(Q_L\delta)}\left[\,..\,\right] = 0$ $\Rightarrow$ $\boxed{Q_L\delta = \pm 1}$

δ_1: MINIMO DI $Im\,S_{11}$ $\Rightarrow$ $Q_L\delta_1 = -1$ $\qquad \delta_1 = -\frac{1}{Q_L}$

δ_2: MAX DI $Im\,S_{11}$ $\Rightarrow$ $Q_L\delta_2 = 1$ $\qquad \delta_2 = \frac{1}{Q_L}$

$$\delta = \left(\frac{f}{f_0} - \frac{f_0}{f}\right) = x - \frac{1}{x} \simeq 2(x-1)$$

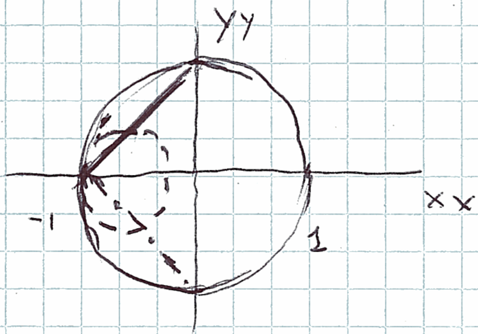
$$\delta_2 - \delta_1 \simeq 2(x_2 - x_1) \cong \frac{2}{Q_L}$$

$$\boxed{Q_L = \frac{1}{x_2 - x_1} = \frac{f_0}{f_2 - f_0}}$$

$x_1 = f_1/f_0$ TALE CHE $Im\,S_{11}$ è minimo

$x_2 = f_2/f_0$ TALE CHE $Im\,S_{22}$ è massimo

HENKE DEMONTRATION



INTERSEZIONE CON LE RETTE

$$yy = xx + 1$$

$$yy = -xx - 1$$

$$xx = Re(S_{11}) \qquad yy = Im(S_{11})$$

$$S_{11} = \frac{(\beta-1)/(\beta+1) - (Q_L\delta)^2}{1 + (Q_L\delta)^2} - j\,\frac{2\beta}{\beta+1}\,\frac{Q_L\delta}{1+(Q_L\delta)^2}$$

$$yy = xx + 1 \quad \Rightarrow \quad \frac{2\beta}{\beta+1}\,Q_L\delta = \frac{\beta-1}{\beta+1} - \cancel{(Q_L\delta)^2} + 1 + \cancel{(Q_L\delta)^2}$$

$$Q_L\delta = 1$$

$$yy = -xx - 1 \quad \Rightarrow \quad \frac{2\beta}{\beta+1}\,Q_L\delta = -\frac{\beta-1}{\beta+1} + \cancel{(Q_L\delta)^2} - 1 - \cancel{(Q_L\delta)^2}$$

$$Q_L\delta = -1$$

E POI COME SOPRA ...

MISURA DI Q_{EXT}

PORTARE LA RISONANZA NELLA DETUNED OPEN POSITION DOVE

$$\frac{Z}{Z_0} = \frac{1}{\beta} + j\,\frac{Q_0}{\beta}\,\delta = \frac{1}{\beta} + j\,Q_E\,\delta$$

SCEGLIERE I PUNTI IN CUI $\mathrm{Im}\left(Z/Z_0\right) = \pm 1$

(O SI LEGGE SUL CURSORE DELLA CARTA DI SMITH QUANDO ~~QUAND~~ LA PARTE IMMAGINARIA E' $\pm 50\,\Omega$

O SI ~~...~~ VISUALIZZA $\mathrm{Im}(Z)$ E SI PREMDE QUANDO QUESTA E' $\pm 50\,\Omega$)

IN QUEI PUNTI

$$Q_E\,\delta_1 = -1 \qquad \delta_1 = -\frac{1}{Q_E}$$

$$Q_E\,\delta_2 = +1 \qquad \delta_2 = +\frac{1}{Q_E}$$

$$\delta = \left(\frac{f}{f_0} - \frac{f_0}{f}\right) = x - \frac{1}{x} \simeq 2(x-1)$$

$$Q_E = \frac{1}{x_2 - x_1} = \frac{f_0}{f_2 - f_1}$$

NOTA

- DETUNED OPEN POSITION LA RISONANZA E' PROPRIO UN CERCHIO AD IMPEDENZA COSTANTE. LO POSSO USARE PER ~~...~~ SCEGLIERE BENE IL PHASE OFFSET
- IL VALORE DI IMPEDENZA MI DA DIRETTAMENTE IL VALORE DI $1/\beta$.