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1. a. $Z_A = 0{,}25\ Z_0$

a.1. $\Gamma_A = \frac{Z_A - Z_0}{Z_A + Z_0} = \frac{0{,}25\ Z_0 - Z_0}{0{,}25\ Z_0 + Z_0}$

$= \frac{0{,}75}{1{,}25} = 0{,}6 + j0$

$|\Gamma_A| = 0{,}6$

$\theta = \tan^{-1}\left(\frac{0}{0{,}6}\right) = 0^\circ$

$SWR = \frac{1 + |\Gamma_A|}{1 - |\Gamma_A|} = \frac{1 + 0{,}6}{1 - 0{,}6} = 4$

$RL = 20 \log |\Gamma_A| = 20 \log 0{,}6 = -4{,}44\ dB$

a.2. 25 dBm

$P = 10^{\frac{25}{10}} = 316\ mW = 0{,}316\ W$

$|\Gamma_A| = \frac{V^-}{V^+}$

$V^- = |\Gamma_A| V^+ = 0{,}6 \cdot 0{,}316 = 0{,}1896$

$V^{2+} = V^+ - V^- = 0{,}316 - 0{,}1896 = 0{,}1264\ W$

a.3. $d = 0{,}375\ \lambda$ $\beta = \frac{2\pi}{\lambda}$

$$Z(d) = Z_0 \cdot \frac{Z_A + j Z_0 \tan(\beta d)}{Z_0 + j Z_A \tan(\beta d)}$$

$$= Z_0 \cdot \frac{0{,}25 Z_0 + j Z_0 \tan\left(\frac{2\pi}{\lambda} \cdot 0{,}375\lambda\right)}{Z_0 + j 0{,}25 Z_0 \tan\left(\frac{2\pi}{\lambda} \cdot 0{,}375\lambda\right)}$$

$$= Z_0 \cdot \frac{0{,}25 - j}{1 - j 0{,}25}$$

$$= 0{,}47 Z_0 + j 0{,}88 Z_0$$

$$|\Gamma_A| = \frac{Z(d) - Z_0}{Z(d) + Z_0} = \frac{0{,}47 Z_0 + j 0{,}88 Z_0 - Z_0}{0{,}47 Z_0 + j 0{,}88 Z_0 + Z_0}$$

