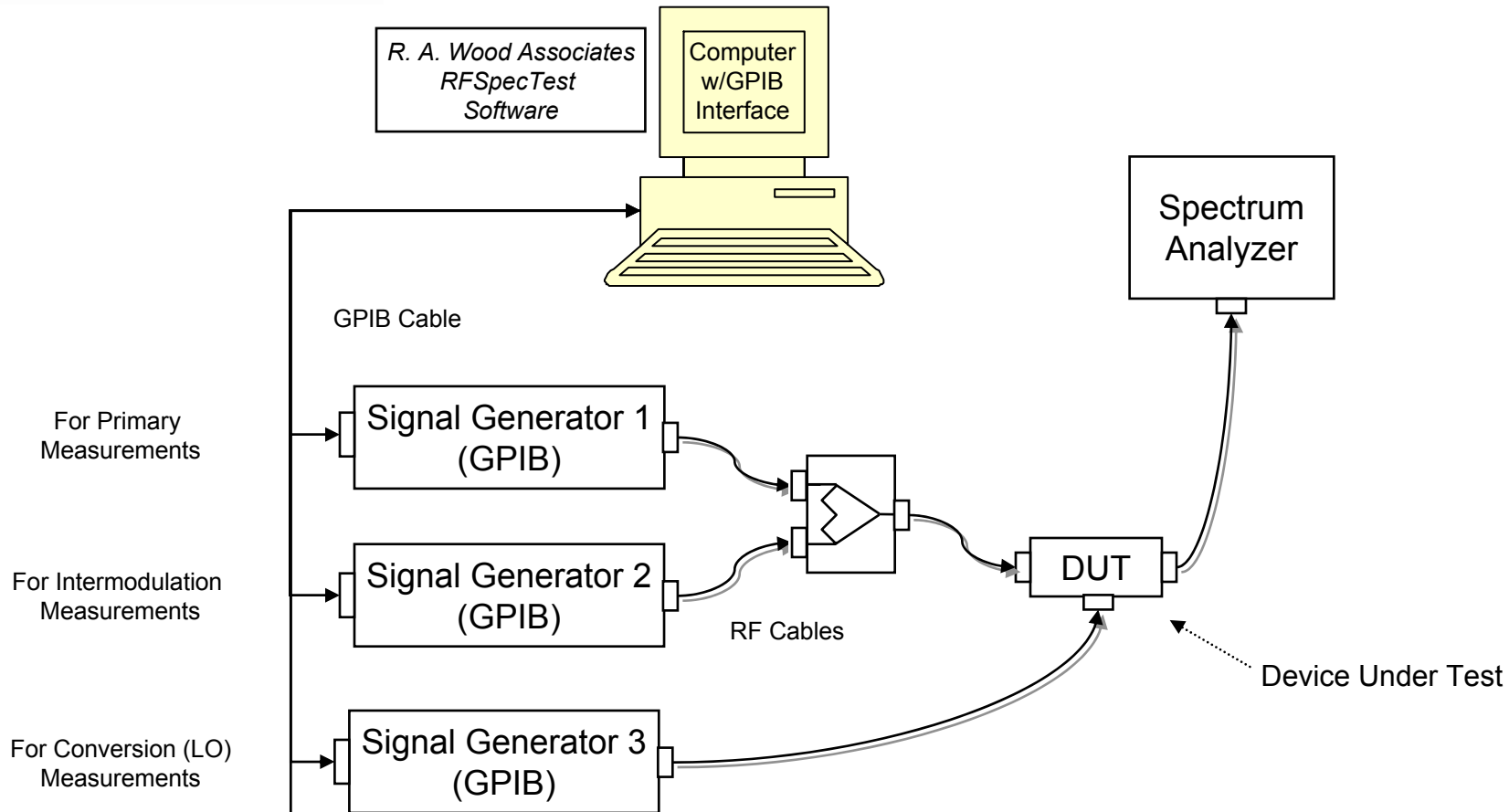


RFSpecTest – RF Spectral Test Executive

RFSpecTest is a software program for performing computer automated tests for RF components, using signal generators and a spectrum analyzer

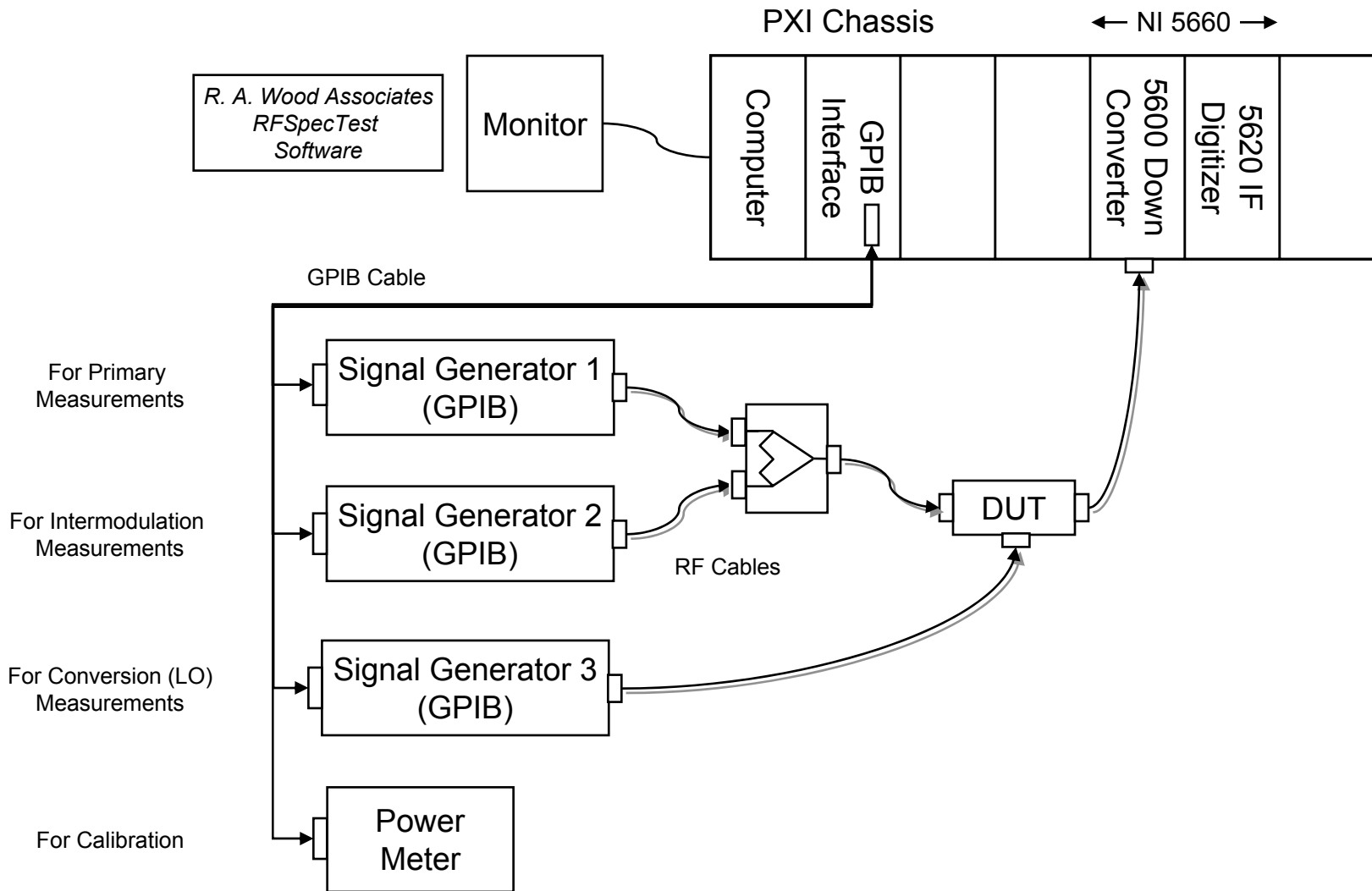
- **R. A. Wood Associates has developed a software program to perform computer automated RF testing using the National Instruments NI 5660**
 - RFSpecTest – RF Spectral Test Executive
- **R. A. Wood Associates has been using the NI 5660 extensively to troubleshoot, upgrade and perform final test of RF Modules for Lockheed Martin**
 - The final test data for 1 RF module contains 480 test data sheets (for gain and gain compression tests)
 - One gain test data sheet contains 21 measurements
 - One gain compression test data sheet contains ~300 measurements
 - The RFSpecTest software and the NI 5660 saved tens of thousands of dollars in test time compared to manual measurements
- **Contents:**
 - RFSpecTest program information
 - Example displays and printouts

General RF Test Configuration



- **Equipment Needed:**
- **RFSpecTest** Software
 - Computer with GPIB Interface
 - 1, 2, or 3 Signal Generators
 - RF Power Meter (for Test System Calibration)
 - RF Power Combiner (for Two Tone Tests)
 - Spectrum Analyzer

RF Test Configuration using NI PXI Equipment



▪ **Tests developed:**

- Gain/Insertion Loss vs. frequency
- 1 dB Gain Compression vs. frequency
- Relative Measurement vs. frequency
- Intermodulation distortion (IMD) products vs. frequency
- Test Station Calibration using RF Power Meter

▪ **Future Tests to be added:**

- Phase vs. frequency
- Adjacent channel power (ACP)
- Others as requested

▪ **All tests can be performed for various frequency plans:**

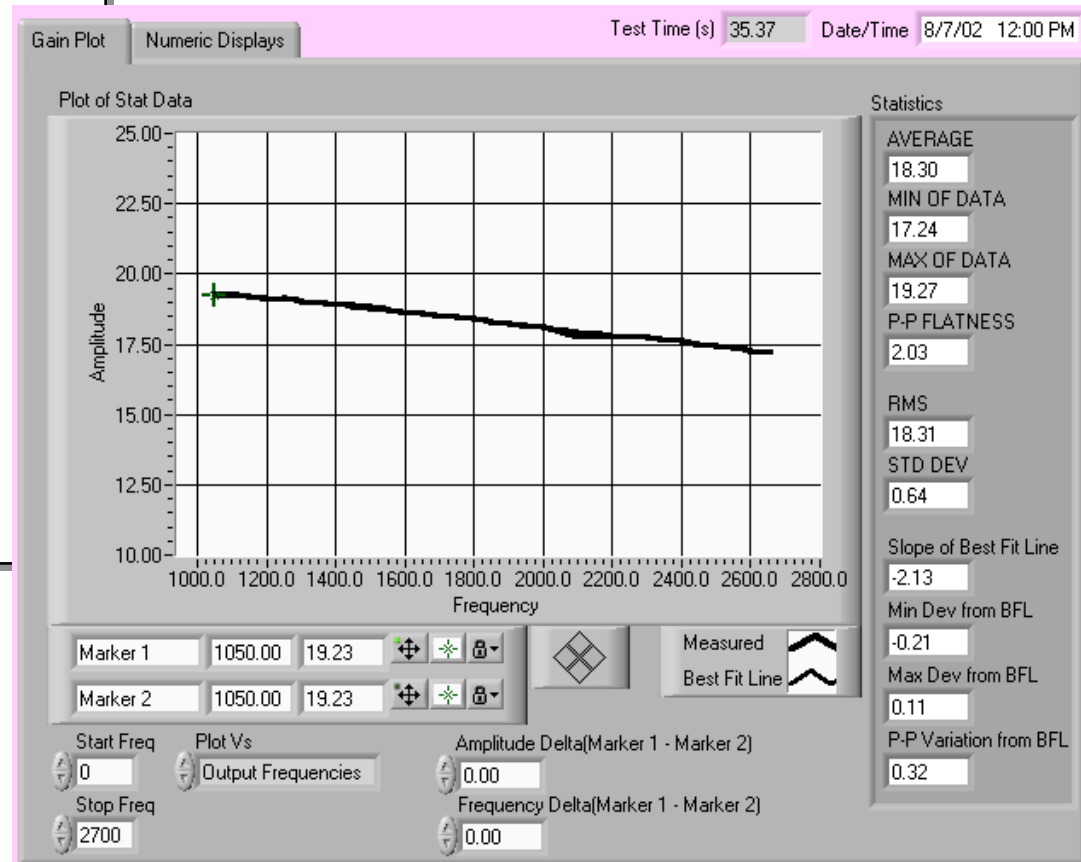
- Same input/output frequency
- Down conversion with local oscillator (LO)
 - High or low side LO
- Up conversion with LO
 - High or low side LO

