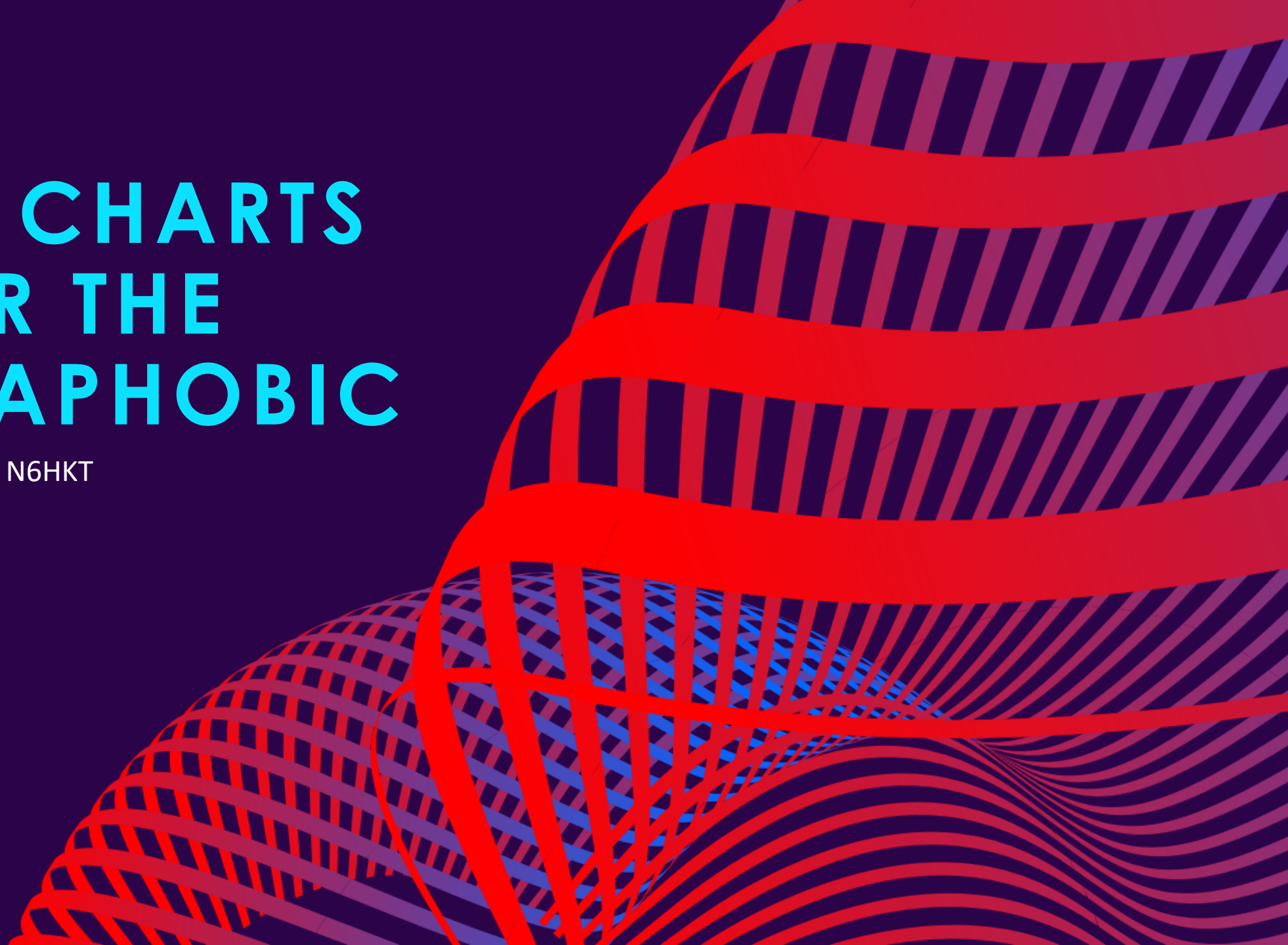


SMITH CHARTS FOR THE CHARTAPHOBIC

Heatherly Takeuchi / N6HKT

2022 March 17th



XENOGRAPHPHOBIA

The fear of graphs and charts.

ABOUT HEATHERLY

- + Mathematics and Computer Science degree from SJSU
- + First Amateur License in 2008, Amateur Extra in 2010
- + ADEC, Assistant Chief RACES officer, CERT, and Comm-L for San Benito County
- + Volunteer dispatcher at Laguna Seca Recreational Area
- + Contact Volunteer Examiner for the SBCARA VE Group with more than 30 VEs, and over 800 Technician licenses earned.



AGENDA

History

What is a Smith Chart?

Why/How would I use one?

