Siglent SVA1015X Network Analyzer Option Review

"Many Opportunities for Improvement"

Chris Grossman

April 14, 2019

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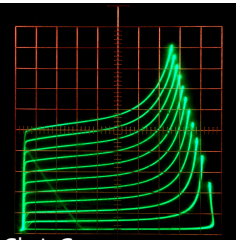
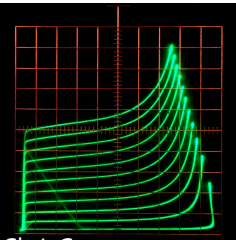
Introduction



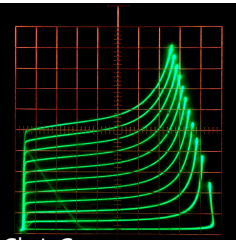
- I had always wanted a spectrum analyzer for my home lab
- I prefer stand-alone instruments to PC connected instruments
  - Computers, OSs, and support software always become obsolete
  - Stand-alone instruments if done well are easier to use
- The price, performance, size, and weight of the latest generation of spectrum analyzers makes them a far more attractive option than used gear.
  - Most used gear today is overpriced, of questionable origin, unknown functionality, and dubious reliability
- The network analyzer seemed like an attractive option
- So far I am impressed with the spectrum analyzer, but disappointed with the network analyzer
- The hardware seems good, almost all of the issues could be fixed with firmware updates
- I am going to show you the issues I have had, and suggest how I think they should be addressed and other improvements made
- I hope Siglent is listening, with some firmware updates they can turn into a winner

Siglent SVA1015X
Spectrum/Network Analyzer



- The Siglent SVA1015X is a 9 KHz to 1.5 GHz Spectrum Analyzer ($1395)
  - The 5 MHz to 1.5 GHz tracking generator option is included
  - Bandwidths from 1 Hz to 1 MHz in a 1-3-10 sequence
- The Vector Network Analyzer Option ($609)
  - S11 & S21 from 10 MHz to 1.5 GHz with 5 MHz minimum span
    - 30 meter (10.1-10.15 MHz) to 23 centimeters (1.24-1.3 GHz) HAM Bands
  - A fixed 751 linearly spaced frequency points
  - Output power is fixed at 0 dBm
- Distance to Fault Option ($289)
  - 0.1m resolution
- Advanced Measurement Kit ($419)
  - Adds a waterfall display & a few simple measurements
- ASK/FSK Modulation Analysis ($329)
- AM/FM Modulation Analysis ($329)
- EMI Measurements ($449)
  - Adds 200 Hz, 9 KHz, & 120 KHz bandwidths, and a Quasi-Peak detector

SVA1015X Network Analyzer Option



GOOD

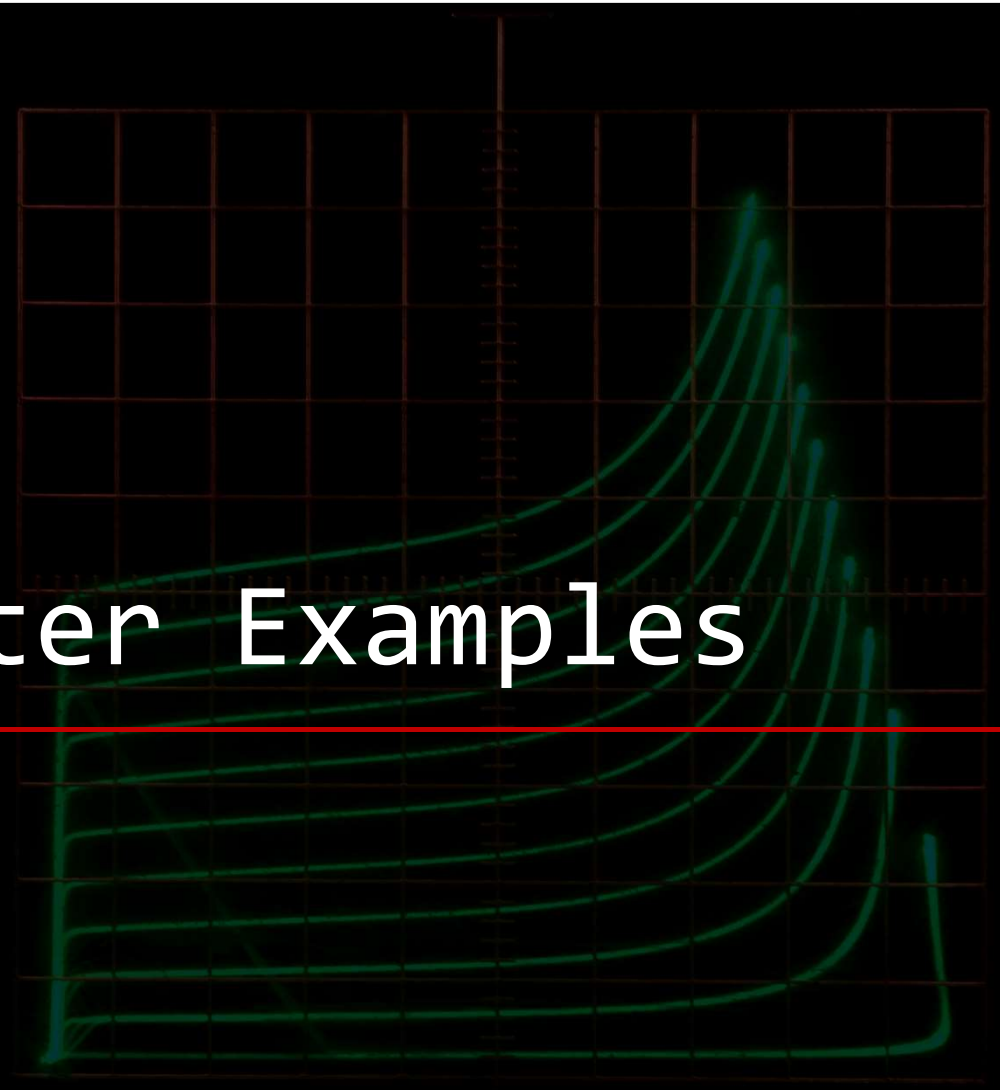
- S_{21} works great for characterizing the gain and phase of passive devices such as filters and attenuators
- S_{21} can work with amplifiers with the judicious use of external attenuators
- Both S_{11} and S_{21} calibrations work through attenuators

BAD

- The measurement reference plane is behind the calibration plane and cannot be moved (S_{11})
- There is no adjustable delay parameter for the through (S_{21})
- There are no user calibration kits or editable calibration parameters
- S_{11} only allows for 1 Siglent and 2 Keysight male N connector calibration kits
- S_{11} does not work for many amplifiers
  - 0 dBm output level too high for many amplifiers
- The cumbersome file system and it's ill conceived user interface truly suck!!!
- Crashes that require power cycling to reset

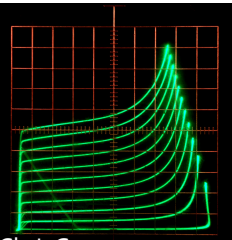
Hopefully these issues can be fixed with firmware updates

The Good: Passive Filter Examples



- 240 MHz High Pass
- 755 MHz Low Pass

240 MHz High Pass Filter $|S_{21}|$



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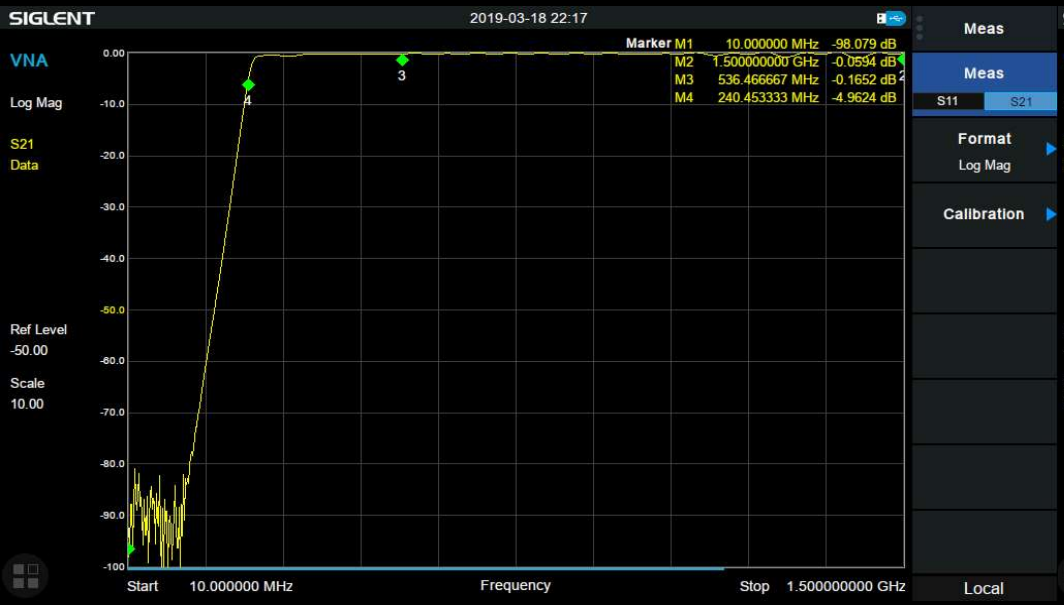
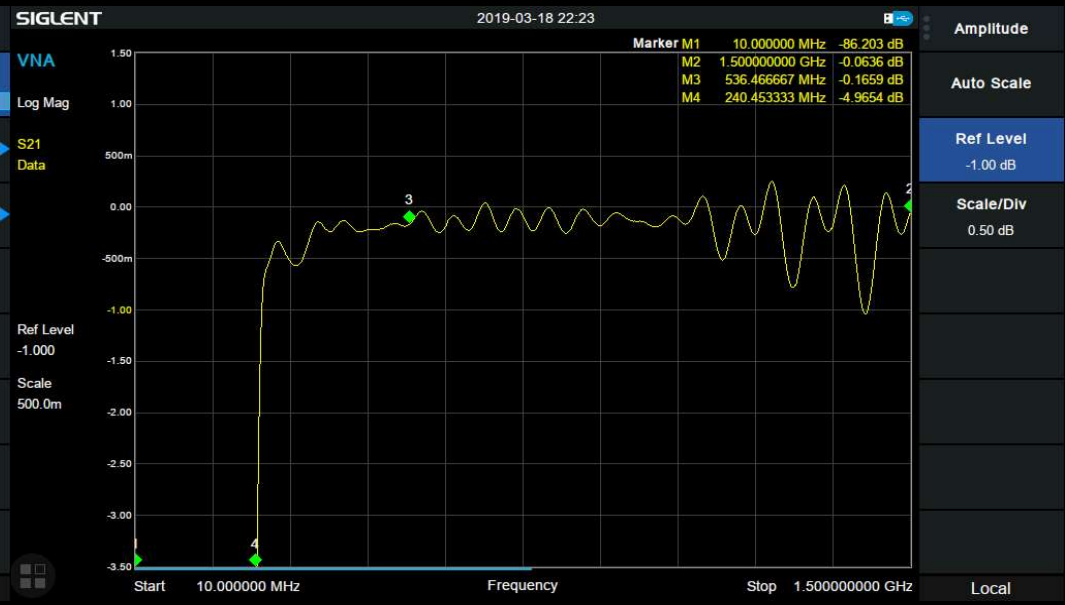
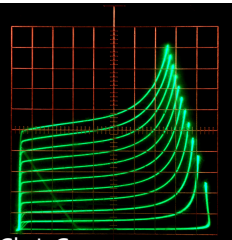