Devices That Can be Tested Using RFSpecTest

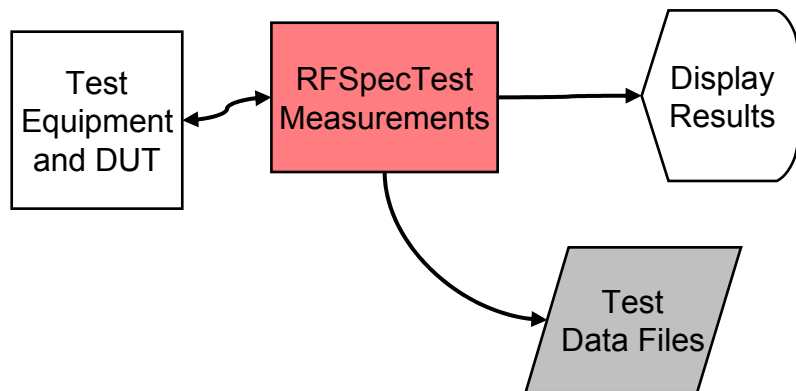
- **Amplifiers**
- **RF Switches**
- **Mixers**
- **Receivers chip sets with down conversion**
- **Filters**
- **Isolators**
- **Fixed attenuators**
- **Variable attenuators**
- **Transmitter chip sets with up conversion**
- **Local oscillators**
- **Couplers**
- **Power Dividers**
- **Higher level RF modules and sub-systems**
- **Other RF and microwave components ...**

Statistical parameters are available for each test parameter across a user-defined frequency range

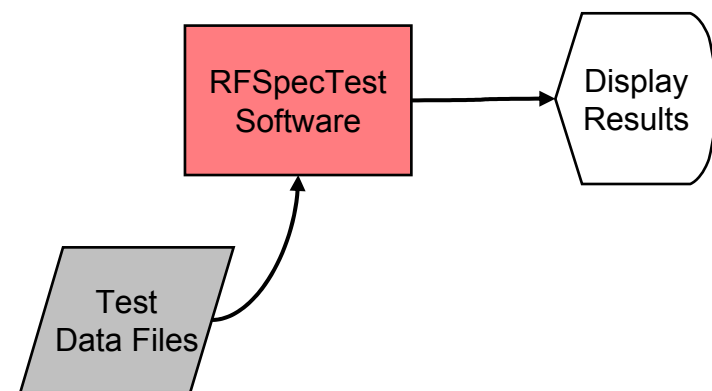
- Average
- Minimum vs. frequency
- Maximum vs. frequency
- Peak to peak (P-P) Flatness vs. frequency
- Standard deviation
- Root mean square (RMS)
- Best fit line slope vs. frequency
- Minimum deviation from best fit line
- Maximum deviation from best fit line
- P-P variation from best fit line



- RFSpecTest provides capability to store measurements to data files, and retrieve measurements from data files
- All measured data can be stored as tab-separated text data files
- Data files can be loaded and analyzed into the program for future use
- Data files can be imported into spreadsheet programs (Excel, etc)

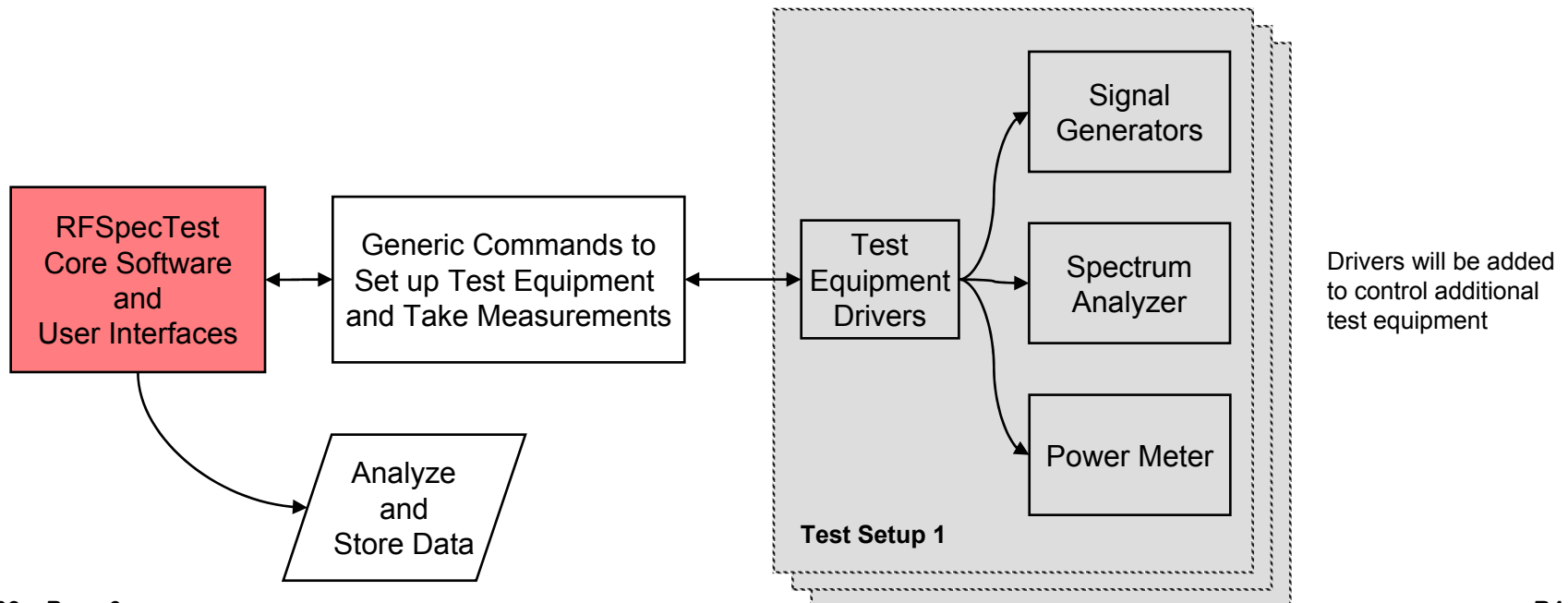


Measurement Process



Retrieval Process

- RFSpecTest is very close to being the first non-customized (off the shelf) RF Automated test program
- The RFSpecTest Software can easily be configured for additional signal generators and spectrum analyzers
 - New test equipment drivers would be added for additional equipment
- The core software does not change as new test equipment is added
- New test equipment would be a custom modification, but the program will be expanded to include additional drivers



- **The base cost for RFSpecTest is \$1995.00**
- **The current software is designed to be used with the NI 5660 PXI-based spectrum/signal analyzer and Agilent 8648C signal generators**
- **Some additional fees may be required to add drivers for your test setup**
 - Call us for quotes for other test equipment
 - We have experience with drivers for other test equipment:
 - Signal Generators (Agilent, Rohde and Schwarz, etc)
 - Spectrum Analyzers (Agilent/HP, Rohde and Schwartz, etc)
 - RF Power Meters (Agilent, Boonton, etc)
- **We can also add additional measurements to the core software**

- **A demonstration version of RFSpecTest can be downloaded from our WWW site**
 - www.rawood.com/software_products
- **The demonstration version shows the various tests and user interfaces**
- **The program does not take real measurements**
- **The program reads data files to simulate actual measurements**
 - The demonstration version should allow the user to see all the features and interfaces
- **Call us to receive the full program**

- **The RFSpecTest uses an RF power meter to calibrate signal generators, RF cabling, and the Spectrum Analyzer**
- **Calibration is performed at the Device Under Test (DUT) interface**
 - Very accurate measurements of output power at the DUT is possible
 - Several calibration steps are built into the software:
 - Input calibration from Signal Generator 1 to the DUT input
 - Input calibration from Signal Generator 2 to the DUT input (for two tone measurements)
 - Input calibration from Signal Generator 3 to the DUT input (for Local Oscillator (LO))
 - Output calibration from the DUT output to the spectrum analyzer
 - Separate input and output calibration files allows measurements to be made through frequency conversions
 - Gain/Insertion loss accuracies comparable with network analyzers are possible (within tenths of a dB)
 - Power measurements with RFSpecTest are generally more accurate than network analyzers
 - Calibration is performed at the DUT output, RF cable losses are taken out
 - VSWR effects can be minimized by adding fixed pads at the DUT interface

Measurements with RFSpecTest – RF Amplifiers

- **Gain vs. frequency**
- **Reverse isolation vs. frequency**
- **1 dB gain compression vs. frequency**
- **Intercept points vs. frequency**

Statistical parameters are available for each test parameter across a defined frequency range

Example Amplifier Test: Mini-Circuits ERA-5SM: Gain

Top_Level_Gain_Test12.vi

File Edit Operate Tools Browse Window Help

Gain Test

Configure Test Frequencies

RF START Frequency (Mhz)

RF STOP Frequency (Mhz)

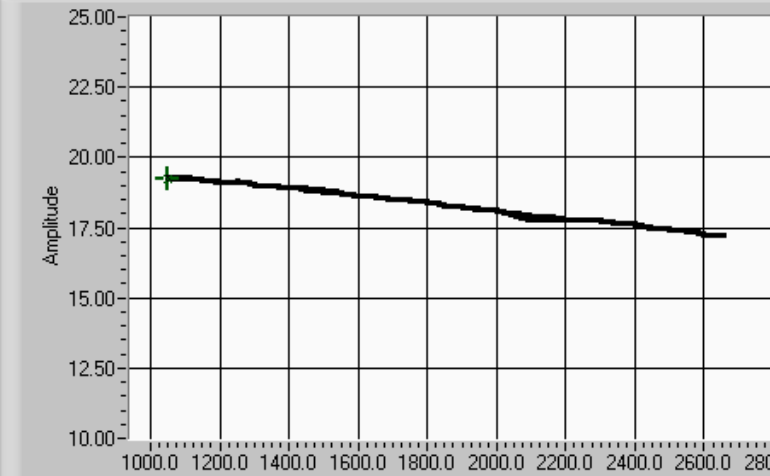
RF STEP Size (Mhz)

RF Power Level (dBm)

Test Time (s) Date/Time

Gain Plot Numeric Displays

Plot of Stat Data



Frequency

Statistics

AVERAGE

MIN OF DATA

MAX OF DATA

P-P FLATNESS

RMS


STD DEV

Slope of Best Fit Line

Min Dev from BFL

Max Dev from BFL

P-P Variation from BFL

Marker 1	<input type="text" value="1050.00"/>	<input type="text" value="19.23"/>	<input type="button" value="↕"/>	<input type="button" value="✱"/>	<input type="button" value="🔒"/>	Measured 
Marker 2	<input type="text" value="1050.00"/>	<input type="text" value="19.23"/>	<input type="button" value="↕"/>	<input type="button" value="✱"/>	<input type="button" value="🔒"/>	

