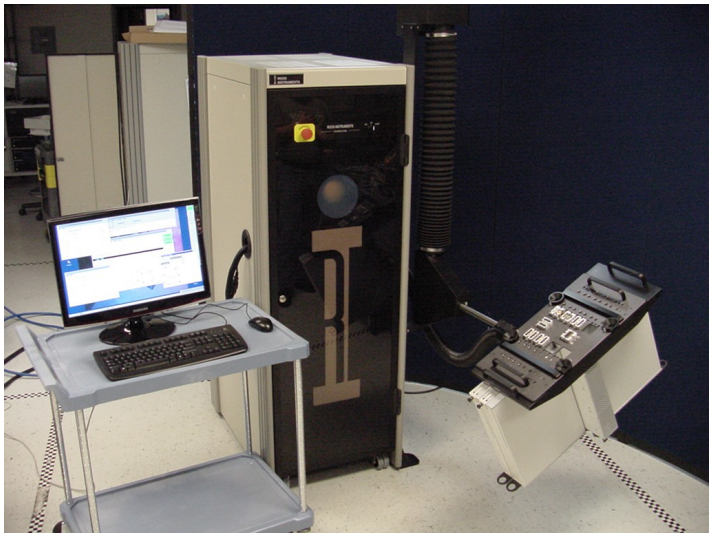
CASSINI RF/ Microwave ATE System
Test Design &
Best Practice Test Optimization

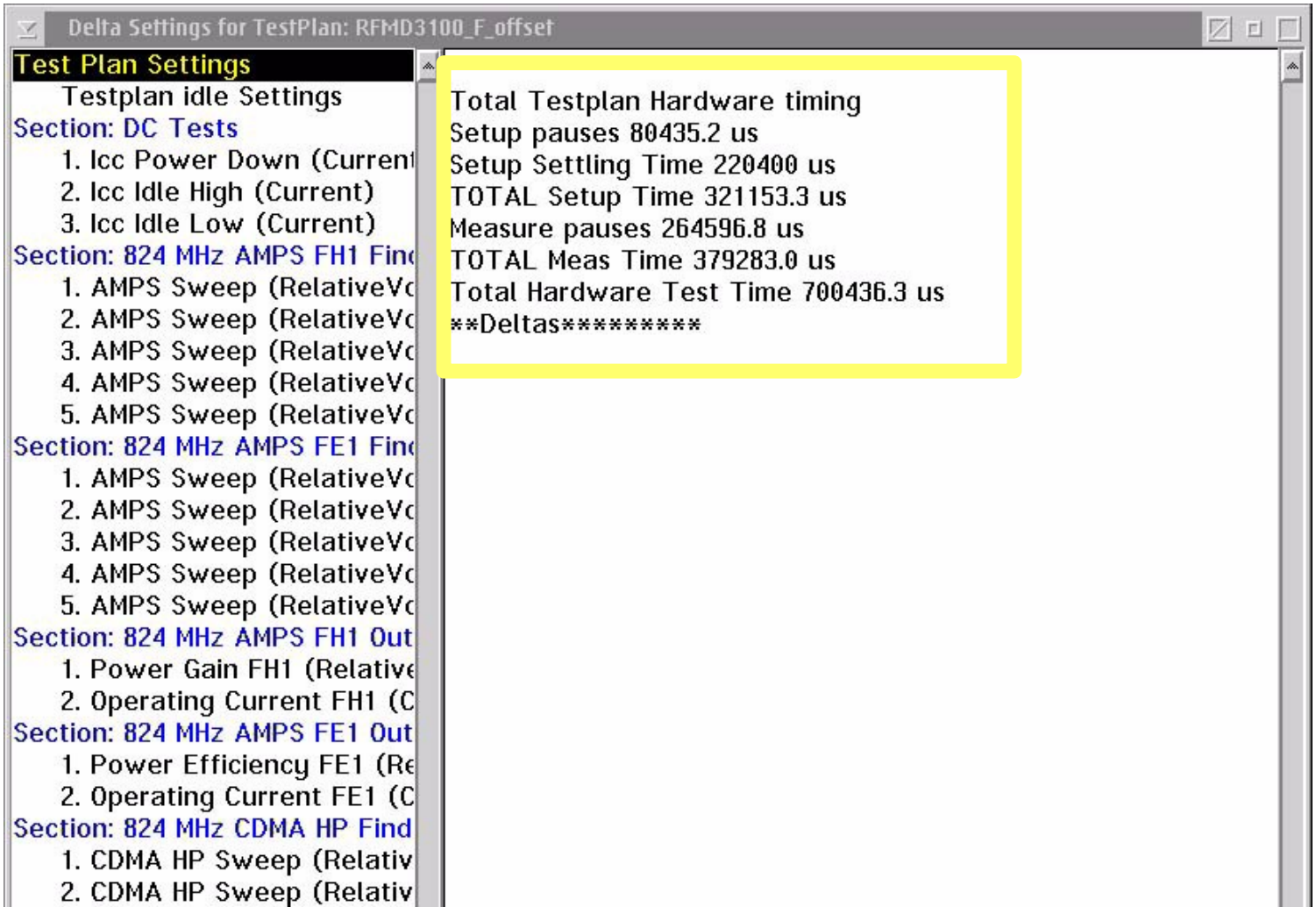


Test Plan - Comments, Guidelines and Suggestions

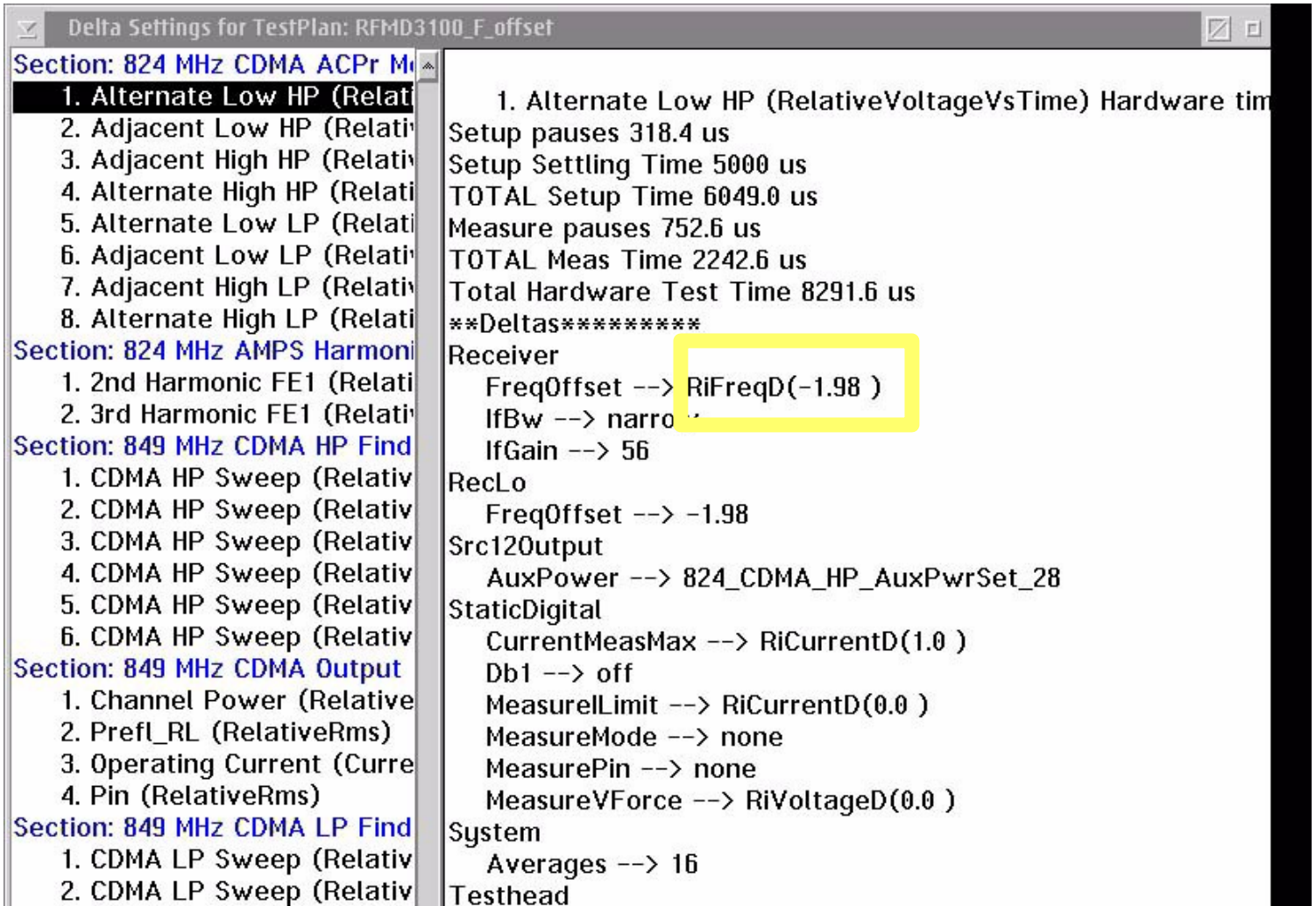
- Optimizer - Optimizes over Test Section
- Only add state buttons that are needed
- Changes cost time and money
- Data is displayed in the order listed & not displayed in the order performed
- Parameters set by LVs must be reset in the Disconnect Settings panel

Optimizer: Optimizes over each Test Section

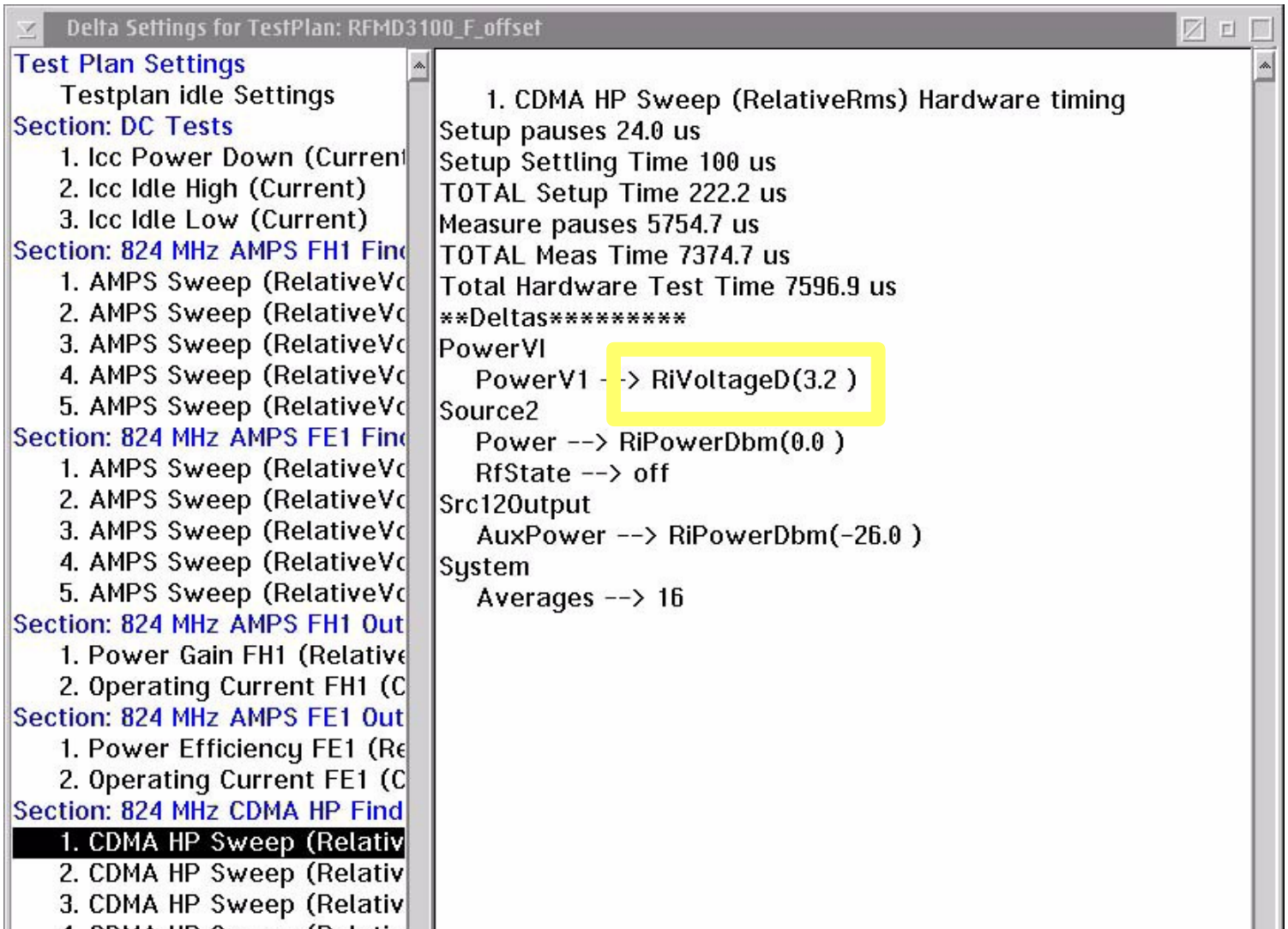
Compiled Delta Settings Shows Test Times