240 MHz High Pass Filter
S_{21} phase & Group Delay



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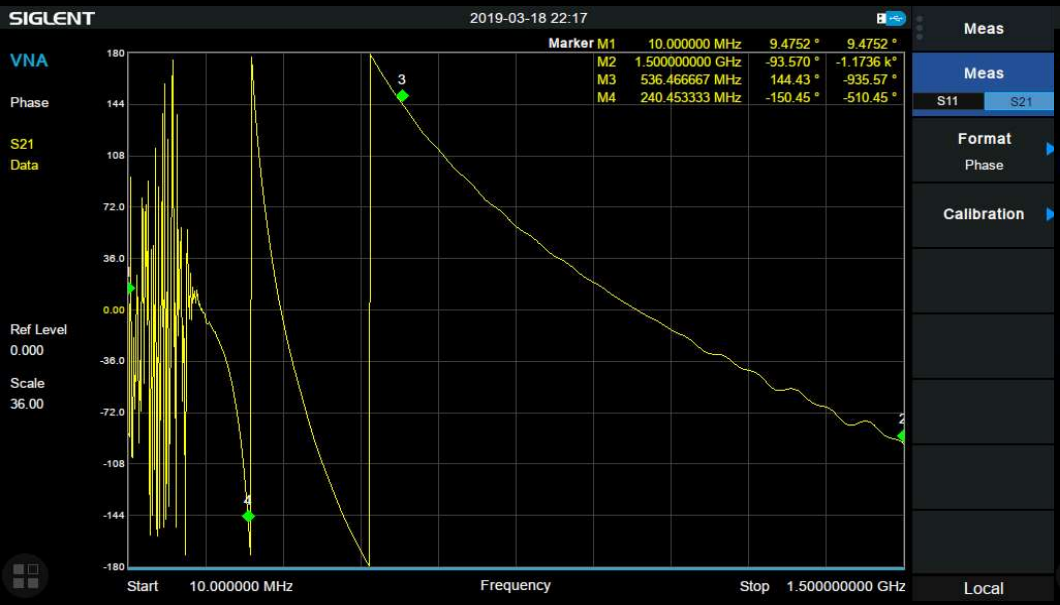
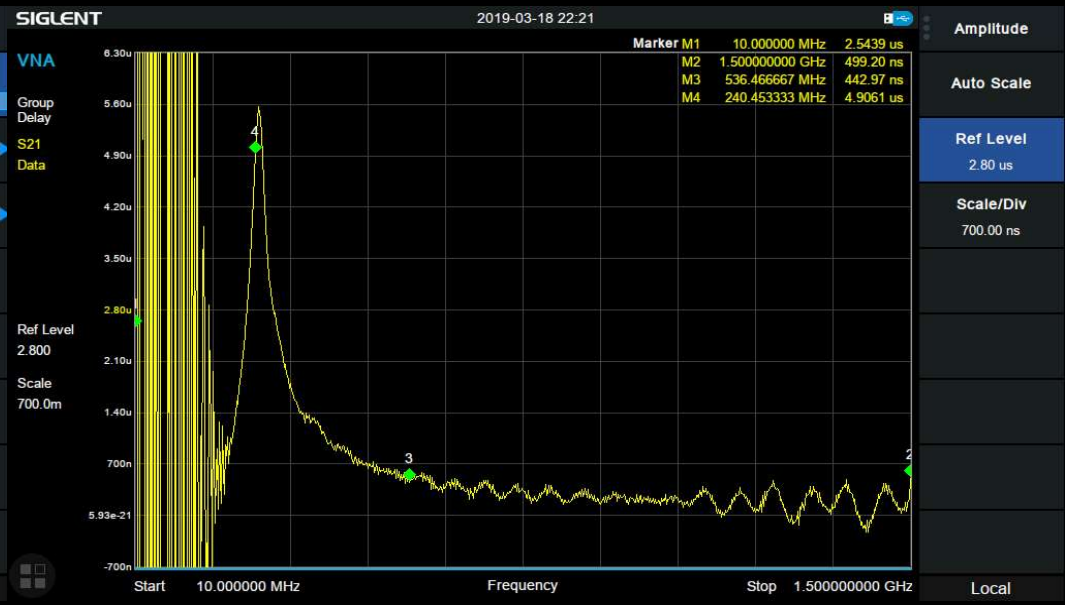
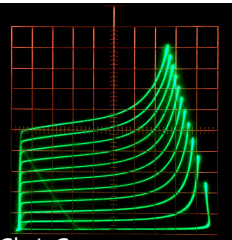




240 MHz High Pass Filter S_{11} & $|S_{21}|$



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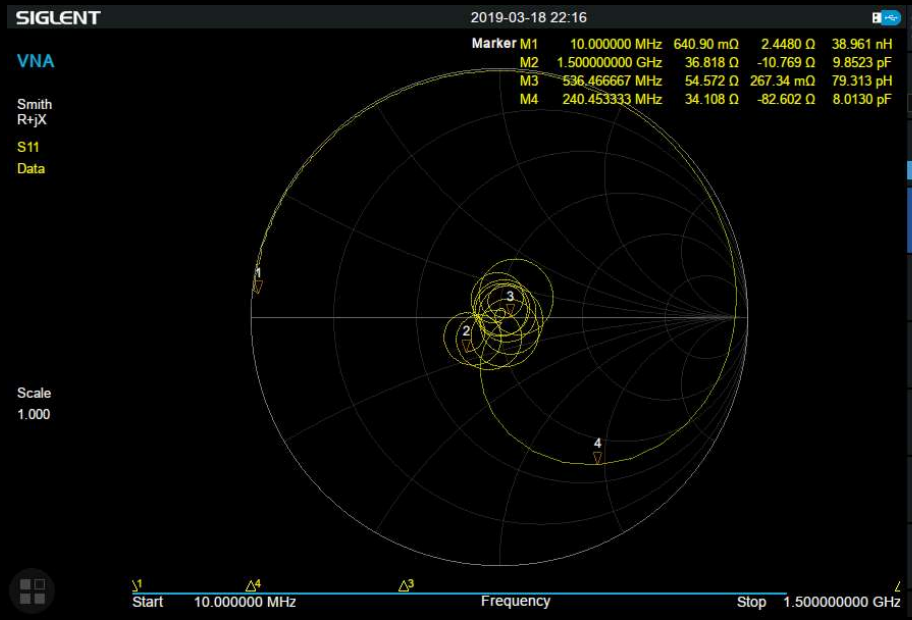
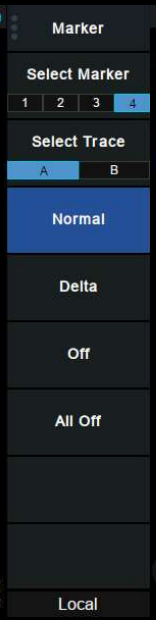
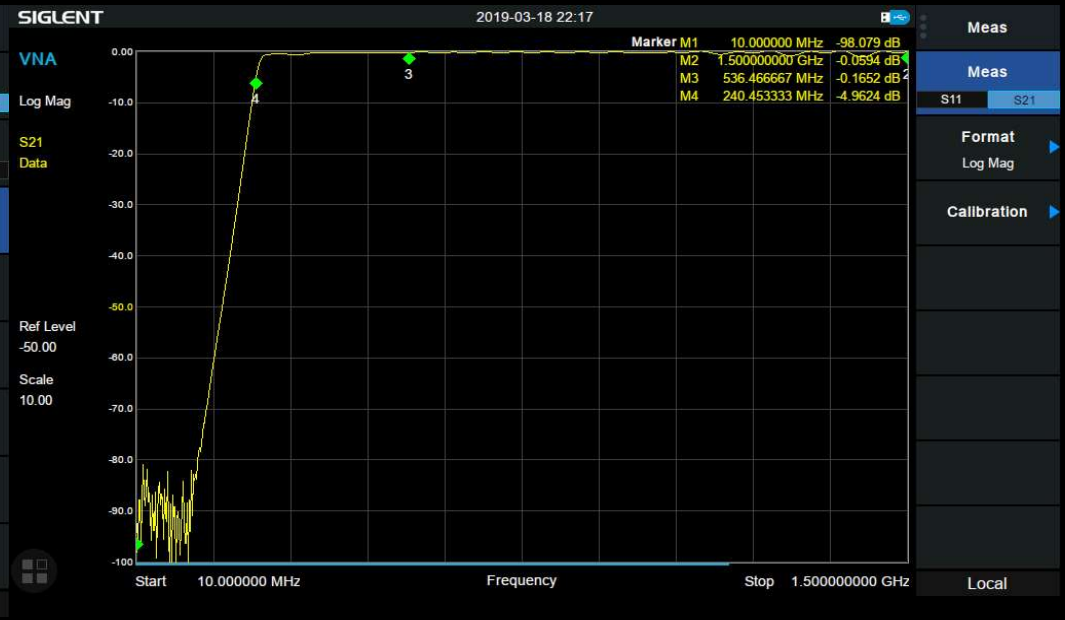
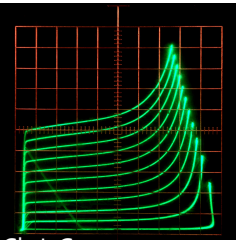






240 MHz High Pass Filter VSWR



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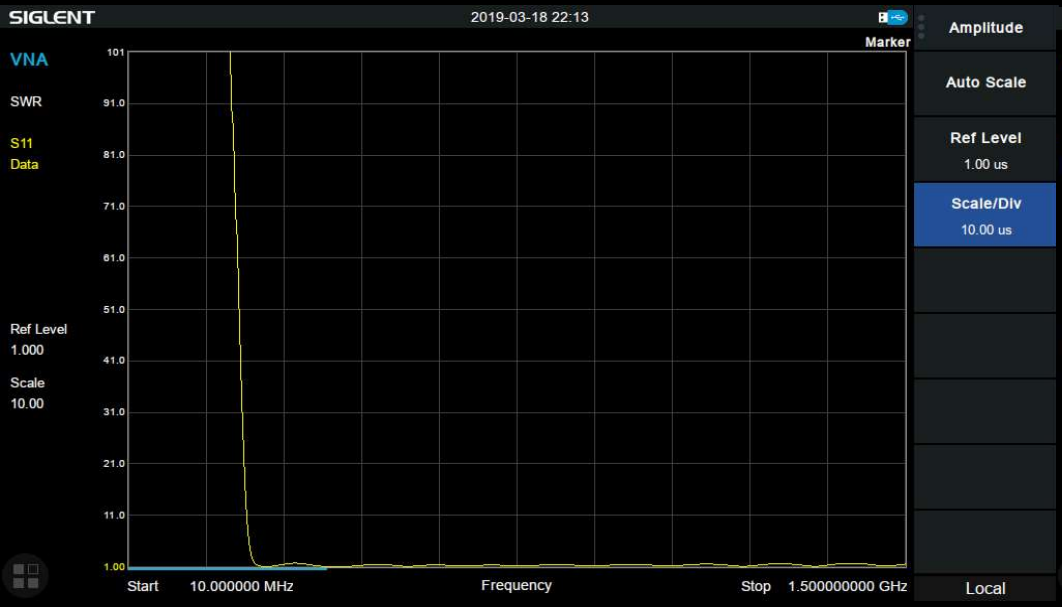
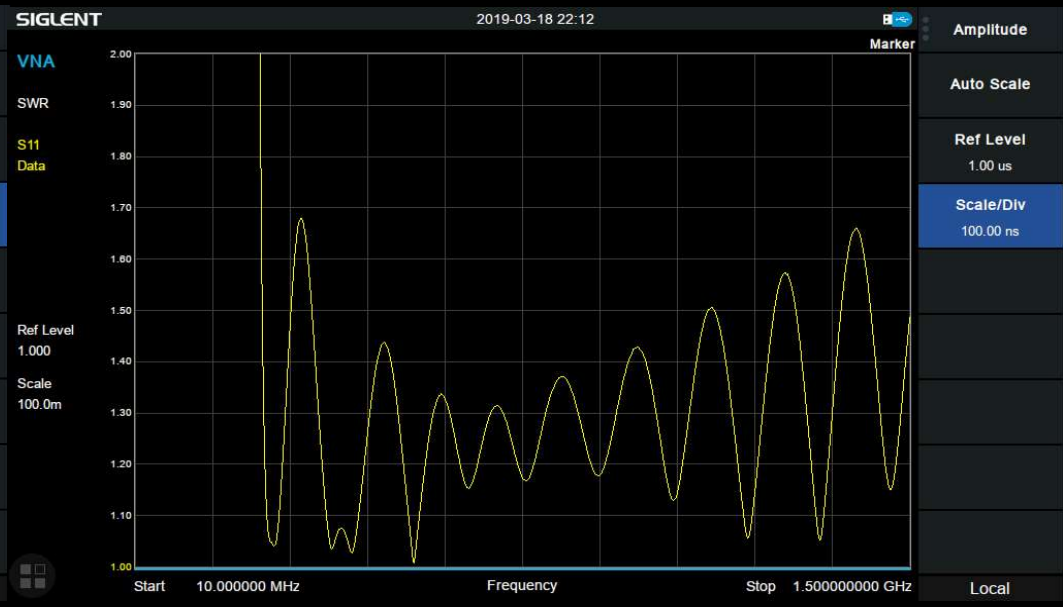
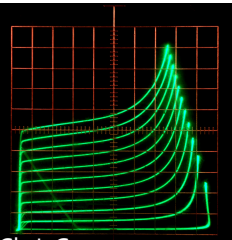




