Smith Chart Tutorial Part 3 - Lumped Matching

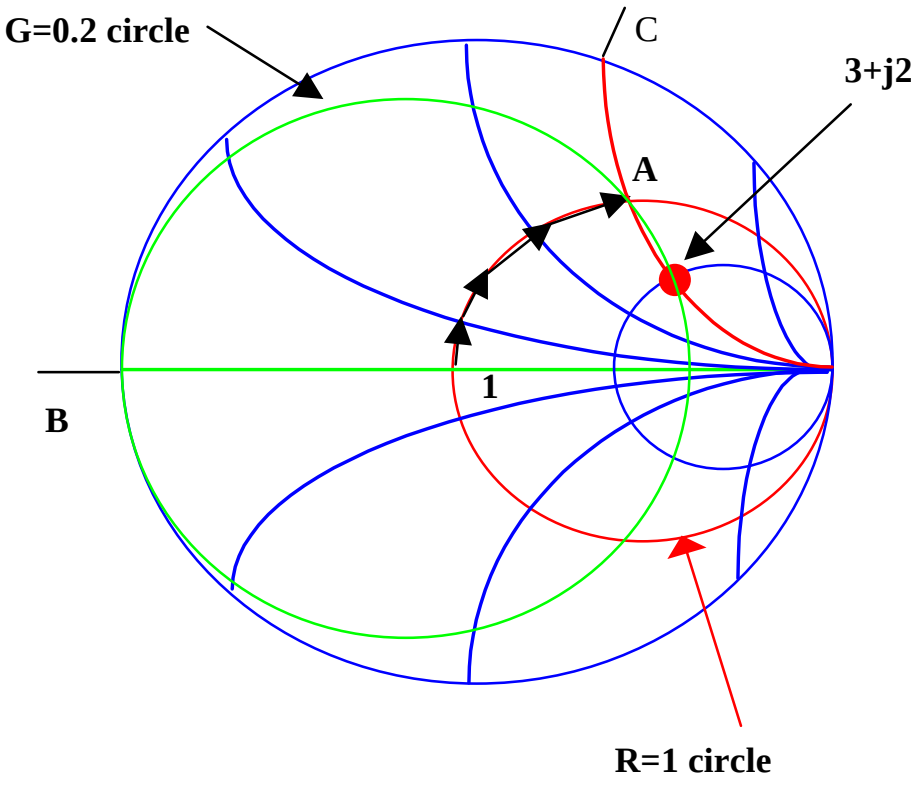
For lower frequency circuits, lumped elements are normally used instead of transmission lines. The rules governing series and shunt capacitors and inductors were given in part 1.

There are two ways to begin matching (1) From the 50-ohm load to the match and (2) From the match to the 50-ohm load.

(1) 50-ohm load to the match

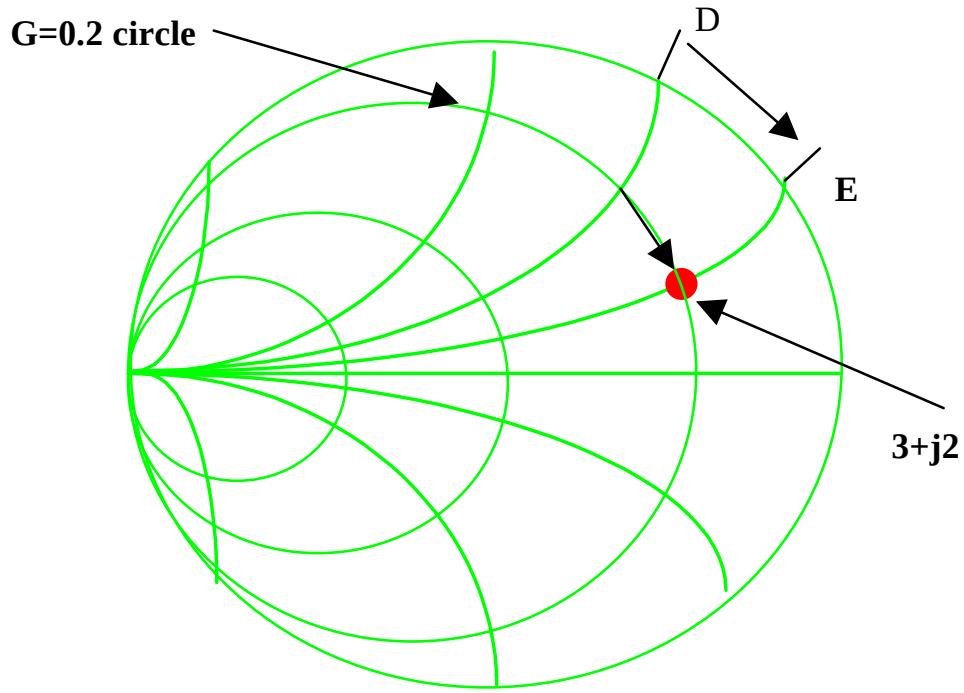
For this example we will design a lumped matching circuit to match 50 ohms to the optimum noise match of a FET. In other words we want to present a particular match to the FET in order to ensure minimum noise. Lets assume that the data sheet or CAD yields a optimum noise match of 3 + j2.0 Ω (normalised to 50-ohms). There are many possible solutions but it is easiest to start with a series inductor.