Start Freq <input type="text" value="0"/>	Plot Vs <input type="text" value="Output Frequencies"/>	Amplitude Delta(Marker 1 - Marker 2) <input type="text" value="0.00"/>
Stop Freq <input type="text" value="2700"/>		Frequency Delta(Marker 1 - Marker 2) <input type="text" value="0.00"/>

Comments

Output File Path

Mini-Circuits ERA-5SM

<< Tab 1 Displayed

Level_Gain_Test12.vi
✖

File Operate Tools Browse Window Help

Gain Test

Configure Test Frequencies

Gain Plot

Numeric Displays

Test Time (s) 35.37
Date/Time 8/7/02 12:00 PM

RF START Frequency (Mhz)
1050.00

RF STOP Frequency (Mhz)
2650.00

RF STEP Size (Mhz)
50.00

RF Power Level (dBm)
-10.00

	Input Frequencies	LO Frequencies	Output Frequencies	Gain Array
0	1050.00	1000.00	1050.00	19.23
	1100.00	1000.00	1100.00	19.27
	1150.00	1000.00	1150.00	19.22
	1200.00	1000.00	1200.00	19.09
	1250.00	1000.00	1250.00	19.14
	1300.00	1000.00	1300.00	19.05
	1350.00	1000.00	1350.00	19.00
	1400.00	1000.00	1400.00	18.95
	1450.00	1000.00	1450.00	18.91
	1500.00	1000.00	1500.00	18.88
	1550.00	1000.00	1550.00	18.74
	1600.00	1000.00	1600.00	18.60
	1650.00	1000.00	1650.00	18.63
	1700.00	1000.00	1700.00	18.52
	1750.00	1000.00	1750.00	18.52
	1800.00	1000.00	1800.00	18.43

Comments

Output File Path

Mini-Circuit Amp ERA-5SM-TB Sn- RAW002

C:\WINDOWS\Desktop\Mini-Circuits
Amps\SN RAW002 Gain Test

TAKE MEASUREMENTS

SAVE DATA

EXIT

Mini-Circuits ERA-5SM

<< Tab 2
Displayed

Amplifier Test: Gain Compression

1_db_gain_comp_test15.vi

File Edit Operate Tools Browse Window Help

X dB Gain Compression Point Test

Configure Test Frequencies

RF START Frequency (Mhz)

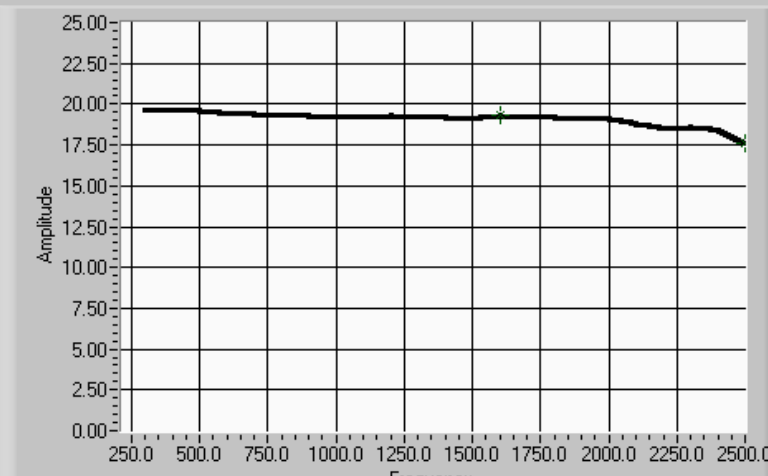
RF STOP Frequency (Mhz)

RF STEP Size (Mhz)

RF Power Level (dBm)

Output vs Frequency Plot Output vs Frequency Data Pin vs Pout

Output dB Comp Point Column for Y



Test Time (s) Date/Time

Statistics

AVERAGE

MIN OF DATA

MAX OF DATA

P-P FLATNESS

RMS

STD DEV

Slope of Best Fit Line

Min Dev from BFL

Max Dev from BFL

P-P Variation from BFL

Marker 1	1600.00	19.30	↕ ✖ 🔒	<input type="checkbox"/> Measured <input checked="" type="checkbox"/> Best Fit Line
Marker 2	2500.00	17.61	↕ ✖ 🔒	

Start Freq Amplitude Delta(Marker 1 - Marker 2)

Stop Freq Frequency Delta(Marker 1 - Marker 2)

dB of Gain Compression

1st Input Power Level Step Size

2nd Input Power Level Step Size

Test Comments

Output Data File

TAKE MEASUREMENTS

SAVE DATA

EXIT

Mini-Circuits ERA-5SM

<< Tab 1

1_db_gain_comp_test15.vi

File Edit Operate Tools Browse Window Help

X dB Gain Compression Point Test

Test Time (s) 699.70 Date/Time 8/9/02 2:16 PM

Configure Test Frequencies

RF START Frequency (Mhz)
300.00

RF STOP Frequency (Mhz)
2500.00

RF STEP Size (Mhz)
100.00

RF Power Level (dBm)
-15.00

Output vs Frequency Plot Output vs Frequency Data Pin vs Pout

	Input Freq (MHz)	Output Freq (MHz)	Startin g Input Power	Gain at Input Power	Input Compr ession Point	Compr essed Gain	dB of Gain Comp	Output 1 dB Comp Point
0	2500.0	2500.0	-15.00	17.31	1.30	16.31	1.00	17.61
0	2400.0	2400.0	-15.00	17.55	1.89	16.55	1.00	18.44
	2300.0	2300.0	-15.00	17.60	1.98	16.60	1.00	18.59
	2200.0	2200.0	-15.00	17.79	1.74	16.79	1.00	18.54
	2100.0	2100.0	-15.00	17.86	1.94	16.86	1.00	18.80
	2000.0	2000.0	-15.00	18.20	1.93	17.20	1.00	19.14
	1900.0	1900.0	-15.00	18.12	2.01	17.12	1.00	19.13
	1800.0	1800.0	-15.00	18.43	1.85	17.43	1.00	19.27
	1700.0	1700.0	-15.00	18.36	1.90	17.36	1.00	19.26
	1600.0	1600.0	-15.00	18.69	1.61	17.69	1.00	19.30
	1500.0	1500.0	-15.00	18.73	1.40	17.73	1.00	19.13
	1400.0	1400.0	-15.00	18.95	1.27	17.95	1.00	19.22
	1300.0	1300.0	-15.00	18.97	1.26	17.97	1.00	19.23
	1200.0	1200.0	-15.00	19.03	1.27	18.03	1.00	19.31
	1100.0	1100.0	-15.00	19.18	1.00	18.18	1.00	19.18
	1000.0	1000.0	-15.00	19.39	0.82	18.39	1.00	19.21

Input Frequencies

0	300.00
	400.00
	500.00
	600.00
	700.00
	800.00
	900.00
	1000.00
	1100.00
	1200.00
	1300.00
	1400.00
	1500.00
	1600.00
	1700.00
	1800.00
	1900.00
	2000.00

LO Frequencies

0	1000.00
	1000.00
	1000.00
	1000.00
	1000.00
	1000.00
	1000.00
	1000.00
	1000.00
	1000.00
	1000.00
	1000.00
	1000.00
	1000.00
	1000.00
	1000.00
	1000.00
	1000.00
	1000.00
	1000.00
	1000.00

Output Frequencies

0	300.00
	400.00
	500.00
	600.00
	700.00
	800.00
	900.00
	1000.00
	1100.00
	1200.00
	1300.00
	1400.00
	1500.00
	1600.00
	1700.00
	1800.00
	1900.00
	2000.00

<< Tab 2

Mini-Circuits ERA-5SM

dB of Gain Compression
1.00

1st Input Power Level Step Size
2.00

2nd Input Power Level Step Size
0.10

TAKE MEASUREMENTS SAVE DATA EXIT

Test Comments
ERA-5SM-TB.

Output Data File
C:\WINDOWS\Desktop\Mini-Circuits Amps\SN RAW002 Gain Compression

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RAWood

1_db_gain_comp_test15.vi
1dB Comp

File Edit Operate Tools Browse Window Help

X dB Gain Compression Point Test

Configure Test Frequencies

RF START Frequency (Mhz)

RF STOP Frequency (Mhz)

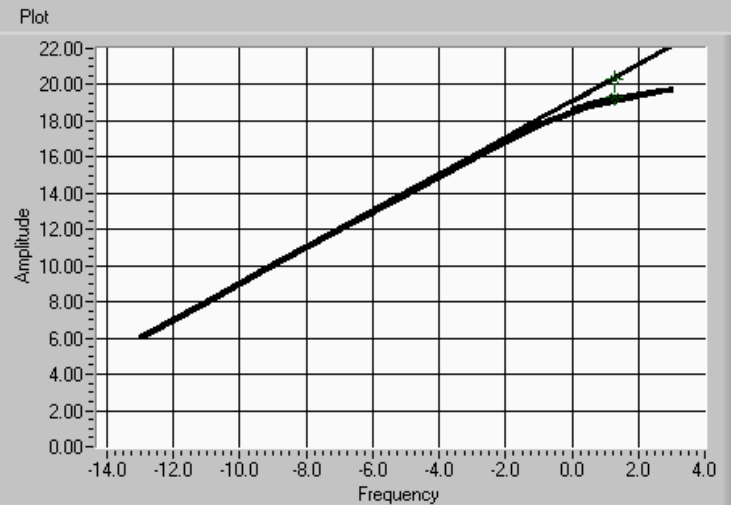
RF STEP Size (Mhz)

RF Power Level (dBm)

Output vs Frequency Plot Output vs Frequency Data Pin vs Pout

Pin Vs Pout Array					
	Pin	Gain	GC	Pout	Ideal
0	-13.00	19.05	-0.01	6.05	6.05
-11.00	19.03	0.00	8.03	8.05	
0	-9.00	19.02	0.01	10.02	10.05
-7.00	19.01	0.02	12.01	12.05	
-5.00	19.00	0.03	14.00	14.05	
-3.00	18.93	0.10	15.93	16.05	
-1.00	18.82	0.21	17.82	18.05	
1.00	18.19	0.85	19.19	20.05	
3.00	16.81	2.22	19.81	22.05	
0.00	18.64	0.39	18.64	19.05	
0.10	18.61	0.42	18.71	19.15	
0.20	18.56	0.47	18.76	19.25	
0.30	18.53	0.50	18.83	19.35	
0.40	18.50	0.53	18.90	19.45	
0.50	18.45	0.58	18.95	19.55	
0.60	18.41	0.62	19.01	19.65	
0.70	18.36	0.67	19.06	19.75	
0.80	18.29	0.74	19.09	19.85	
0.90	18.25	0.78	19.15	19.95	
1.00	18.19	0.84	19.19	20.05	
1.10	18.16	0.87	19.26	20.15	
1.20	18.08	0.95	19.28	20.25	
1.30	18.01	1.02	19.31	20.35	
0.00	0.00	0.00	0.00	0.00	
0.00	0.00	0.00	0.00	0.00	