Optimizer: Optimizes each Test Section. Lowest DUT Frequency Measured First



Optimizer: Optimizes each Test Section. Measurement with Lowest Input Power Performed First



Test Plan - Comments, Guidelines and Suggestions

- The tester is very fast changing state
- Your part may not be fast, add Pauses
- The tester will find unstable DUT states

Test Plan - Comments, Guidelines and Suggestions

- Fewer Test Sections better than more
- More simple test panels are better than fewer complex test panels
- Duplicate test states/conditions when ever possible
- Be consistent about where you place buttons in a test panel

Test Plan - Comments, Guidelines and Suggestions

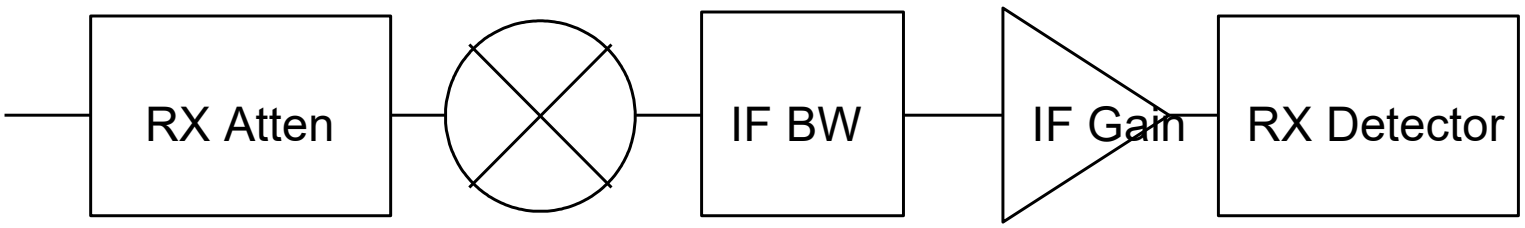
- IMD Tests - more Receive Attn is better
- Noise Figure - Use 0 dB Rec Attn.
- Set DB Current Limit = DB I Meas Max.
- Set VI Current Limit ≥ VI I Meas Max.
- RF Sources - Levels ≤-22 to ≥+13 dBm
- DMSG - Optimum levels <-5 dBm
- RF Off is <-30 dBm

System Receive Gain Adjustment

- Receive Attenuation
- IF Gain
- Signal Dependent
  - Single tone
  - Multi tone
- Measurement Repeatability

Simplified Receive Diagram

- Receive Attenuator
- Mixer
- IF Filter
- IF Amplifier
- Receiver Detector



System Sensitivities

- RI 7100A Receiver Mixer
  Saturate (Compression)
  Generate Intermodulation Distortion

- Receiver Detector
  Compression
  "Fold-over"

Single Tone Measurements

- RF Power, S-Parameters, Noise Figure
- Objectives
  - Maximize Power to Receiver
  - Maximize Power to Mixer
  - Set Appropriate IF Gain

Single Tone Method

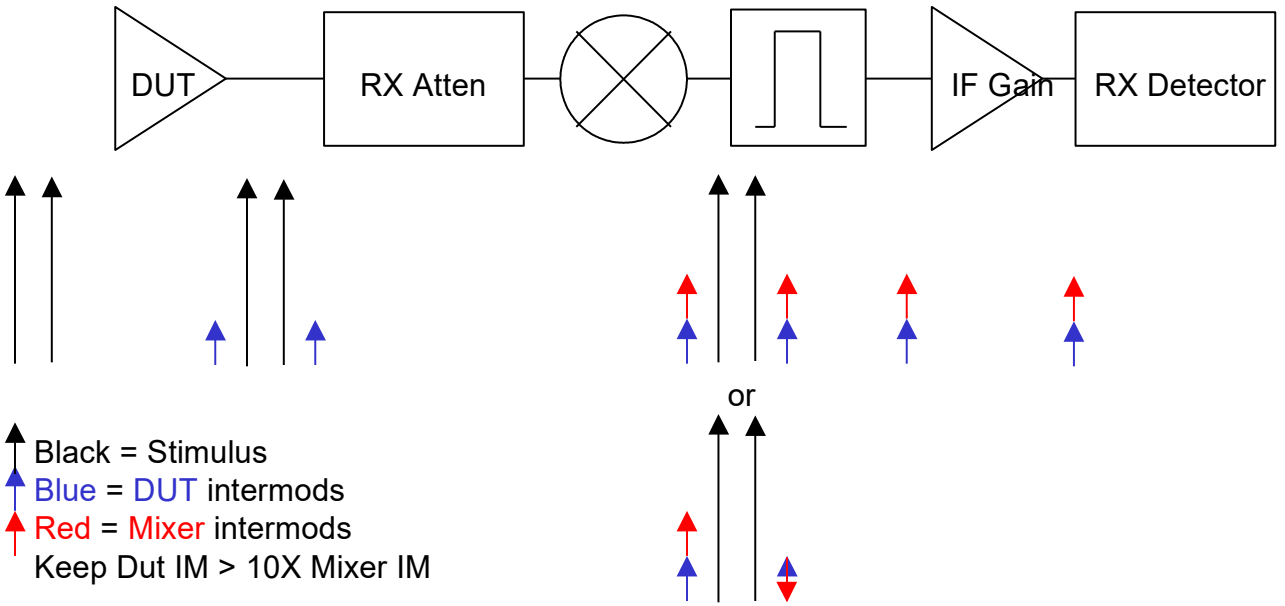
- Set IF Gain to 20 dB or Lower
- Reduce Rx Atten Until Error Message
- Backoff One Rx Atten Setting
- Increase IF Gain Until Error Message
- Backoff One IF Gain Setting

Multi-Tone Measurements

- IM3/5/7 and ACPR
- Measure Device not Tester's Mixer
- Operate in the Mixer's Linear Range
- The Mixer Can Add to or Subtract from the Measurement

Mixer Intermods

- Receive Attenuator Controls Mixer IM Performance and System Noise Floor



Multi-Tone Method

- Measuring Main Tone(s)
  - Not Sensitive to Mixer IMs
  - Use Method for Single Tone
- Measuring IM & ACPR Tones
  - Sensitive to Mixer's IM performance
  - IF Gain usually at or near Maximum (Minimize noise floor)
  - Verify with Spectrum Analyzer (SA)
  - Be careful of SA's intermods!

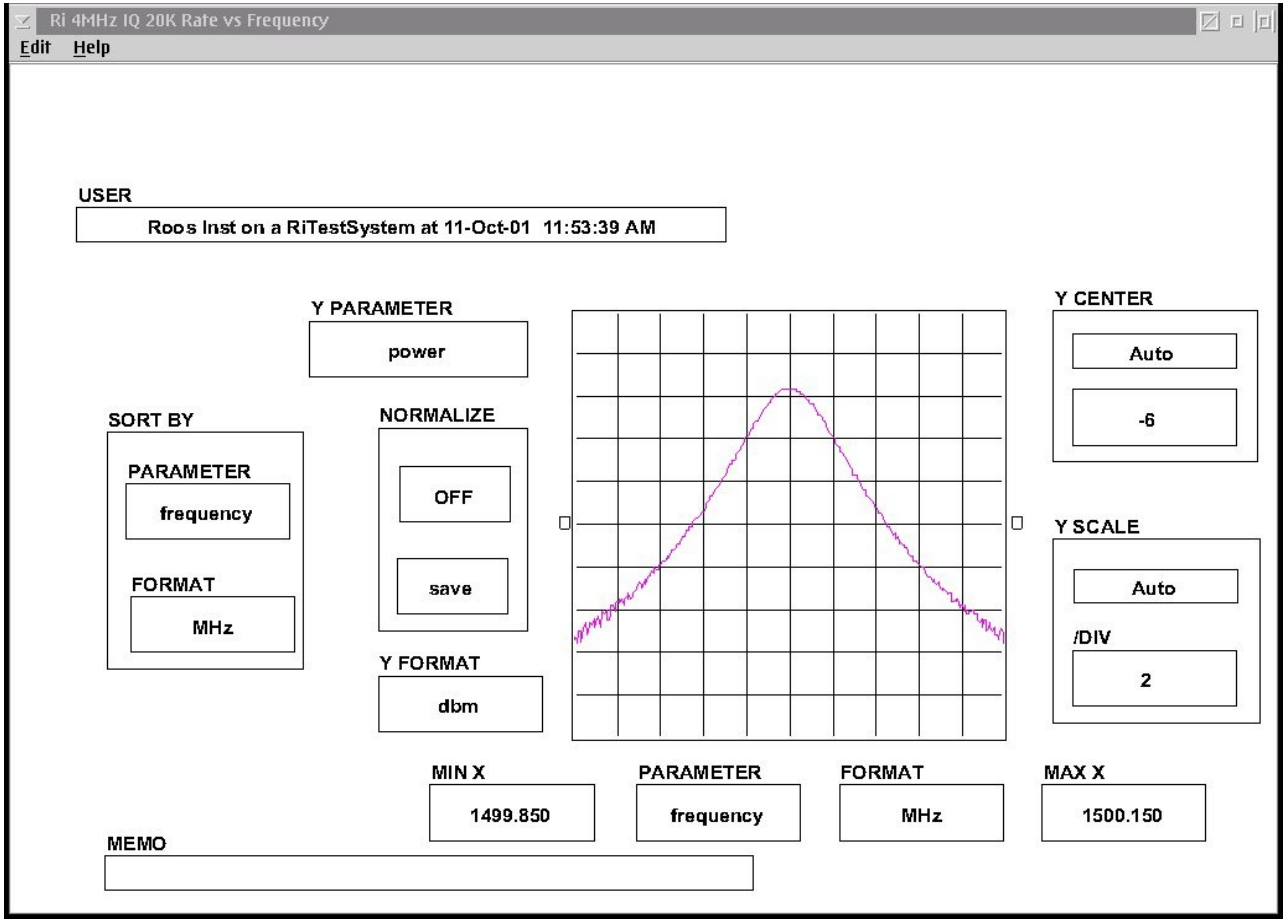
Measure IM Tone

- Set IF Gain 50/55; Receive Atten 20 dB
- Measure C/I
- Verify with Spectrum Analyzer
  - Go to break point
  - Set Receive input to Aux out
  - Measure C/I
- If Different, Increase RF Attenuator
- Repeat