We start at 50-ohms (ie the centre of the Smith chart) and move around the r=1 circle. At the same time we superimpose a constant admittance circle that intersects the required load which also intersects the r=1 circle at point A.

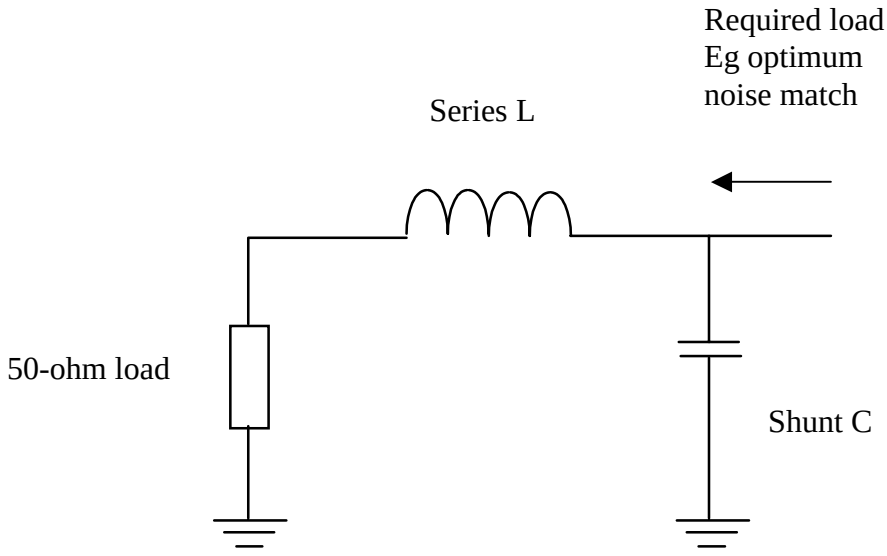


Therefore the distance between point B to C gives the value of the inductor as shown in the smith chart tutorial part 1.

We are now at point A and we need to move to the required match along the admittance circle (shown in green) – this equates to a shunt capacitance or a length of transmission line. The value of the capacitance is given by the reactance between points D & E.



The matching circuit is shown below :