755 MHz Low Pass Filter $|S_{21}|$



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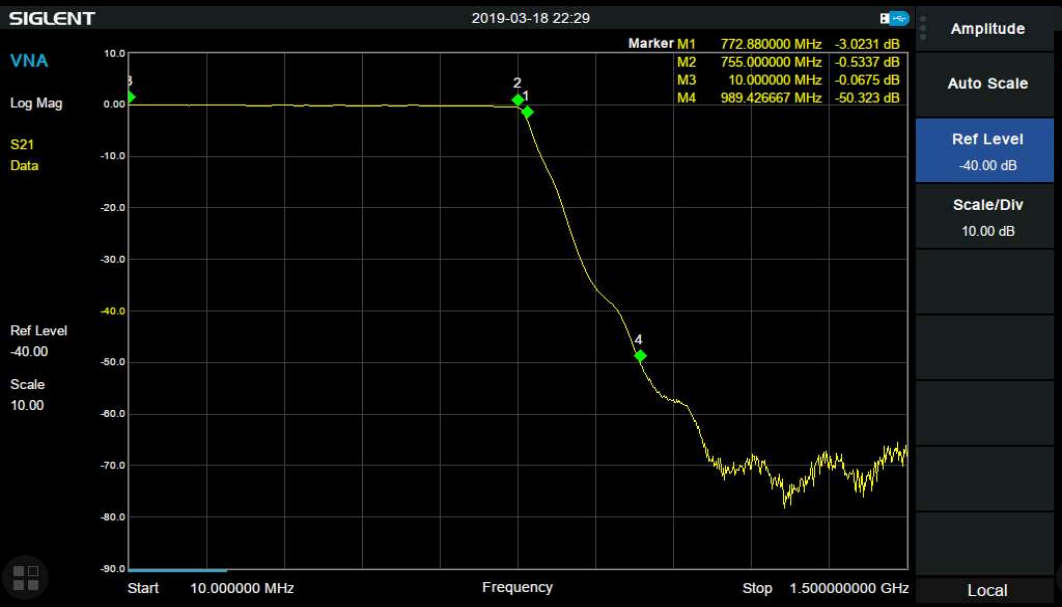
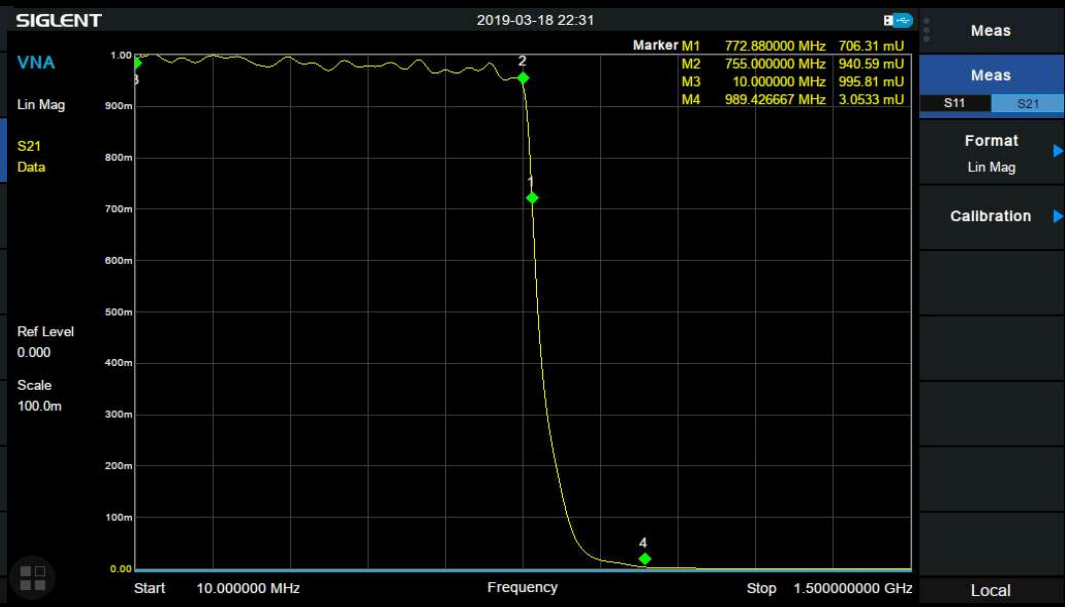
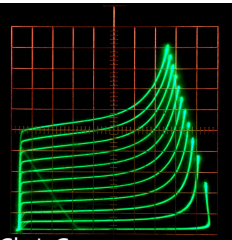




755 MHz Low Pass Filter
Phase of S_{21} & Group Delay



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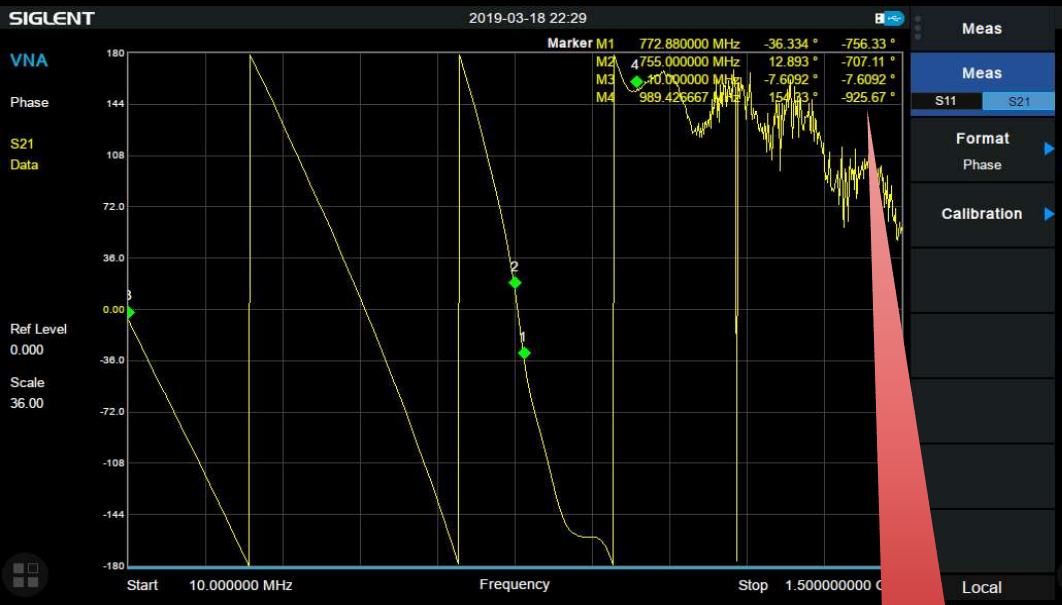
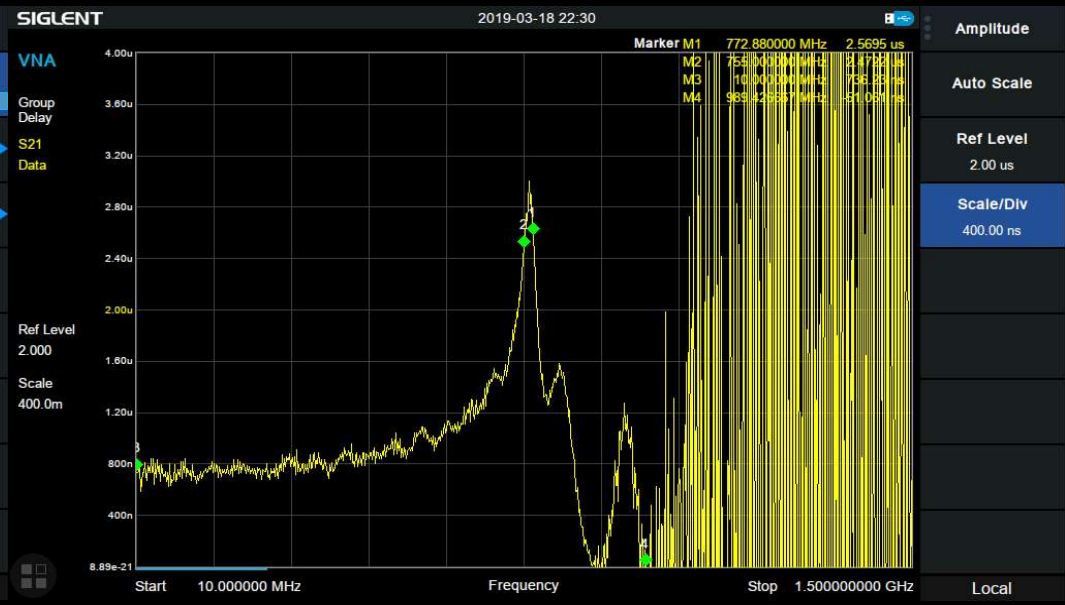
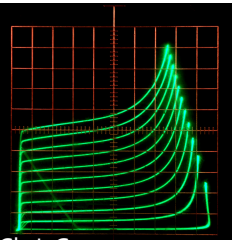




Uncropped Phase
(no ±180° limit)