IM Considerations

- Verify High and Low IM Tones
- Use Highest Linear Power DUT Condition
- Typically 20 dB Rx Atten, 55 dB IF Gain
- Too Much Rx Atten Raises Noise Floor

Effective Receiver Bandwidth



Organizing Your Test Plan

- Define 1st RF state in Global Defaults
- Add Fixture ON to Global Defaults
- Define general test conditions in Section Default Panels
- Define DC tests in 1st or last Section which require the RF Sources to be off
- Define DC tests in 1st or last Section which require the DUT to be turned off

Organizing Your Test Plan

- Define special startup sequences in the Connect Sequence panel or in the 1st Test Section
- Write the tests in the order listed on your test list

Speeding-up Your Test Plan

- VCC Changes & DC Measurements: < 2 msec.
- RF Measurements: <30 msec.
- RF Frequency Moves: <20 msec. (Fast Settle) or
  <1.5 msec (Freq Offset)
- RF Mechanical Switches: >30 msec. & Expensive
- Minimize RF Source and Receiver Frequency Moves
- Minimize/Eliminate RF Mechanical Switch Changes:
  Changing RF Ports from Src to Rec or Rec to Src
  Changing RF Src 1 and RF Src 2 RF Attenuators
- Using the Wide IF Filter is faster than Narrow IF
  Typically use 16 or less Averages for RF Measure
  Typically use 32 or less Averages for DC Measure

Speeding-up Your Test Plan 2

- Fast RF Meas: S parameters, RF Power and Phase
- Slow RF Meas: ACPR, Noise Figure, IP3, Harmonics
- Setting a Parameter to a Local Variable Value is very costly : Requires a Mini-Compile
- The Optimizer only Optimizes within a Test Section
- Time Domain vs Freq Domain:
  If the RF Receiver can make the Measurement, it is faster with better Frequency & Dynamic Range
- Oscope is designed to measure Pulse Characteristics
  Rise/Fall Time, Period, Duty Cycle, etc.
- Receiver is designed to measure Complex Signals:
  Amplitude, Phase, Noise, Power, Frequency, etc.

Speeding-up Your Test Plan 3

- Items to Set in Global Defaults
  - Receiver Freq Tracking to Source 1 or System
  - Test Head Parameter to b2
  - RF Ports to Receive or Source
  - Receiver IF Gain
  - Source 1 Freq & Level to first RF Stimulus Signal
  - Source 2 Freq & Level to the first IM Stimulus Signal
  - Source 3 Freq & Level to the first LO Stimulus Signal
- Turning On and Off a RF Source is fast
  Switching Source 1 Mode to Noise is faster!
- Use Source 1 Mode button to Isolate Src 1 & 2 from DUT

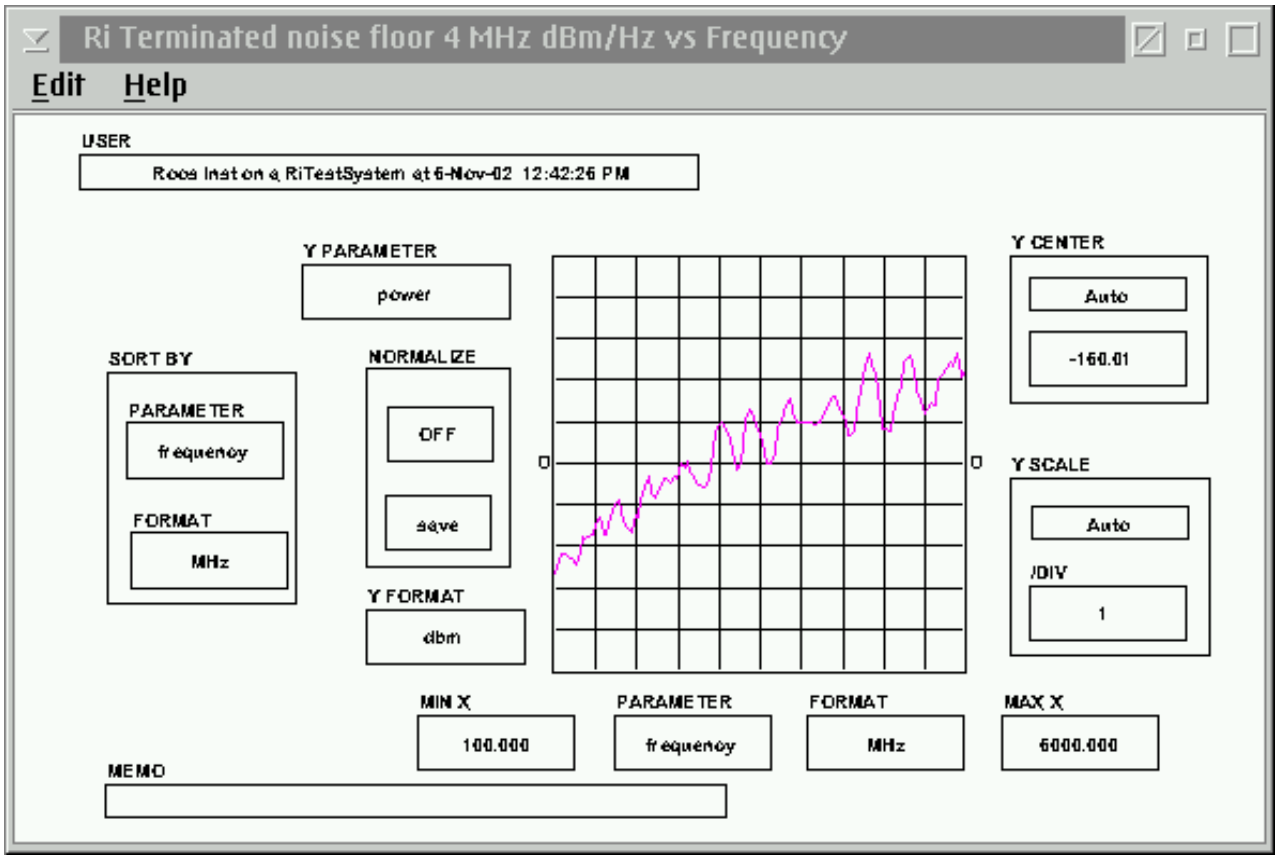
Speeding-up Your Test Plan 4

- Check Compiled Delta Settings to Improve Test Speed
- Look for changes in Receiver & Source Frequency, Attenuator & Test Head Settings, etc.
- Minimize Test State changes by making test conditions exactly the same for as many meas as possible: i.e. RF Stimulus Levels, Frequencies, Receiver Settings, DC Levels, Current Limits, Ranges, etc.
- Use b1 to test LO Leakage at the DUT's RF Input
- Use Source 1 "back door" for S22 Measurements
- For IM measurements, leave RF Source 1 at the normal stimulus Freq, this saves 2 RF Freq Moves
- Remember DC only measurements still set the Receiver and RF Src's to their Default Frequencies

Typical RI 7100A RF ATE Measurement Time

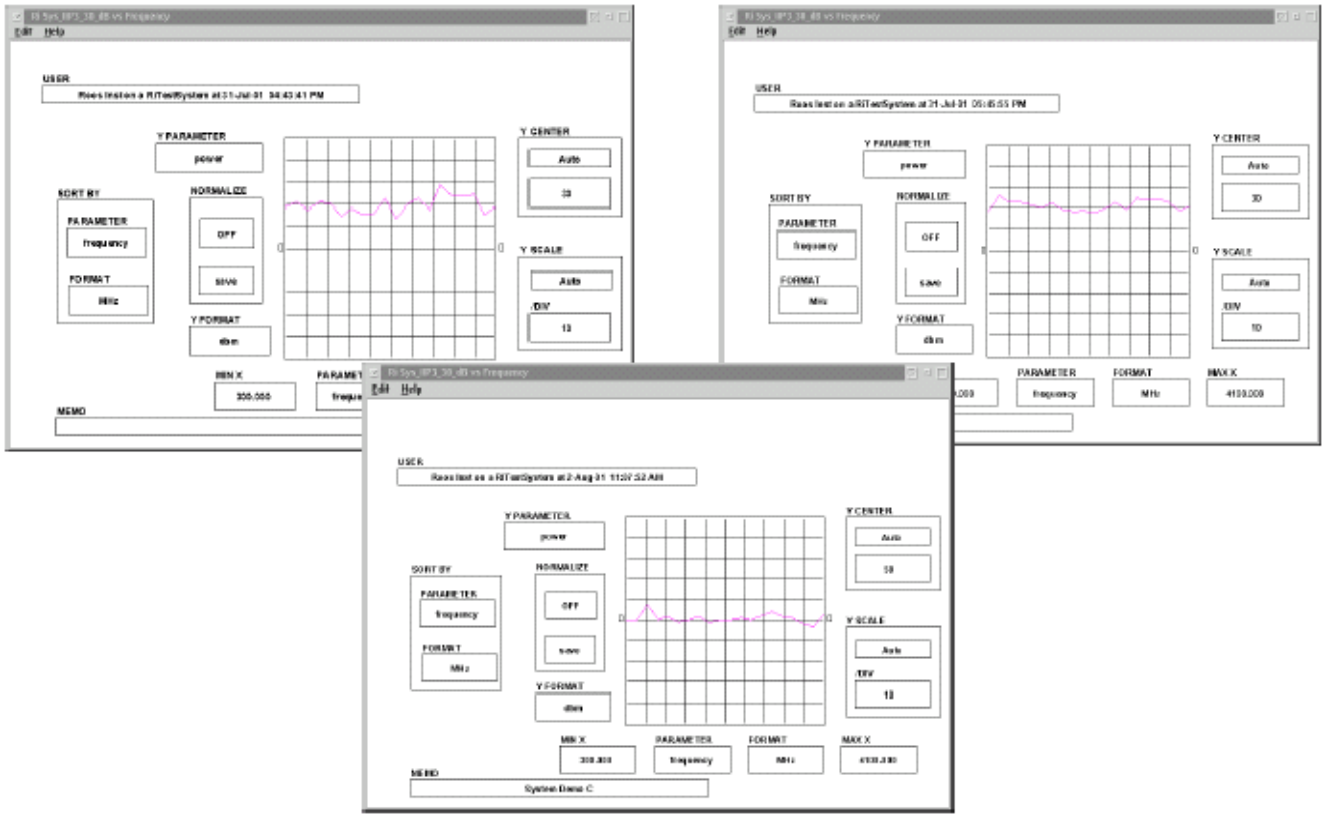
Measurement	Time (msec.)	Std. Dev
Power	2.5	<0.02 dB
Frequency	11.5	<0.5 Hz
S11, S12, S21 & S22	12	0.02 dB (S21)
Noise Figure	26	0.1 dB
Phase Noise	60	0.3 dB
IIP3	78	0.3 dB
P1dB	17.5	0.1 dB
ACLR or ACPR	93	0.4 dB
Harmonic Power	56	0.05 dB
I/Q Mod Phase & Amp	25	0.1 dB, 0.1 deg.
I/Q Demod Phase & Amp	60	0.02 dB, 0.15 deg.
DC Voltage	2	0.025%
DC Current	2	0.03%