SimSmith Demo

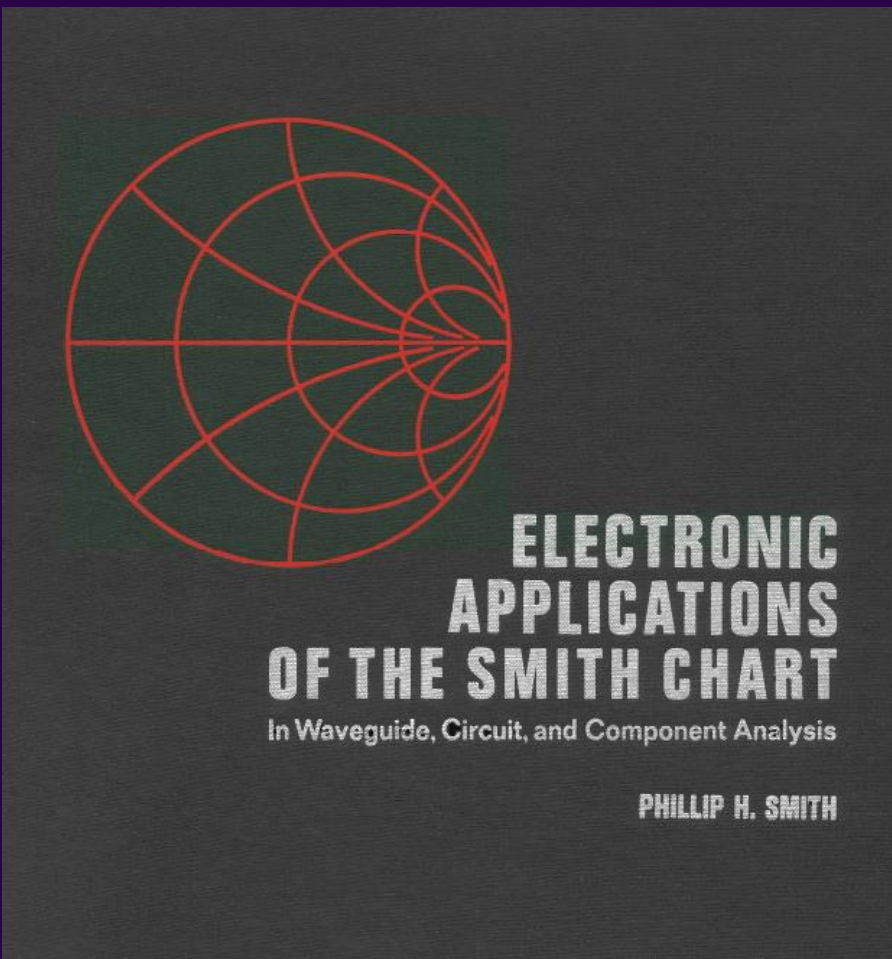
Conclusion/Discussion

HISTORY

Phillip H. Smith 1905 – 1987

Bell Labs in 1930s.

Also Mizuhashi Tosaku in Japan.



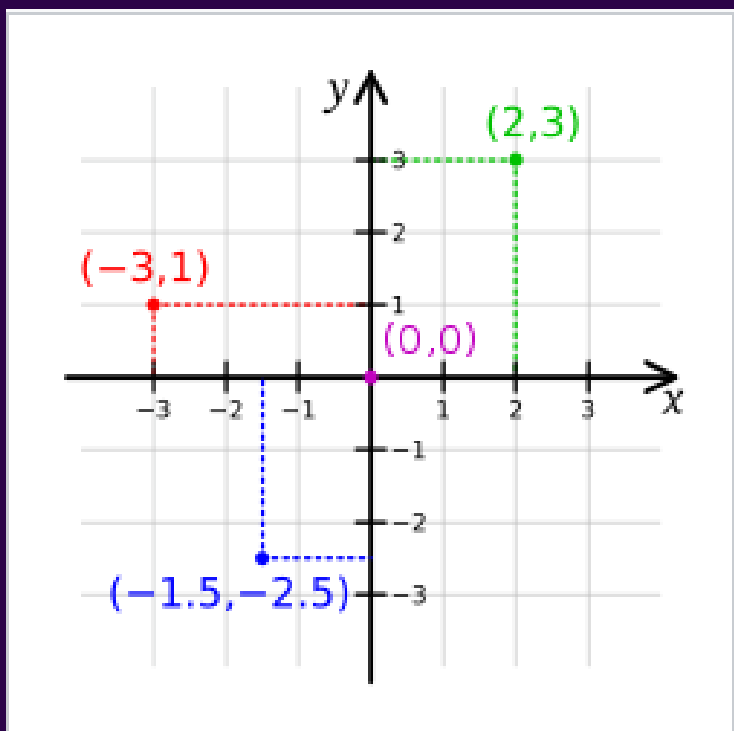
WHAT IS A SMITH CHART?

A graphical way to plot:

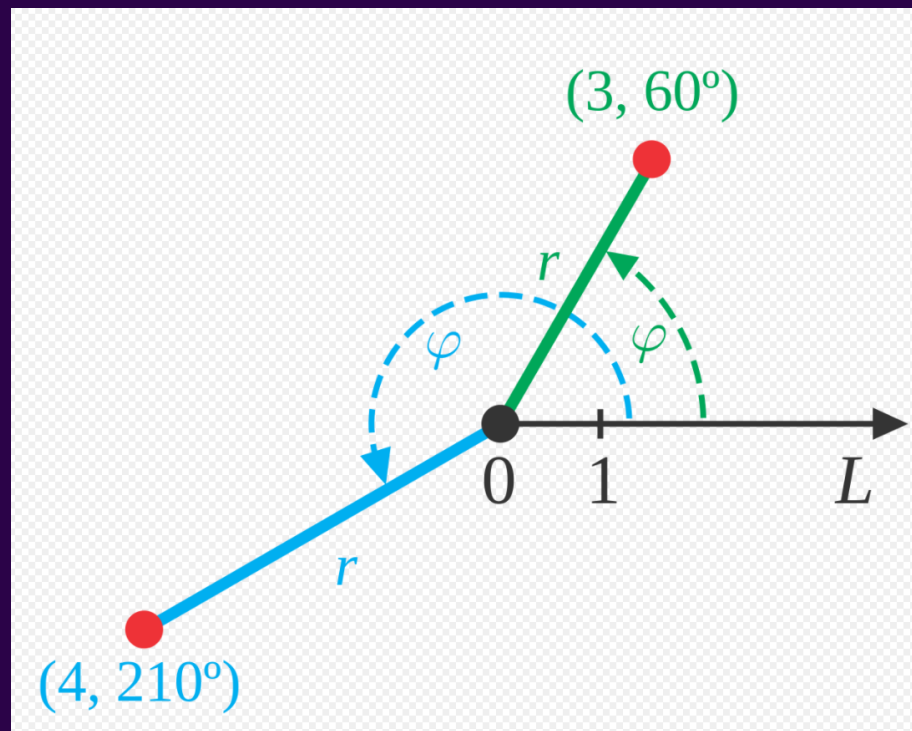
- + Complex impedance
- + Complex reflection coefficient
- + Matching Networks

And so much more!

