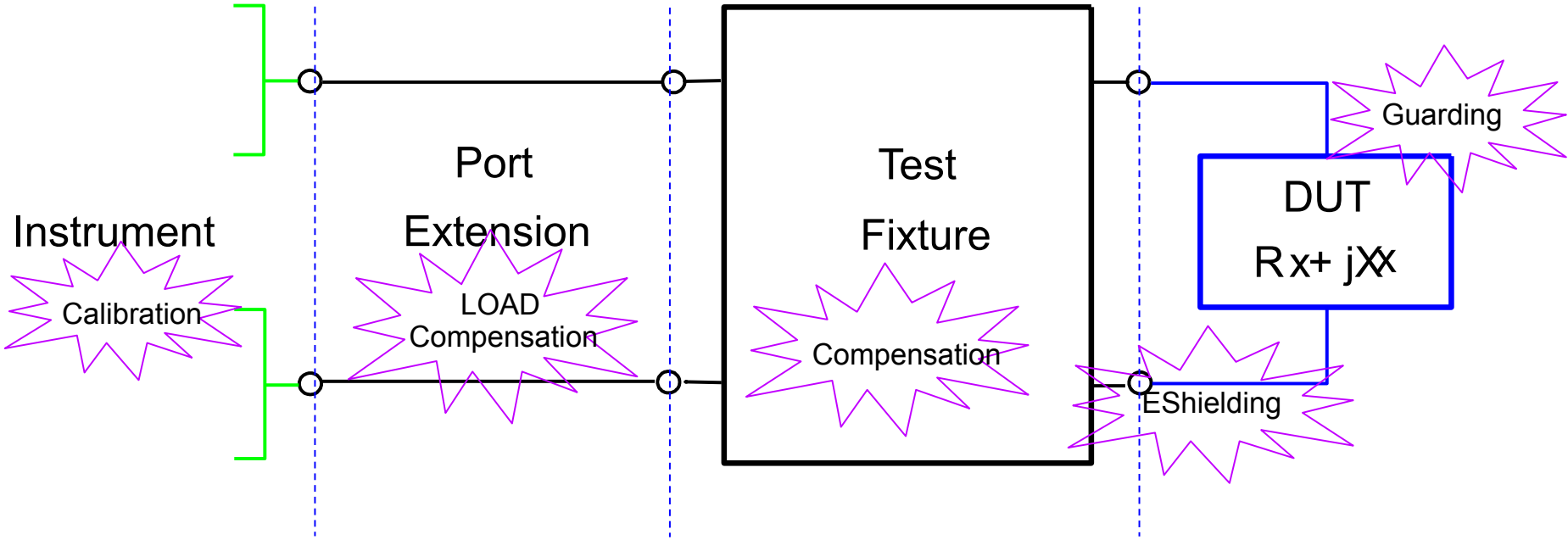
Actions for Limiting Measurement Errors



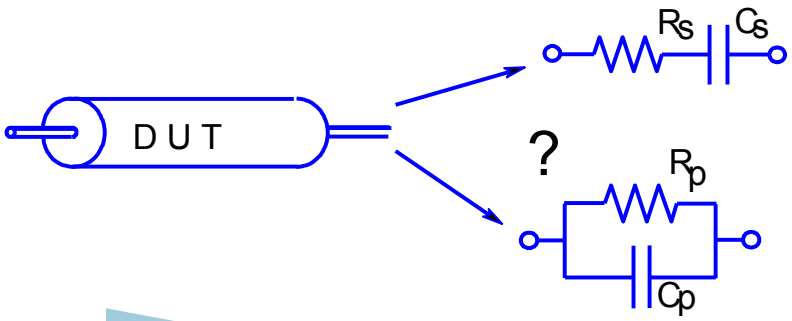
What Do Instruments...

Measure ?

Calculate ?

Approximate ?