Typical RI 7100A Noise Floor <-155 dBm/Hz to 6 GHz



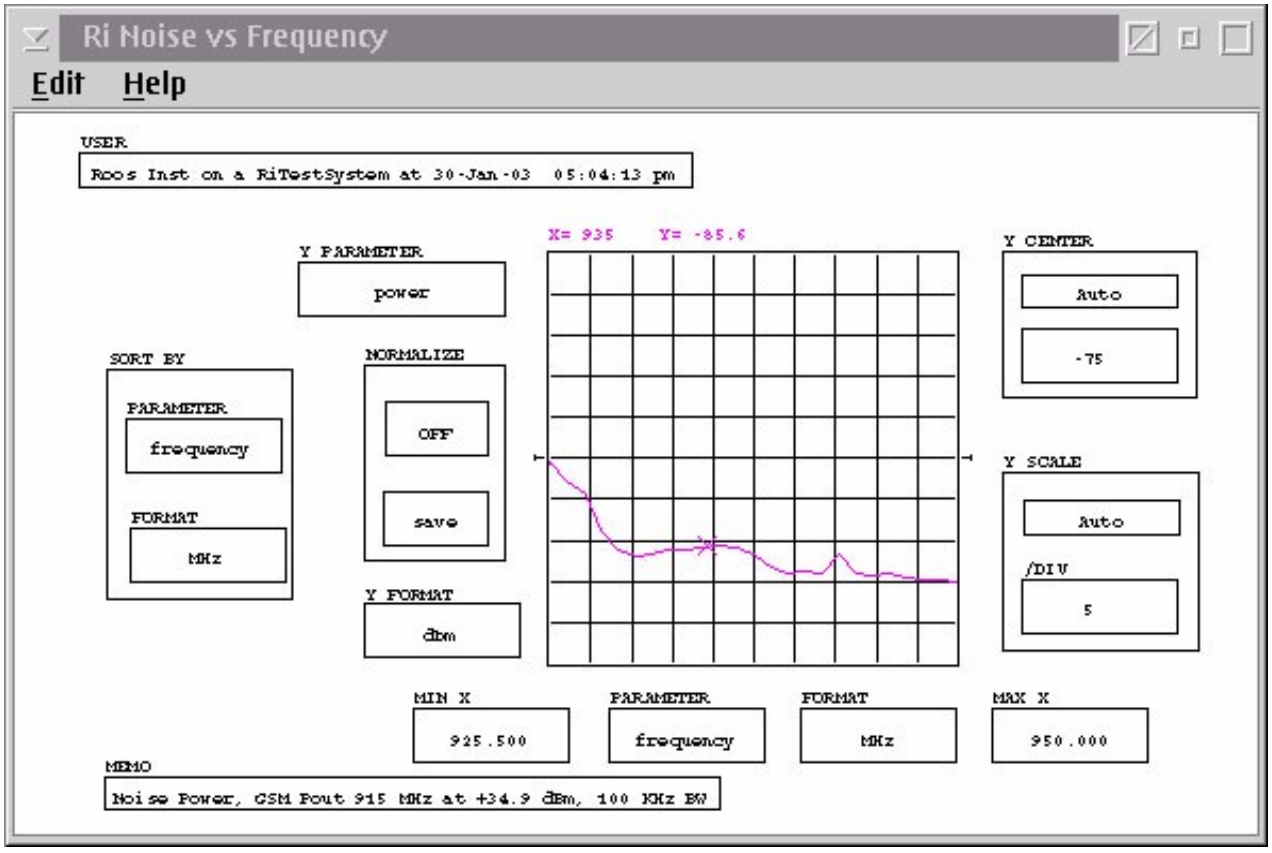
Typical Test System IIP3

+49 dBm
3 Testers (30 dB Rec Attenuation)



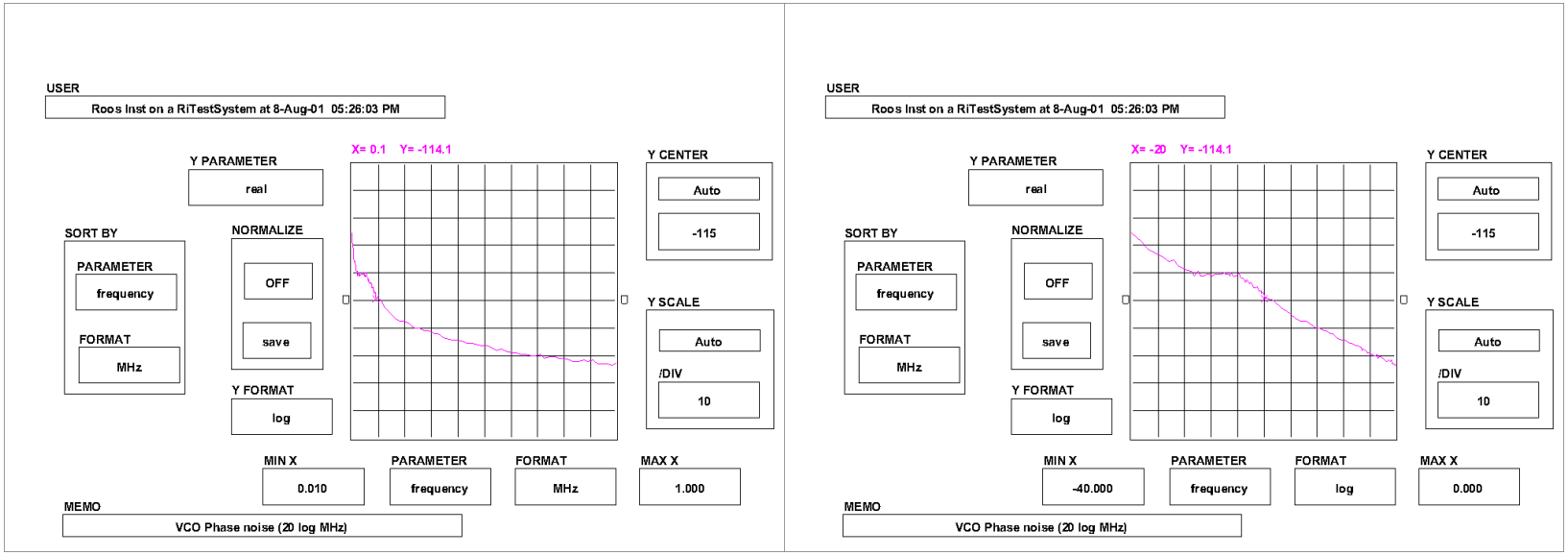
1 dB Noise Figure – Two Testers

Noise Floor Measurements
Pout +34.9 dBm, Noise Floor <-85 dBm



VCO Phase Noise Measurements

-114 dBc/Hz at 100 kHz Offset
-137 dBc/Hz at 1 MHz Offset



Production Measurement Performance Limits

DUT	Measurement	Performance
LNA	Noise Figure	<1.0 dB
	IIP3	>+25 dBm
PA	CDMA ACPR1	<-60 dBc
	CDMA ACPR2	<-70 dBc
Mixer	Noise Floor	<-150 dBm/Hz
PLL/VCO	Phase Noise	<-114 dBc/Hz @ 100 kHz
		<-137 dBc/Hz @ 1 MHz

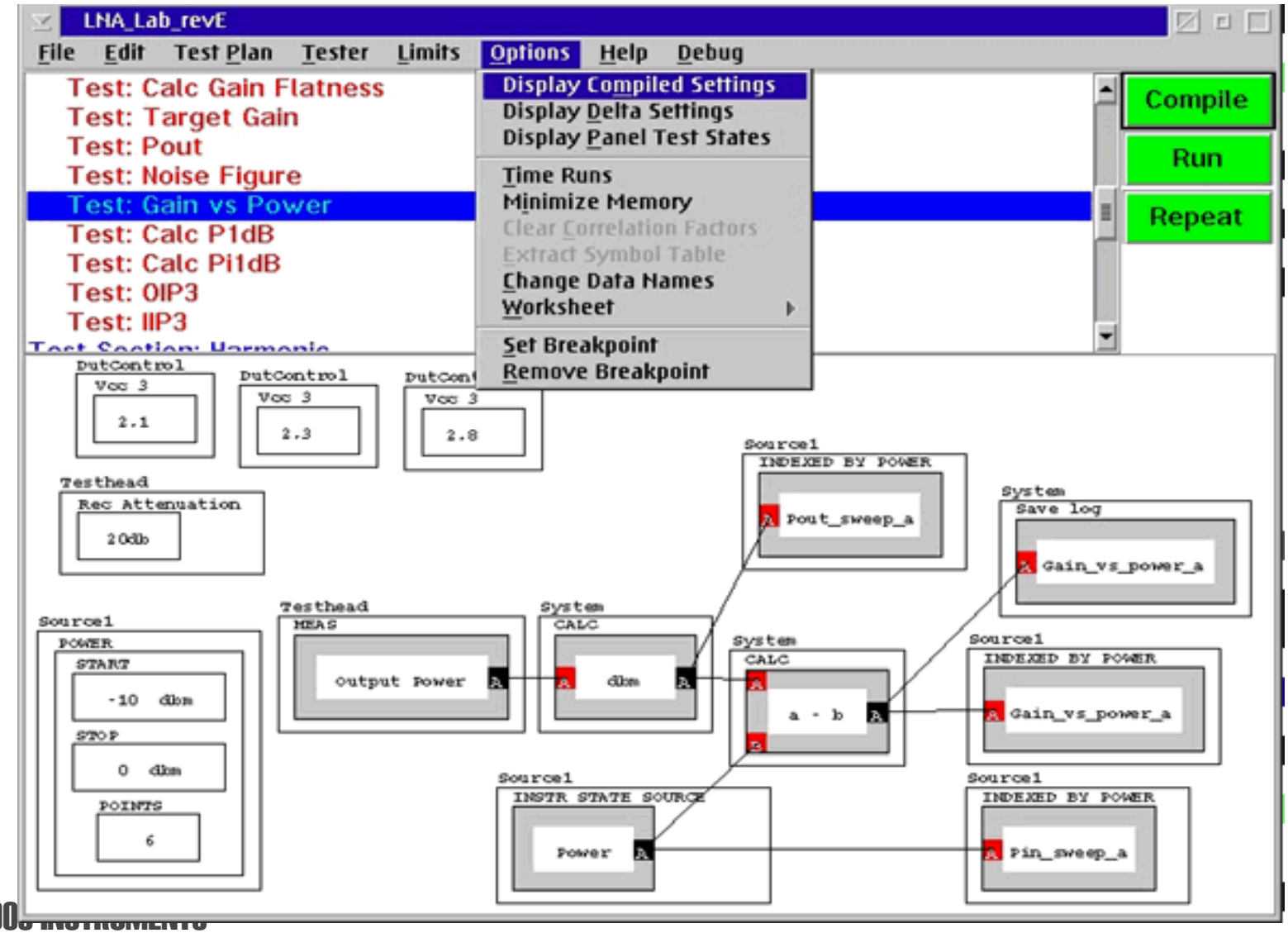
Production Measurement Performance Limits cont.