WHAT IS A SMITH CHART?



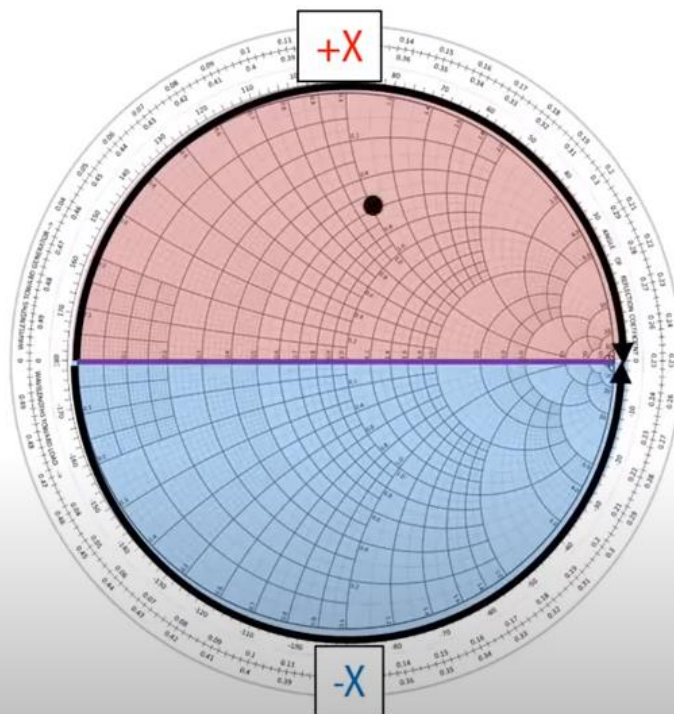
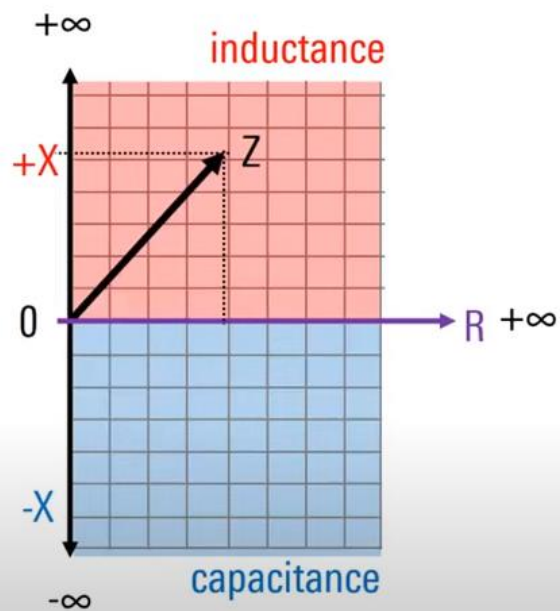
Cartesian graph



Polar graph

WHAT IS A SMITH CHART?