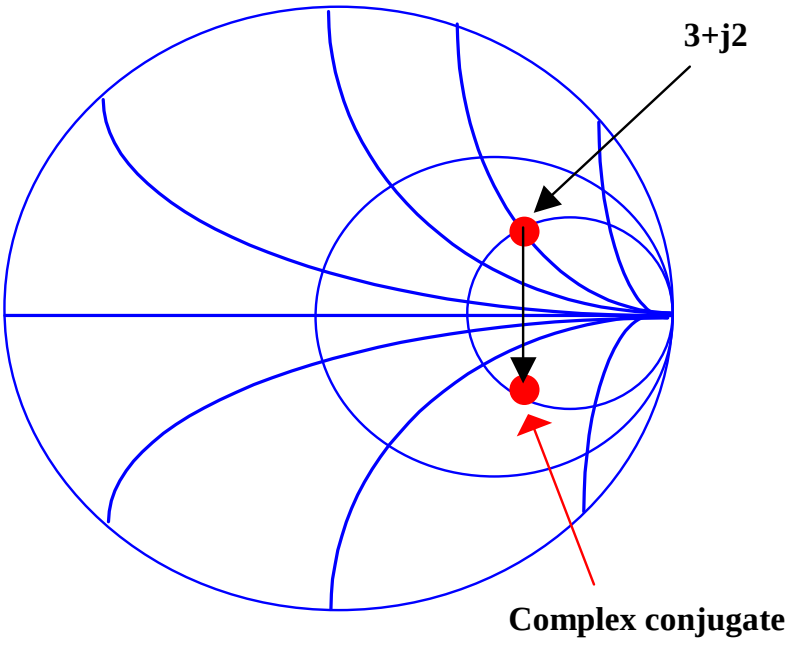


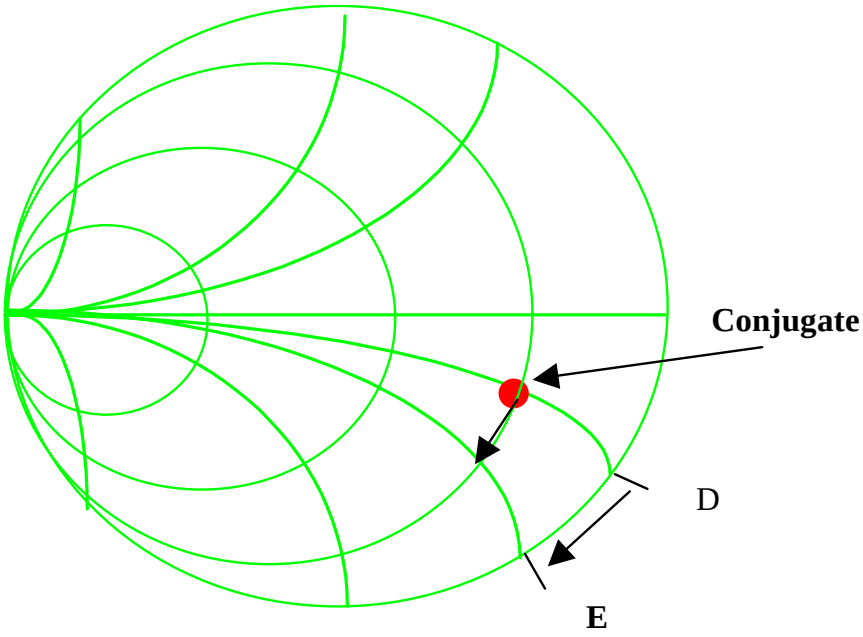
Alternatively, you can start at the device and move towards the 50-ohm load.

(2) Match to the 50-ohm load

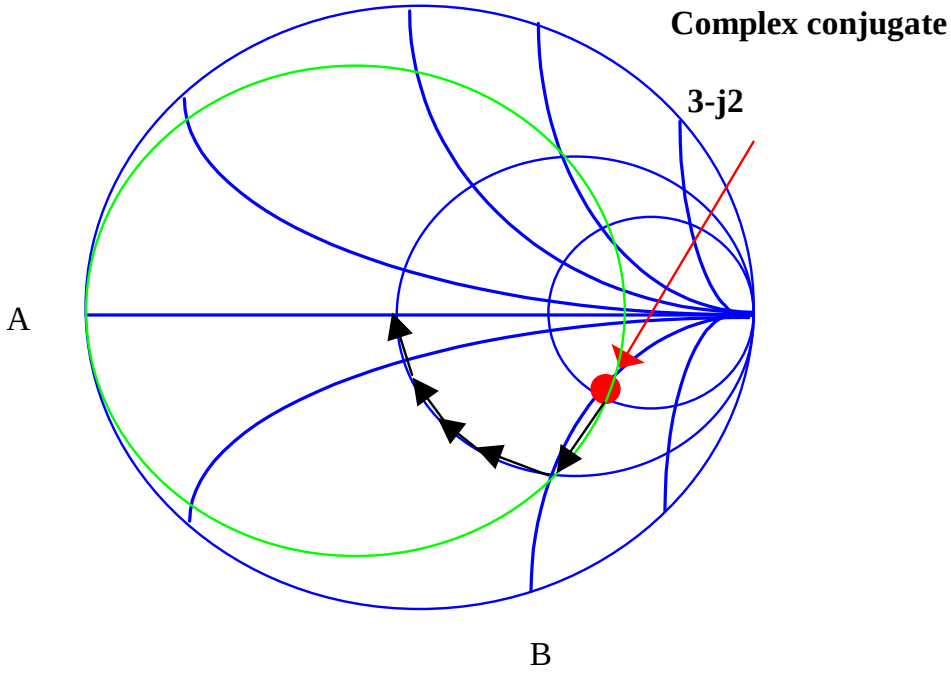
The first thing we need to do is take the complex conjugate of the required match (ie reverse the sign of the phase). We can do this on a Smith chart by plotting the 'mirror' of the match (as shown below).