=

$Z_L = 50 + j25\ \Omega$

$Z_0 = 50$

~~$Z_{LN} = 1 + j0{,}5$~~

$Z_{LN} = 1 + j0{,}5$

$d = 40\,cm = 0{,}4\,m$

$V_s = 60\,V$

$f = 150\,MHz = 1{,}5 \times 10^8$

$R_s = 50\,\Omega$

$\varepsilon_r = 1$

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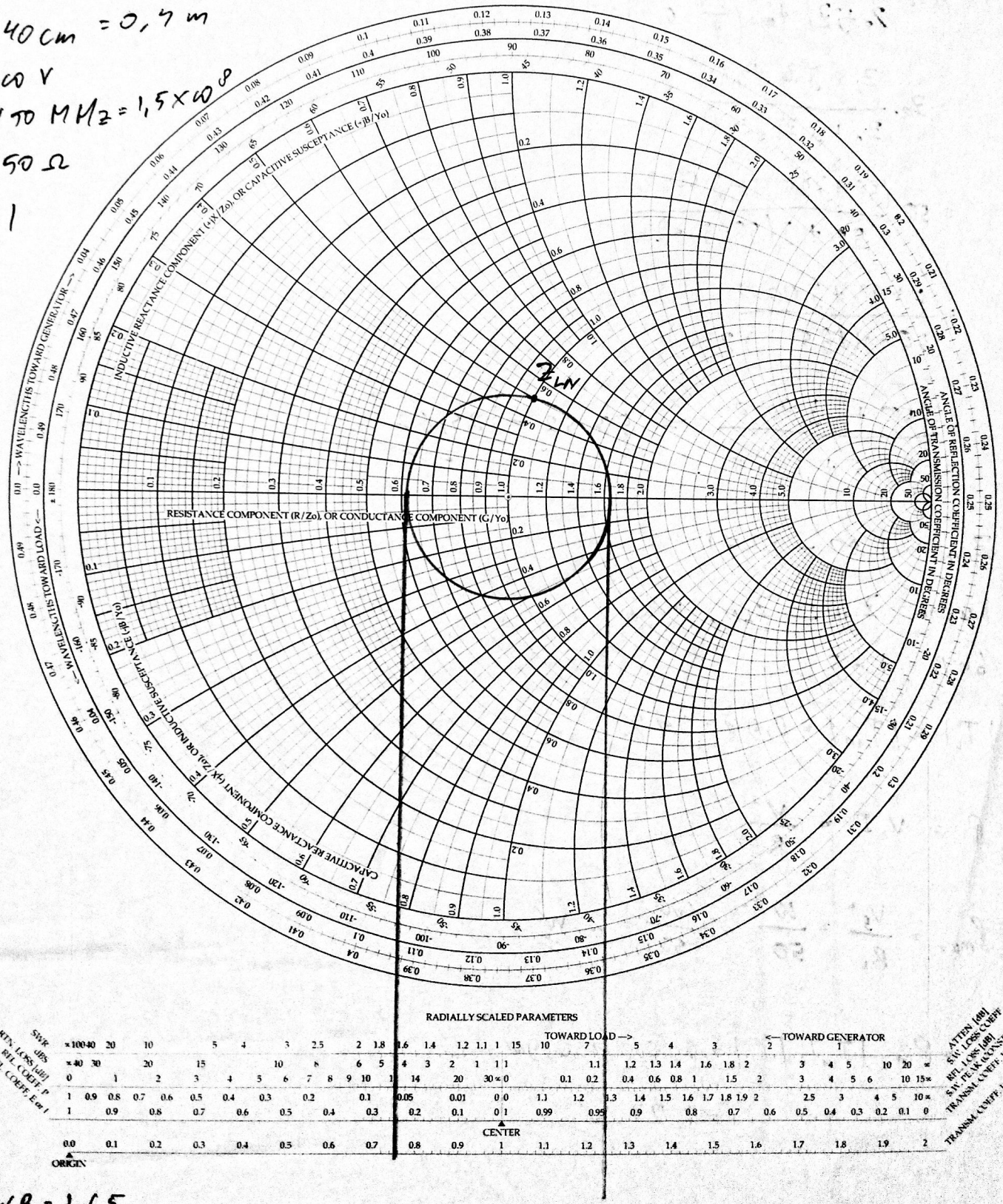
The Complete Smith Chart

Black Magic Design



a. SWR = 1,65

b. $|T| = 0{,}94 = 94\,\%$

c. $Z_{in} = Z_0 \cdot \frac{Z_L + jZ_0 \tan(\beta d)}{Z_0 + jZ_L \tan(\beta d)}$

$\beta = \frac{2\pi}{\lambda}$; $\lambda = \frac{c}{f\sqrt{\varepsilon_r}} \cdot \frac{3\times10^8}{1,5\times10^9} = 2$

$= Z_0 \cdot \frac{Z_L + jZ_0 \tan\left(\frac{2\pi}{2} \cdot 0,4\right)}{Z_0 + jZ_L \tan\left(\frac{2\pi}{2} \cdot 0,4\right)}$