Cartesian to Smith Chart



inductive

resistive

capacitive

IMAGINARY NUMBERS

$$a + b*i*'$$

Coined by René Descartes

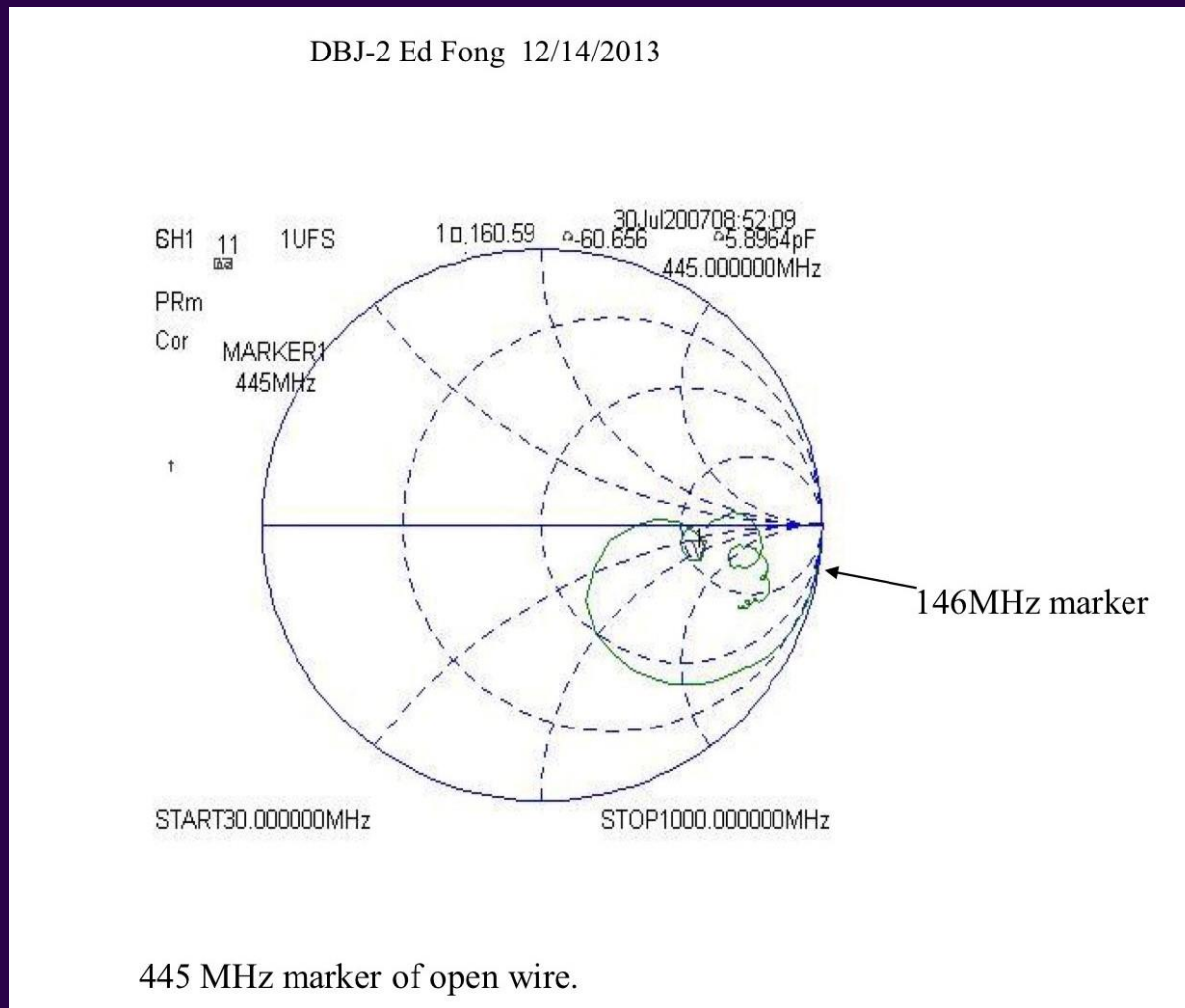
Rules formalized by Rafael Bombelli

Used Leonhard Euler &

Carl Friedrich Gauss

CHILDREN HAVE
IMAGINARY FRIENDS.
MATHEMATICIANS
HAVE
IMAGINARY NUMBERS.

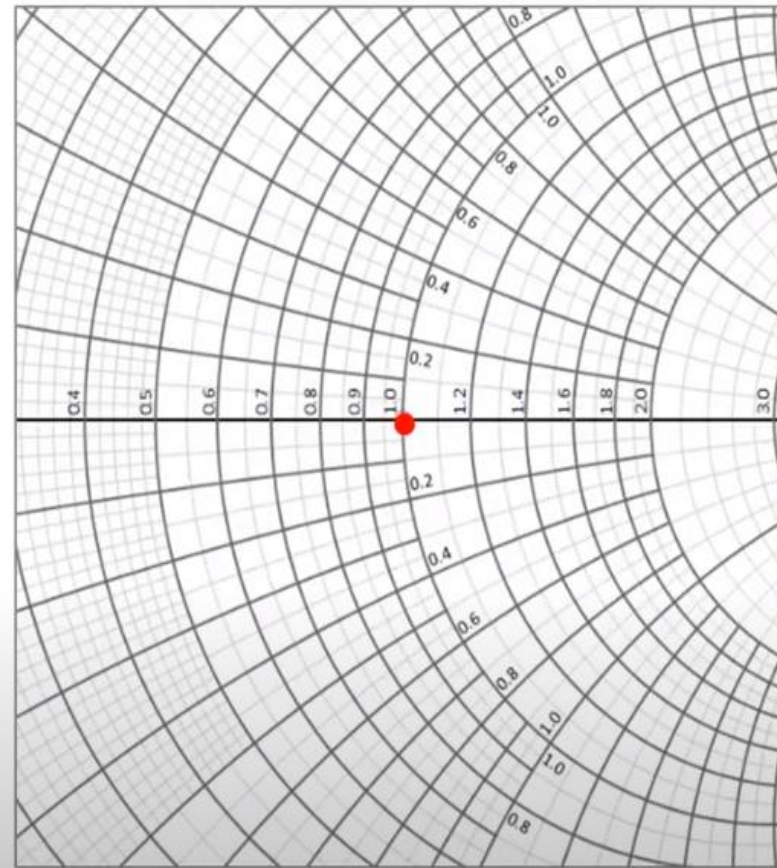
WHY TO USE A SMITH CHART



HOW TO USE SMITH CHARTS

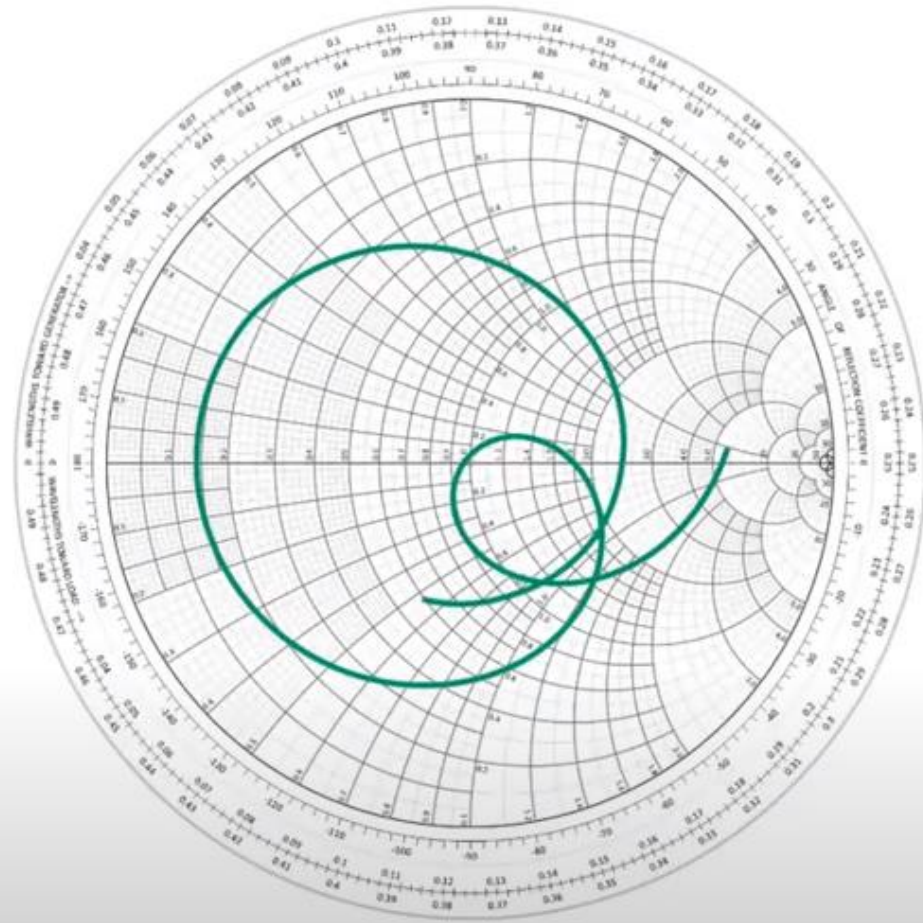
Prime center

- Center of chart (“prime center”) is our source impedance, Z_0 .
 - 50Ω in most RF systems