DUT	Measurement	Performance
Dividers	Frequency	<1 Hz Resolution to 20 GHz
I/Q Mod	Phase Match	<0.1 degree
	Amplitude Match	<0.025%
	LO Rejection	<-60 dBS
	Image Rejection	<-70 dBS
I/Q Demod	Phase Match	<0.1 degree
	Amplitude Match	<0.1 dB

Debugging and Breakpointing

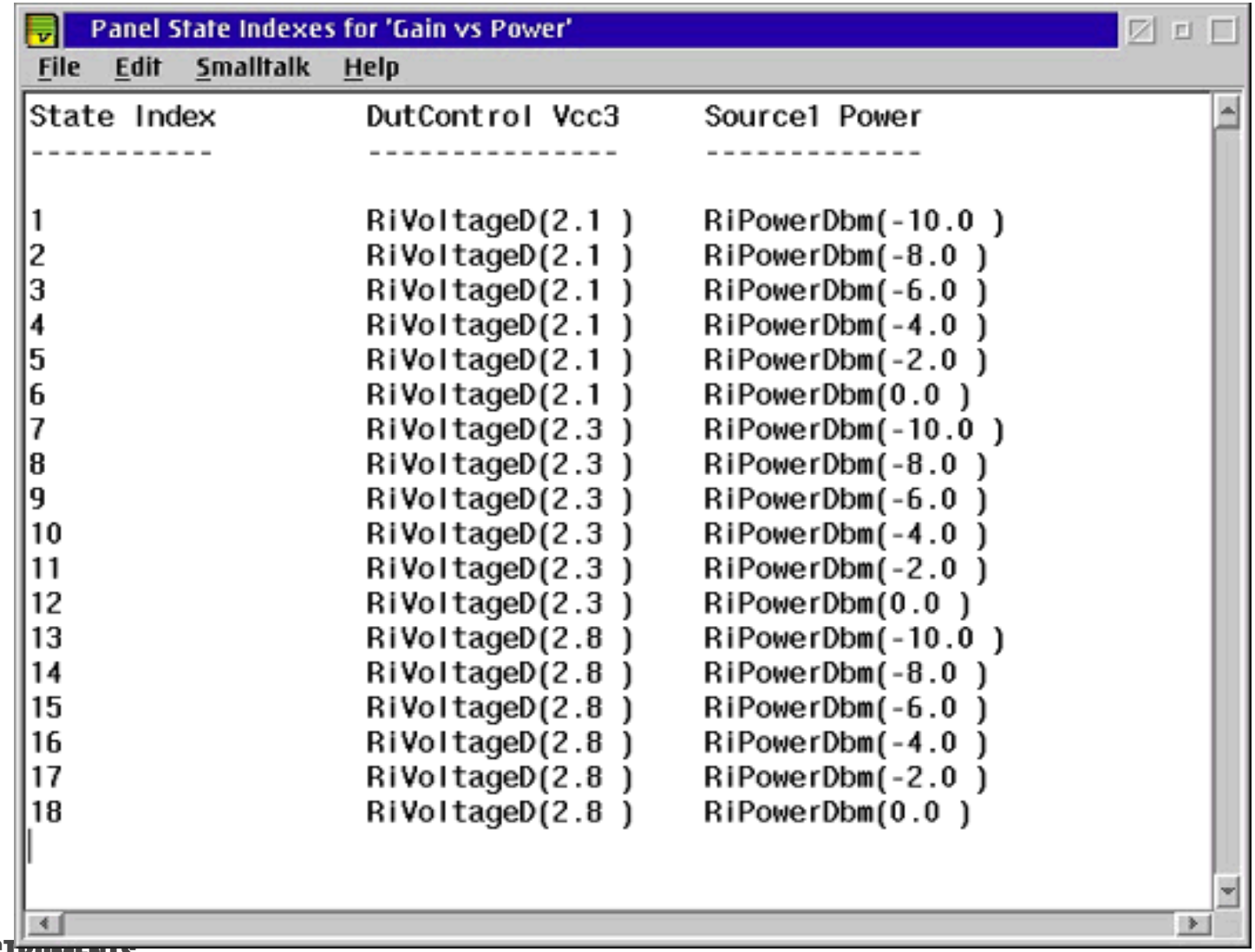
- Measurement Order and Test Flow
- Setting a Breakpoint

