

Tuned (Resonant) Networks

(excerpted from Chapter 14 of the ARRL Handbook, 2009 and previous editions)

There is a large class of LC networks that utilize resonance at a single frequency to transform impedances over a narrow band. In many applications the circuitry that the network connects to has internal reactances, inductive or capacitive, combined with resistance. We want to absorb these reactances, if possible, to become an integral part of the network design. By looking at the various available network possibilities we can identify those that will do this at one or both ends of the network. Some networks must operate between two different values of resistance, others can also operate between equal resistances. As mentioned before, nearly all networks also allow a choice of selectivity, or Q , where Q is (approximately) the resonant frequency divided by the 3-dB bandwidth.

As a simple example that illustrates the method, consider the generator and load of **Fig 14.58A**. We want to absorb the 20 pF and the 0.1 μ H into the network. We use the formulas to calculate L and C for a 500 Ω to 50 Ω L-network, then subtract 20 pF from C and 0.1 μ H from L . As a second iteration we can improve the design by considering the resistance of the L that we just found. Suppose it is 2 Ω . We can recalculate new values L' and C' for a network from 500 Ω to 52 Ω , as shown in Fig 14.58B.

Further iterations are possible but usually trivial. More complicated networks and more difficult problems can use a computer to expedite absorbing process. Always try to absorb an inductance into a network L and a capacitance into a network C in order to minimize spurious LC resonances and undesired frequency responses. Inductors and capacitors can be combined in series or in parallel as shown in the example. Fig 14.58C shows useful formulas to convert series to parallel and vice versa to help with the designs.

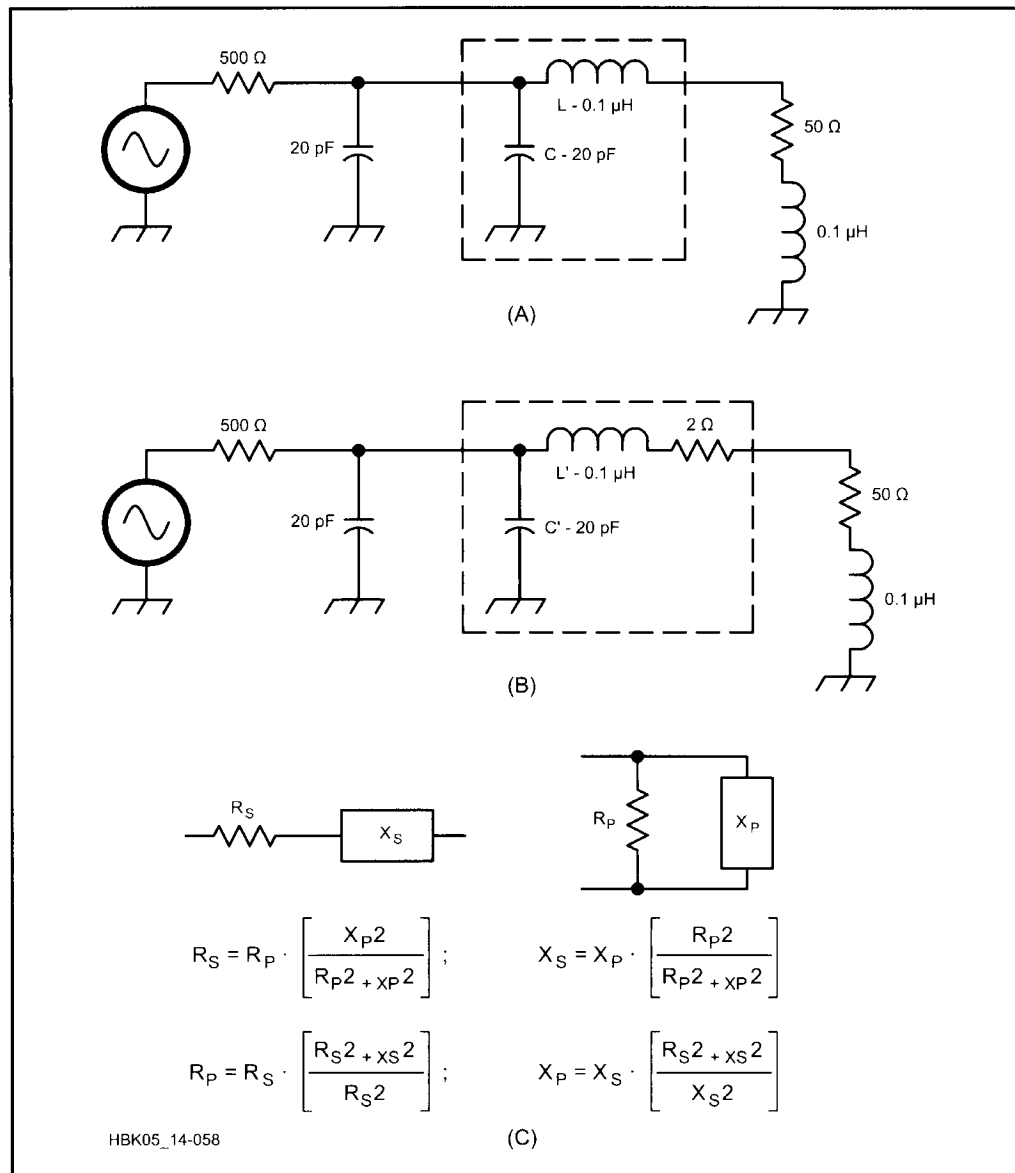


Fig 14.58 — At A, impedance transformation, first iteration. At B, second iteration compensates L and C values for coil resistance. At C, series-parallel conversions.