Significance of the prime center

- ▶ Ideally, $Z_L = Z_0$ (“matched”)
- ▶ Measured Z_L is plotted on the Smith chart
- ▶ The closer our measured Z_L is to the center (Z_0), the better the impedance match
- ▶ Mismatch increases with increasing distance from the center
- ▶ Often want to move Z_L toward the center, e.g. using a matching network.
- ▶ A device is resonant at the frequency where the trace moves through the center.

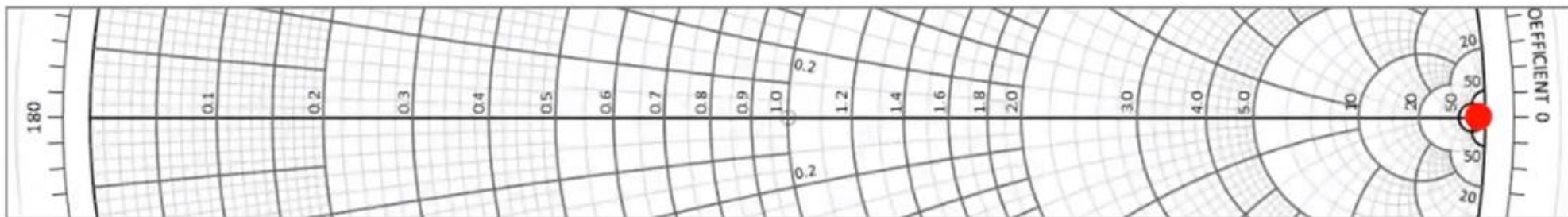


Resistance axis

0Ω – short circuit

(50Ω)