Test Time (s) Date/Time



Marker 1	<input type="text" value="1.30"/>	<input type="text" value="19.31"/>	<input type="text" value="1600.00"/>		
Marker 2	<input type="text" value="1.30"/>	<input type="text" value="20.35"/>			
Pin Delta(Marker 1 - Marker 2)		<input type="text" value="-1.03"/>			
Pout Delta(Marker 1 - Marker 2)		<input type="text" value="0.00"/>			

dB of Gain Compression

1st Input Power Level Step Size

2nd Input Power Level Step Size

Test Comments

Output Data File

TAKE MEASUREMENTS
SAVE DATA
EXIT

<< Tab 3

Mini-Circuits ERA-5SM

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RAWood

Amplifier Test: Reverse Isolation

Top_Level_Gain_Test12.vi

File Edit Operate Tools Browse Window Help

Gain Test

Configure Test Frequencies

RF START Frequency (Mhz)
300.00

RF STOP Frequency (Mhz)
2500.00

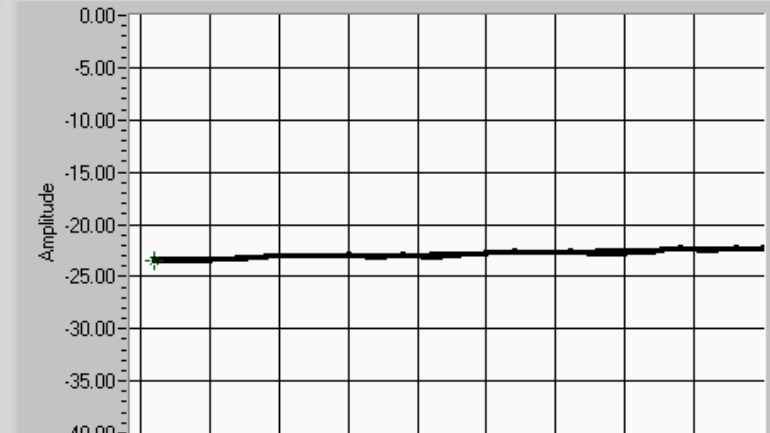
RF STEP Size (Mhz)
100.00

RF Power Level (dBm)
-15.00

Gain Plot Numeric Displays

Test Time (s) 25.21 Date/Time 8/9/02 2:33 PM

Plot of Stat Data



Amplitude

Frequency

Statistics

AVERAGE
-22.81

MIN OF DATA
-23.44

MAX OF DATA
-22.21

P-P FLATNESS
1.23

RMS
22.82

STD DEV
0.36

Slope of Best Fit Line
1.11

Min Dev from BFL
-0.27

Max Dev from BFL
0.19

P-P Variation from BFL
0.46

Marker 1	300.00	-23.44		Measured
Marker 2	300.00	-23.44		

Start Freq: 0 Plot Vs: Output Frequencies Amplitude Delta(Marker 1 - Marker 2): 0.00

Stop Freq: 2700 Frequency Delta(Marker 1 - Marker 2): 0.00

Comments

ERA-5SM-TB Reverse Isolation

Output File Path

g

TAKE MEASUREMENTS SAVE DATA EXIT

Mini-Circuits ERA-5SM

Amplifier Test: Intercept Points (dBm)

Top Level Intermod Test2.vi
_ □ ×

File Edit Operate Tools Browse Window Help

Intermodulation Distortion (IMD) Measurement

Configure Test Frequencies

RF START Frequency (Mhz)

RF STOP Frequency (Mhz)

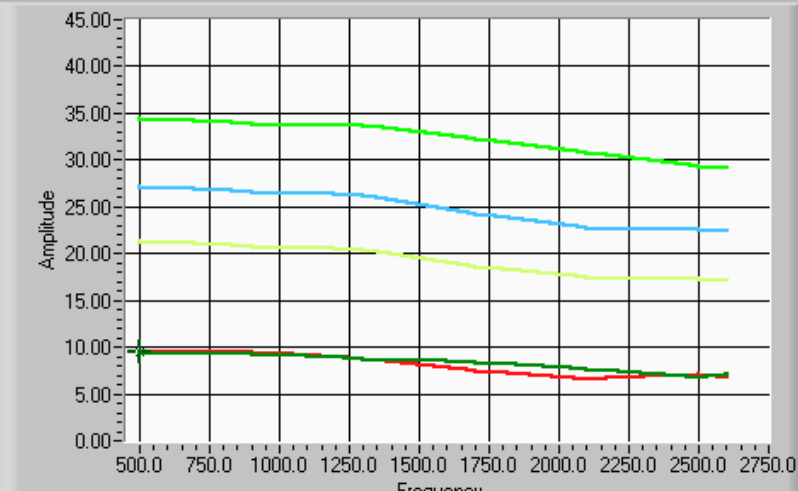
RF STEP Size (Mhz)

RF Power Level (dBm)

Intermod Measurement Plot
Numeric Displays

Test Time (s) Date/Time

Plot of IMD



Frequency

Marker 1	500.00	9.52			
Marker 2	500.00	9.52			
Stat Start Freq	Frequency Difference(Marker 1 - Marker 2)				
<input type="text" value="0"/>	0.00				
Stat Stop Freq	Amplitude Difference(Marker 1 - Marker 2)				
<input type="text" value="2700"/>	0.00				

Data to Run Stats on

AVERAGE

31.95

MIN OF DATA

29.14

MAX OF DATA

34.38

P-P FLATNESS

5.24

RMS

32.02

STD DEV

2.05

Slope of Best Fit Line

-5.64

Min Dev from BFL

-0.68

Max Dev from BFL

0.88

P-P Variation from BFL

1.56

Tone 2 Freq Offset(MHz)

Data Display

Comments

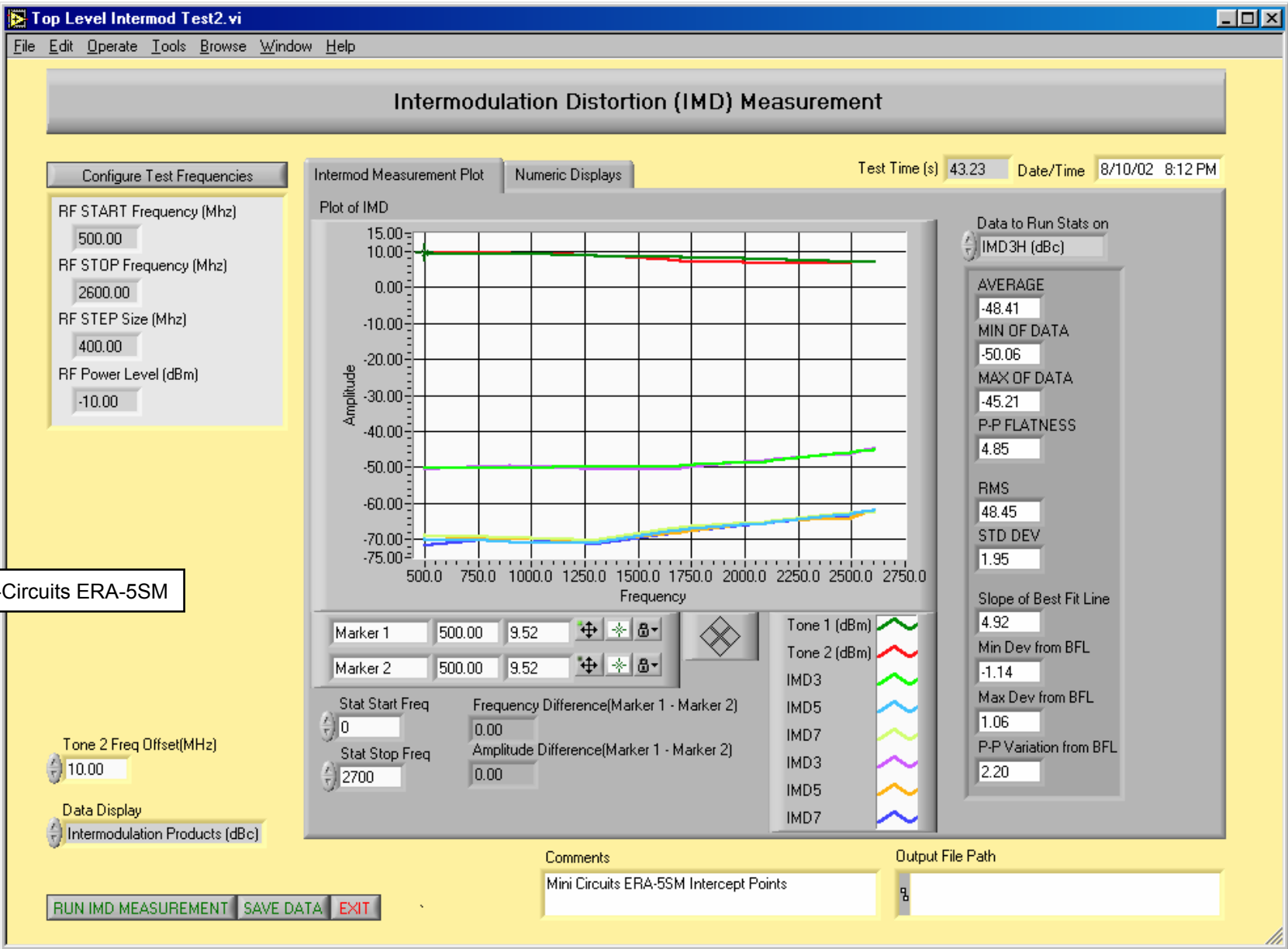
Output File Path

RUN IMD MEASUREMENT
SAVE DATA
EXIT

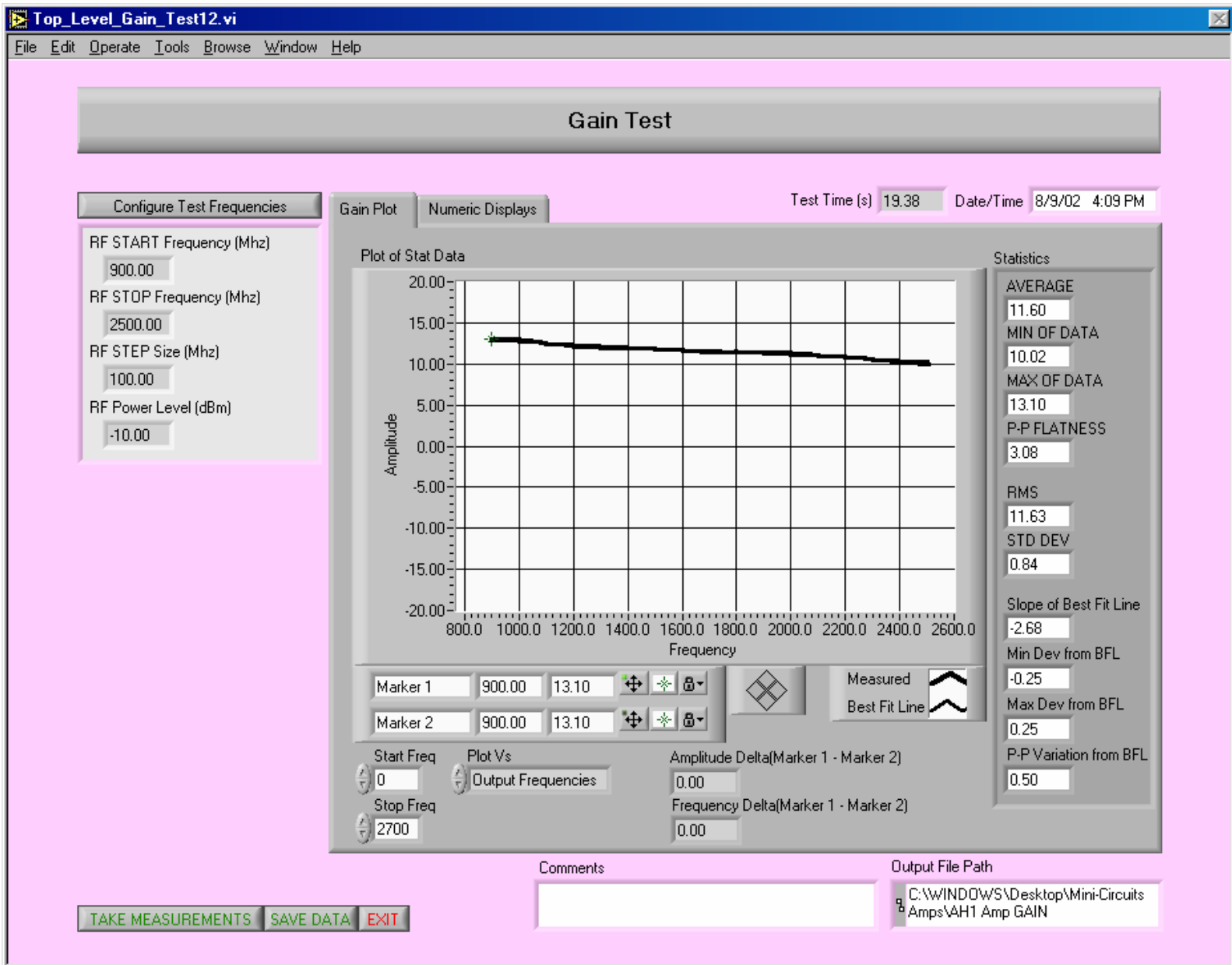
Mini-Circuits ERA-5SM

>>

Amplifier Test: Intermodulation Distortion (dBc)