$= Z_0 \cdot \frac{Z_L + jZ_0 \cdot 3,1}{Z_0 + jZ_L \cdot 3,1}$

$= 50 \cdot \frac{(50 + j25) + j50 \cdot 3,1}{50 + j(50 + j25)3,1}$

$= \frac{2500 + j9000}{50 + j(-77,5 + j77,5)}$

$= \frac{2500 + j9000}{-27,5 + j155} = 53,52 - j25,62$

d. $Z_{inN} = 1,07 - j0,51$

Karena $Z_{inN} \simeq Z_{LN}$, maka

SWR = 1,65

e. $|T_L| = |T_{in}| = 0,94 = 94\%$

f. $P = V \cdot I = \frac{V^2}{R}$

$P_{max} = \frac{V_s^2}{R_s} = \frac{10^2}{50} = \frac{100}{50} = 2\ W$

g. $P_L = P_{in} \cdot |T_{in}| \cdot |T_L| = 2 \cdot 0,94 \cdot 0,94$

$= 1,77\ W$

$Z_L = 100 + j100\ \Omega$

$Z_0 = 50\ \Omega$

$Z_{LN} = 2 + j2$

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The Complete Smith Chart

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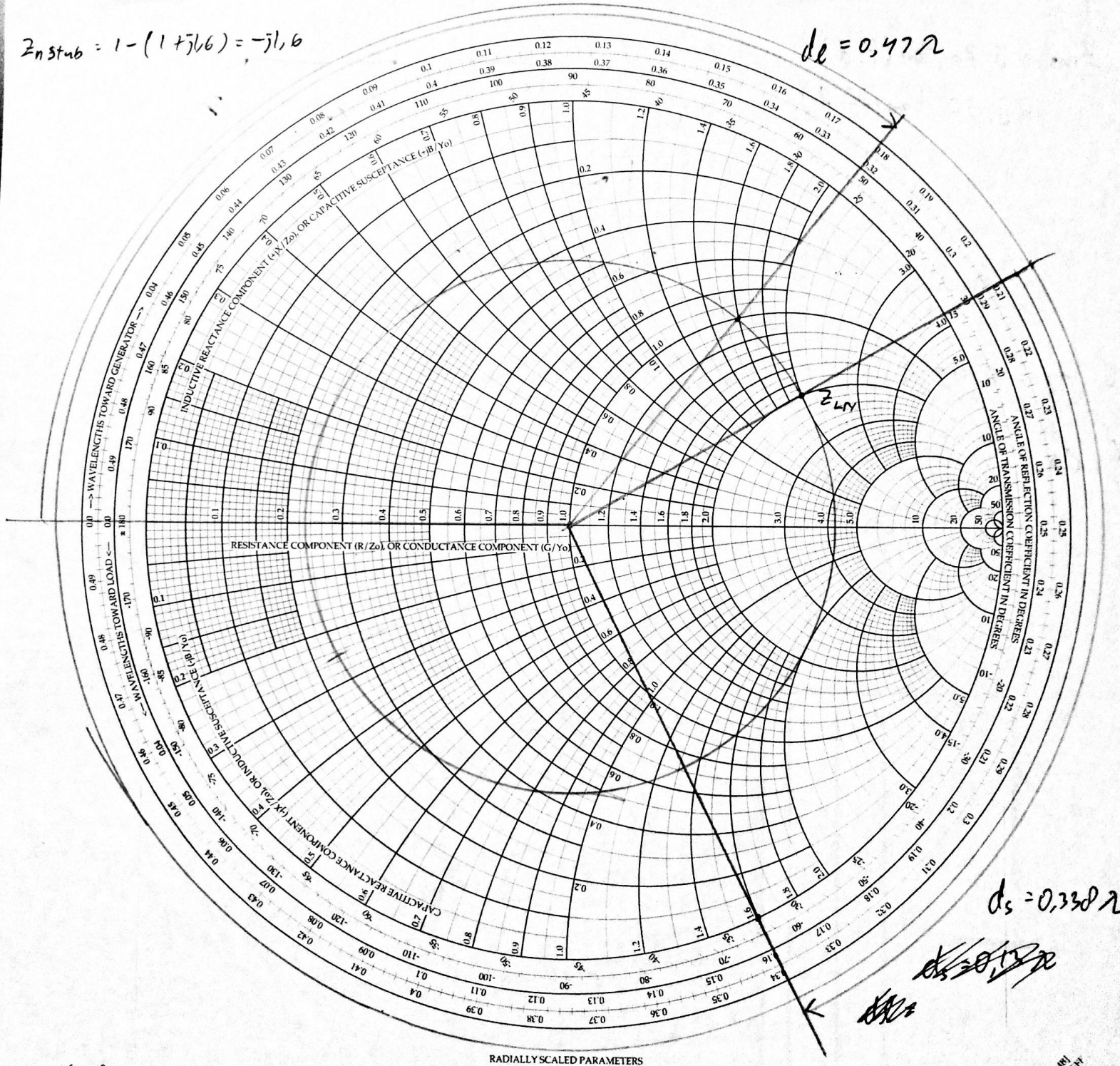
$Z_{n\,stub} = 1 - (1 + j1.6) = -j1.6$

$d_\ell = 0,477\lambda$



$d_s = 0,330\lambda$

~~$d_s = 0,17\lambda$~~

RADIALLY SCALED PARAMETERS

SWR

RTN. LOSS [dB]

REFL. COEFF. P

REFL. COEFF. E or I

TOWARD LOAD —> <— TOWARD GENERATOR

ATTEN. [dB]

SW. LOSS COEFF.