$\infty \Omega$ – open circuit



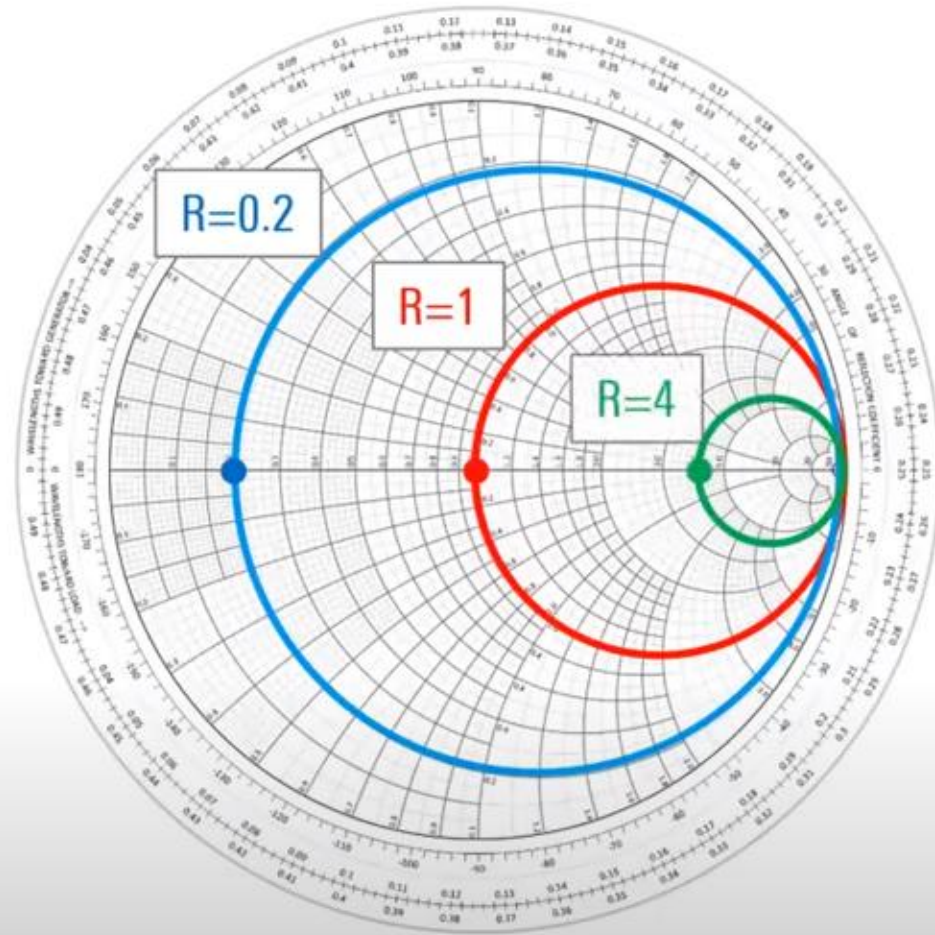
VSWR = ∞

VSWR = 1

VSWR = ∞

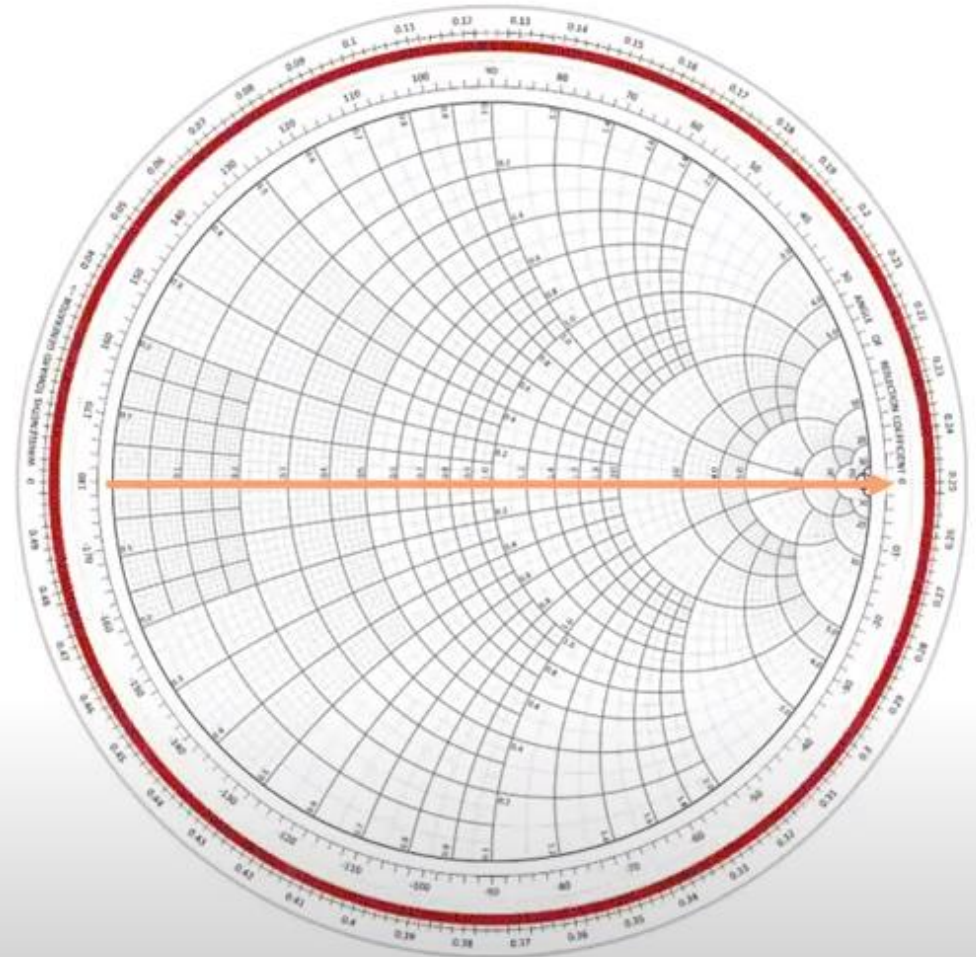
Resistance circles

- ▶ Complex impedances do not lie along the horizontal resistance axis ($R + jX$)
- ▶ Normalized resistances are shown as resistance circles
- ▶ Every point along a circle has the same resistive or real part