Example Amplifier Test: WJ Communications AH1: Gain



Measurements with RFSpecTest – RF Switches

- **Insertion loss vs. frequency**
- **On/Off isolation vs. frequency**
- **1 dB gain compression vs. frequency**
- **Intercept points vs. frequency**

Statistical parameters are available for each test parameter across a defined frequency range

RF Switch Example: Hittite HMC194MS8: Insertion Loss

Top_Level_Gain_Test12.vi [X]

File Edit Operate Tools Browse Window Help

Gain Test

Configure Test Frequencies

RF START Frequency (Mhz)

RF STOP Frequency (Mhz)

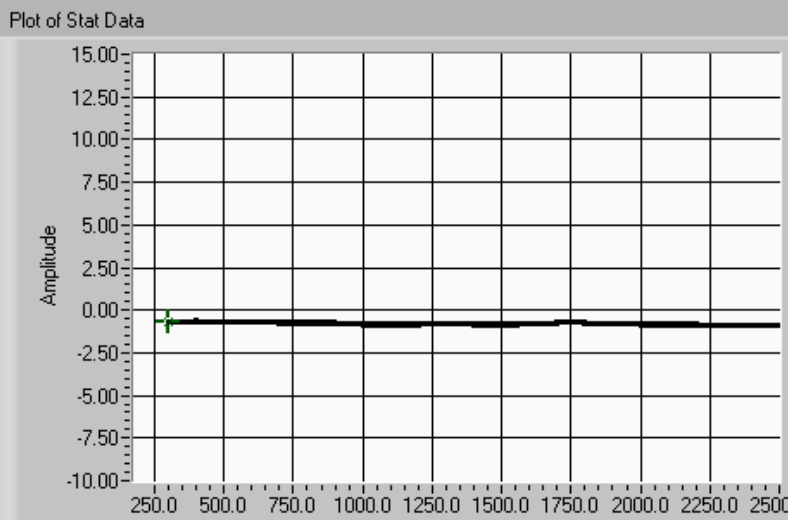
RF STEP Size (Mhz)

RF Power Level (dBm)

Test Time (s) Date/Time

Gain Plot

Plot of Stat Data



Statistics

AVERAGE:

MIN OF DATA:

MAX OF DATA:

P-P FLATNESS:

RMS:


STD DEV:

Slope of Best Fit Line:

Min Dev from BFL:

Max Dev from BFL:

P-P Variation from BFL:

Marker 1	300.00	-0.67	+	*	L	Measured 
Marker 2	300.00	-0.67	+	*	L	

Start Freq	Plot Vs	Amplitude Delta(Marker 1 - Marker 2)
<input type="text" value="0"/>	<input type="text" value="Output Frequencies"/>	<input type="text" value="0.00"/>
Stop Freq		Frequency Delta(Marker 1 - Marker 2)
<input type="text" value="2700"/>		<input type="text" value="0.00"/>

Comments

Hittite Switch Insertion Loss

Output File Path

C:\WINDOWS\Desktop\Mini-Circuits
Amps\Hittite Switch Insertion Loss

TAKE MEASUREMENTS

SAVE DATA

EXIT

RF Switch Example: Hittite HMC194MS8: On/Off Isolation

Relative Isolation_Test5.vi

File Edit Operate Tools Browse Window Help

Relative Measurement Test Time (s) 25.38

Configure Test Frequencies A Measurement Plot B Measurement Plot Difference Plot Numeric Displays Date/Time 8/9/02 6:19 PM

RF START Frequency (Mhz) 330.00

RF STOP Frequency (Mhz) 2500.00

RF STEP Size (Mhz) 100.00

RF Power Level (dBm) 0.00

Label for Measurement A Hittite Sw. RF1 ON

Amplitude vs Frequency

Statistics A

AVERAGE: -0.79

MIN OF DATA: -0.93

MAX OF DATA: -0.66

P-P FLATNESS: 0.27

RMS: 0.79

STD DEV: 0.08

Slope of Best Fit Line: -0.14

Min Dev from BFL: -0.14

Max Dev from BFL: 0.16

P-P Variation from BFL: 0.31

Marker 1: 1375.00, 2.75 Marker 2: 1375.00, 2.75

Stat Start Freq A: 0 Frequency Difference A(Marker 1 - Marker 2): 0.00

Stat Stop Freq A: 2700 Amplitude Difference A(Marker 1 - Marker 2): 0.00

Difference Plot A - B

Comments: Hittite Switch RF1 On, RF2 Off

Output File Path: C:\WINDOWS\Desktop\Mini-Circuits\Amps\Hittite Sw. RF 1 ON

RUN A MEASUREMENT

RUN B MEASUREMENT SAVE DATA EXIT

"ON" Measurement

<< Tab 1

RF Switch Example: Hittite HMC194MS8: Off Isolation

Relative Isolation Test5.vi

File Edit Operate Tools Browse Window Help

Test Time (s) 25.49

Date/Time 8/9/02 6:19 PM

Configure Test Frequencies

RF START Frequency (Mhz) 330.00

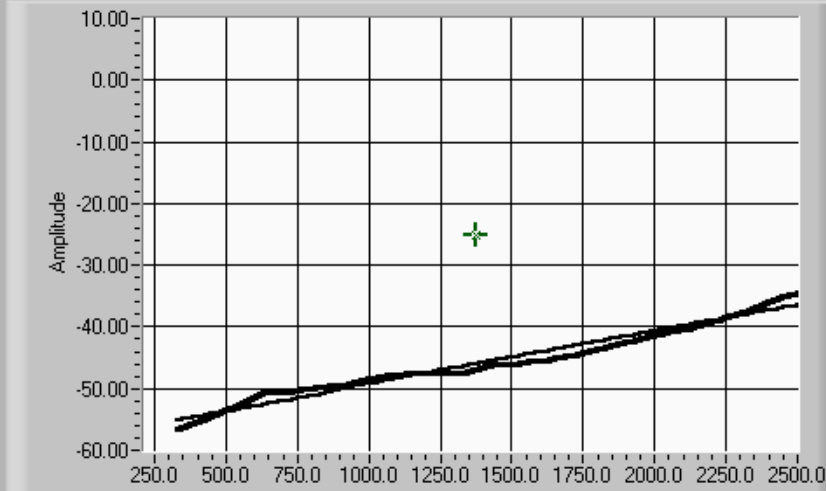
RF STOP Frequency (Mhz) 2500.00

RF STEP Size (Mhz) 100.00

RF Power Level (dBm) 0.00

A Measurement Plot | B Measurement Plot | Difference Plot | Numeric Displays

Label for Measurement B



Statistics B

AVERAGE -45.65

MIN OF DATA -56.50

MAX OF DATA -34.58

P-P FLATNESS 21.92

RMS 46.01

STD DEV 5.79

Slope of Best Fit Line 18.68

Min Dev from BFL -1.47

Max Dev from BFL 1.84

P-P Variation from BFL 3.32

Marker 1 1375.00 -25.00

Marker 2 1375.00 -25.00

Stat Start Freq B 0

Stat Stop Freq B 2700

Frequency Difference B(Marker 1 - Marker 2) 0.00

Amplitude Difference B(Marker 1 - Marker 2) 0.00

Difference Plot A - B

Comments Hittite Switch RF1 Off, RF2 Term.

Output File Path C:\WINDOWS\Desktop\Mini-Circuits Amps\Hittite Sw. RF 1 Off

RUN A MEASUREMENT

RUN B MEASUREMENT SAVE DATA EXIT

"OFF" Measurement

<< Tab 2

RF Switch Example: Hittite HMC194MS8: On/Off Ratio

Relative Isolation Test5.vi [X]

File Edit Operate Tools Browse Window Help

Test Time (s) 25.49

Relative Measurement

Date/Time 8/9/02 6:19 PM

Configure Test Frequencies

RF START Frequency (Mhz) 330.00

RF STOP Frequency (Mhz) 2500.00

RF STEP Size (Mhz) 100.00

RF Power Level (dBm) 0.00

A Measurement Plot | B Measurement Plot | **Difference Plot** | Numeric Displays

Difference Label - Hittite Sw. RF1 off RF2 Term.

Statistics 3

AVERAGE	-44.86
MIN OF DATA	-55.84
MAX OF DATA	-33.79
P-P FLATNESS	22.05
RMS	45.24
STD DEV	5.83
Slope of Best Fit Line	18.82
Min Dev from BFL	-1.54
Max Dev from BFL	1.78
P-P Variation from BFL	3.32

<< Tab 3

“ON/OFF” Ratio

Difference Plot B - A

Marker 1	1008.15	-47.61	+	*	🔒
Marker 2	1992.53	-40.81	+	*	🔒

Stat Start Freq Difference 0 | Frequency Difference(Marker 1 - Marker 2) -984.37

Stat Stop Freq Difference 2700 | Amplitude Difference(Marker 1 - Marker 2) -6.80

RUN A MEASUREMENT [X]

RUN B MEASUREMENT [X] **SAVE DATA** **EXIT**

Comments

Hitite Switch RF1 Off, RF2 Term.

