PCB
- corners
- tapers
- 0 ohm
- connectors

Stability
- k factor
- impedance circles
- Beware the supply & via inductance
- T. line effects

Final Exam
- Take home logistics
- Topics
- Format & time
- Review

Phase noise
- it exists
- conversion to V
- spectrum

wrap-up
- cell phone
- AM radio
- Blue sheets

Final exam details

- Out Monday, I'll leave in office mailbox
- Take home exam, 3 hours, seal w/ tape when done, hand to Sydney & get answer
- 2x 8.5"x11" sheets front & back + writing utensils
- ~ 3-4 questions ~ starts w/ match/short answer & quick problems
  - ~ middle is design exercise close to class
  - ~ end is synthesis/application
- Back ½ focused, but cumulative, esp. in sense front ½ informs back
  e.g. comm. system w/ mismatch

Topics from back ½

Antennas & propagation
- Near & far field
- Gain/directivity
- Path loss
- Types
- Ckt model

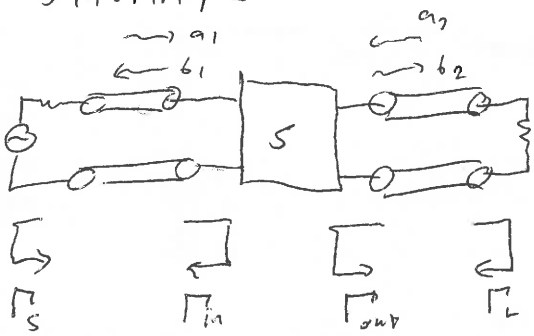
Noise
- def^n
- noise temp of components
- referring to system temp
- spec. an.

Linearity
- 2HD, 3HD
- 2IM, 3IM
- calculating values from IIP3, P-1dB
- relations between metrics
- frequency planning
- referring a little

Comm. System
- modulation/demodulation
- common architectures
- analysis & freq. planning

- Study resources ~ quizzes, I'll post handouts by Monday, midterm, lab qs

Stability -



- recall S-parameters
- we've speculated S_{12} can let a reflection get back to the input
  ↳ instability

$$a_2 = \Gamma_L b_2 = \Gamma_L (S_{21} a_1 + S_{22} a_2)$$

$$b_1 = S_{11} a_1 + S_{12} a_2 = S_{11} a_1 + \frac{\Gamma_L S_{21} S_{12}}{1 - \Gamma_L S_{22}} a_1 \longrightarrow \Gamma_{in} = S_{11} + \frac{\Gamma_L S_{21} S_{12}}{1 - \Gamma_L S_{22}}$$

- similar derivation will give us $\Gamma_{out} = S_{22} + \dfrac{\Gamma_L S_{21} S_{12}}{1 - \Gamma_L S_{11}}$
- if $|\Gamma_{in}|$ & $|\Gamma_{out}|$ always <1 then stable, >1 unstable
  ↳ Need to eval both, but Γ_{in} usually issue
  ↳ Test @ all frequencies ~ mix in, clip amps, etc. ~ & Γ's vary w/ f
  ↳ beware! Γ_L can vary w/ t. line distance (it stability)
- Test stability in a few ways, often cast in Y-params

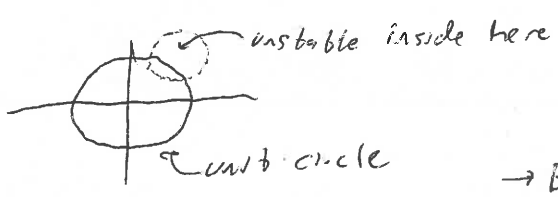
$$\mu = \frac{1 - |S_{11}|^2}{|S_{11}^*(S_{12}S_{21} - S_{11}S_{22}) - S_{22}| + |S_{12}S_{21}|} \quad \text{stable if } > 1$$

Rollett stability

$$k = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |S_{12}S_{21} - S_{11}S_{22}|^2}{2|S_{12}||S_{21}|} \quad \text{stable if } > 1$$

} unconditional stability, not a fn of Γ_L
↳ on datasheets

- Can also indicate boundary between stable & unstable Γ_L on smith

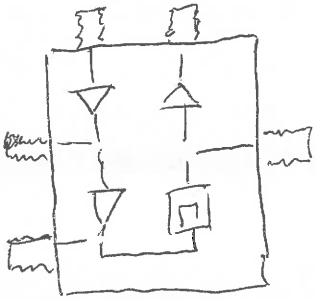


- comes from $|\Gamma_{in}| < 1$ ~> circle sol^n
- one way datasheets specify stable loads

→ Beware of excess BW & gain ←

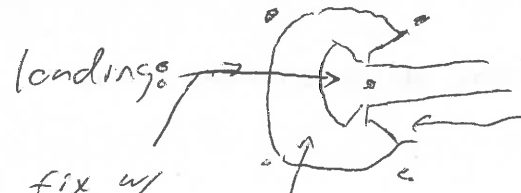
- These stability factors capture <u>load</u> instability
- can still have regular old supply instability
  - ↳ esp. b/c trace to power plane has high Z @ high f
  - ↳ bypass like crazy & follow recommended layouts closely

Ties into PCB layout

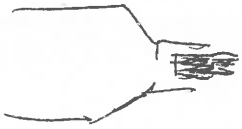


- short straight wiring runs
- side launch SMA
- taps separated by 0 Ω resistor
- wires are microstrip t. line
  - ↳ care about stackup & metal weight

- Vertical SMA don't look like 50 Ω @ corner b/c uneven



- custom footprints to taper into & out of PCB pins



- 45° linear taper ok @ low f
- exponential taper looks like wide-band match

- Filet corners if need be
- FR4 creaps out above 2GHz, but adhesion bad on other PCB substrates

loss vector

$\alpha = 0.03$ dB/cm/GHz

- Nearby ground plane confines fields → less radiation

Consider 1st day

- Is high speed design important → cell phones ← comm. arch
  → back planes ← μ

- said we'd cover
  - T lines
  - S parameters
  - antennas
  - comm. systems

- can use this to build modern cell phone