Measurement Order and Test Flow

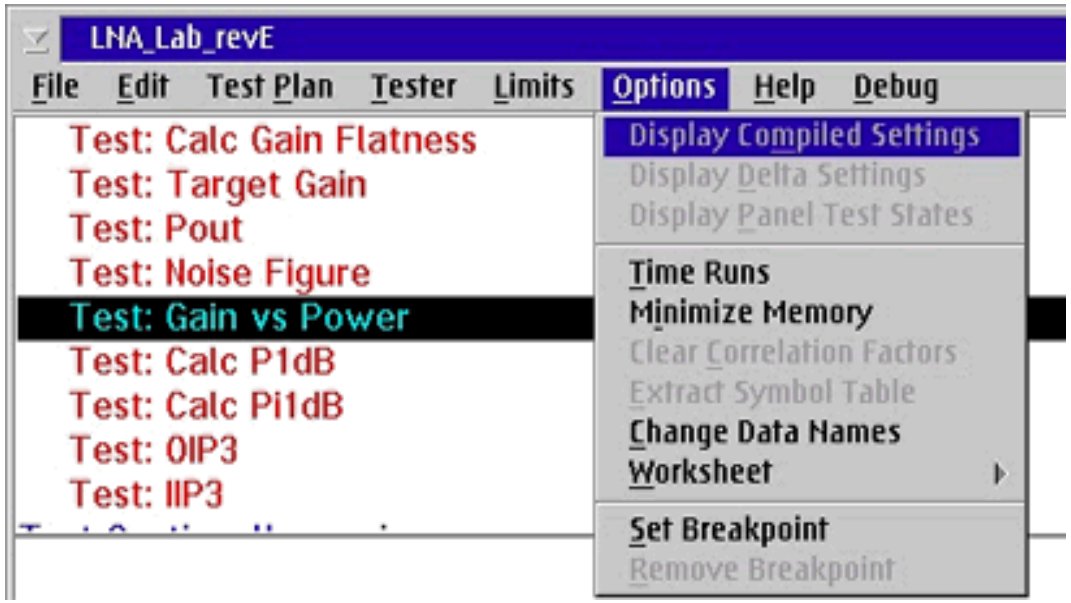


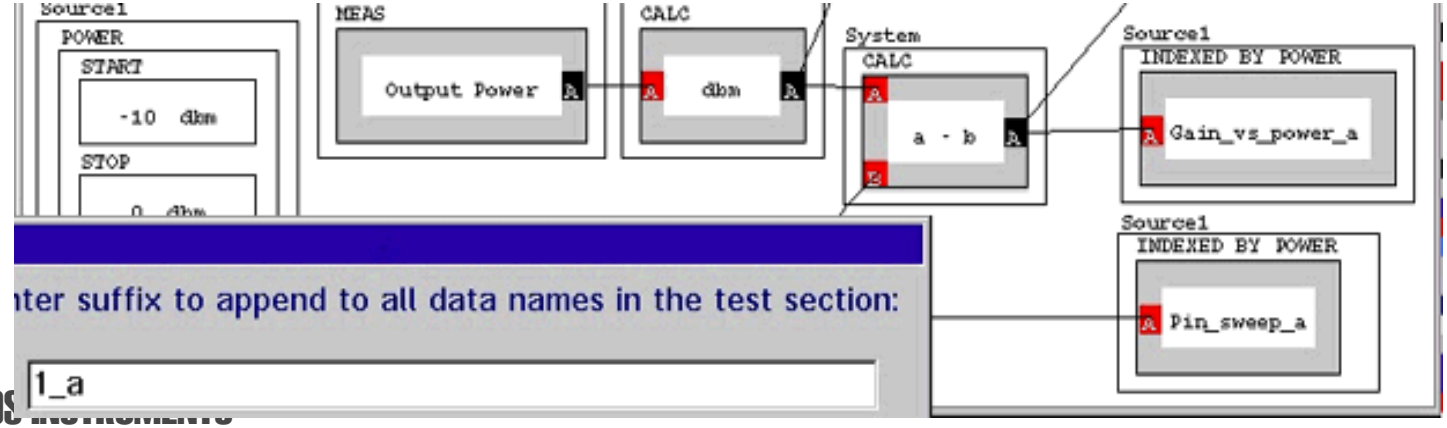
Test Section Optimization

Multiple States in a Panel

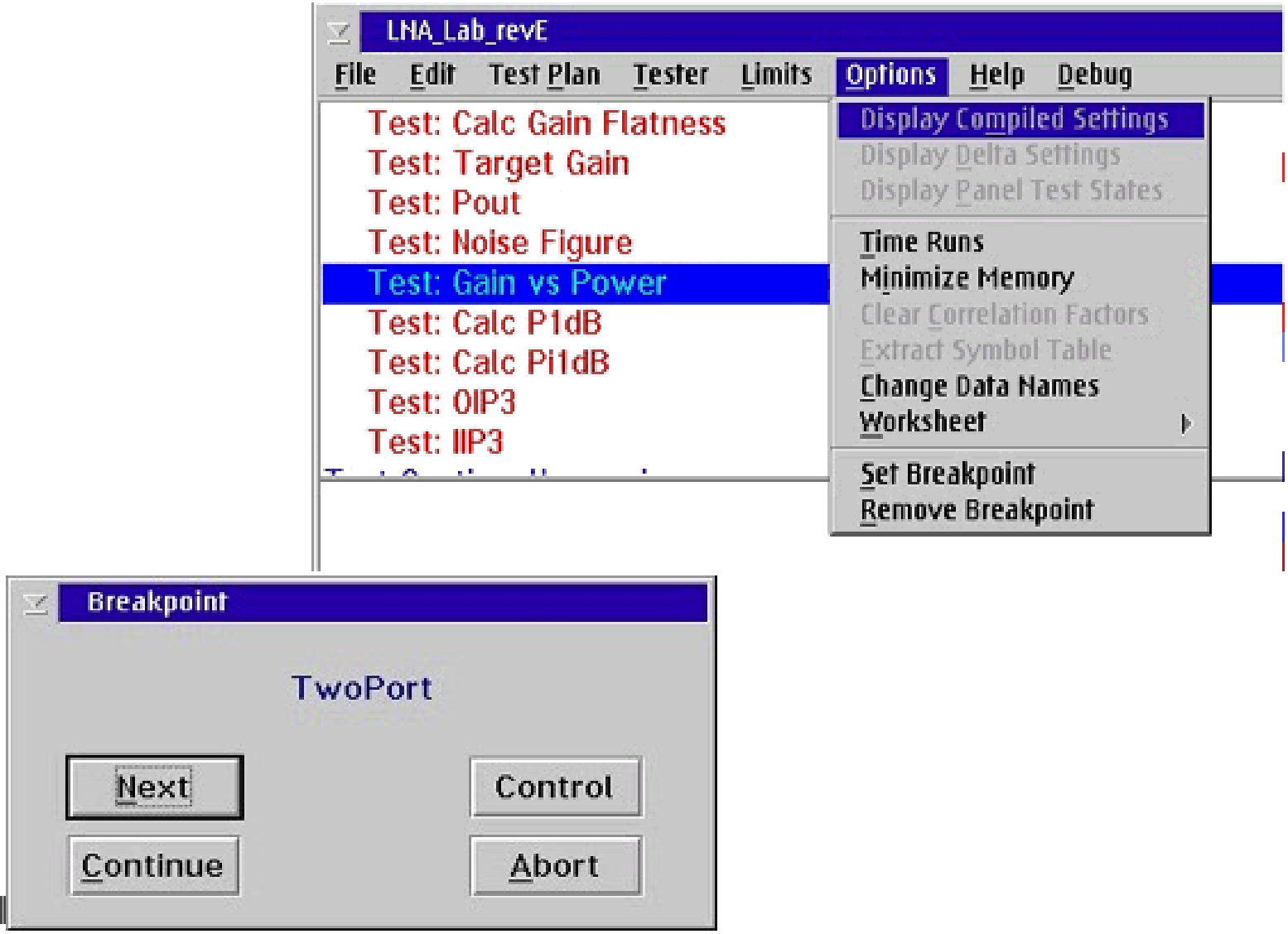


Copy a Test or Test Section

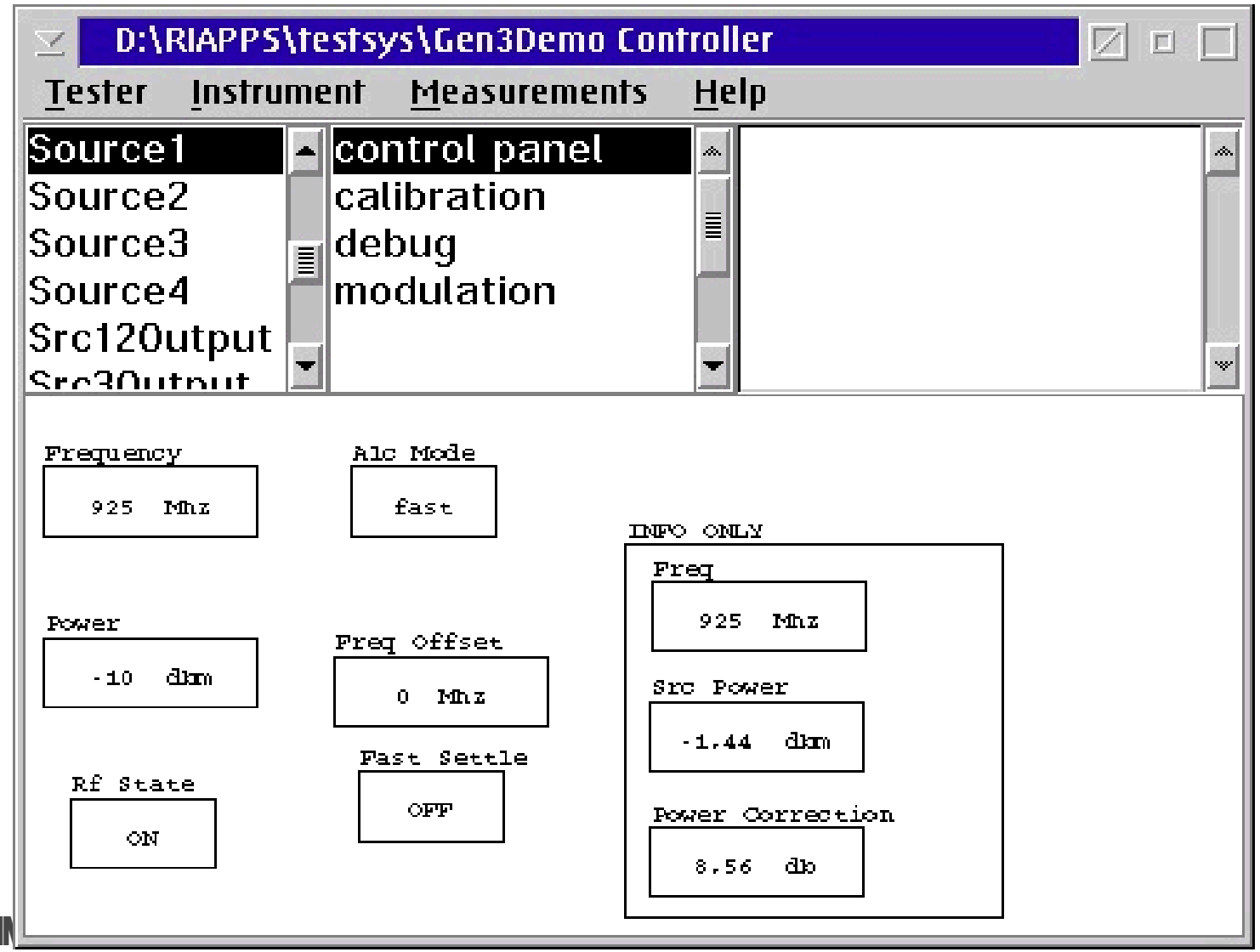




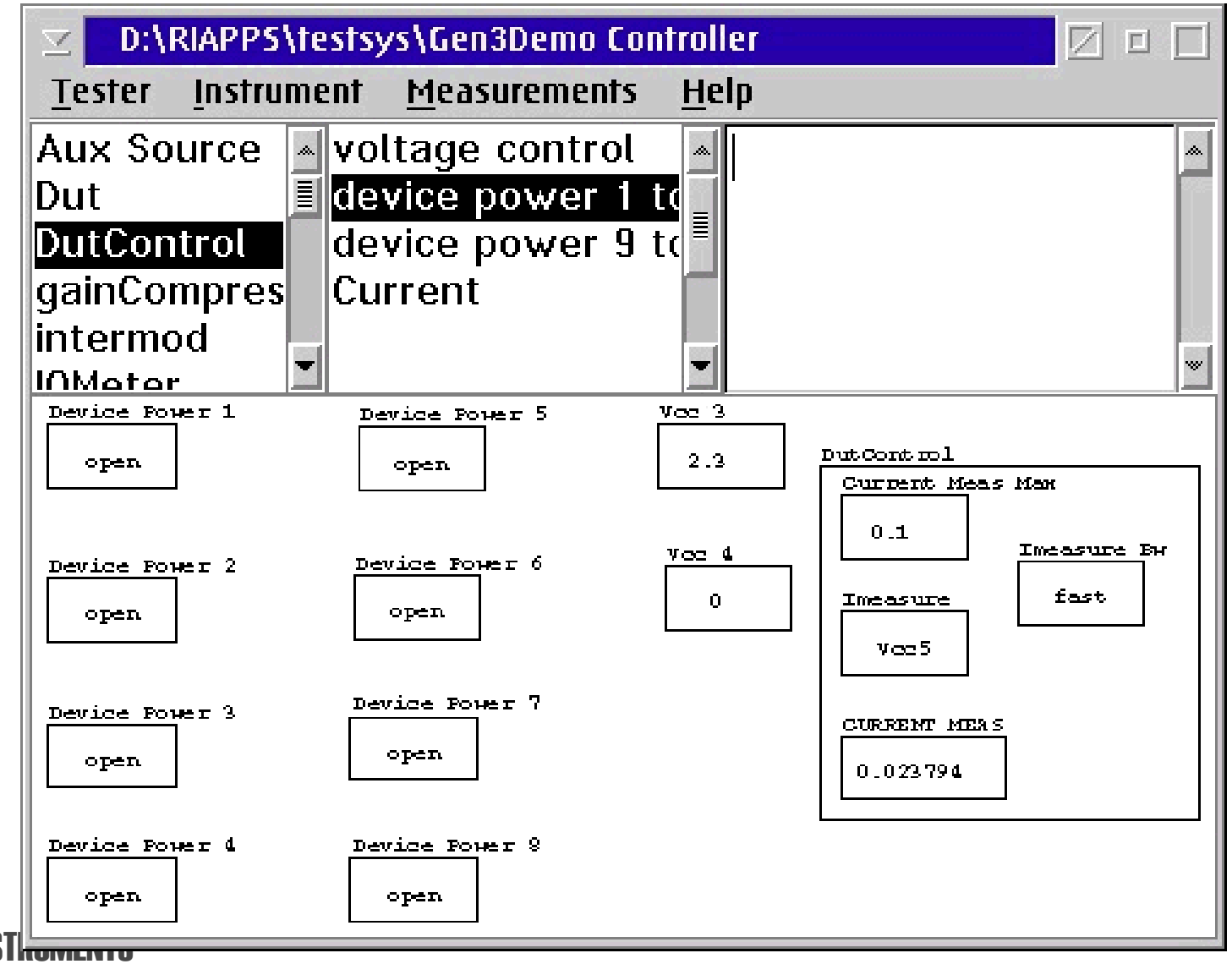
Setting a Breakpoint



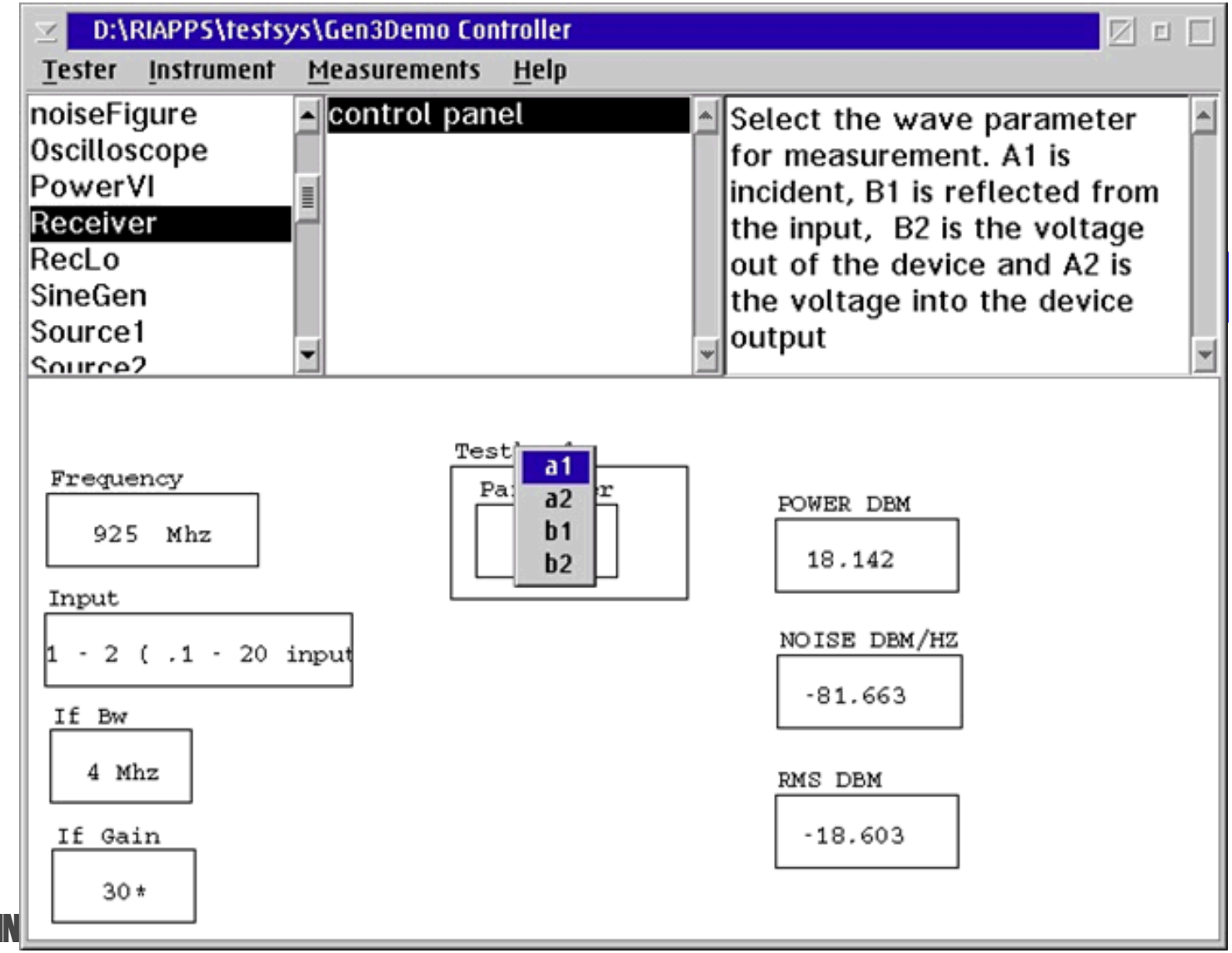
RI Interactive Control Window



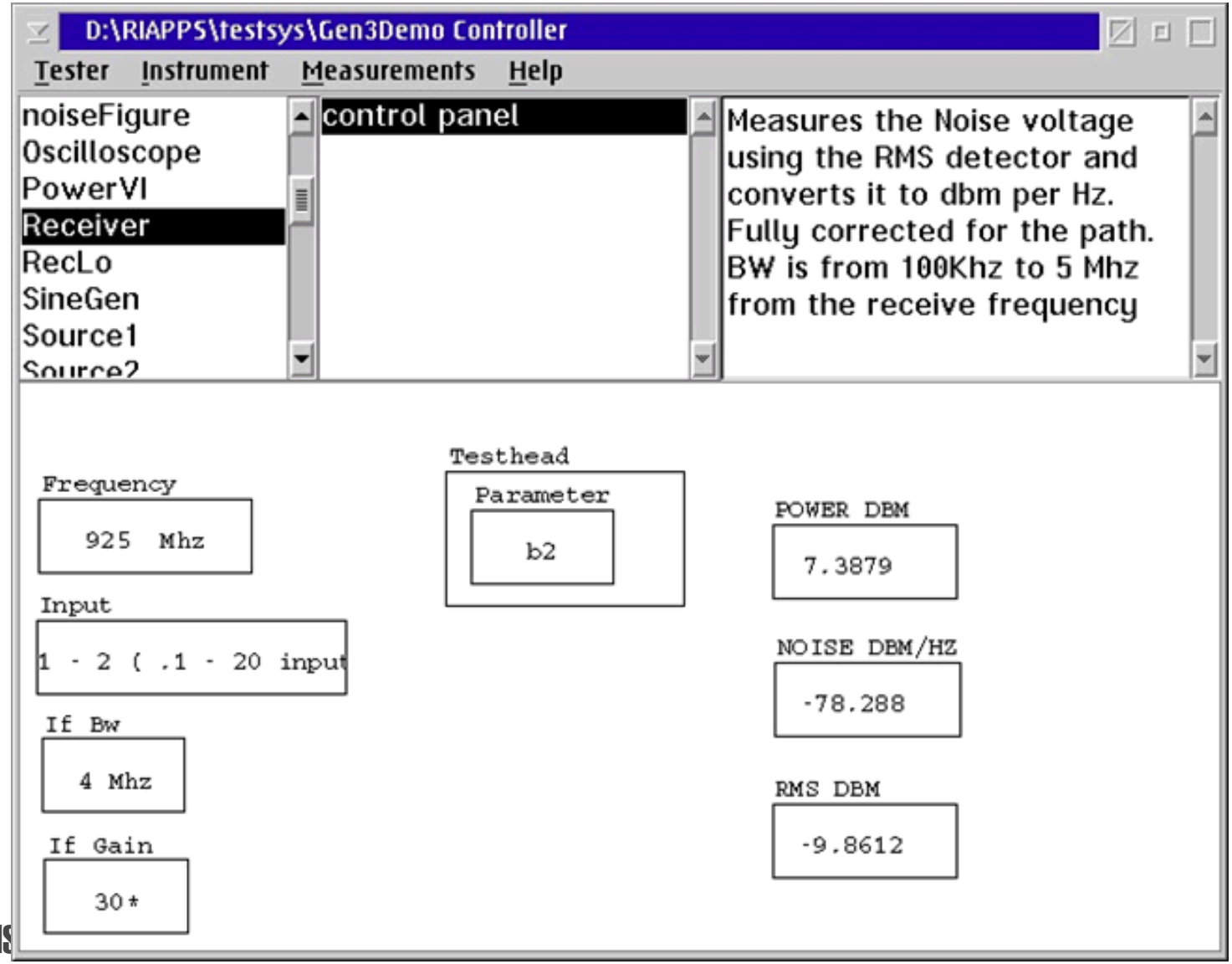
