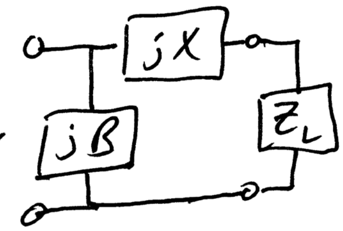
For a circuit operating at 125 MHz, design and sketch a lossless *L*-network using a series inductor match a load $Z_L = 150 + j120\ \Omega$ to a lossless transmission line ($300\ \Omega$, 2.8×10^8 m/s). Use Smith chart solution method. Confirm results using analytic equations.

Note that $R_L = 150\,\Omega < Z_0 = 300\,\Omega$

L-network



Follow notes:

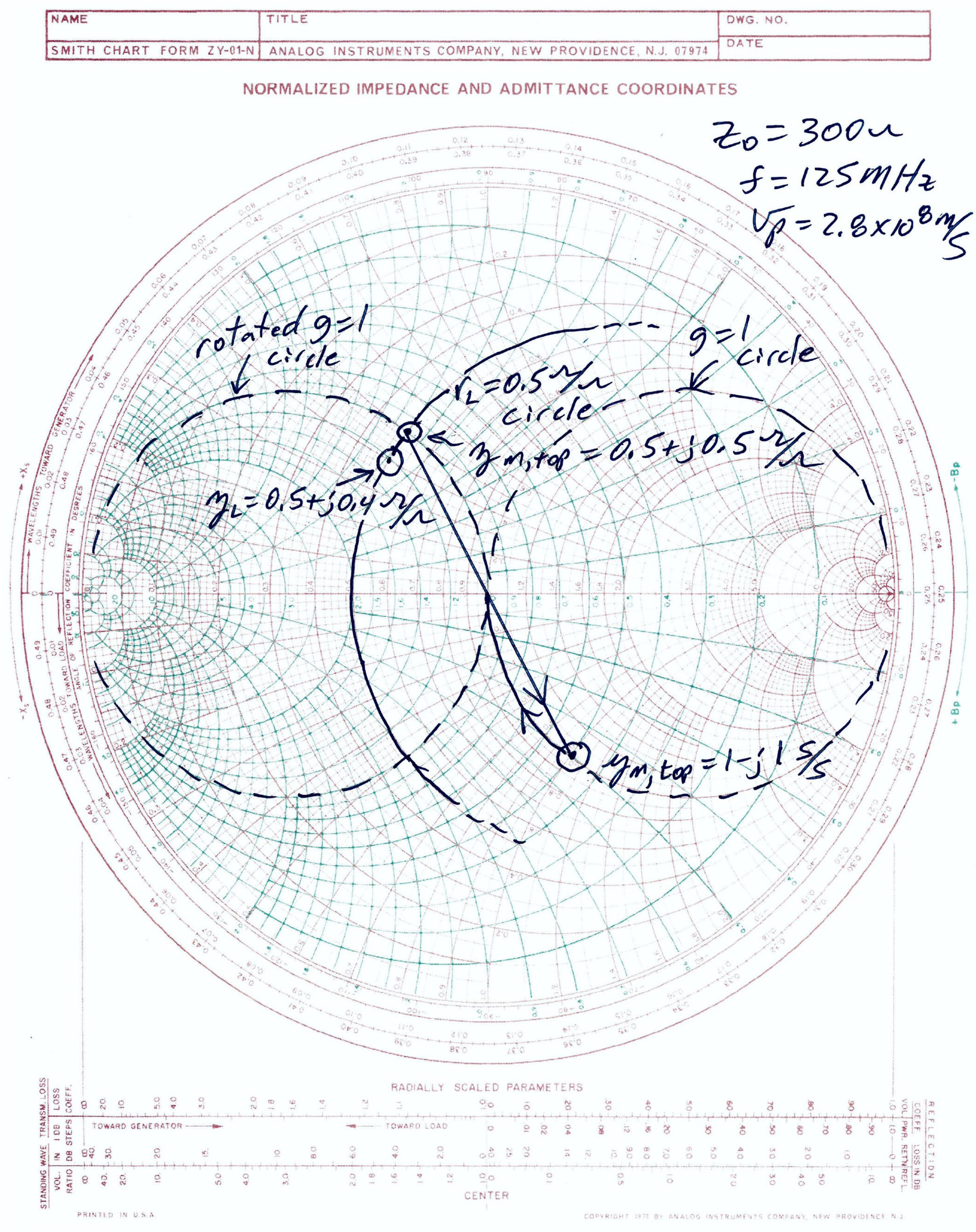
→ Calculate $z_L = \frac{Z_L}{Z_0} = \frac{150 + j120}{300} = \underline{0.5 + j0.4\ \Omega/\Omega}$ and plot on Smith Chart.

