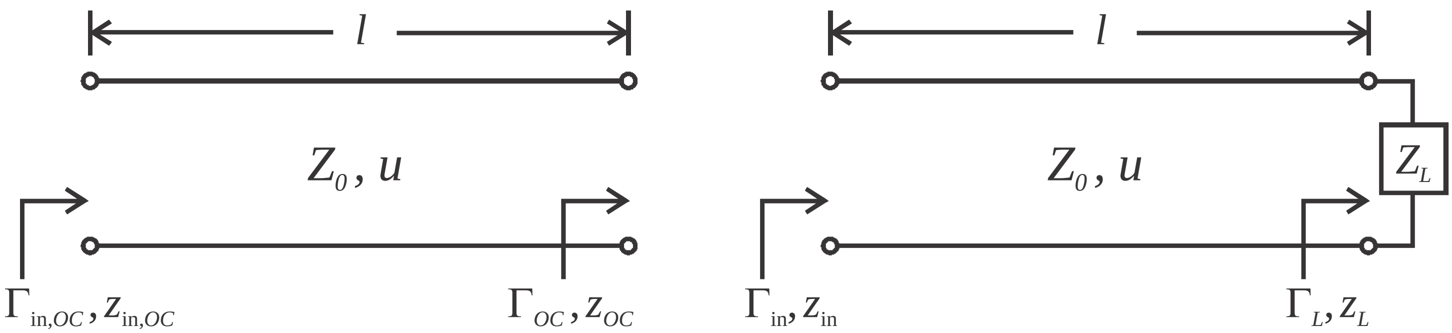


For the lossless transmission line circuits above: $f = 1$ GHz, $u = 3\times10^8$ m/s, $Z_0 = 50\ \Omega$, and the transmission line has length l_{tape} = 63.6 cm as measured by a tape measure. The wavelength is calculated to be $\lambda = u/f = 3\times10^8/1\times10^9 = 30$ cm.

<u>Open Circuit Termination</u>

For an open circuit, we know $z_{OC} = Z_{OC} \rightarrow \infty$ and $\Gamma_{OC} = 1$. For the left hand circuit, an input impedance of $Z_{in,OC} = -j50\ \Omega$ is measured.

1) Normalize and plot open circuit termination input impedance

- Normalize $z_{in,OC} = Z_{in,OC} / Z_0 = (-j\,50)/50 \Rightarrow$ **<u>$z_{in,OC} = -j\,1\ \Omega/\Omega$</u>**.
- Plot $z_{in,OC}$ on Smith chart by finding the intersection of the $r = 0$ circle (outer edge) with the $x = -1$ arc.

2) Find length of transmission line

- Use straight-edge to draw radial line from center of Smith chart through $z_{in,OC}$ and outer rings of Smith chart. Where the radial line crosses the “WAVELENGTHS TOWARD LOAD” scale reads 0.125.
- The $z_{OC} \rightarrow \infty$ point, on the right edge of the Smith chart, reads 0.25 on the “WAVELENGTHS TOWARD LOAD” scale. The distance <u>toward the load</u> from $z_{in,OC}$ is then $l = (0.25-0.125)\lambda + n\lambda/2 = 0.125\lambda + n\lambda/2$.
- Using $\lambda = 30$ cm, the transmission line length must be $l = 3.75 + n15$ cm. When $n = 4$, $l = 3.75 + (4)15 \Rightarrow$ **<u>$l = 63.75$ cm</u>**, quite close to $l_{tape} = 63.6$ cm.