755 MHz Low Pass Filter S_{11} &$|S_{11}|$



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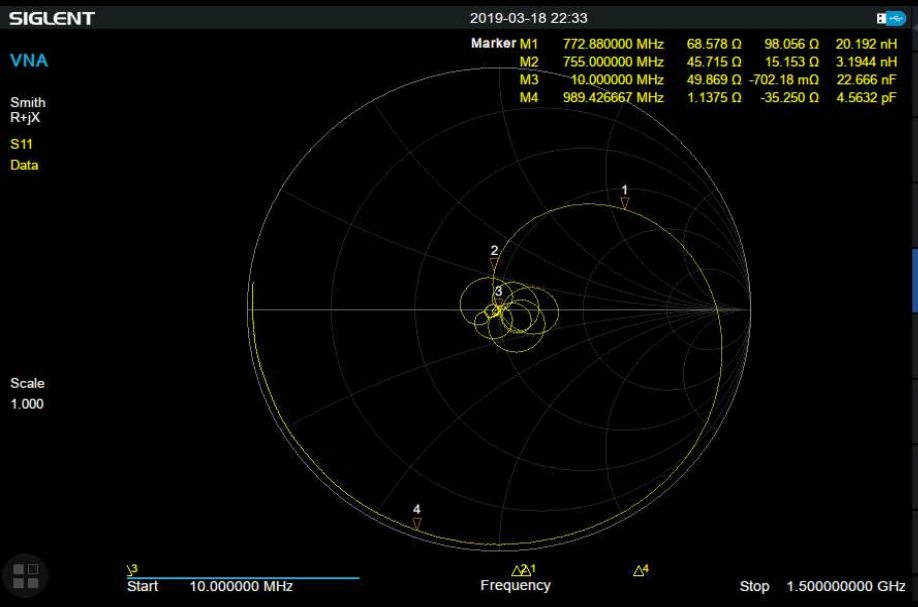
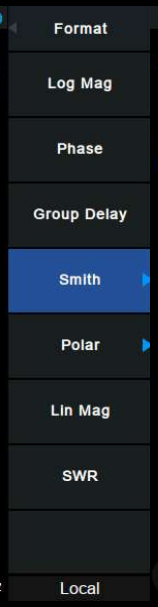
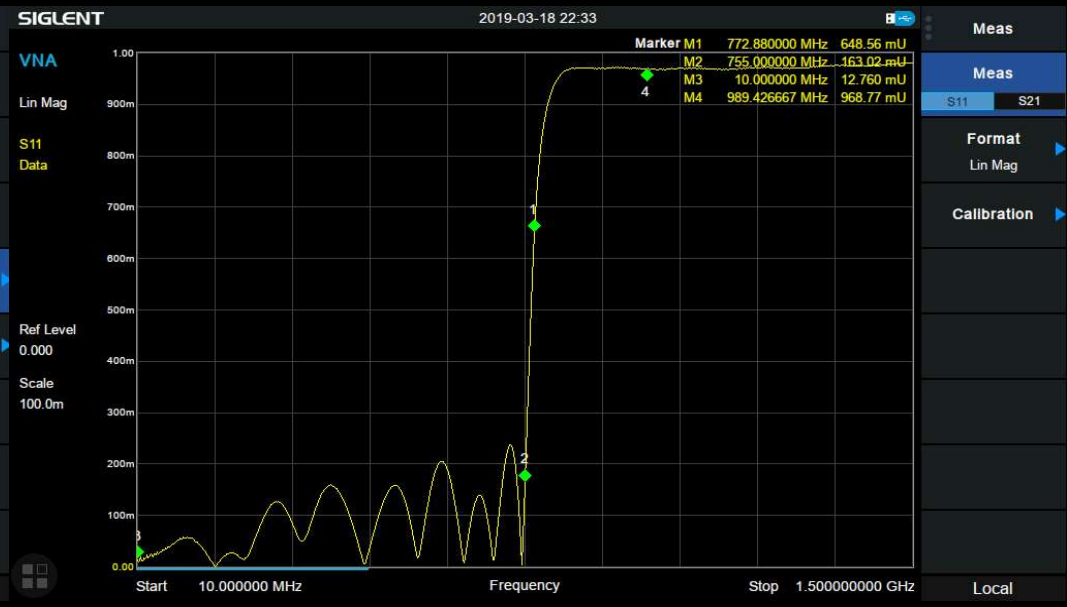
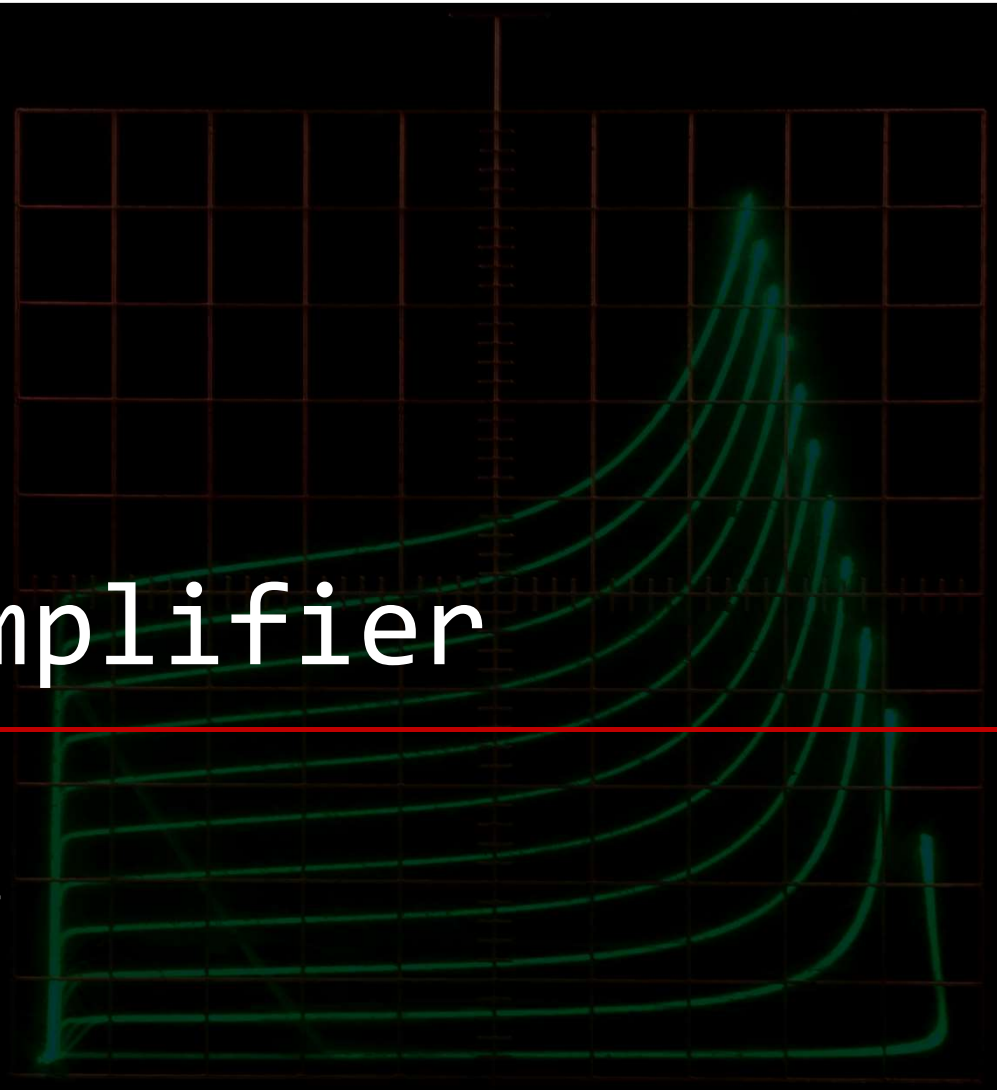




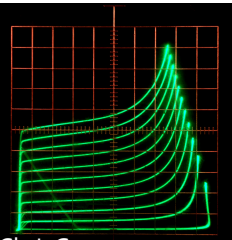


The Good:
High Gain Amplifier



- 0.1-500 MHz
- 45 dB gain nominal
- 17 dBm maximum output power

Calibration Through 50dB of attenuation



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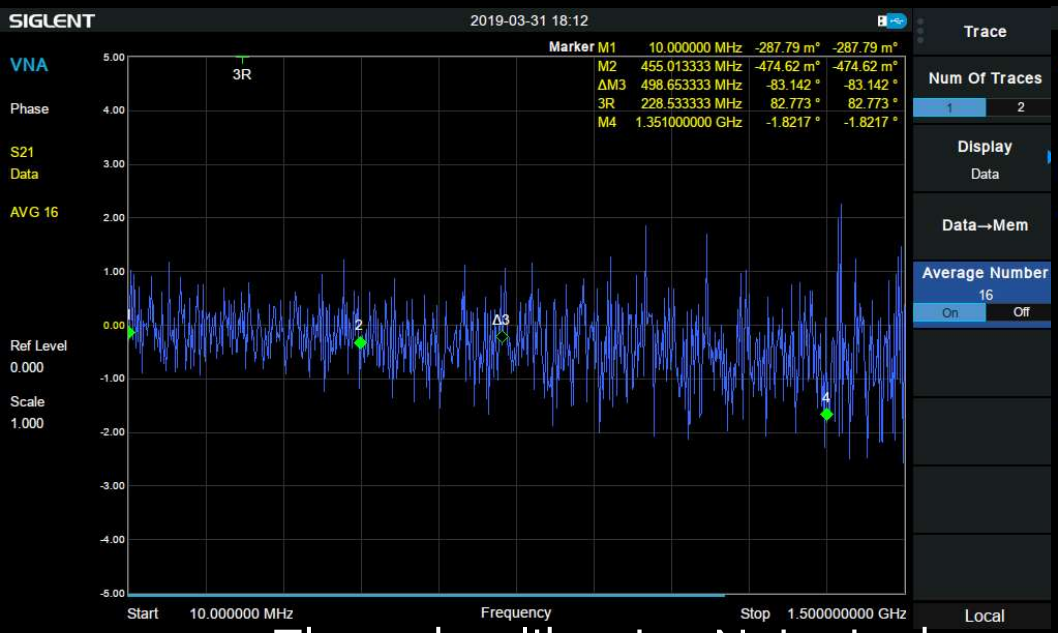
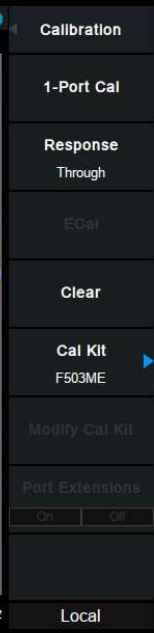
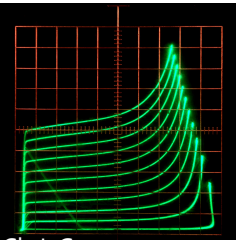
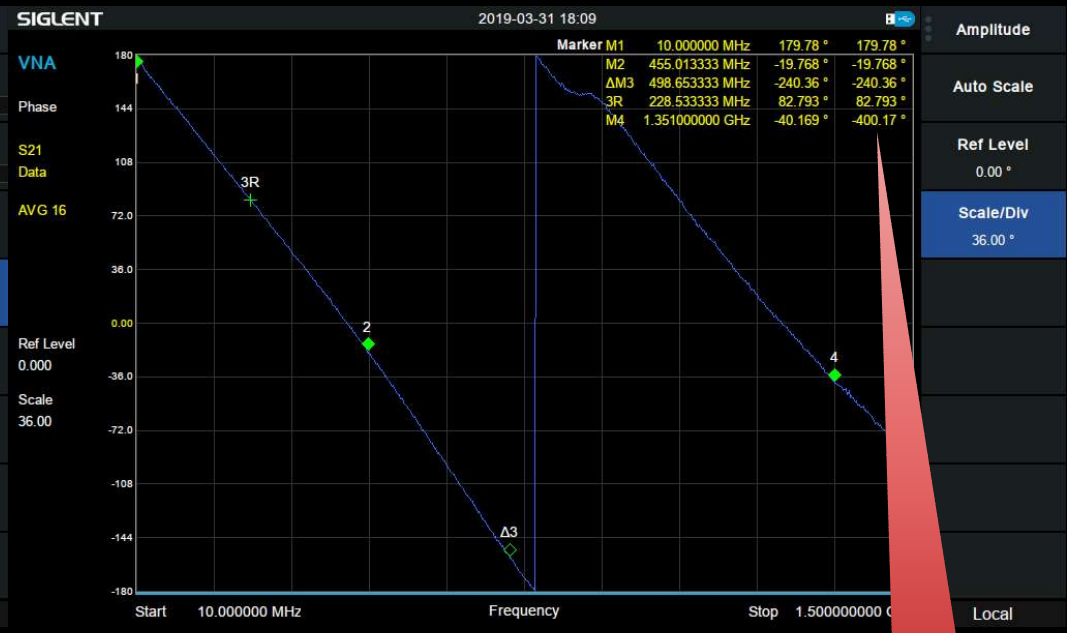