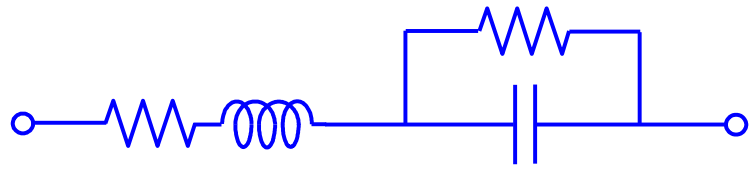
	I-V Method	Reflection Coefficient Method
Measured	I, V	$\Gamma_{x,y}$
Direct Calculations	$Z = \frac{V}{I}$	$Z = Z_o \frac{1 + \Gamma}{1 - \Gamma}$
Model based Approximations	Ls , Lp, Cs, Cp, Rs or ESR, Rp, D, Q	



Circuit Mode

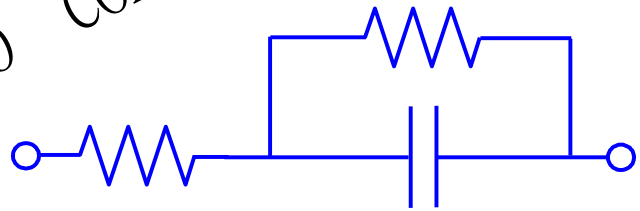
Requires Simplified Models

Complete Capacitor Model
Rs,Ls,Rp,Cp ?



TOO COMPLEX

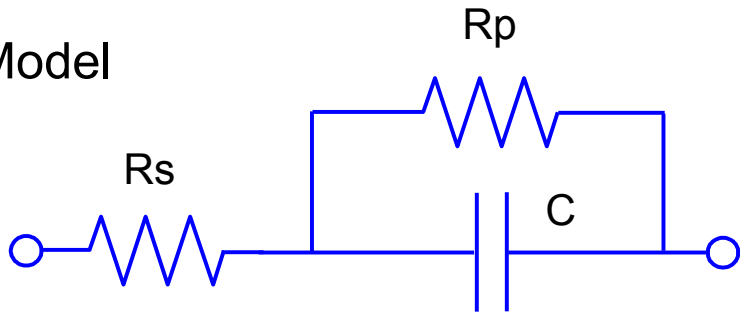
No L Capacitor Model



Circuit Mode

Rs vs Rp , who wins ?

No L Capacitor Model

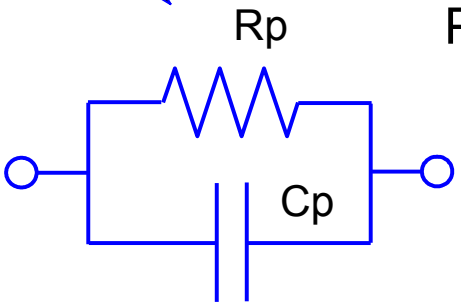


Series model

Large C

Small L

Parallel model



Small C

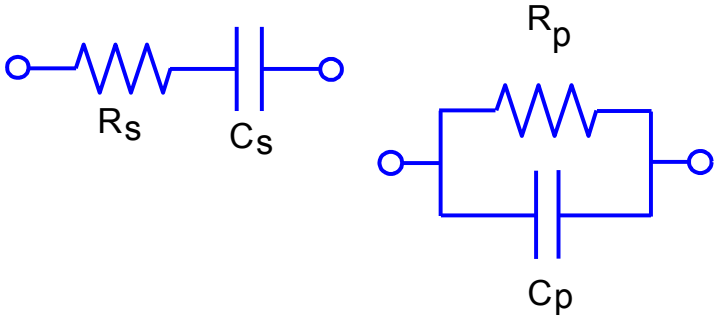
Large L

SMD

Which Model is Correct ?