Unknown Load Termination

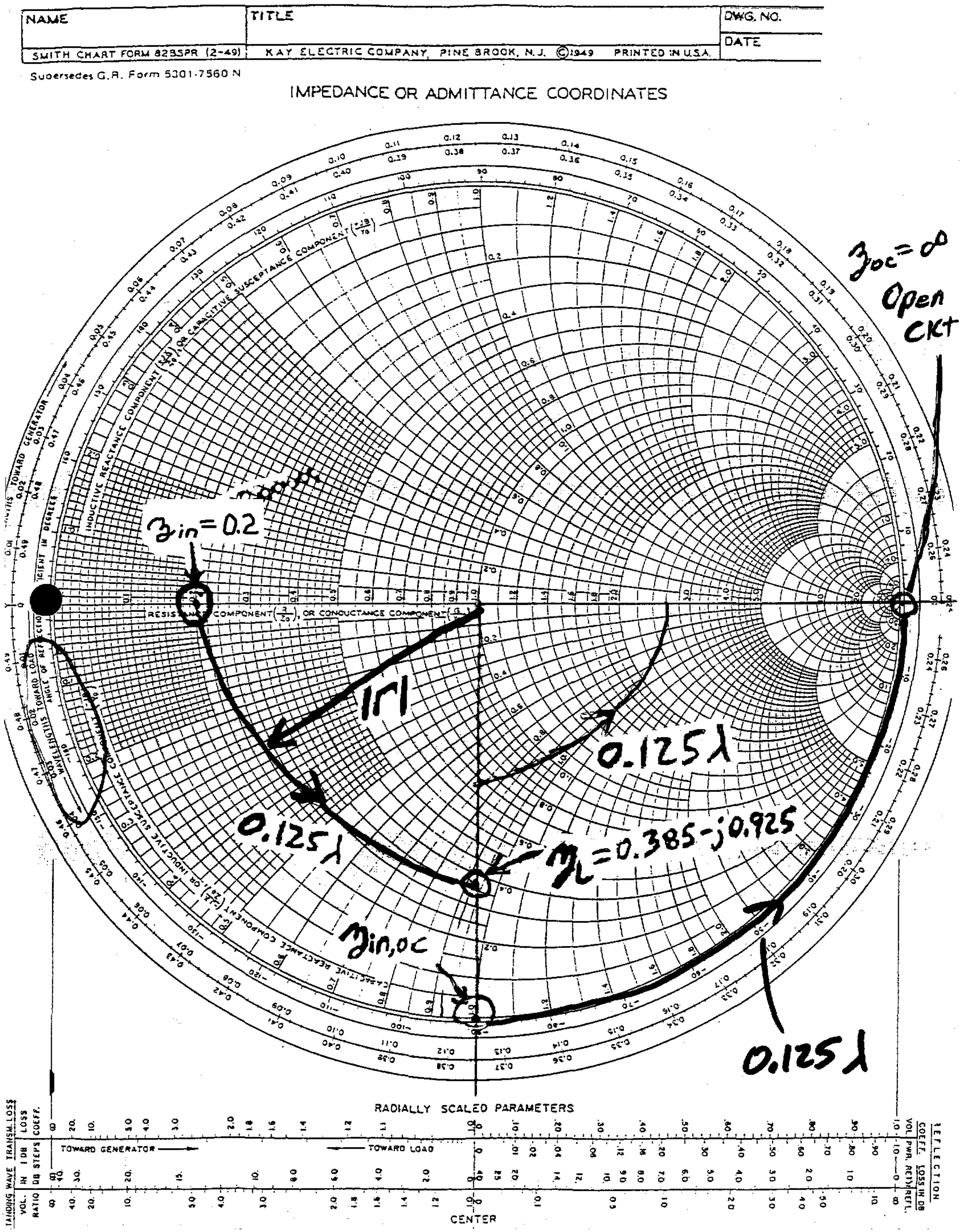
For the right hand circuit, an input impedance of $Z_{in} = 10\ \Omega$ is measured.

1) Normalize and plot unknown load input impedance

- Normalize $z_{in} = Z_{in} / Z_0 = 10 / 50 \Rightarrow$ **$z_{in} = 0.2\ \Omega/\Omega$**.
- Plot z_{in} on Smith chart by finding the intersection of the $r = 0.2$ circle with the $x = 0$ arc/line (i.e., horizontal/real axis).

2) Find unknown load impedance

- Note that horizontal axis passes through z_{in} where the "WAVELENGTHS TOWARD LOAD" scale reads 0.
- Draw a radial line from the center of the Smith chart through 0.125 (i.e., the TL length) on the "WAVELENGTHS TOWARD LOAD" scale.
- Draw an arc, centered on Smith chart, through z_{in} that connects it to the radial line at 0.125 on "WAVELENGTHS TOWARD LOAD" scale.
- Read/interpolate value of normalized load resistance at intersection of arc and line as $r_L = 0.385$.
- Read/interpolate value of normalized load reactance at intersection of arc and line as $x_L = -0.925$.
- Put together to get normalized load impedance **$z_L = 0.385 - j0.925\ \Omega/\Omega$.**
- Find load impedance by multiplying z_L by characteristic impedance Z_0 to get $Z_L = z_L Z_0 = (0.385 - j0.925)\ 50 \Rightarrow$ **$Z_L = 19.25 - j\ 46.25\ \Omega$.**


NAME
TITLE
DWG. NO.
DATE
SMITH CHART FORM 82BSPR (2-49)
KAY ELECTRIC COMPANY, PINE BROOK, N.J. ©1949 PRINTED IN U.S.A.
Supersedes G.R. Form 5301-7560 N
IMPEDANCE OR ADMITTANCE COORDINATES
$z_{oc} = \infty$
Open CKt
$z_{in} = 0.2$
$|\Gamma|$
0.125λ
0.125λ
$z_L = 0.385 - j0.925$
$z_{in,oc}$
0.125λ
RADIALLY SCALED PARAMETERS
TOWARD GENERATOR
TOWARD LOAD
CENTER