- Through calibration Noise is about .03dB and 2° with 50dB of attenuation
  - The total attenuation must be greater than the amplifier gain
    - output power is 0 dBm & maximum input power is 0 dBm
- Averaging is not used for calibration sweeps
  - It could greatly improve the results if it's use was available

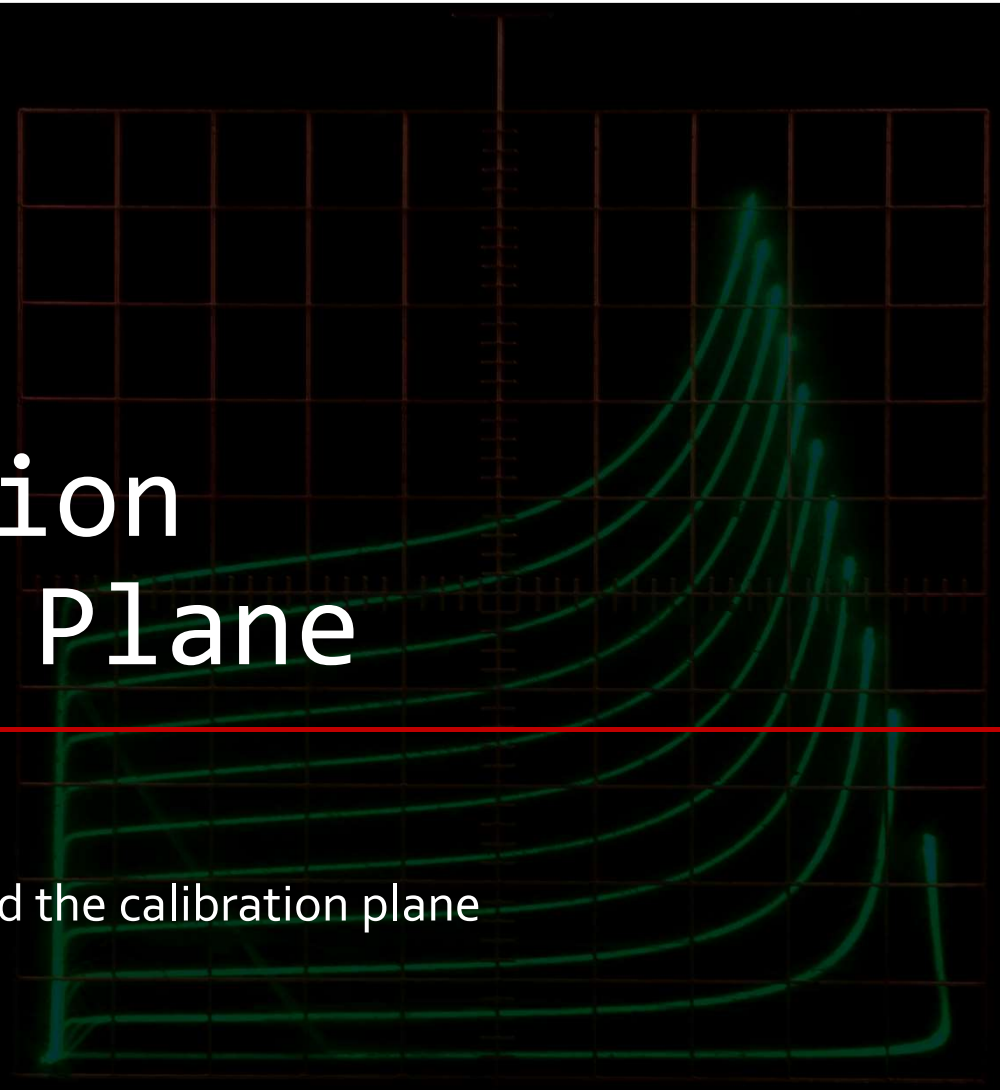
500 MHz Amplifier Measurement





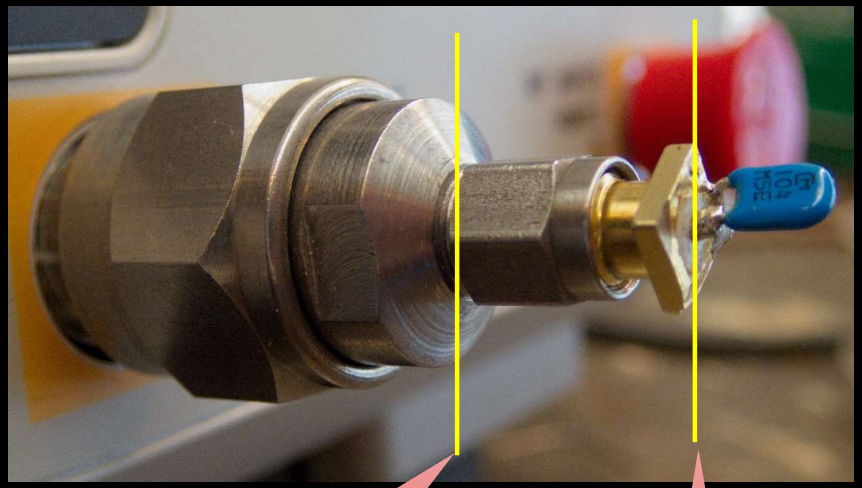
- 40 dB of attenuation on input to keep out of compression
- 10 dB of attenuation on the output to protect the SVA1015X
  - Since the amplifier can output +17 dBm
  - I don't ever want the input to see more than +10 dBm (rated for +30 dBm)

The Bad: S_{11} Calibration & Reference Plane



- No user calibration kits
- Calibration kits are not editable
- Reference plane is always behind the calibration plane

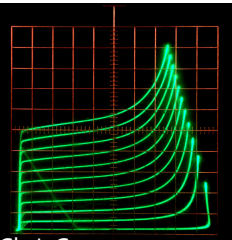
Using the network analyzer to measure components



- One of the reasons I bought this unit was to characterize components I have or may buy at RF frequencies
  - Chinese SMAs are 18¢ to 25¢ in 100s making them cheap enough to be disposable fixtures
- I am using the reflection method here
  - There are also shunt & series through methods
  - I will go into these more in a future video

Until the Port Extension Option is enabled the Smith Chart is not really usable above about 100 MHz

Female SMA Short



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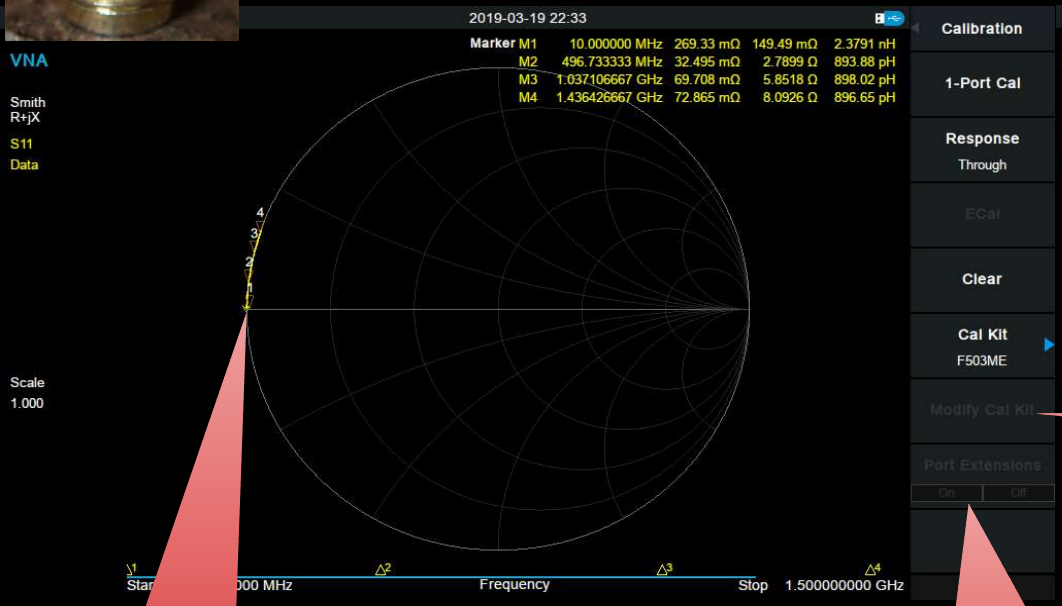
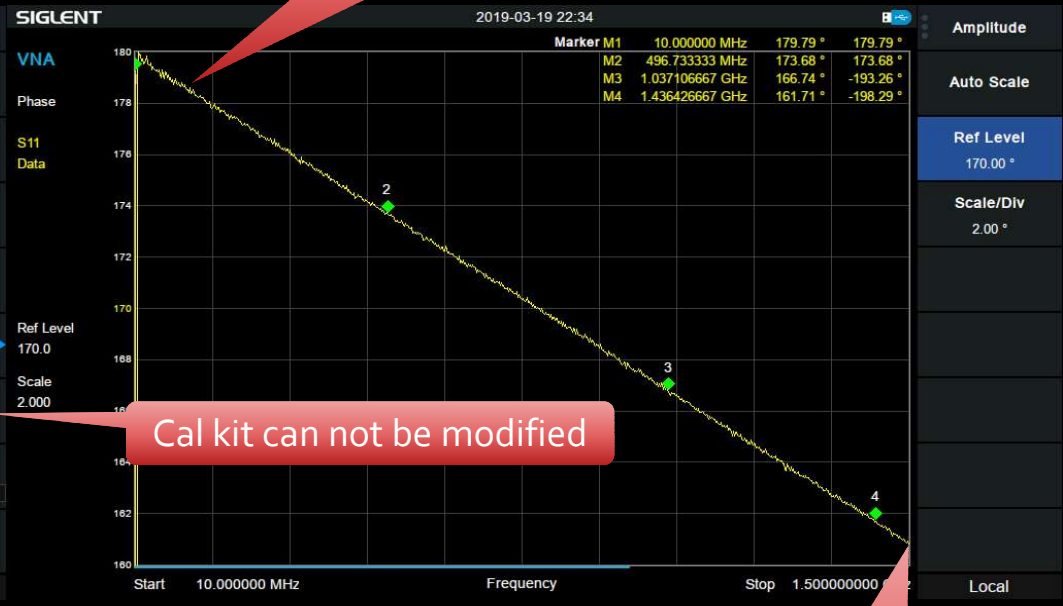
~ 1.6° of error at 100 MHz





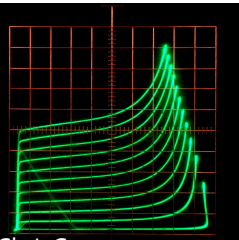
Cal kit can not be modified

A short at the reference plane should be a single point here

The unavailable port extension option would allow moving the reference plane to correct this