REFL. LOSS [dB]

SW. PEAK EXCESS P

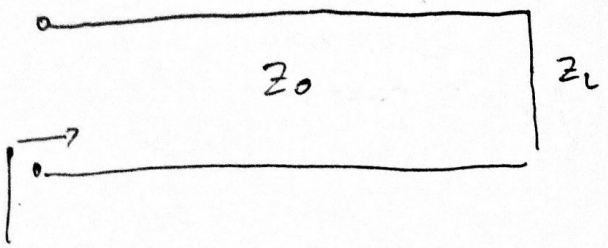
TRANSM. COEFF. P

TRANSM. COEFF. E or I

CENTER

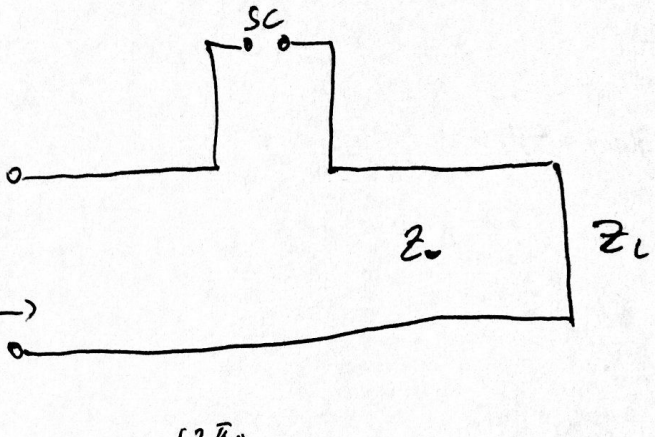
ORIGIN

a.



$$Z_{ins} = j\, Z_0 \tan(\beta \cdot d)$$

$$= j \cdot 50 \tan\left(\frac{2\pi}{\lambda} \cdot d\right)$$



$$Z_{ins} = j\,50 \tan\left(\frac{2\pi}{\lambda} d\right)$$

b. $d_L = 0{,}47\,\lambda$

c. $d_S = 0{,}330\,\lambda$

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4. $a = 10{,}1\ cm = 10{,}1 \times 10^{-2}\ m$

$b = 5{,}1\ cm = 5{,}1 \times 10^{-2}\ m$

$TM_{11} \rightarrow m = 1,\ n = 1$

a. $f_c = \frac{1}{2\pi\sqrt{\mu\varepsilon}} \sqrt{\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2}$

$= \frac{c}{2\pi} \sqrt{\left(\frac{\pi}{a}\right)^2 + \left(\frac{\pi}{b}\right)^2}$

$= \frac{3 \times 10^8}{2\pi} \sqrt{\left(\frac{\pi}{10{,}1 \times 10^{-2}}\right)^2 + \left(\frac{\pi}{5{,}1 \times 10^{-2}}\right)^2}$

$= 3{,}29\ GHz$

b. $\beta_{11} = \omega\sqrt{\mu\varepsilon} \sqrt{1 - \left(\frac{f_c}{f}\right)^2}$

$f = 6{,}6\ GHz$

$= 6{,}6 \times 10^9\ Hz$

$= \frac{2\pi f}{c} \sqrt{1 - \left(\frac{f_c}{f}\right)^2}$

$= \frac{2\pi \cdot 6{,}6 \times 10^9}{3 \times 10^8} \sqrt{1 - \left(\frac{3{,}29 \times 10^9}{6{,}6 \times 10^9}\right)^2}$

$= 119{,}71$

c. $\lambda_{11} = \frac{2\pi}{\beta_{11}} = \frac{2\pi}{119{,}71} = 0{,}052\ m$

d. $V_{p_{11}} = \frac{\omega}{\beta_{11}} = \frac{2\pi f}{c} \cdot \frac{1}{119{,}71} = \frac{2\pi \cdot 6{,}6 \times 10^9}{3 \times 10^8} \cdot \frac{1}{119{,}71} = 1{,}15\ m/s$

$$\eta_{11} = \eta_0 \sqrt{1 - \left(\frac{f_c}{f}\right)^2}$$

$$= 120\pi \sqrt{1 - \left(\frac{3{,}29 \times 10^9}{6{,}6 \times 10^9}\right)^2}$$

$$= 120\pi \sqrt{1 - 0{,}5^2} = 326{,}5\ \Omega$$