A set of 14 simple resonant networks, and their equations, is presented in **Fig 14.59**. Note that in these diagrams R_S is the low impedance side and R_L is the high impedance side and that the X values are calculated in the top-down order given. The program *MATCH.EXE* can perform the calculations.

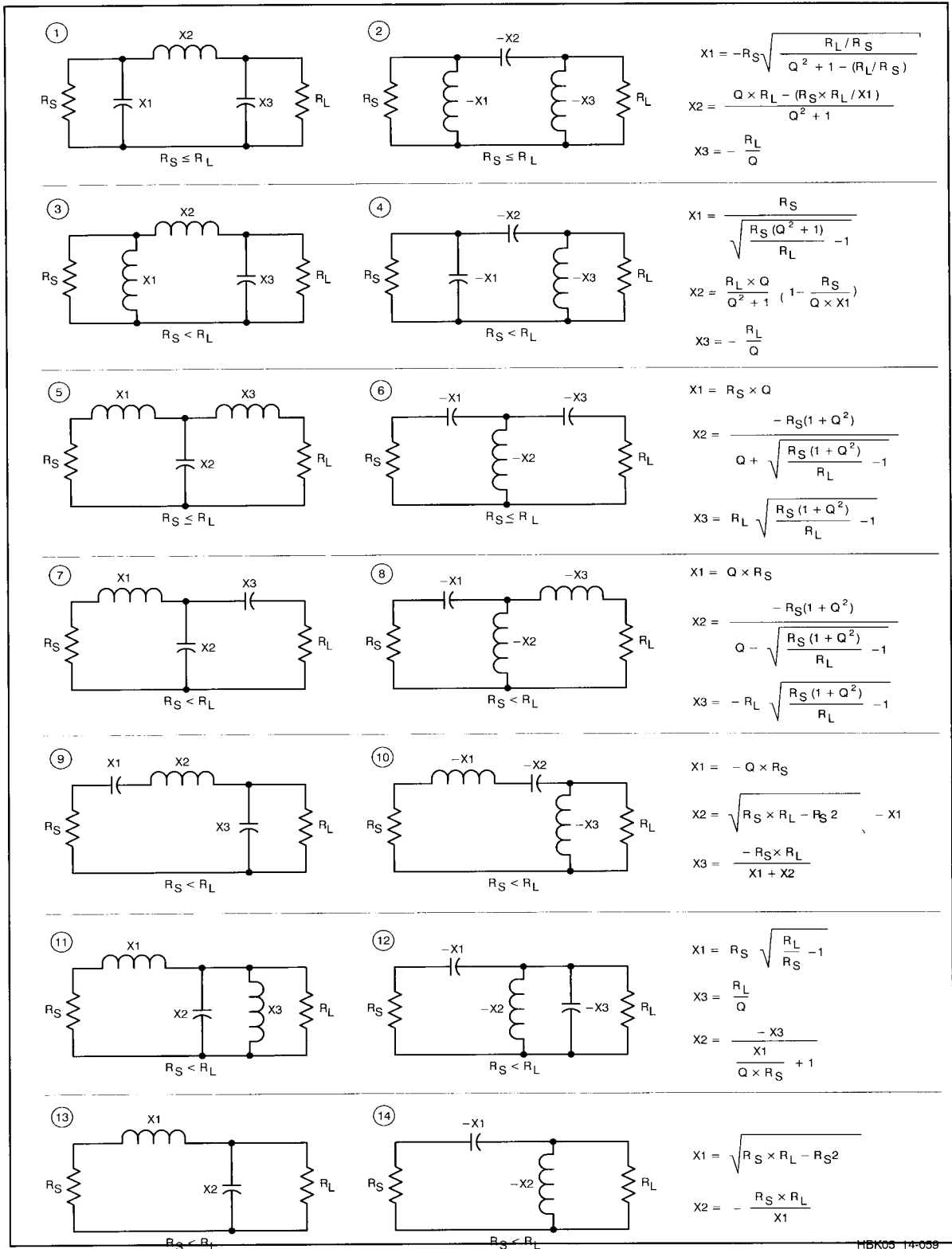


Fig 14.59 — Fourteen impedance transforming networks with their design equations (for lossless components).

Circuit simulation programs can also help a lot with special circuit-design problems and some approaches to resonant network design. It can graph the frequency response, compute insertion loss and also tune the capacitances and inductances across a frequency band. You may select the selectivity (Q) in such programs based on frequency-response requirements. The program can also be trimmed to help realize realistic or standard component values. A math program such as *Mathcad* can also make this a quick and easy process.