19° of error at 1.5 GHz

Female SMA Open



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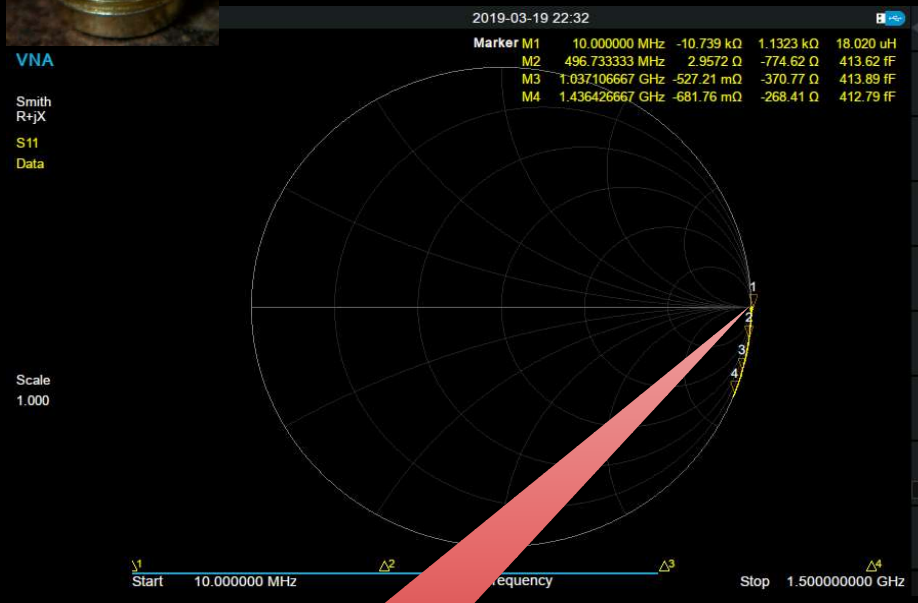
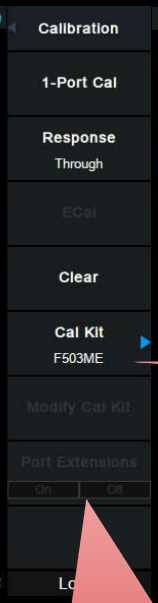
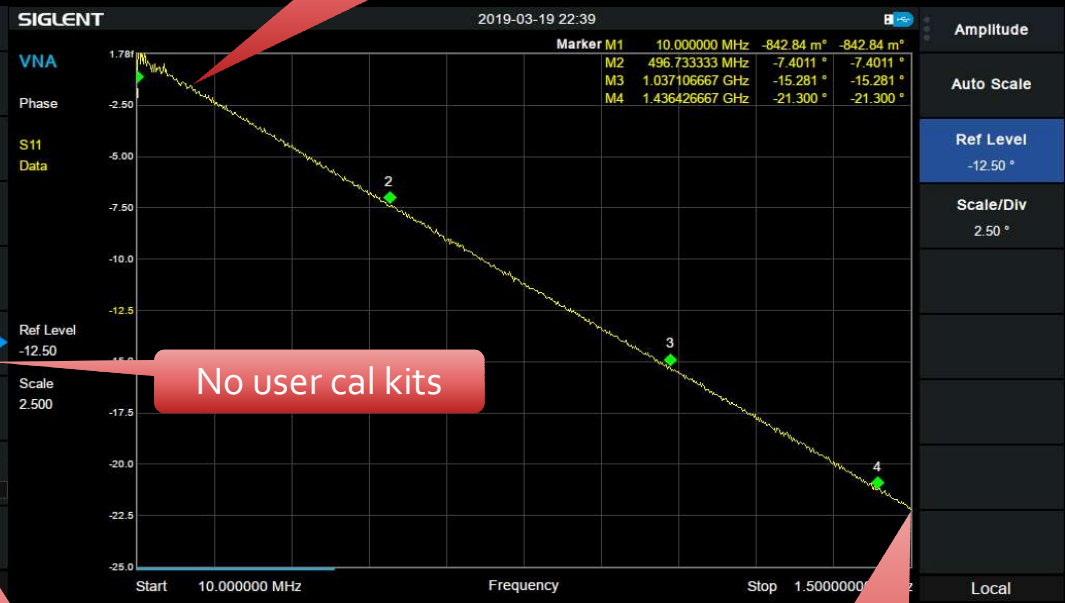
~ 1.8° of error at 100 MHz







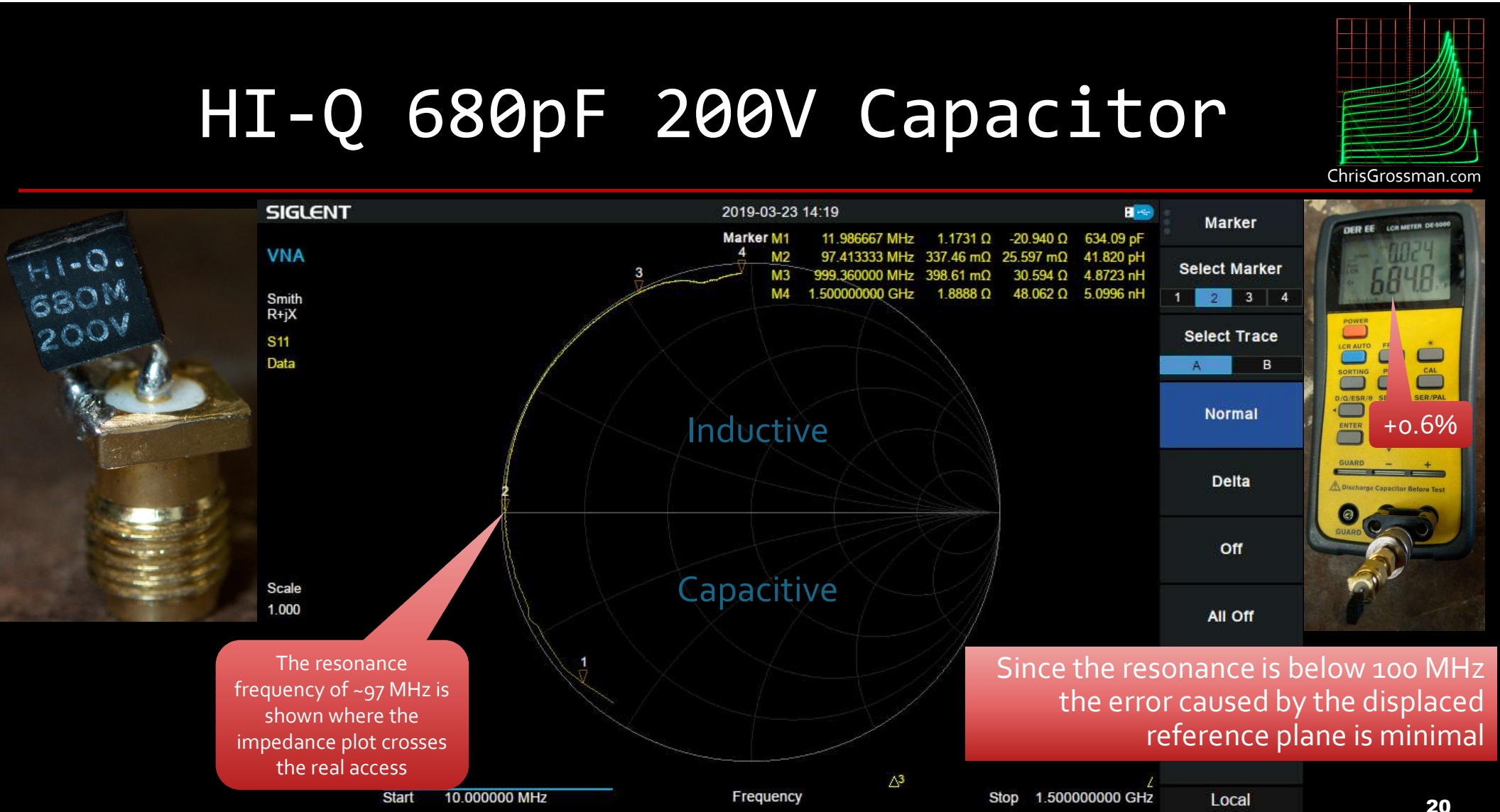
No user cal kits

An open at the reference plane should be a single point here

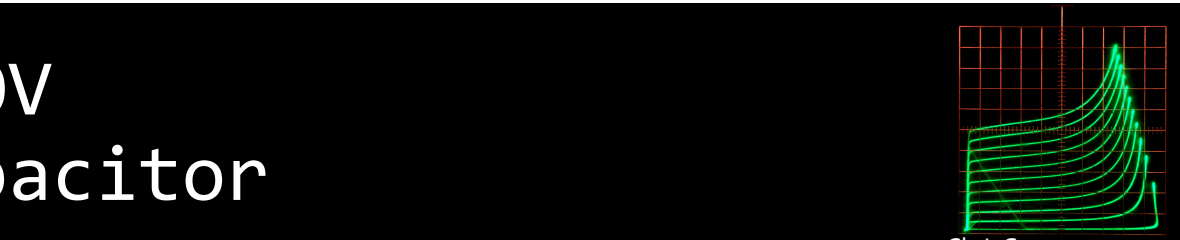
The unavailable port extension option would allow moving the reference plane to correct the phase error

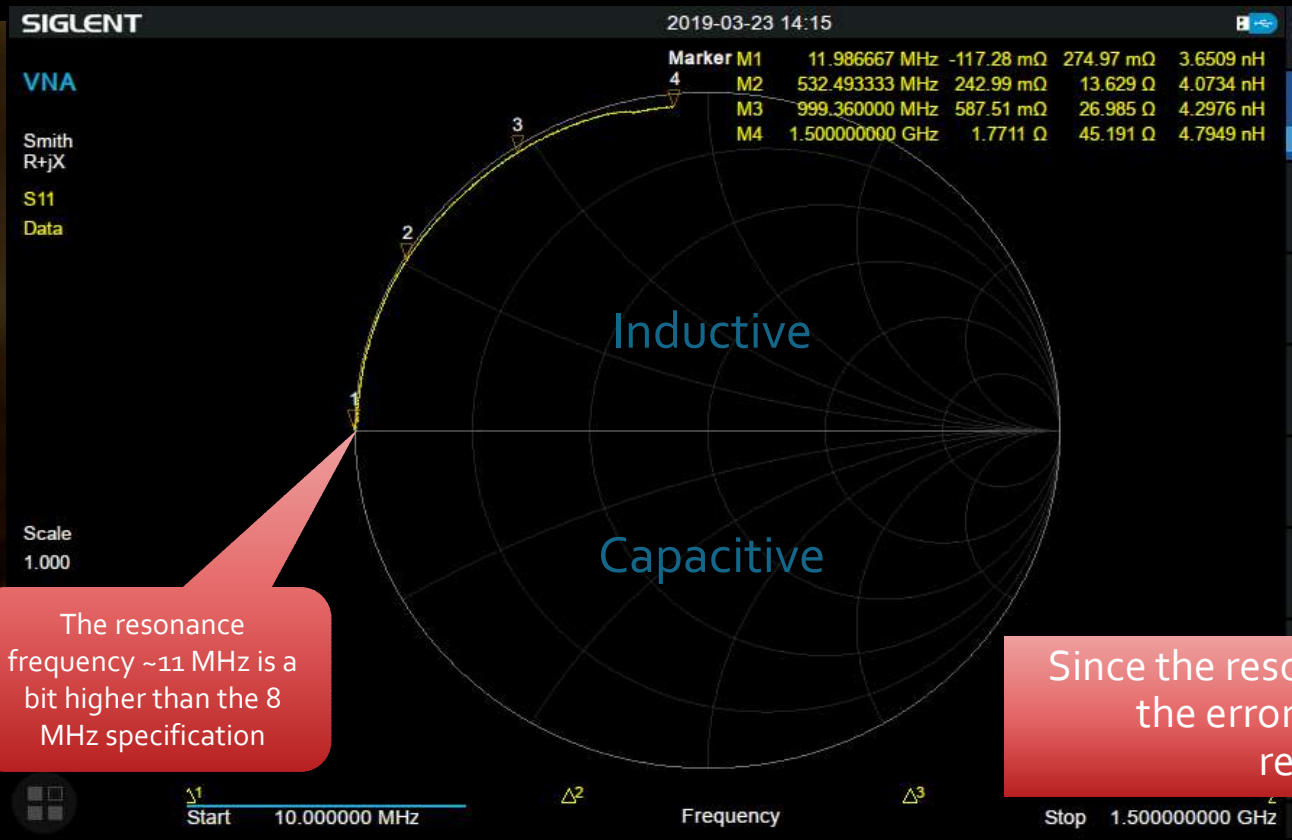
22.5° of error at 1.5 GHz

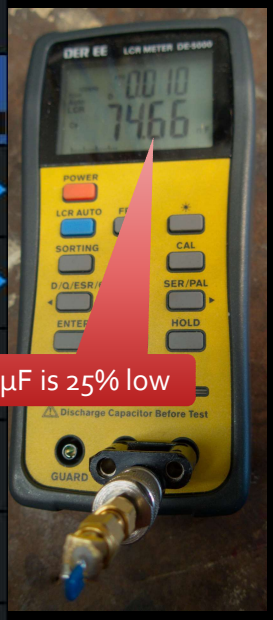
HI-Q 680pF 200V Capacitor



Murata 0.1µF 50V
Z5U Ceramic Capacitor



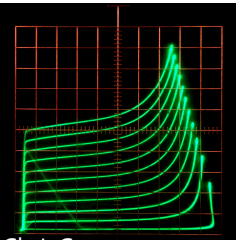




The resonance frequency ~11 MHz is a bit higher than the 8 MHz specification

Since the resonance is below 100 MHz the error caused by the displaced reference plane is minimal

