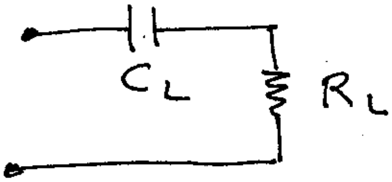
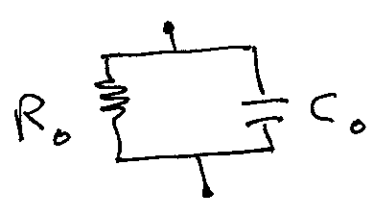
Lossless impedance matching requires the ability of transforming a resistance R_L (say a LOAD) to a new value, call it R_o. We may transform this resistance either up or down in value in relation to R_L. For simplification here, will treat the case where the new value R_o is LARGER than R_L and R_L is just 50Ω.

A basic transform network is the ell network (topology looks like the letter L when drawn) and it is easy to show that this network in its sereis form – for example,



(a)

has an equivalent parallel form, for example,



(b)

These forms are equivalent, since it is possible to write the impedance Z for network (a) as an admittance Y for figure (b).

Then, I can equate the REAL or resistance part of (a), R_L, to the REAL part or conductance part of (b), or G_o. I can do the same for the IMAGINARY parts and a find a C_L (sereis part of (a)) REACTANCE that is equivalent to the parallel C_o or susceptance. These networks are equivalent in so far as they have identical resonant frequency and bandwidth. That is to say they have identical Q's. So, $Q_{sereis} = Q_{parallel}$! Now, there is some algebra involved to find this relation — I'll spare you the details. The results though are easy to use and they are an invaluable tool in design.

$$R_o = R_L\left(Q_s^2 + 1\right) \qquad (1)$$

where $$Q_s = \frac{XC_L}{R_L} \qquad (2)$$

$$Q_s = Q_p \Rightarrow \frac{XC_L}{R_L} = \frac{R_o}{XC_o} \qquad (3)$$

and $R_o > R_L$.

An example — At 3 MHz, let our desired Pout be capable of 250mW with a transistor operating at 14v. Let $V_{cc} = 14v$ and $V_{CE_{SAT}} = 2v$ (a little high but easier math!) Then at 3MHz

$$R_Q \Rightarrow \frac{(V_{CC} - V_{CE\,SAT})^2}{2R_Q} = P_{out} = \frac{144}{(2)(.25W)} = \underline{\underline{288\Omega}}$$

Then need to match 288Ω to 50Ω.

$R_o = 288\Omega \qquad R_L = 50\Omega$

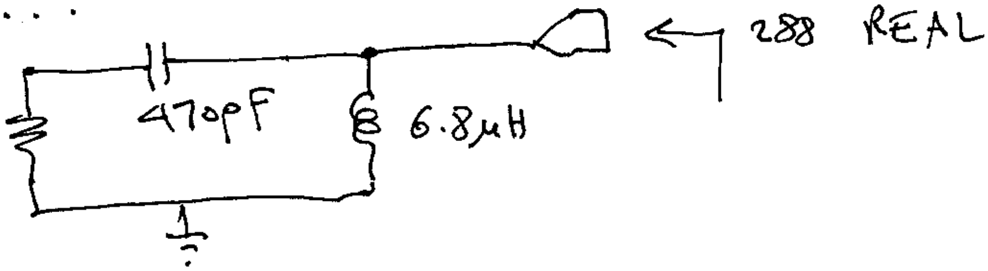
$$Q_s = \sqrt{\frac{288}{50} - 1} = 2.2 \quad \text{and} \quad Q_s = \frac{X_{C_L}}{R_L} = 2.2$$

this uses our Eqn ① and ②. Then $X_{C_L} = (2.2)(50)$

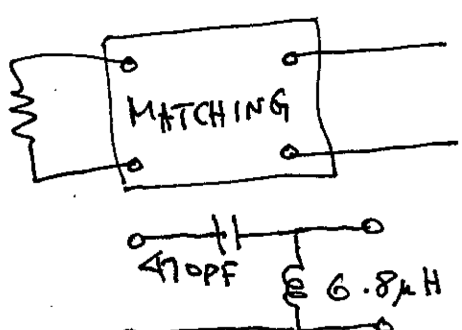
$X_{C_L} = 110\Omega$ or $480pF$ ($470pF$). Now need C_o or parallel equivalent C. The Q's are equal – so...

$$\frac{110}{50} = \frac{288}{X_{C_o}} \quad \text{or} \quad X_{C_o} = 288\left(\frac{50}{110}\right) = 130\Omega$$

for X_{C_o} of 130Ω, $C_o = 408\,pF$. Finally need to cancel our reactance so all that remains is the Lossless match of 50Ω to 288Ω. A shunt L of 130Ω or $6.9\,\mu H$ ($6.8\,\mu H$) is chosen. So our match is ...



Therefore we have ...



(Our all network)

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