Output File Path

C:\WINDOWS\Desktop\Mini-Circuits Amps\Hitite Sw. Difference Plot

RF Switch Example: Hittite HMC194MS8: On/Off Ratio

Relative_Isolation_Test5.vi

File Edit Operate Tools Browse Window Help

Relative Measurement Test Time [s] 25.49

Configure Test Frequencies A Measurement Plot B Measurement Plot Difference Plot Numeric Displays Date/Time 8/9/02 6:19 PM

RF START Frequency (Mhz)

RF STOP Frequency (Mhz)

RF STEP Size (Mhz)

RF Power Level (dBm)

	Input Frequencies	LO Frequencies	Output Frequencies	Gain A Array	Gain B Array	Difference Array
	330.00	1000.00	330.00	-0.67	-56.50	-55.84
	430.00	1000.00	430.00	-0.67	-54.94	-54.27
	530.00	1000.00	530.00	-0.71	-52.95	-52.24
	630.00	1000.00	630.00	-0.73	-50.76	-50.03
	730.00	1000.00	730.00	-0.74	-50.41	-49.66
	830.00	1000.00	830.00	-0.75	-49.89	-49.15
	930.00	1000.00	930.00	-0.77	-49.35	-48.58
	1030.00	1000.00	1030.00	-0.91	-48.23	-47.33
	1130.00	1000.00	1130.00	-0.80	-47.52	-46.72
	1230.00	1000.00	1230.00	-0.80	-47.29	-46.48
	1330.00	1000.00	1330.00	-0.79	-47.66	-46.87
	1430.00	1000.00	1430.00	-0.84	-46.10	-45.26
	1530.00	1000.00	1530.00	-0.74	-45.71	-44.97
	1630.00	1000.00	1630.00	-0.80	-45.38	-44.58
	1730.00	1000.00	1730.00	-0.73	-44.52	-43.79
	1830.00	1000.00	1830.00	-0.77	-43.23	-42.46

Difference Plot: B - A

Comments:

Output File Path:

"ON/OFF" Ratio

<< Tab 4

RF Switch Example: Hittite HMC194MS8: Intercept Points

Top Level Intermod Test2.vi

File Edit Operate Tools Browse Window Help

Intermodulation Distortion (IMD) Measurement

Test Time (s) 55.53 Date/Time 8/9/02 3:55 PM

Configure Test Frequencies

RF START Frequency (Mhz) 300.00

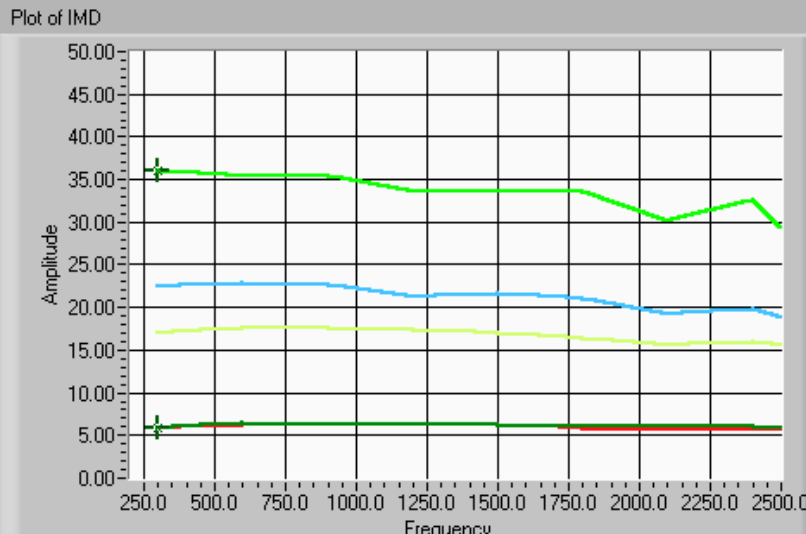
RF STOP Frequency (Mhz) 2500.00

RF STEP Size (Mhz) 300.00

RF Power Level (dBm) 7.00

Intermod Measurement Plot Numeric Displays

Plot of IMD



Amplitude

Frequency

Data to Run Stats on

Tone 1 (dBm)

AVERAGE 2.74

MIN OF DATA 2.74

MAX OF DATA 2.74

P-P FLATNESS 0.00

RMS 2.74

STD DEV 0.00

Slope of Best Fit Line NaN

Min Dev from BFL 0.00

Max Dev from BFL 0.00

P-P Variation from BFL 0.00

Marker 1 300.00 36.01

Marker 2 300.00 5.82

Stat Start Freq 0

Stat Stop Freq 2700

Tone 2 Freq Offset(MHz) 0.10

Data Display Intercept Points (dBm)

Frequency Difference(Marker 1 - Marker 2) 0.00

Amplitude Difference(Marker 1 - Marker 2) 30.19

Tone 1 (dBm)

Tone 2 (dBm)

IMD3

IMD5

IMD7

IMD3

IMD5

IMD7

Comments

Hittite Switch

Output File Path

C:\WINDOWS\Desktop\Mini-Circuits Amps\
Hittite Sw. Intercept points

RUN IMD MEASUREMENT

SAVE DATA

EXIT

- **Conversion loss vs. frequency (up or down conversion)**
- **Isolation vs. frequency**
 - L to I isolation
 - L to R isolation
 - R to I isolation
 - I to R Isolation
- **1 dB gain compression vs. frequency**
- **Intercept points vs. frequency**

Statistical parameters are available for each test parameter across a defined frequency range

Mixer Example: Anzac MD-525: Conversion Loss

Top_Level_Gain_Test12.vi

File Edit Operate Tools Browse Window Help

Gain Test

Configure Test Frequencies

RF START Frequency (Mhz)
1500.00

RF STOP Frequency (Mhz)
1800.00

RF STEP Size (Mhz)
25.00

RF Power Level (dBm)
-10.00

Frequency Options
Mixer - Down Conversion

Mixer Options
Fixed LO, Stepped RF and IF

Down Conversion Options
I = R - L

LO Frequency (Mhz)
1000.00

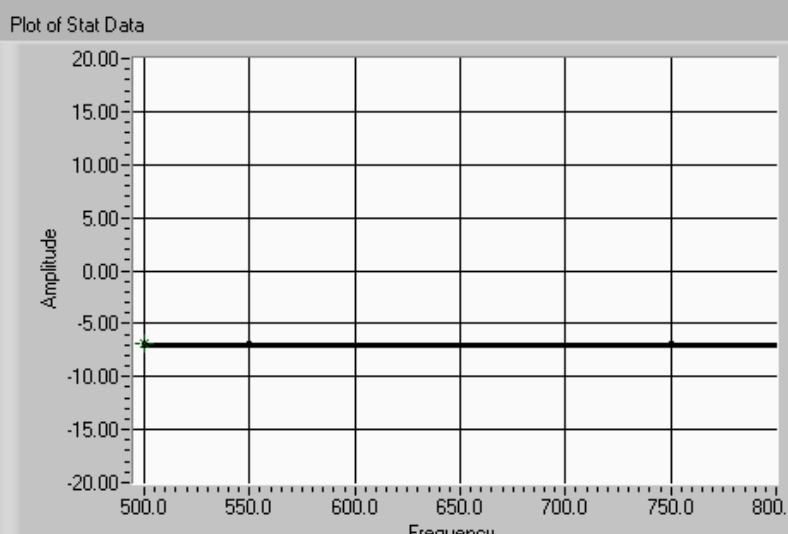
LO Power Level (dBm)
12.00

LO Power(dBm)
12.00

Gain Plot Numeric Displays

Test Time (s) 15.05 Date/Time 8/9/02 4:56 PM

Plot of Stat Data



Statistics

AVERAGE: -7.01

MIN OF DATA: -7.12

MAX OF DATA: -6.94

P-P FLATNESS: 0.18

RMS: 7.01

STD DEV: 0.05

Slope of Best Fit Line: -0.02

Min Dev from BFL: -0.11

Max Dev from BFL: 0.06

P-P Variation from BFL: 0.18

Marker 1 500.00 -6.94

Marker 2 500.00 -6.94

Start Freq: 0 Plot Vs: Output Frequencies Amplitude Delta(Marker 1 - Marker 2): 0.00

Stop Freq: 2700 Frequency Delta(Marker 1 - Marker 2): 0.00

Comments: Mixer Down Conversion

Output File Path: C:\WINDOWS\Desktop\Mini-Circuits Amps\AH1 Amp GAIN

Tab 1

Down Conversion,
Fixed LO,
Stepped RF and IF

Mixer Example: Anzac MD-525: Conversion Loss

Top_Level_Gain_Test12.vi

File Edit Operate Tools Browse Window Help

Gain Test

Test Time (s) 15.05 Date/Time 8/9/02 4:56 PM

Configure Test Frequencies

RF START Frequency (Mhz)
1500.00

RF STOP Frequency (Mhz)
1800.00

RF STEP Size (Mhz)
25.00

RF Power Level (dBm)
-10.00

Frequency Options
Mixer - Down Conversion

Mixer Options
Fixed LO, Stepped RF and IF

Down Conversion Options
I = R - L

LO Frequency (Mhz)
1000.00

LO Power Level (dBm)
12.00

LO Power(dBm)
12.00

Gain Plot **Numeric Displays**

Input Frequencies	LO Frequencies	Output Frequencies	Gain Array
0	0	0	0
1500.00	1000.00	500.00	-6.94
1525.00	1000.00	525.00	-6.97
1550.00	1000.00	550.00	-6.96
1575.00	1000.00	575.00	-7.12
1600.00	1000.00	600.00	-7.02
1625.00	1000.00	625.00	-7.07
1650.00	1000.00	650.00	-7.04
1675.00	1000.00	675.00	-7.02
1700.00	1000.00	700.00	-7.06
1725.00	1000.00	725.00	-7.01
1750.00	1000.00	750.00	-6.95
1775.00	1000.00	775.00	-6.98
1800.00	1000.00	800.00	-7.03
0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00

Comments: Mixer Down Conversion

Output File Path: C:\WINDOWS\Desktop\Mini-Circuits Amps\AH1 Amp GAIN

TAKE MEASUREMENTS **SAVE DATA** **EXIT**

Tab 2

Down Conversion,
Fixed LO,
Stepped RF and IF

Mixer Example: Conversion Loss: Up Conversion

Top_Level_Gain_Test12.vi

File Edit Operate Tools Browse Window Help

Gain Test

Configure Test Frequencies

IF START Frequency (Mhz)
500.00

IF STOP Frequency (Mhz)
800.00

IF STEP Size (Mhz)
25.00

IF Power Level (dBm)
-10.00

Frequency Options
Mixer - Up Conversion

Mixer Options
Fixed LO, Stepped RF and IF

Up Conversion Options
R = L + I

LO Frequency (Mhz)
1000.00

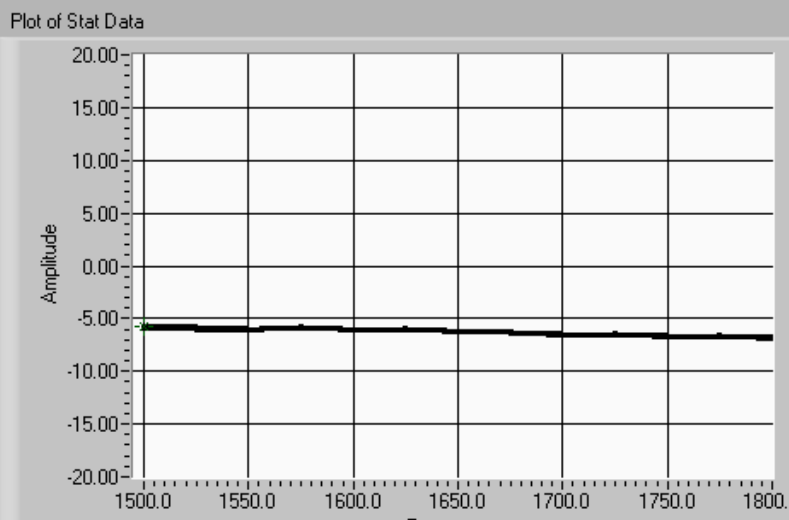
LO Power Level (dBm)
12.00

LO Power(dBm)
12.00

Gain Plot Numeric Displays

Test Time (s) 14.23 Date/Time 8/9/02 5:03 PM

Plot of Stat Data



Statistics

- AVERAGE: -6.26
- MIN OF DATA: -6.91
- MAX OF DATA: -5.82
- P-P FLATNESS: 1.09
- RMS: 6.27
- STD DEV: 0.35
- Slope of Best Fit Line: -1.05
- Min Dev from BFL: -0.18
- Max Dev from BFL: 0.26
- P-P Variation from BFL: 0.44