3.9pF Ceramic Capacitor in Glass



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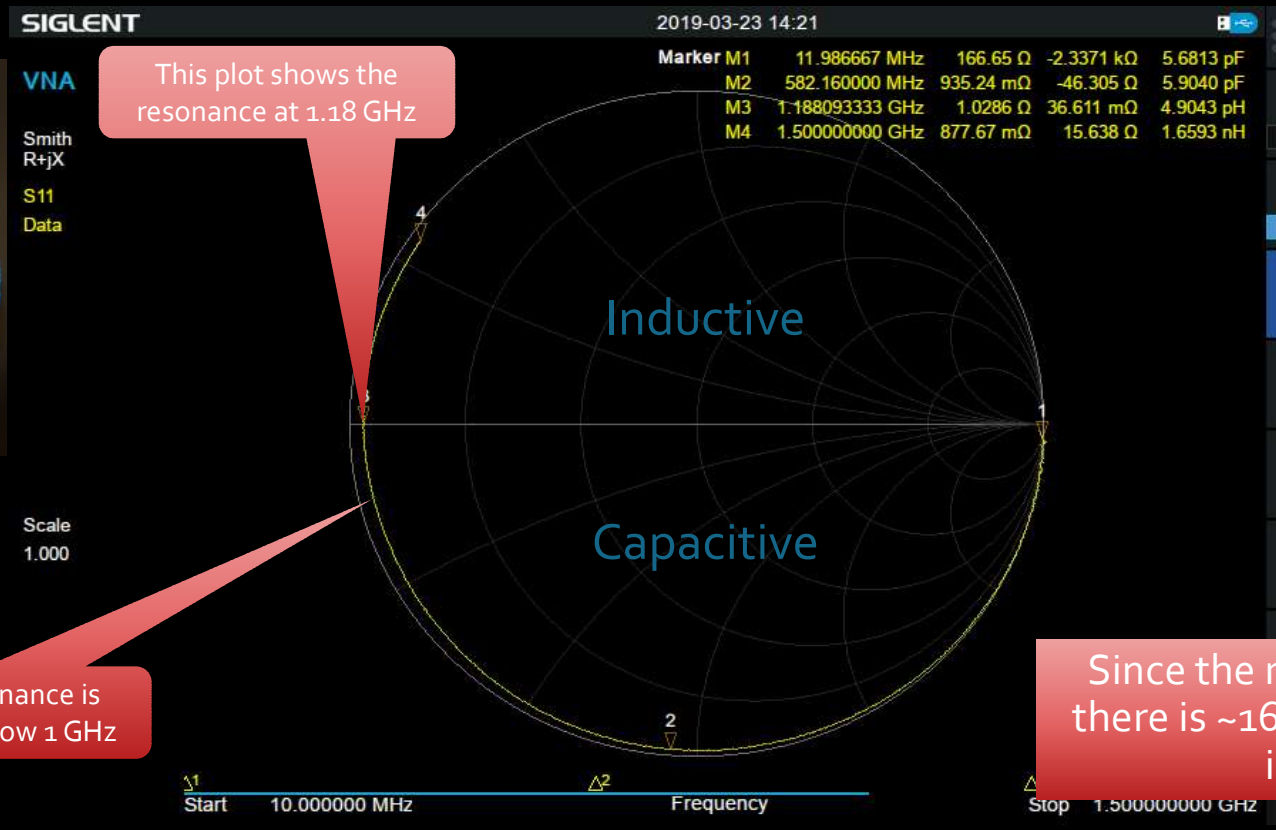
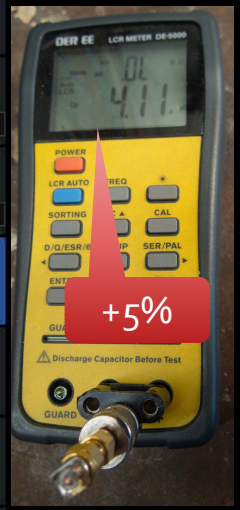


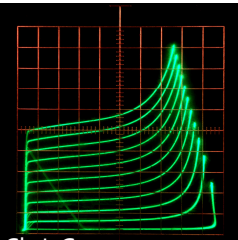
This plot shows the resonance at 1.18 GHz

The actual resonance is probably just below 1 GHz

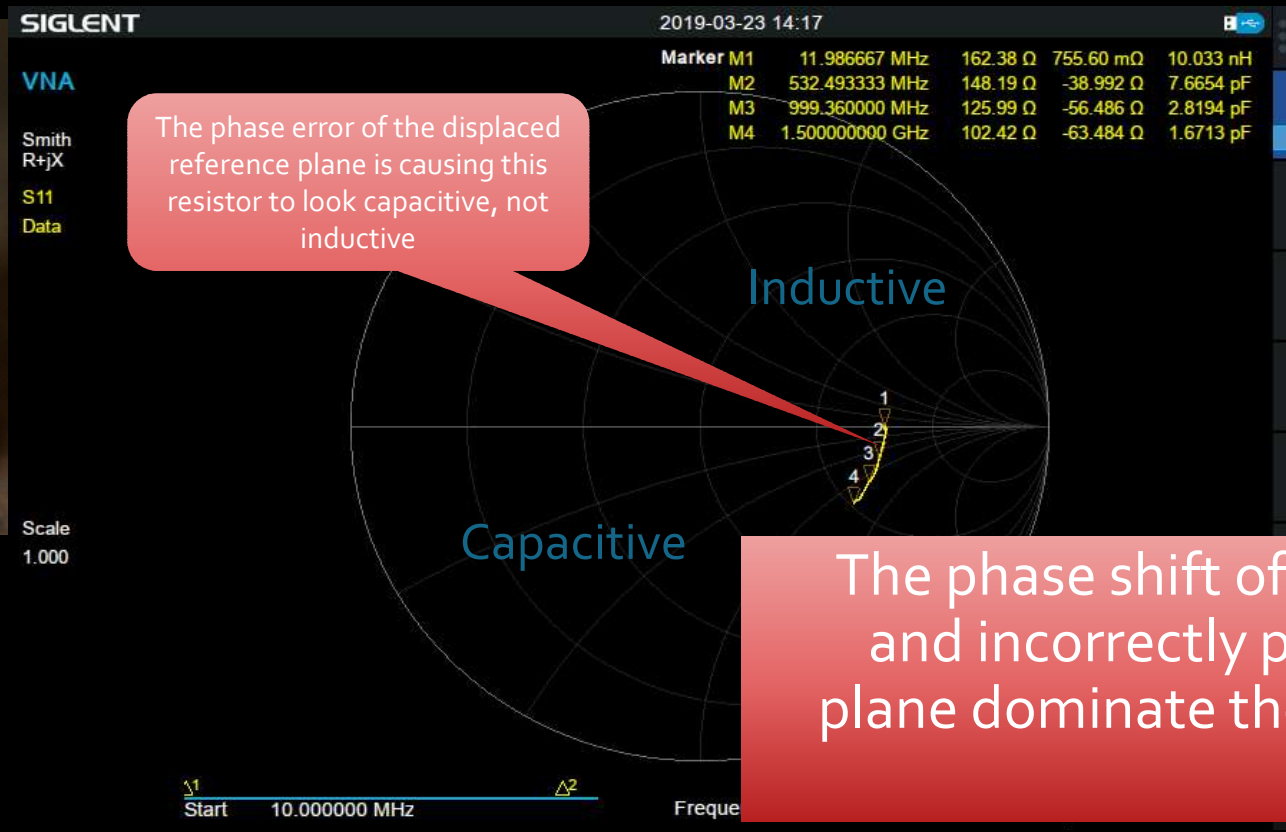


Since the resonance is ~1 GHz there is ~16° error or 18° in the indicated frequency

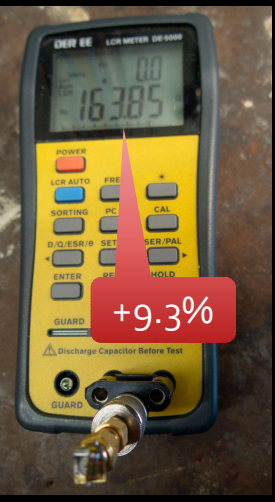
Allen Bradley
150Ω Carbon Composition Resistor



These leads should add inductance and no more than 300fF of capacitance

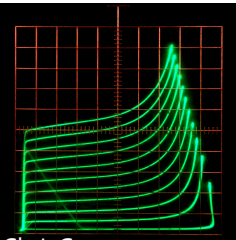


The phase error of the displaced reference plane is causing this resistor to look capacitive, not inductive



The phase shift of the immovable and incorrectly placed reference plane dominate the measurement of this resistor

