Ultrasound HW1 M11107309 何柏昇

1. PZT-5H : $f_0 = 8\,MHz$, $C = 4350\,m/s$

(a) $d_{PZT-5H} = ?$

<sol> $d = \frac{\lambda}{2}$, $\lambda = \frac{c}{f}$

$\Rightarrow \lambda = \frac{4350}{8M} = 0.54375\,mm$

$\Rightarrow d_{PZT-5} = 0.271875\,mm$ #

(b) $Z_m = ?$, $Z_1 = 30$, $Z = 1.65$

<sol> $Z_m = \sqrt{Z_1 Z_2} = \sqrt{30 \times 1.65}$

$\fallingdotseq 7.036$ Mrayls #

(c) $d_m = ?$, $C_m = 2500\,m/s$

<sol>

$d_m = \frac{\lambda}{4}$, $\lambda = \frac{c}{f}$

$\Rightarrow \lambda = \frac{2500}{8M} = 0.3125\,mm$

$d_m = 0.078125\,mm$ #

(d)

Z_1	Z_m	Z_2
30	7.036	1.65

① without Z_m

$\%T = 1 - \left[\frac{30-1.65}{30+1.65}\right]^2$

$= 20\%$

② with Z_m

$\%T_1 = 1 - \left[\frac{30-7.036}{30+7.036}\right]^2$

$= 62\%$

$\%T_2 = 1 - \left[\frac{7.036-1.65}{7.036+1.65}\right]^2$

$= 62\%$

$\%T = 62\% \times 62\%$

$= 38\%$

$\Rightarrow \uparrow 18\%$ #

2. find Z_{m1} & Z_{m2}, %T

Z_1	Z_{m1}	Z_{m2}	Z_2
30			1.65

<sol>

①

$$Z_{m1} = \sqrt[3]{Z_1^2 Z_2}, \quad Z_{m2} = \sqrt[3]{Z_1 Z_2^2}$$

$$\Rightarrow \begin{cases} Z_{m1} = \sqrt[3]{30^2 \times 1.65} \fallingdotseq 11.4 \text{ Mrayls} \\ Z_{m2} = \sqrt[3]{30 \times 1.65^2} \fallingdotseq 4.3 \text{ Mrayls} \end{cases} \#$$

②

$$\%T_1 = 1 - \left[\frac{30 - 11.4}{30 + 11.4}\right]^2 \fallingdotseq 80\%$$

$$\%T_2 = 1 - \left[\frac{11.4 - 4.3}{11.4 - 4.3}\right]^2 \fallingdotseq 80\%$$

$$\%T_3 = 1 - \left[\frac{4.3 - 1.65}{4.3 + 1.65}\right]^2 \fallingdotseq 80\%$$

$$\%T = 80\% \times 80\% \times 80\% \fallingdotseq 51\%$$

$$\Rightarrow \uparrow 31\% \ \#$$

3. The total loss

(a) transmitted wave:

$$\text{Loss (dB)} = \mu f z$$
$$= 0.6(\text{dB/cm/MHz}) \cdot 5\,\text{MHz} \cdot 10\,\text{cm}$$
$$= 30\,\text{dB}$$

returning echo:

$$30\,\text{dB}$$

reflection:

$$\%R = \left[\frac{Z_2 - Z_1}{Z_2 + Z_1}\right]^2 = \left[\frac{7.5 - 1.5}{7.5 + 1.5}\right]^2$$
$$= 44\%$$
$$\Rightarrow 10 \log\left(\frac{100}{44}\right) \doteq 3.6\,\text{dB}$$

Total:

$$\text{Loss(dB)} = 30 + 30 + 3.6 = 63.6\,\text{dB}$$

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(b) $\text{Level(dB)} = 10 \log\left(\frac{I}{I_{max}}\right)$, $\text{Level (dB)} = -63.6\,\text{dB}$

$I_{max} = 8\,\text{W/cm}^2$

<sol>

$$-63.6 = 10 \log\left(\frac{I}{8\,\text{W/cm}^2}\right)$$
$$10^{-6.36} = \frac{I}{8\,\text{W/cm}^2} \Rightarrow I = 3.49\,\mu\text{W/cm}^2$$

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