- Both are correct

$$C_s = C_p (1 + D)^2$$



- One is a better approximation

- For high Q or low D components,

$$C_s \approx C_p$$

Measurement Techniques

- Auto Balancing Bridge
- Resonant (Q-adapter / Q-Meter)
- I-V (Probe)
- RF I-V
- Network Analysis (Reflection Coefficient)
- TDR (Time Domain Reflectometry)

Measurement Technique Topics

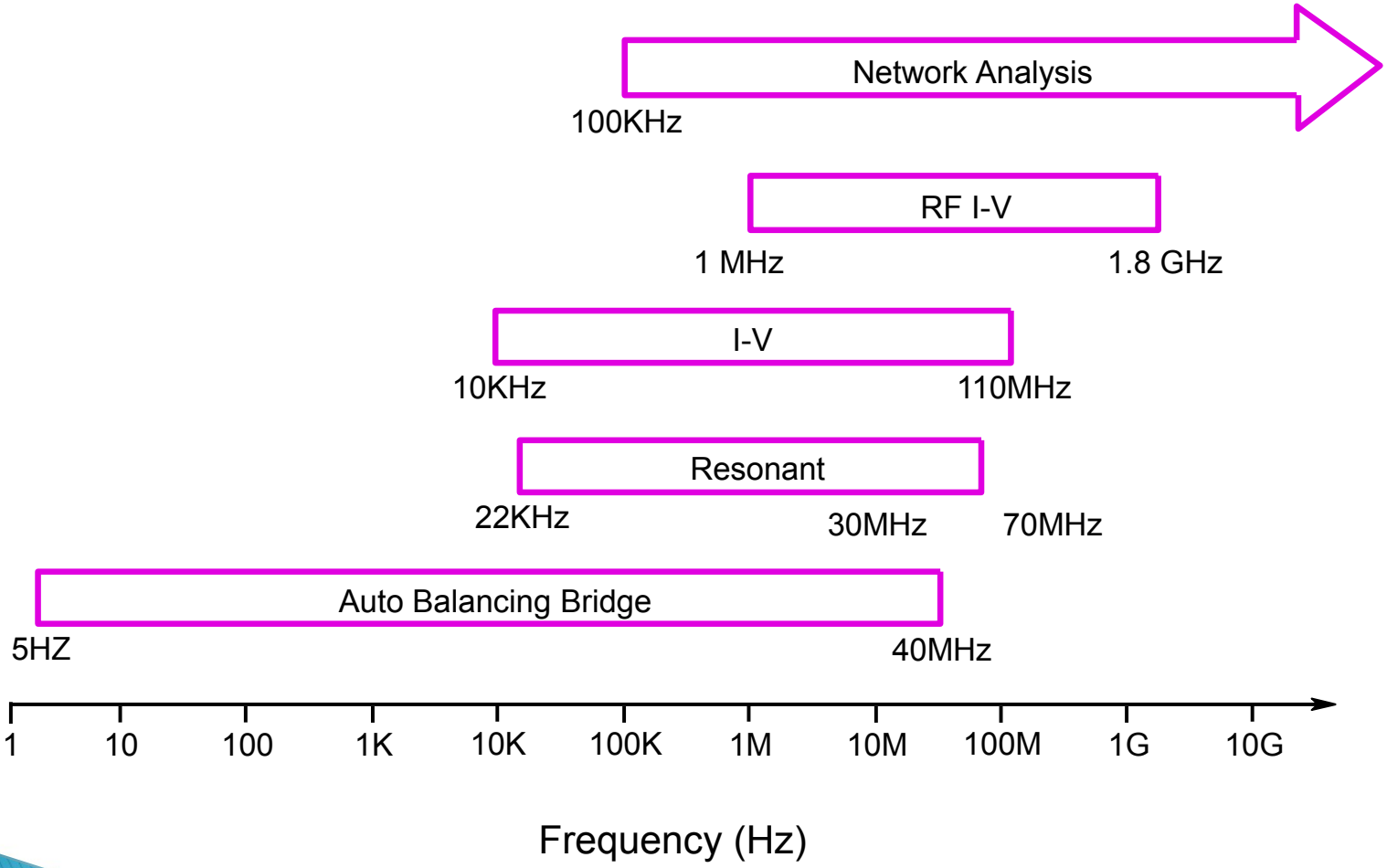
Technique Selection Criteria

- Theory of Operation
- Advantages and Disadvantages of each technique
- Expanded connection information and theory for auto balancing bridge (r4 terminal pair) instruments
- Error Compensation to minimize measurement error