Calibration
What needs to be fixed



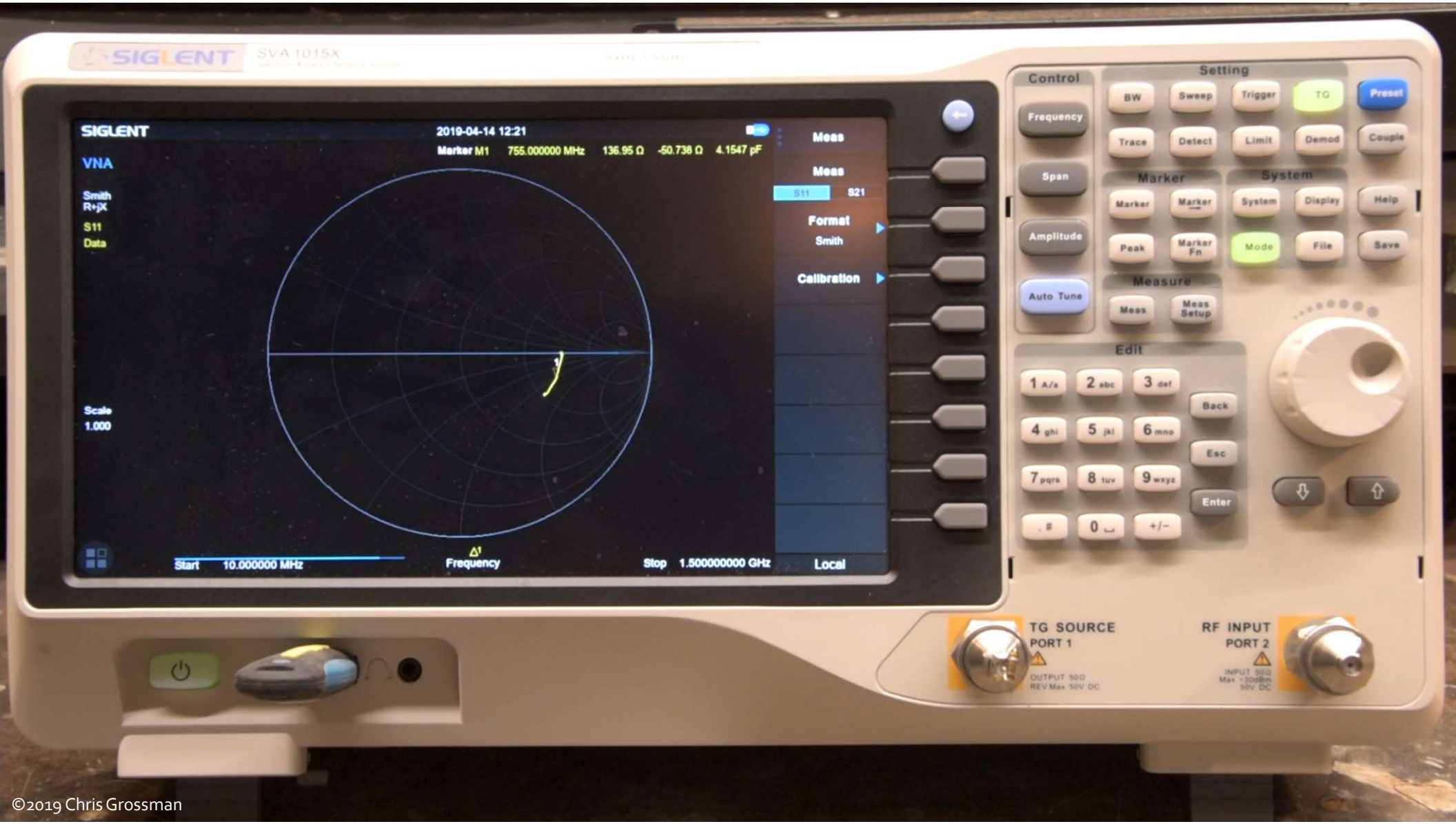
- Enable port extensions for S_{11}
  - To make Smith Chart usable
- Enable "through" extensions for S_{22}
  - Allows adjustment of the length difference of the through cal and DUT (device under test)
- Allow at least 3 user definable & namable calibration kits
- Allow saving and recall of cal kits in a text (XML) file (.cal)

Cal kit parameters in **white** are must have now
Parameters in ***gray italic*** are lower priority

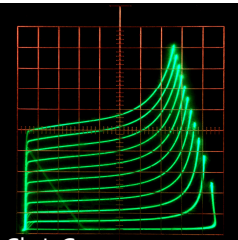
- Suggested Cal Kit Parameters
  - Load
    - resistance – default: 50Ω
    - time offset – default: 0 ps
    - *parallel capacitance – default: 0 fF*
    - *series inductance – default: 0 pH*
  - Short
    - time offset - default: 0 ps
    - *series inductance – default: 0 pH*
  - Open
    - time offset – default: 0 ps
    - *parallel capacitance - default: 0 fF*
  - Through
    - delay : default: 60 ps
    - *attenuation - default: 0 dB/GHz*

The Bad:
The cumbersome file system

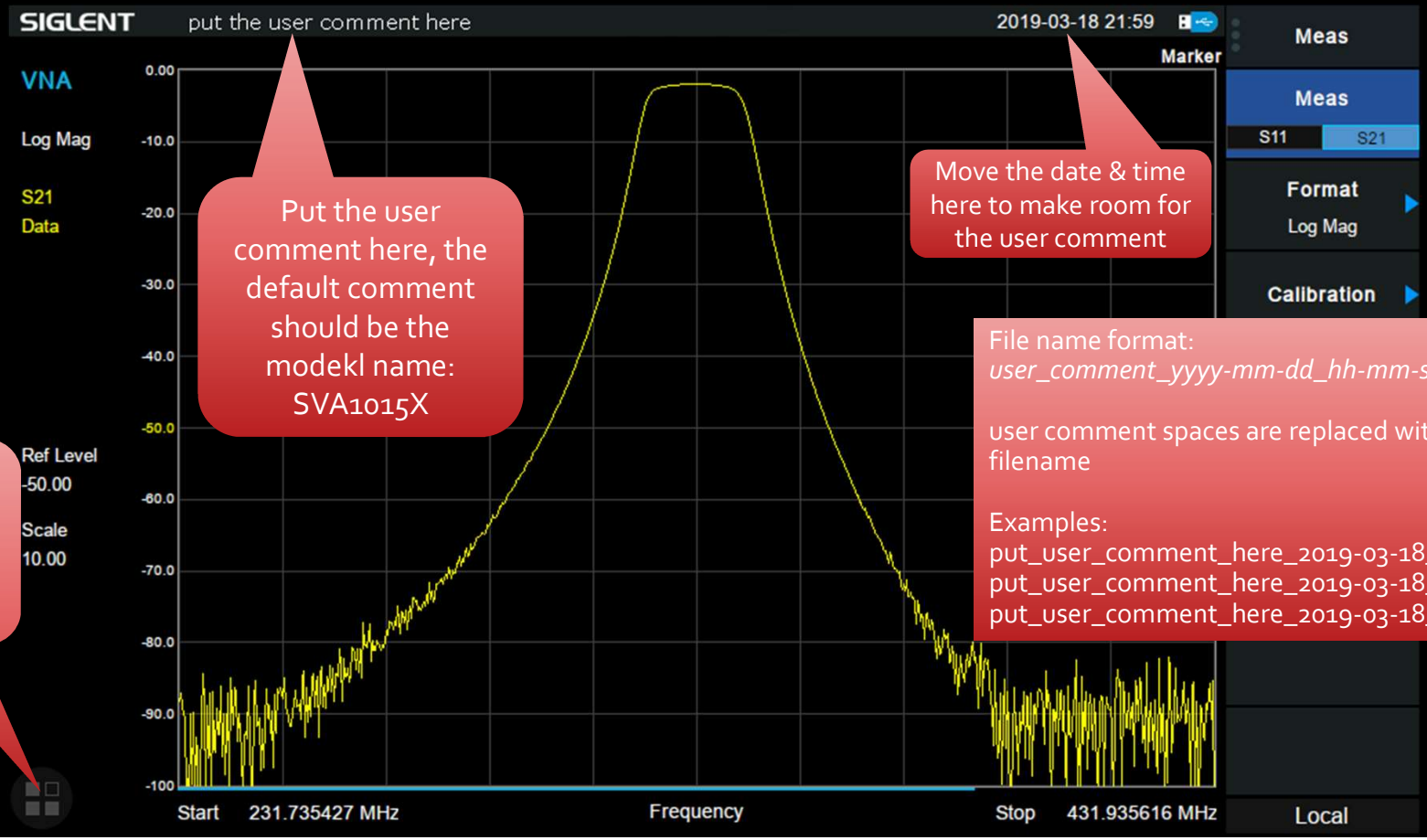
- csv data files only contain the parameter plotted (not all data)
- multiple screens must be displayed and data saved to save all data
- a default file name (CSVXX or PNGXX) comes up for every save
- the keypad makes old flip phone keypads for texting look good
- there is no way to enter user comments



User Comment & File Name



ChrisGrossman.com



Put the user comment here, the default comment should be the modekl name: SVA1015X

Move the date & time here to make room for the user comment

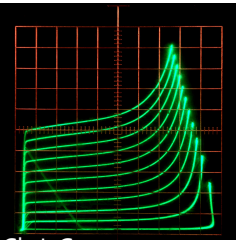
Add an entry to this floating touch menu that allows the user to edit the comment from any screen

File name format:
user_comment_yyyy-mm-dd_hh-mm-ss.xxx

user comment spaces are replaced with underbars (_) in filename

Examples:
put_user_comment_here_2019-03-18_21-59-23.csv
put_user_comment_here_2019-03-18_21-59-28.png
put_user_comment_here_2019-03-18_21-59-33.sta

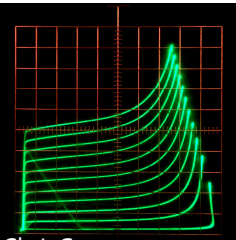
CSV Data File Header Information



- Model number: Siglent SVA1015X
- Software revision
- Mode: S11 or S21
- Date & Time
- **User Comment**
- Power On Date & Time
- Internal Temperature
- # Averages
- Port (S11) or Through (S22) Extension Time: 0 ps
- Output Power: 0 dBm
- Measurement Bandwidth: 10 KHz
- Number of Frequency Points: 751
- Calibration Kit Name
- Date & Time of Calibration
- Internal Temperature at Calibration
- # Averages used for Cal

All data should be saved for any CSV save, not just the displayed measurement plot

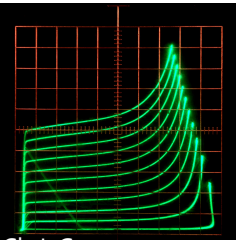
S_{11} Data File Columns



- Frequency
- $|S_{11}|$ linear
- Log($|S_{11}|$) dB
- Phase of S_{11}
- Real(S11)
- Imaginary(S11)
- SWR
- Resistance
- Reactance
- $|Z|$ *Impedance*
- *Phase angle of Z*
- Conductance
- Susceptance
- $|Y|$ *Admittance*
- *Phase Angle of Y*
- Capacitance (blank if L)
- Inductance (blank if C)
- Marker Label
  - Use of this additional column is preferable & more versatile to putting this in the header
  - Leave entry blank for no marker

All data should be saved for any CSV save, not just the displayed measurement plot

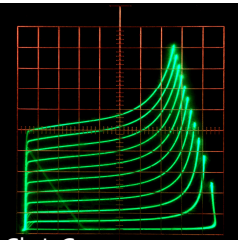
S_{21} Data File Columns



- Frequency
- $|S_{21}|$ linear
- Log($|S_{21}|$) dB
- Cropped (±180° limits) Phase of S_{21}
- Uncropped Phase of S_{21}
- Group Delay
- Marker Label
  - Use of this additional column is preferable & more versatile to putting this in the header
  - Leave entry blank for no marker

All data should be saved for any CSV save, not just the displayed measurement plot

SVA1050X VNA option
What needs to be fixed now

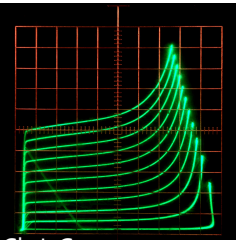


1. Port extension for S11 and through extension for S22
2. Enable user comment
   - On screen
   - Make it the default root for saved file names
3. Update CSV files to save all data
4. Averaging enabled for calibrations
5. User Calibration Kits

- Allow output powers from -20 dBm to 0 dBm
  - 0 dBm is too high for many amplifiers

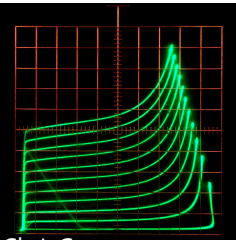
These changes would change the VNA option from a barley usable option into a highly useful tool

SVA1050X VNA option
Other Nice to Have Features



- Sweep spans less than 5 MHz
  - Useful for aligning IF stages
- Simultaneous display of magnitude and phase
  - This thing has a color screen → use it!
  - Ex: |S21| and Phase(S21)
- Log frequency sweeps and plots
  - S11 ex: log|Z| and phase(Z) vs. log(f)
  - S21 ex: log|S21| and phase(S21) vs. Log (f)
  - It would be possible to get away with less than 761 points on a log(f) plot.

Siglent SVA1015X Network Analyzer Option Conclusion



- The SVA1015X is a very nice spectrum analyzer for the price
  - It includes the tracking generator
- The network analyzer is an interesting but flawed option
  - With some firmware changes it could be great
- I hope Siglent is sees this and takes some of my suggestions