Answer on Question #54802-Engineering-Electrical Engineering

Explain the procedure of quarter wave-line impedance matching in transmission lines.

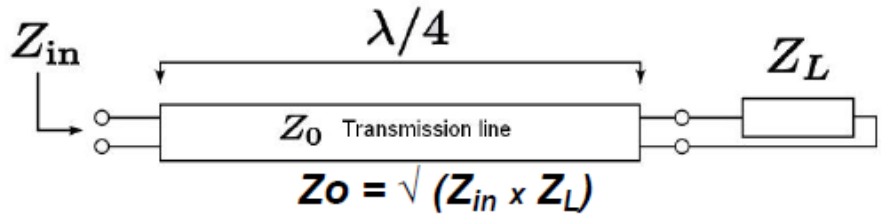
Answer

An impedance transformer may be realized by inserting a section of a different transmission line with appropriate characteristic impedance.

A quarter-wave impedance transformer is a component used in RF engineering consisting of a length of transmission line one quarter of a wavelength (λ/4) long and terminated in some known impedance Z_L.

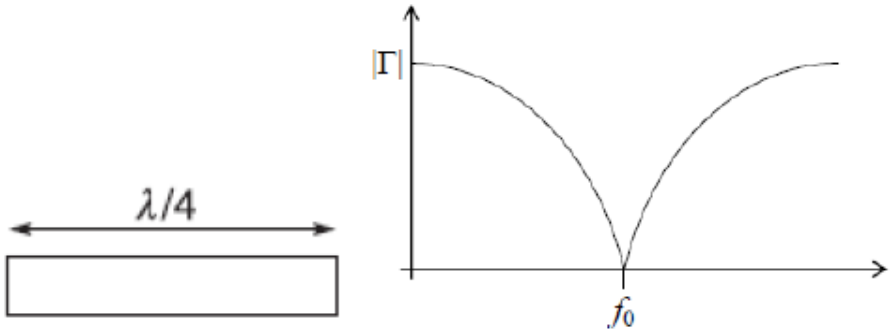
- Although quarter-wave transformer can in theory used to match complex impedances, it is more common to use it to match real impedances.
- However, a complex load impedance can always be transformed to a real impedance by adding the correct series or shunt reactive component.

At the operating frequency, the electrical length of the matching section is λ/4. But at other frequencies the length is different, so a perfect match is no longer obtained. The quarter wave transformer has a limited bandwidth, like other transformation methods.

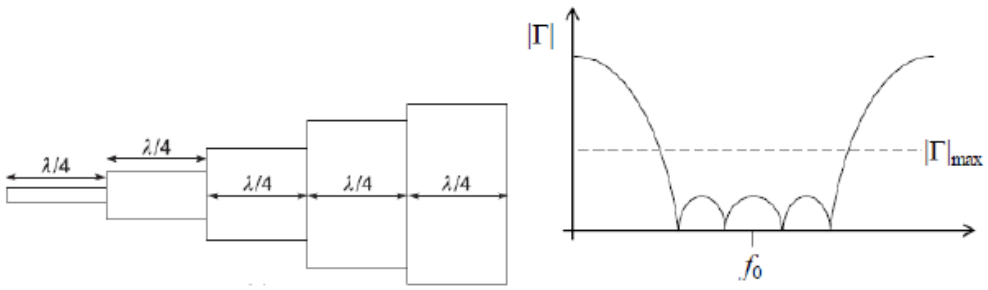


The characteristic impedance of the quarter-wave line is the geometric average of Z_{in} and Z_L.

a) A quarter-wave λ/4 transformer provides a perfect match at only one frequency.



b)



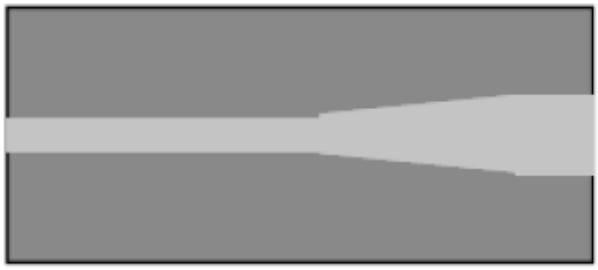
A broadband design may be obtained by a cascade of λ/4 line sections of gradually varying their characteristic impedance.

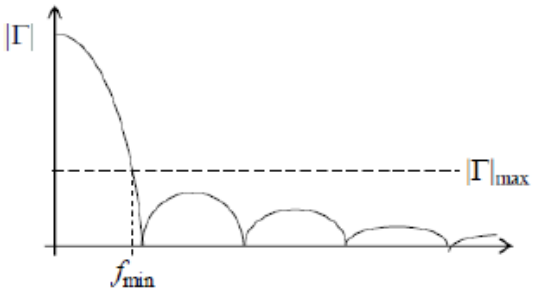
It is not possible to obtain exactly zero reflection coefficient for all frequencies in the desired band.

Therefore, available design approaches specify a maximum reflection coefficient (or maximum VSWR) which can be tolerated in the frequency band of operation.

- The change of characteristic impedances Z_{in} must increase or decrease monolithically.

c)





Another broadband matching approach may use a tapered line transformer with continuously varying characteristic impedance along its length (characteristic impedance varies continuously in a smooth fashion).

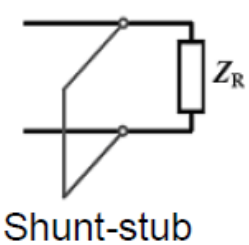
In this case, the design obtains reflection coefficients lower than a specified tolerance at frequencies exceeding a minimum value.

- The required length of the taper section should be about 0.5 to 1.5 of wavelength.

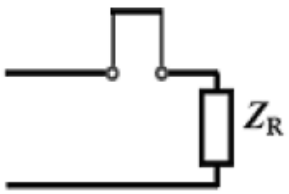
A different narrow-band approach involves the insertion of a shunt imaginary admittance on the line.

Often, the admittance is realized with a section (or stub) of transmission line and the technique is commonly known as stub matching. The end of the stub line is short-circuited or open-circuited, in order to realize an imaginary admittance.

A second narrow-band example involves the insertion of series impedance (stub) along the line.



Shunt-stub



Series-stub