Marker 1: 1500.00, -5.83

Marker 2: 1500.00, -5.83

Start Freq: 0 Plot Vs: Output Frequencies Amplitude Delta(Marker 1 - Marker 2): 0.00

Stop Freq: 2700 Frequency Delta(Marker 1 - Marker 2): 0.00

Up Conversion,
Fixed LO,
Stepped RF and IF

Comments: Mixer Up Conversion

Output File Path: %

TAKE MEASUREMENTS SAVE DATA EXIT

Anzac MD-525

Mixer Example: Conversion Loss: Up Conversion

Top_Level_Gain_Test12.vi

File Edit Operate Tools Browse Window Help

Gain Test

Test Time (s) 14.55 Date/Time 8/9/02 5:48 PM

Configure Test Frequencies

LO START Frequency (Mhz) 900.00

LO STOP Frequency (Mhz) 1200.00

LO STEP Size (Mhz) 25.00

LO Power Level (dBm) 12.00

Frequency Options
Mixer - Up Conversion

Mixer Options
Fixed IF, Stepped RF and LO

Up Conversion Options
R = L + I

IF Frequency (Mhz) 650.00

IF Power Level (dBm) -10.00

LO Power(dBm) 12.00

Gain Plot Numeric Displays

Plot of Stat Data

Statistics

- AVERAGE: -7.02
- MIN OF DATA: -7.28
- MAX OF DATA: -6.86
- P-P FLATNESS: 0.42
- RMS: 7.03
- STD DEV: 0.14
- Slope of Best Fit Line: -0.18
- Min Dev from BFL: -0.23
- Max Dev from BFL: 0.16
- P-P Variation from BFL: 0.39

Start Freq 0 Plot Vs Output Frequencies Amplitude Delta(Marker 1 - Marker 2) 0.00

Stop Freq 2700 Frequency Delta(Marker 1 - Marker 2) 0.00

Up Conversion, Fixed IF, Stepped RF and LO

Anzac MD-525

Comments Mixer Up Conversion

Output File Path C:\WINDOWS\Desktop\Mini-Circuits Amps\Mixer Up conversion

TAKE MEASUREMENTS
SAVE DATA
EXIT

Up Conversion, Fixed IF, Stepped RF and LO

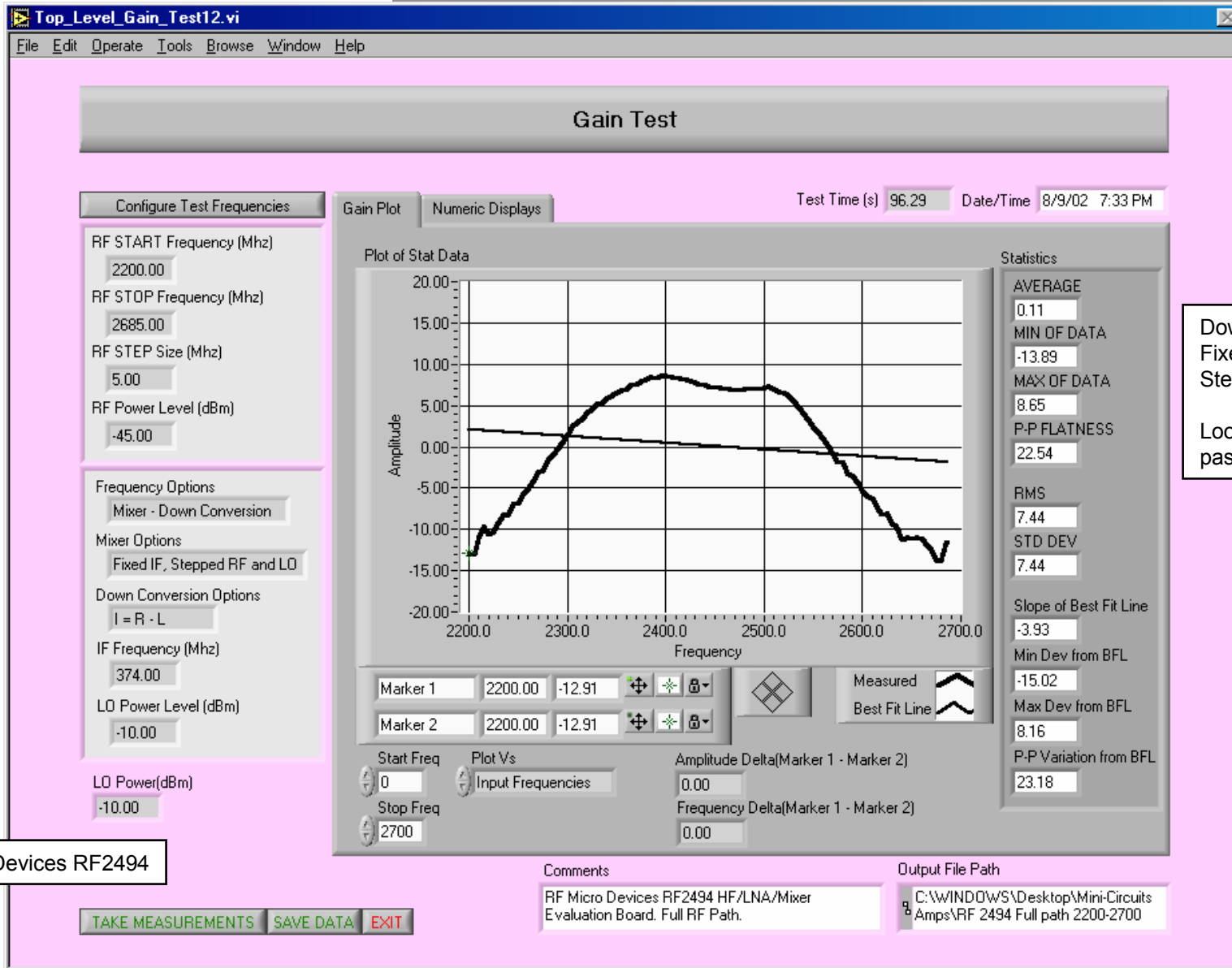
Anzac MD-525

Measurements with RFSpecTest – Receiver Chip Sets with Down Conversion

- **Gain vs. frequency (through down conversion)**
- **1 dB gain compression vs. frequency**
- **Intercept points vs. frequency**
- **Gain/attenuator adjust accuracy vs. frequency**

Statistical parameters are available for each test parameter across a defined frequency range

