Impedansi Saluran Transmisi

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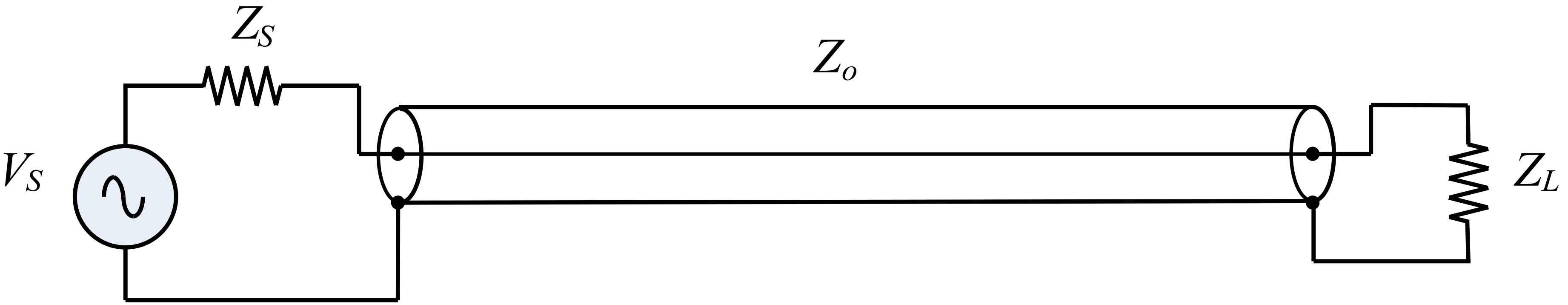
Model terminal saluran transmisi



Impedansi input

- For a lossless transmission line, it can be shown that the impedance measured at a given position $\boldsymbol{l}$ from the load impedance $\boldsymbol{Z_L}$ is:

$$Z_{in}(l) = Z_o \frac{Z_L + jZ_o \tan(\beta l)}{Z_o + jZ_L \tan(\beta l)}$$

dimana :

$$\beta = \frac{2\pi}{\lambda}$$

Half-wave Length

- For the special case where $\beta l = n\pi$ where n is an integer (meaning that the length of the line is a multiple of half a wavelength), the expression reduces to the load impedance so that :

$$Z_{in} = Z_L$$

for all *n*. This includes the case when *n* = 0, meaning that the length of the transmission line is negligibly small compared to the wavelength. The physical significance of this is that the transmission line can be ignored (i.e. treated as a wire) in either case.

Quarter-wave length

- For the case where the length of the line is one quarter wavelength long, or an odd multiple of a quarter wavelength long, the input impedance becomes:

$$Z_{in} = \frac{Z_o^2}{Z_L}$$

Beban Match

- Another special case is when the load impedance is equal to the characteristic impedance of the line (i.e. the line is *matched*), in which case the impedance reduces to the characteristic impedance of the line so that:

$$Z_{in} = Z_o = Z_L$$

Shorted

- For the case of a shorted load (i.e. *ZL* = 0), the input impedance is purely imaginary and a periodic function of position and wavelength (frequency):

$$Z_{in}(l) = jZ_o \tan(\beta l)$$

Open

- For the case of an open load (i.e. $Z_L = \infty$), the input impedance is once again imaginary and periodic:

$$Z_{in}(l) = -jZ_o \cot(\beta l)$$

Impedansi Karakteristik (Zo)

- Misal sebuah saluran transmisi yang sangat panjang (*infinite length*), pada titik input diberi sinyal dan sinyal tidak pernah mencapai output, maka impedansi yang terukur pada input saluran tersebut adalah impedansi karakteristik, yang dinyatakan dalam satuan ohm dan dinotasikan sebagai Zo
- Sedangkan untuk kondisi yang nyata, impedansi karakteristik diukur pada saluran transmisi yang panjangnya tertentu dengan ujung outputnya dipasang sebuah beban yang impedansinya sama dengan impedansi karakteristik saluran yang diukur tersebut

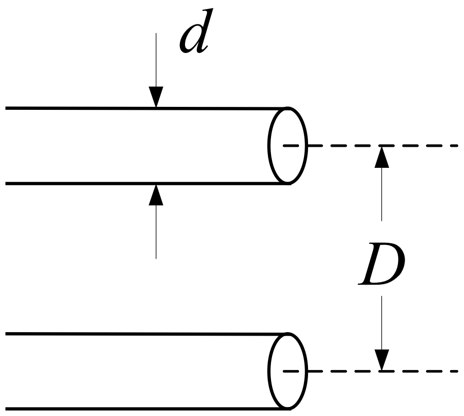
Rumus Impedansi Karakteristik (Umum)

$$Z_o = \sqrt{\frac{Z}{Y}} = \sqrt{\frac{R + jX_L}{G + jX_c}} \text{ ohm}$$

untuk lossless line (R dan G dianggap kecil), maka :

$$Z_o = \sqrt{\frac{L}{C}} \text{ ohm}$$

Parallel Wire (twinex or twin-lead)



$$Z_o = 276 \log \frac{2D}{d} \text{ ohm}$$

Contoh

- Sebuah kabel paralel dengan spasi 2 cm dan Zo = 300 ohm. Tentukan diameter kawat yang digunakan!
- Jawab:

$$Z_o = 276 \log \frac{2D}{d} \quad \text{ohm}$$

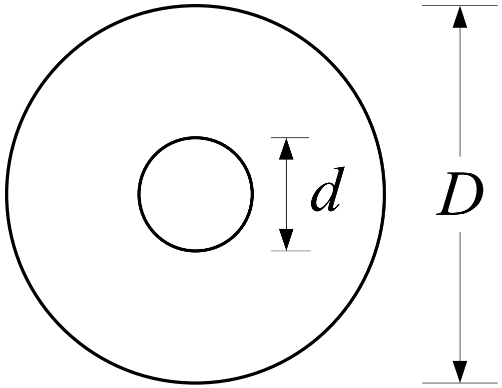
shg :

$$d = \frac{2D}{anti\log \frac{Z_o}{276}} \text{cm}$$

$$d = \frac{4}{anti\log 1{,}087} \quad \text{cm}$$

$$d = 0{,}3273 \ \text{cm}$$

Koaksial



$$Z_o = \frac{138}{\sqrt{k}} \log \frac{D}{d} \quad \text{ohm}$$

k = konstanta dielektrik antara shield dan center conductor

Contoh:

- Sebuah kabel koaksial dengan dielektrik 1,2. Tentukan perbandingan diameter luar dan diameter dalam agar menghasilkan impedansi karakteristik sebesar 72 ohm!
- Jawab:

$$Z_o = \frac{138}{\sqrt{k}} \log \frac{D}{d} \quad \text{ohm}$$

$$\frac{D}{d} = anti \log \frac{Z_o \sqrt{k}}{138} = anti \log \frac{72 \times \sqrt{1{,}2}}{138}$$

$$= anti \log 0{,}5715$$

$$= 3{,}729$$