Interactive DC Measurements



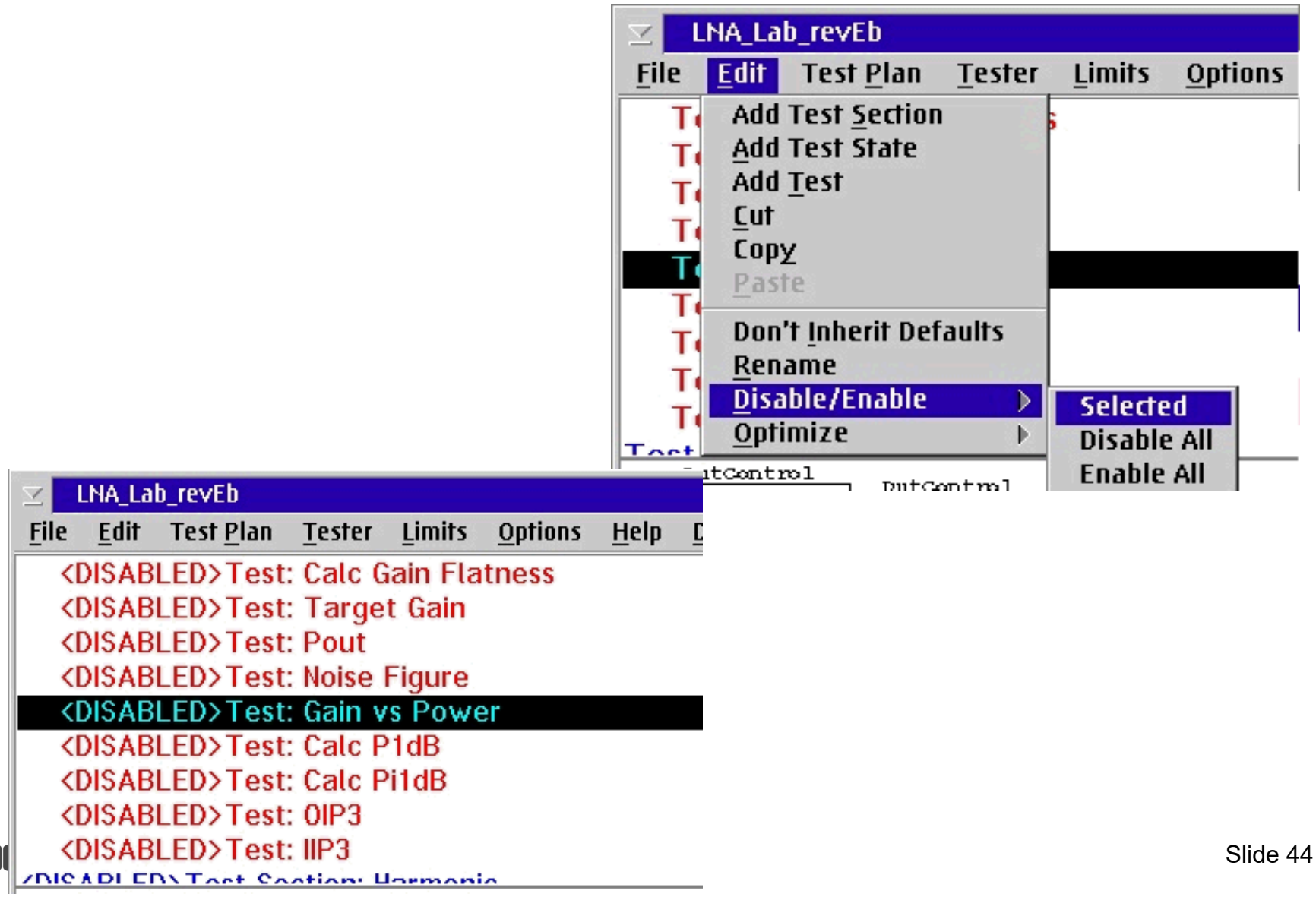
Interactive RF Measurements



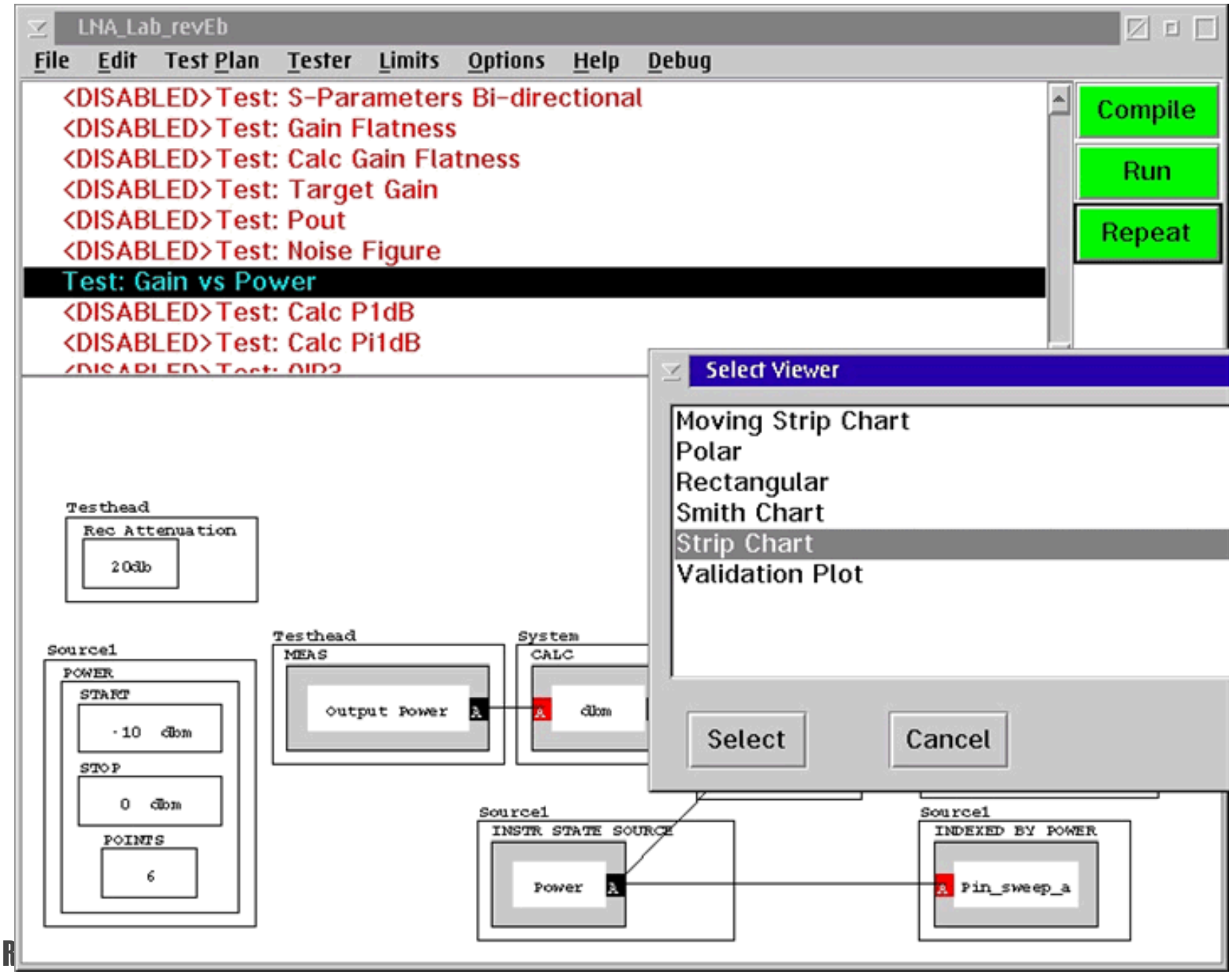
Receiver Measurement Types



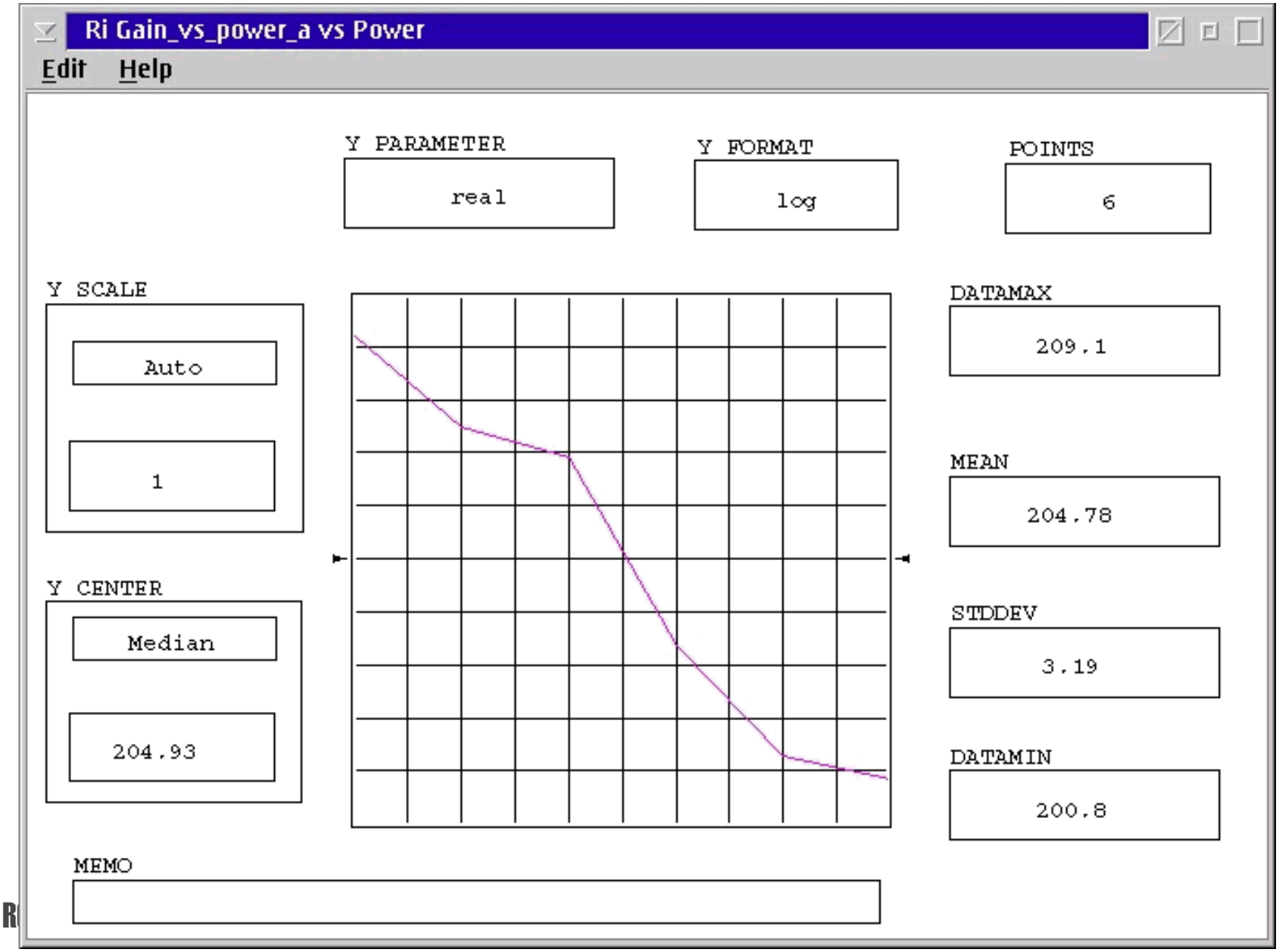
Test Disable Usage



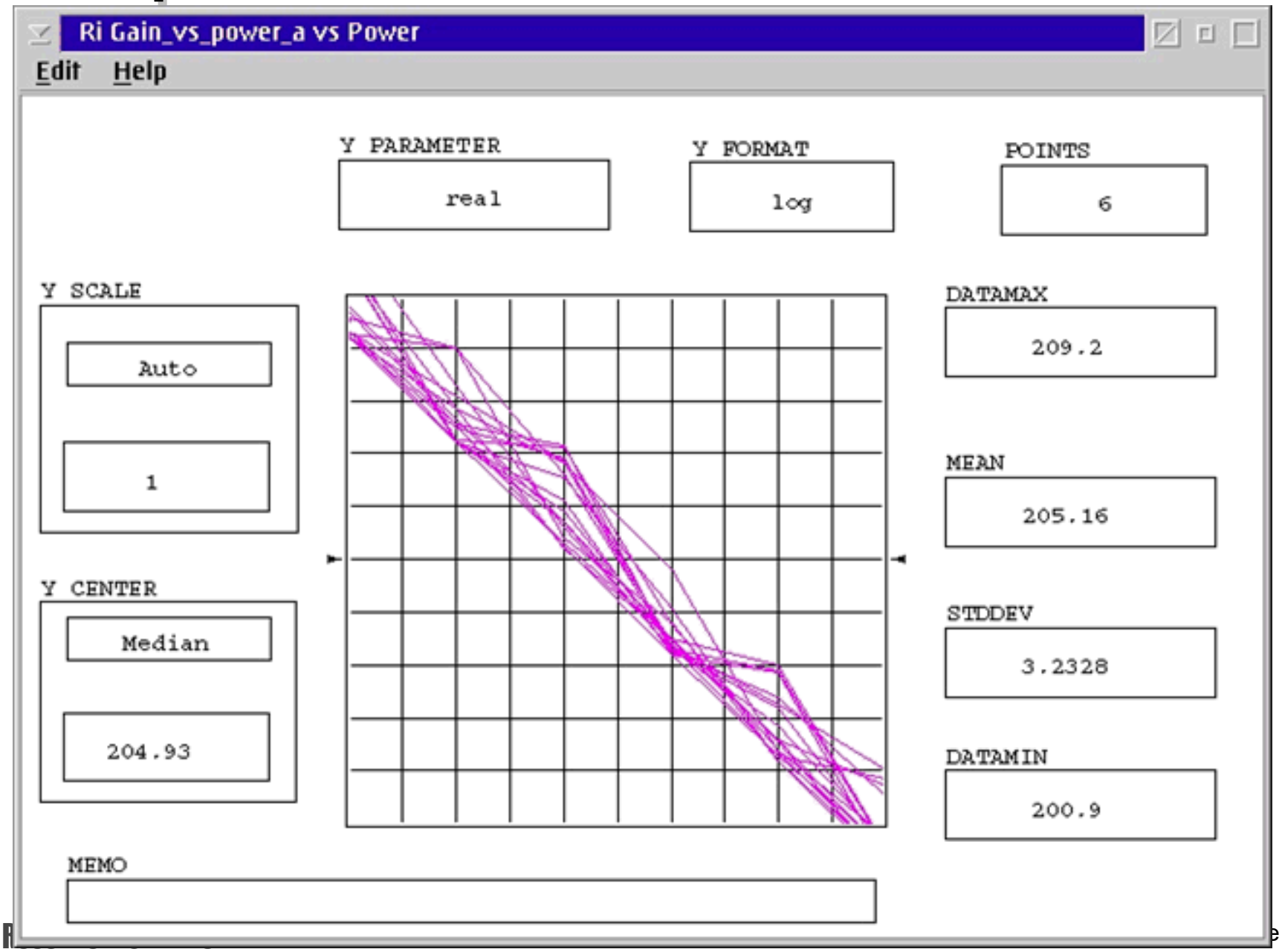
Data Viewers



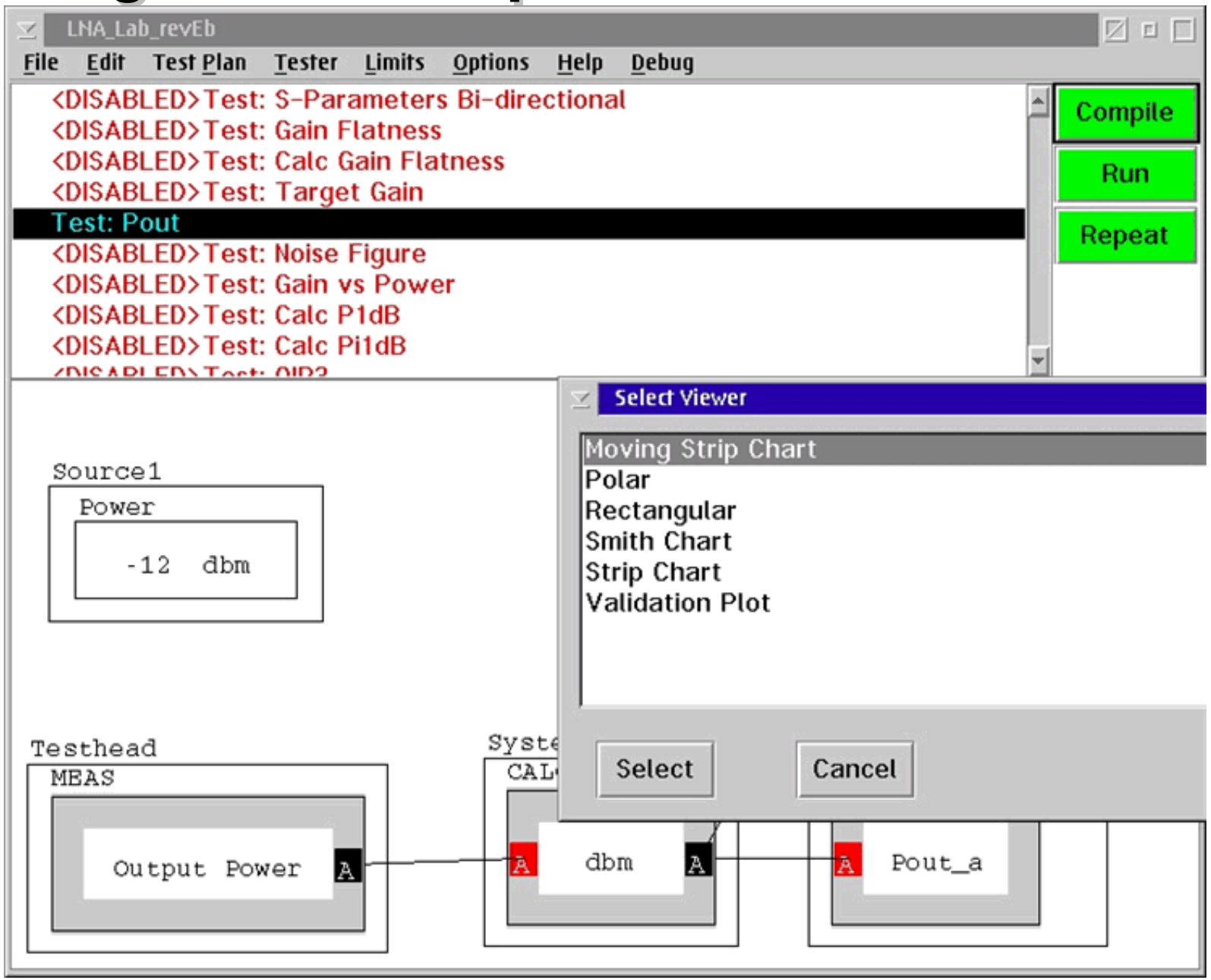
Single Variable Data Viewers



Overpaint Function



Single Event Repetitive Measurements



Moving Strip Chart Display

Debugging Tips

- Check active Calibration data for anomalies
- Check each measurement for optimal RF Attenuator and IF Gain settings (max S/N).
- Measurement must "Fit" in the Receiver's 70 dB instantaneous Dynamic Range
- Small changes (1 to 5 dB) in Device Power Level can be large if using all the dynamic range. (i.e. measure a 50 to 60 dB carrier to tone.)
- Setting resolution in the RF Attenuator is 10 dB steps and the IF Gain is 6 dB