→ On circle of constant $r_L = 0.5\ \Omega/\Omega$ go CW (add more inductive reactance) to get to $\underline{z_{m,top} = 0.5 + j0.5\ \Omega/\Omega} = r_L + jx_m$

→ $x_m = X_L + x = 0.5 = 0.4 + x \Rightarrow x = 0.1$.
The required series inductance is then $L = \frac{x Z_0}{\omega} = \frac{0.1(300)}{2\pi(125\times10^6)} \Rightarrow \underline{\underline{L = 38.197\,nH}}$

→ Go $\lambda/4$ around Smith chart on circle of constant $|\Gamma|$ to arrive at $\underline{y_{m,top} = 1 - j1\ S/S} = 1 - jb_{m,top}$

→ Since $b_{m,top} = -1\ S/S$, we need a parallel capacitor to match. $C = \frac{b_{cap}}{\omega Z_0} = \frac{1}{2\pi(125\times10^6)300}$
$\underline{\underline{C = 4.244\,pF}}$


NAME
TITLE
DWG. NO.
SMITH CHART FORM ZY-01-N
ANALOG INSTRUMENTS COMPANY, NEW PROVIDENCE, N.J. 07974
DATE
NORMALIZED IMPEDANCE AND ADMITTANCE COORDINATES
Z0 = 300Ω
f = 125MHz
Vp = 2.8x10^8 m/s
rotated g=1 circle
g=1 circle
r_L=0.5 Ω/Ω circle
z_m,top = 0.5+j0.5 Ω/Ω
z_L=0.5+j0.4 Ω/Ω
y_m,top = 1-j1 S/S
RADIALLY SCALED PARAMETERS
TOWARD GENERATOR
TOWARD LOAD
CENTER
PRINTED IN U.S.A.
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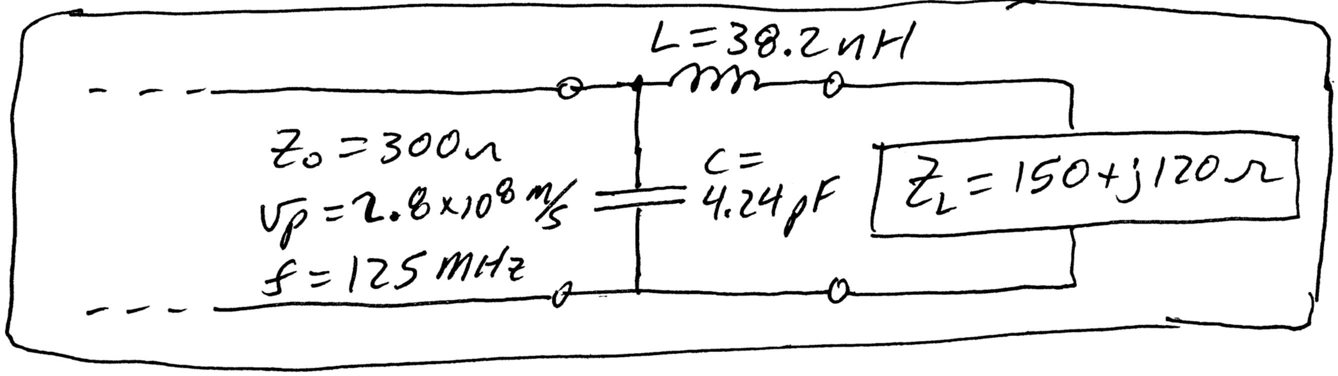
Smith Chart L-network design



Verify design using analytic equations

(5.6a) $X = -X_L \pm \sqrt{R_L(Z_0 - R_L)} = -120 \pm \sqrt{150(300-150)}$

$= -120 \pm 150 = \underline{30\Omega}$ or -270Ω

↑ inductive reactance

$L = \dfrac{X_{ind}}{\omega} = \dfrac{30}{2\pi(125\times10^6)} \Rightarrow \underline{L = 38.197\text{ nH}}$

(5.6b) $B = \pm \dfrac{\sqrt{(Z_0 - R_L)/R_L}}{Z_0} = \dfrac{\sqrt{(300-150)/150}}{300}$ ← choose '+' sol'n

$= \dfrac{1}{300}\text{ S} = \omega C$ ← parallel

$C = \dfrac{1}{300(2\pi)125\times10^6}$

$\underline{C = 4.244\text{ pF}}$

Both agree exactly w/ Smith Chart solution!