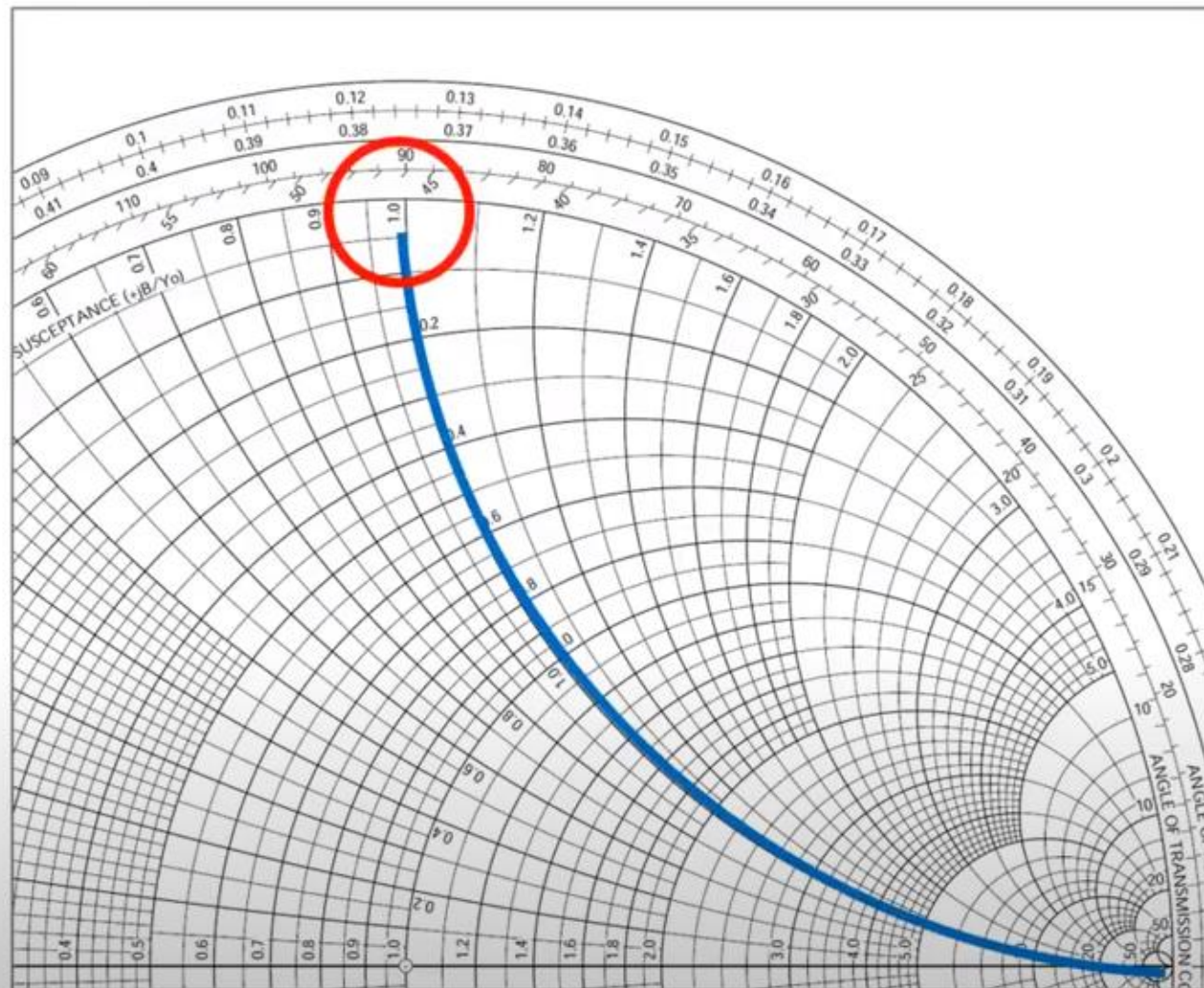
Reactance axis

- ▶ Reactance axis lies along the circumference of the Smith chart



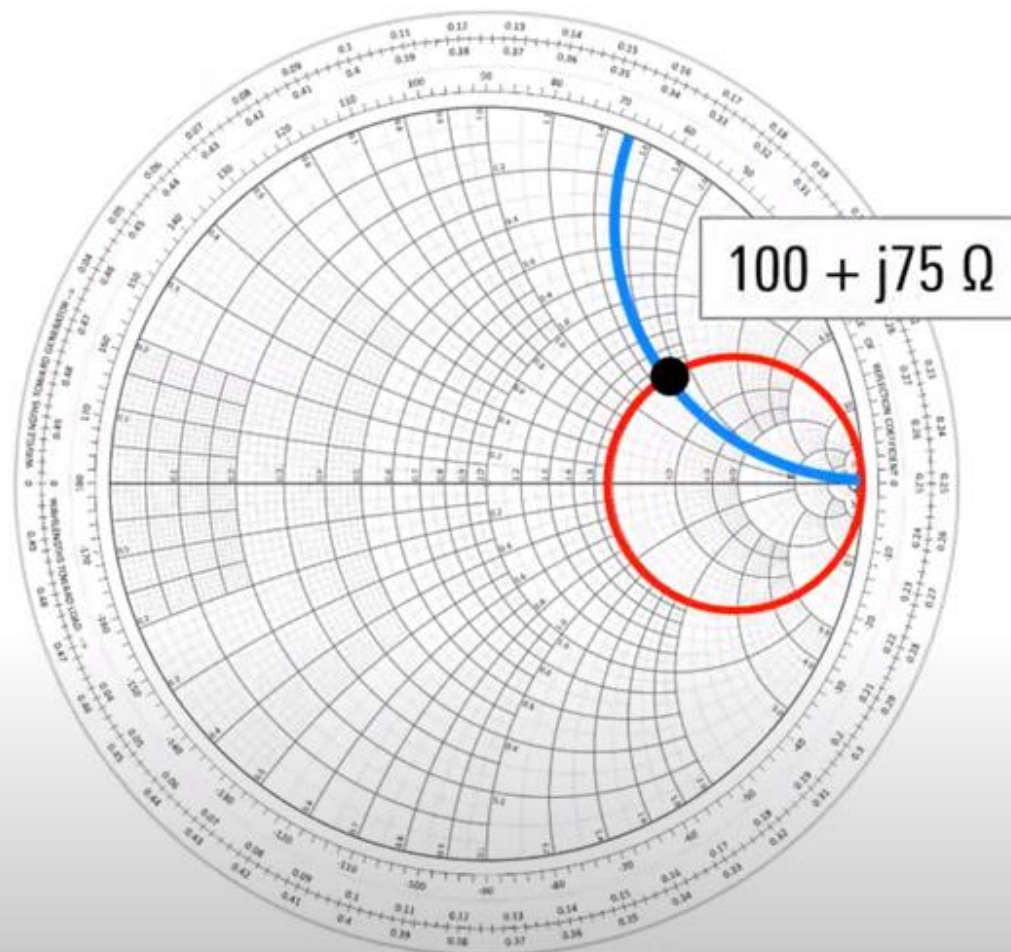
Reactance curves

- ▶ Normalized reactance is shown as reactance curves
- ▶ Every point along a curve has the same reactive or imaginary part



Plotting impedance on the Smith chart

- ▶ Complex impedance: $Z = R \pm jX$
 - $100 + j75 \Omega$
- ▶ Normalize the impedance by dividing by Z_0
 - $(100 + j75) / 50 = 2 + j1.5$
- ▶ Find the resistance circle
 - $R_{\text{normalized}} = 2$
- ▶ Find the reactance curve
 - $X_{\text{normalized}} = 1.5$
- ▶ Impedance is at the intersection of the circle and the curve and the curve