Measurement Technique Selection Criteria

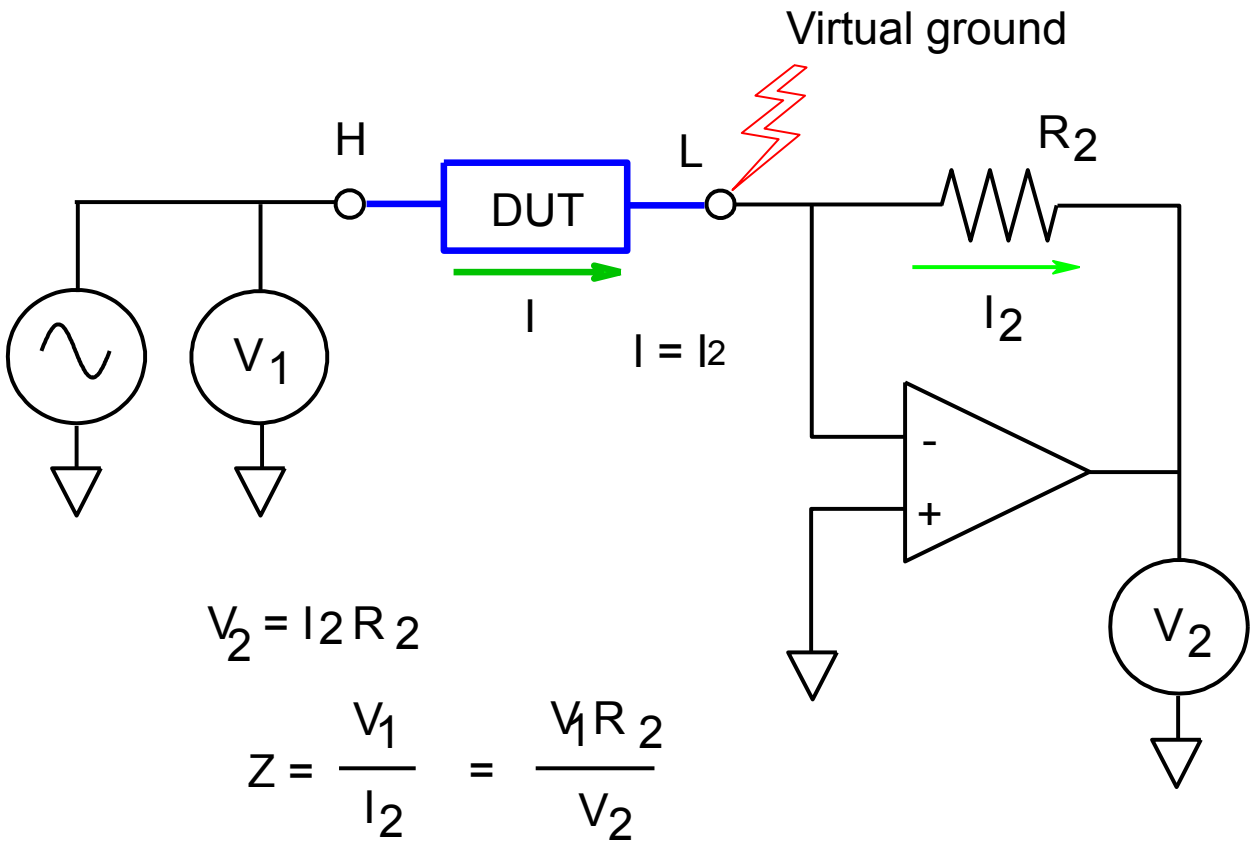
- Frequency
- DUT Impedance
- Required measurement accuracy
- Electrical test conditions
- Measurement parameters
- Physical characteristics of the DUT

Frequency vs. Measurement Techniques



Auto Balancing Bridge

Theory of Operation



$$V_2 = I_2 R_2$$

$$Z = \frac{V_1}{I_2} = \frac{V_1 R_2}{V_2}$$

Auto Balancing Bridge

Advantages and Disadvantages

- Most accurate, basic accuracy 0.05%
- Widest measurement range
- C,L,D,Q,R,X,G,B,Z,Y,O,...
- Widest range of electrical test conditions
- Simple-to-use
- Low frequency, f < 40MHz