Circuit Conversions and L, C, R circuits

Introduction: Analog signal processing for a great many tasks involves the use of series, parallel and transformer based L, C, R circuits. A number of transformations can be defined for these circuits as well as key quantities such as the quality factor, impedance transformation, resonant frequency, bandwidths and terminal or tank impedance and tank quality factors need to be calculated for use in practical circuits. This technical note describes these factors and the accompanying software helps to reduce the time required for these calculations.

Resonant RL||C circuit: The resonant RL||C circuit has the resistor and the inductor in series while the capacitor is in parallel to both. The program **mag1c** calculates the resonant frequency, the tank quality factor, the terminal resistance and the bandwidth given R, L and C values for the circuit.

Resonant RC||L circuit: The resonant RC||L circuit has the resistor in series with the capacitor while the inductor is in parallel to both. The program **mag2c** calculates the resonant frequency, the tank quality factor, the terminal resistance and the bandwidth given R, L and C values for the circuit.

Parallel to series conversion for RC networks: The program **mag3c** converts a parallel RC circuit into an equivalent series circuit. It calculates, the quality factor, the series resistance and the series capacitance given the parallel RC circuit component values.

Series to parallel conversion for RC networks: the program **mag4c** converts a series RC circuit into an equivalent parallel RC circuit. It calculates the quality factor, the parallel resistance and the parallel capacitance given the series network component values.

Parallel to series conversion for a RL network: The program **mag5c,** converts a series RL network into an equivalent parallel RL network. It

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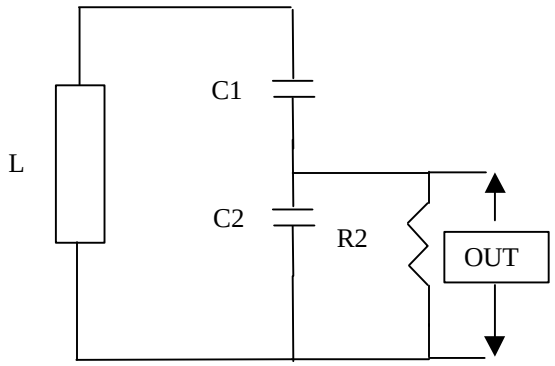
calculates the quality factor, the parallel resistance and the parallel inductance given the series R and the series L.

Parallel to series conversion of a RL network: The program **mag6c** converts a parallel RL network into a series RL network. It calculates the quality factor, the series resistance and the series inductance given the parallel resistance and the parallel inductance.

Tapped capacitor LCR circuits: Tapped capacitor circuits are used extensively in the design of Colpitt's oscillators as well as in other tuned frequency applications. The circuit is shown below:



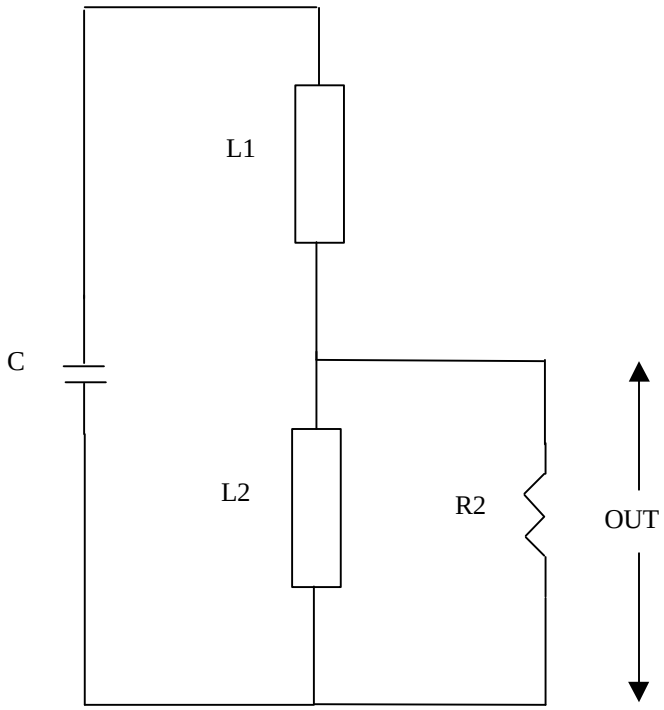
Here R2 is the load across the tap. What is required is to find the values of L, C1, C2 when given R2, Rt, fo and B. fo is the resonant frequency, R2 is the load, Rt is the tank or terminal impedance and B is the bandwidth. The program **mag7c** calculates the values of all the components under the required constraints.

Note that this circuit acts a transformer in that, it transform the values of R2 into a value of Rt given by:

$$Rt/R2 = N^2$$

Where N can be associated with the turns ratio of a transformer. This is the impedance transforming property of the tapped capacitor circuit.

Tapped inductor circuits: Tapped inductor circuits are circuits where the inductor is divided into two parts with a tap. This is shown below:



The analysis of the tapped inductor circuit is similar to that for the tapped capacitor circuit. It should be noted that a tapped inductor is really an auto-transformer and as such has the properties of impedance transformation. The program **mag8c** calculates the components of the tapped inductor circuit given the resonant frequency fo, the bandwidth B, the load R2 and the terminal impedance Rt.

Single tuned transformer circuits: The single tuned transformer also provides a way for impedance matching. In addition it can also provide isolation between the input and the output as well as phase reversal if desired. Program **mag9c** calculates values of L1, L2, mutual inductance M and the coupling coefficient k which satisfy the specified values of the terminal impedance Rt, the load impedance r2, the resonant frequency fo and the bandwidth B.

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