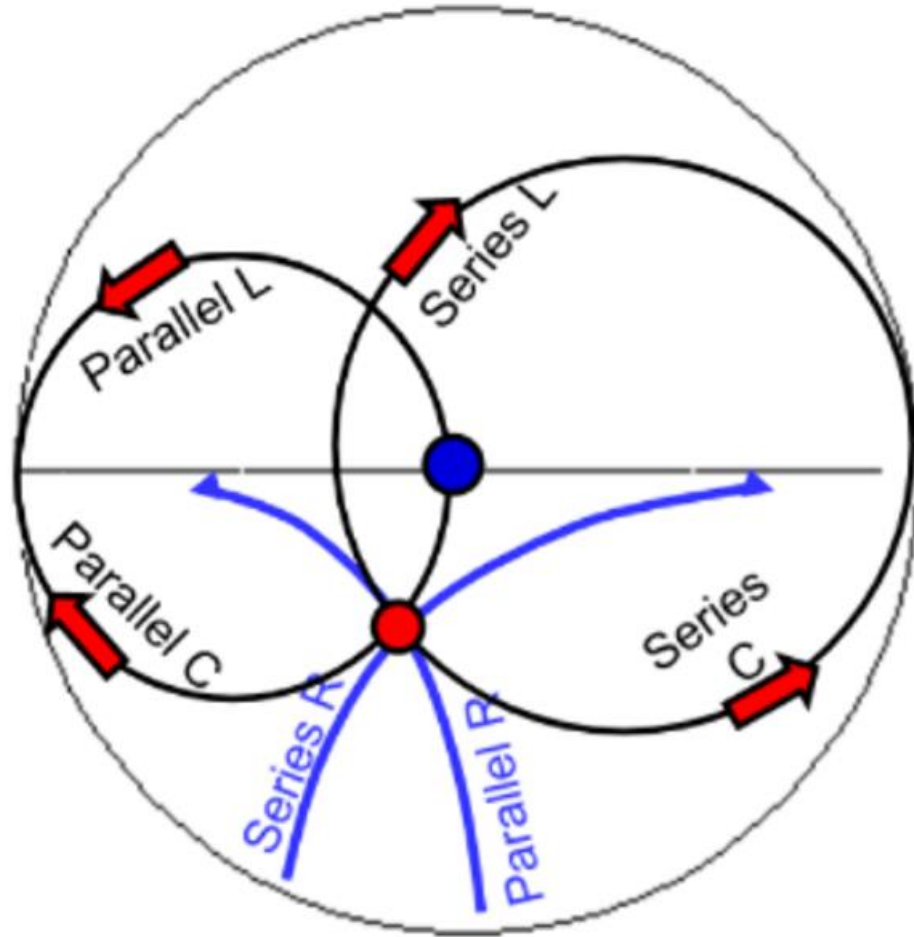
SIM SMITH DEMO

Moving toward the center of the Smith Chart!

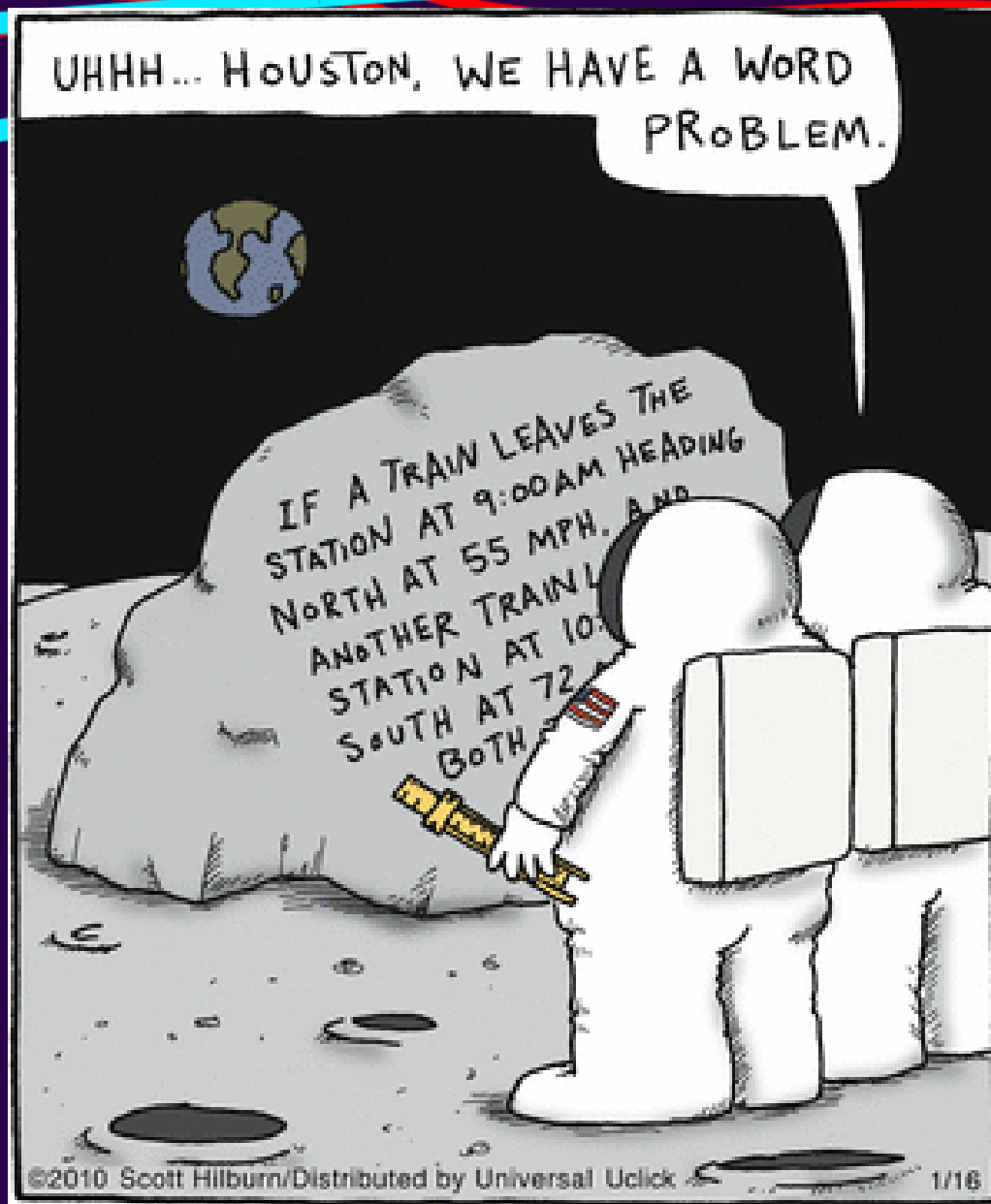
Add Series or
Parallel (shunt)
components.

You will do this
in the lab.

Adjust the value to move
toward open, short,
L, C, or center of chart.



POP QUIZ



THANK YOU

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DISCUSSION