Then again going clockwise we work our way to the centre of the Smith chart





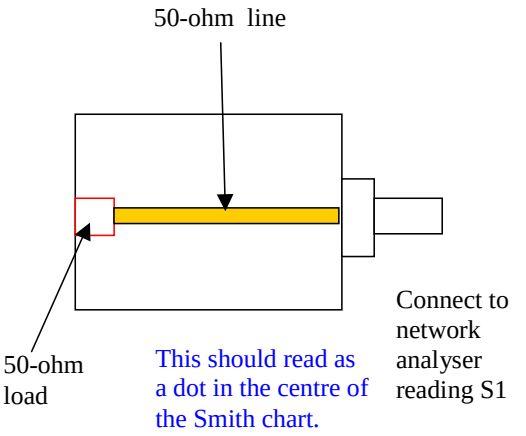
Again the difference in reactance between points D & E (read off the edge of the Smith chart) gives the required capacitance or transmission line from the device.

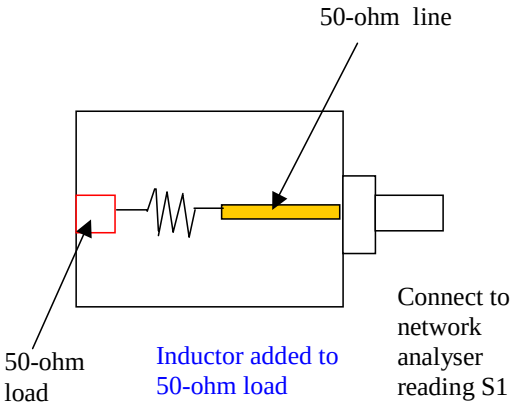


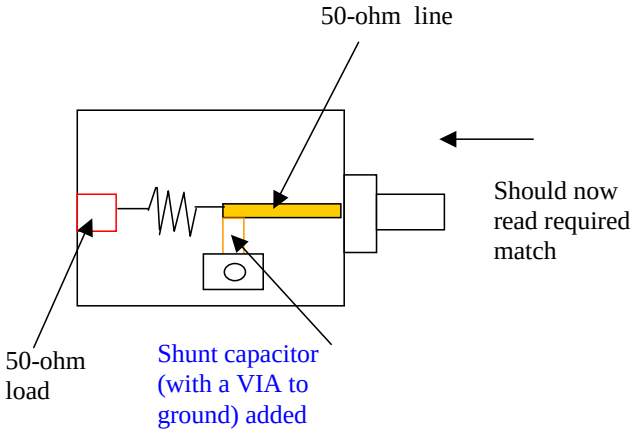
The required series inductance is given by the reactance difference between points A & B (as read on the reactance scale on the edge of the Smith Chart).

Both methods are equally valid but it is important that one method is chosen and always adhered to. The advantage in starting from the 50-ohm load is that for low frequencies the circuit and be measured on a network anaylser and gradually built up to get the required match ie.

Each addition of a component should yield the same result as seen on the simulation/Smith chart.


50-ohm line
50-ohm load
This should read as a dot in the centre of the Smith chart.
Connect to network analyser reading S1


50-ohm line
50-ohm load
Inductor added to 50-ohm load
Connect to network analyser reading S1


50-ohm line
Should now read required match
50-ohm load
Shunt capacitor (with a VIA to ground) added