Receiver Chip: RF 2494 High Frequency LNA/Mixer: Conversion Loss

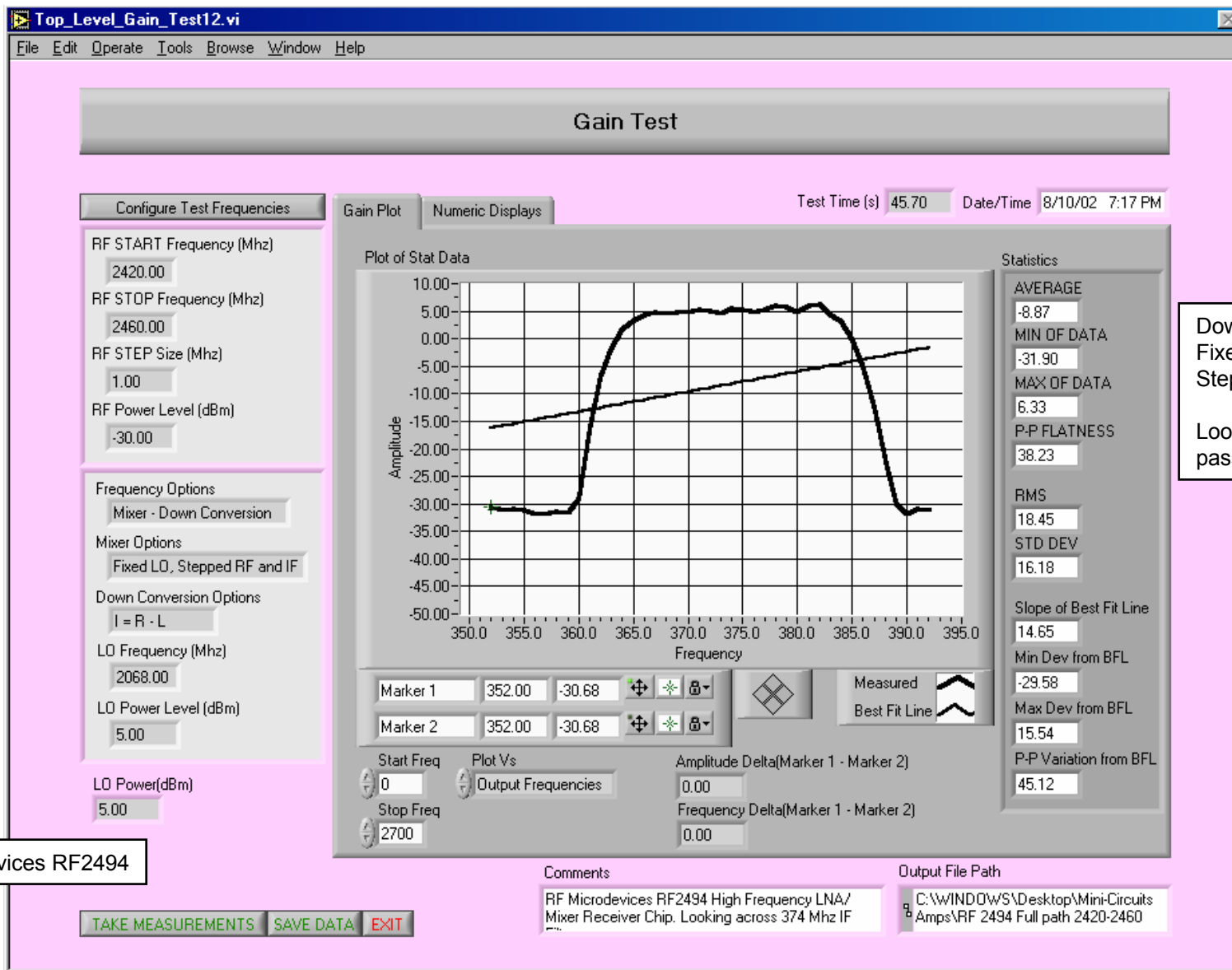


Down Conversion,
 Fixed IF,
 Stepped RF and LO

Looking at RF
 passband

RF Micro Devices RF2494

Receiver Chip: RF 2494 High Frequency LNA/Mixer: Conversion Loss



Down Conversion,
Fixed LO,
Stepped RF and IF

Looking at IF
passband

RF Micro Devices RF2494

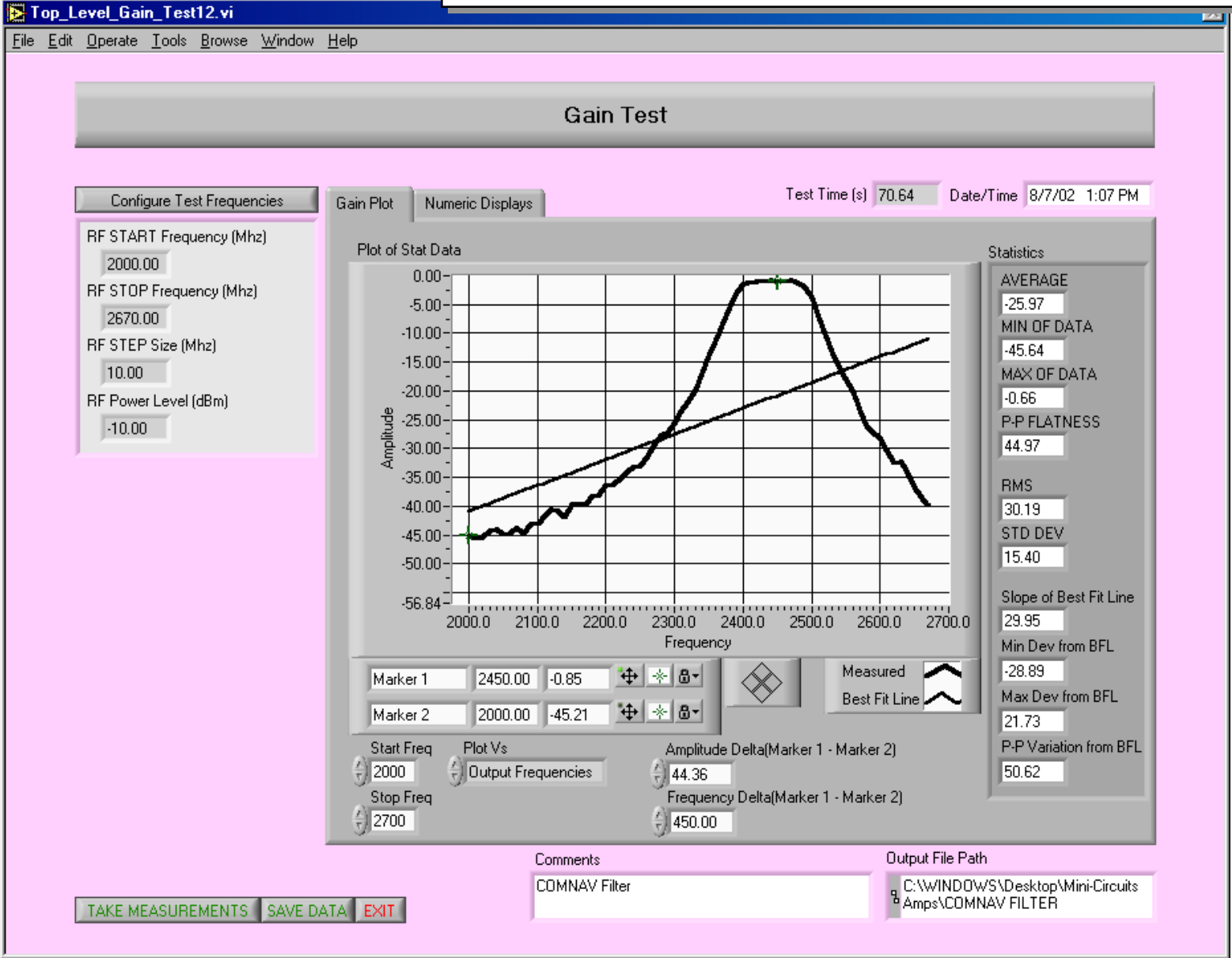
Measurements with RFSpecTest – Filters

- **Insertion loss vs. frequency**
- **P-P ripple across the passband**
- **Rejection vs. frequency**

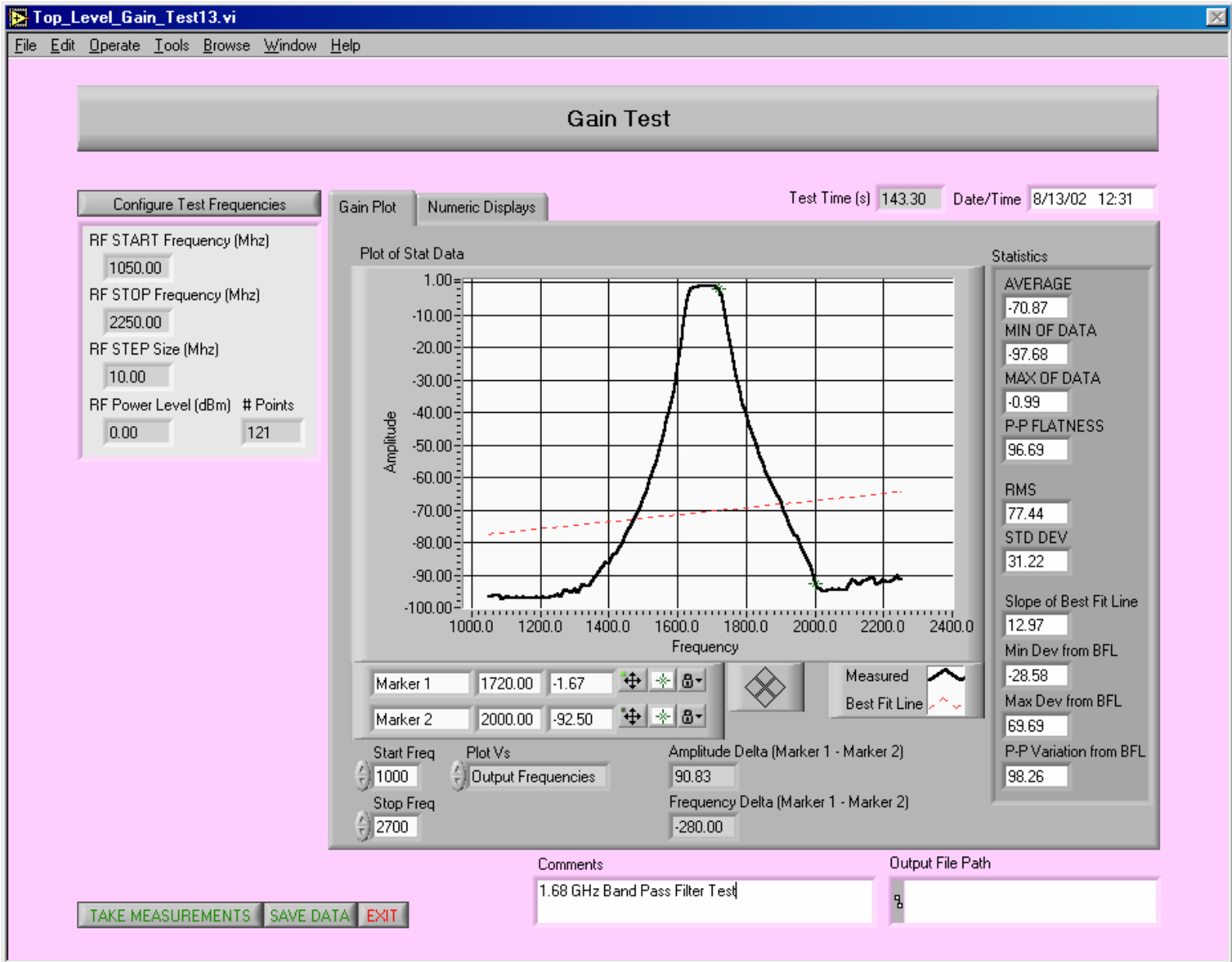
Statistical parameters are available for each test parameter across a defined frequency range

Filter Example 1 – Insertion Loss vs. Frequency

2.4 GHz ISM BPF



Filter Example 2 – Insertion Loss and Rejection



Measurements with RFSpecTest – Isolators

- **Insertion loss vs. frequency**
- **Reverse isolation vs. frequency**

Statistical parameters are available for each test parameter across a defined frequency range

Measurements with RFSpecTest – Fixed Attenuators

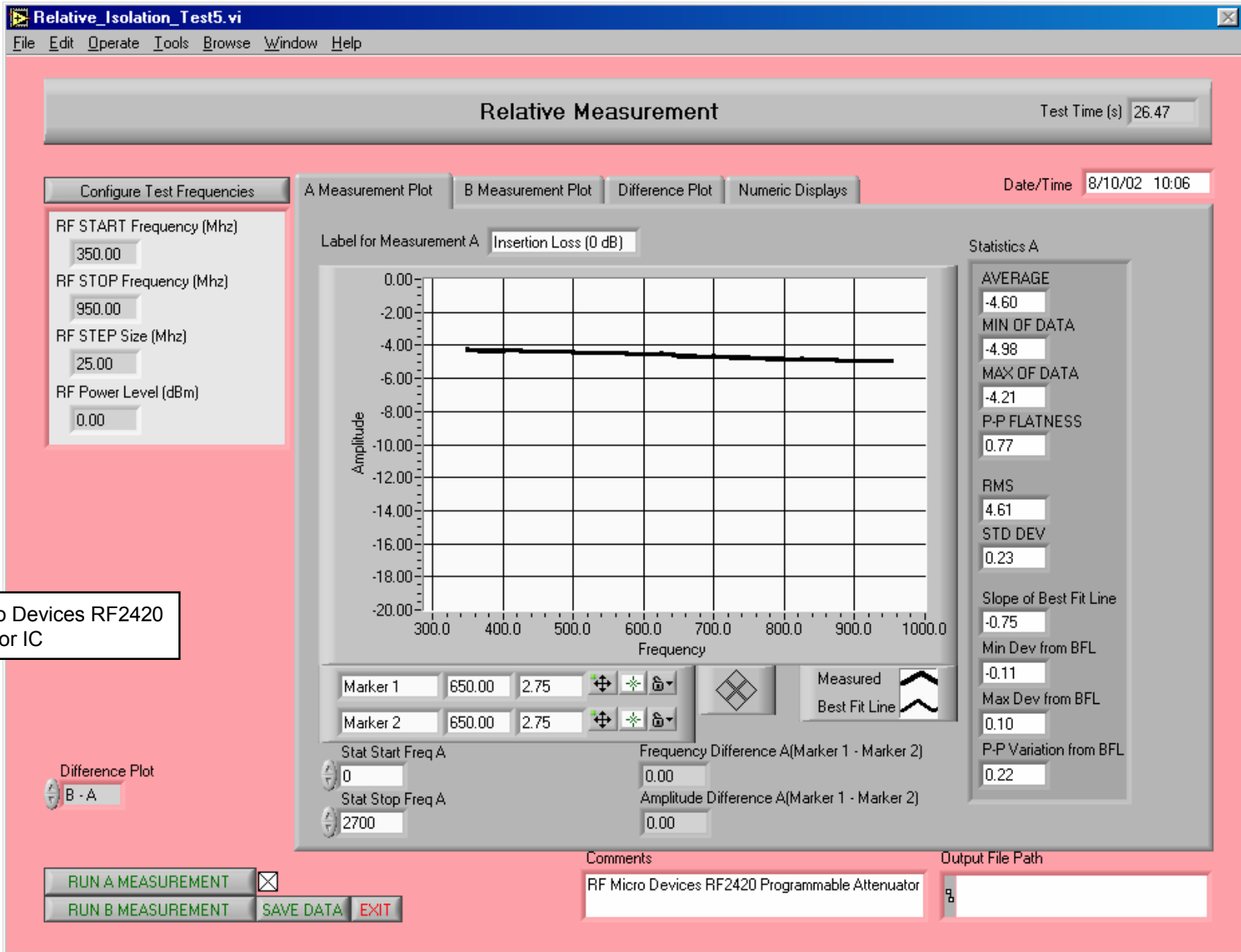
- **Insertion loss vs. frequency**
- **Attenuation accuracy vs. frequency**

Measurements with RFSpecTest – Variable Attenuators

- **Insertion loss vs. frequency**
- **Attenuation accuracy vs. frequency**
 - vs. attenuation setting
- **1 dB gain compression vs. frequency**
- **Intercept points vs. frequency**

Statistical parameters are available for each test parameter across a defined frequency range

Variable Attenuator Example: 0 dB State (Reference)



RF Micro Devices RF2420
Attenuator IC

Variable Attenuator Example: 4 dB Measurement

Relative_Isolation_Test5.vi

File Edit Operate Tools Browse Window Help

Relative Measurement

Test Time (s) 26.47

Configure Test Frequencies A Measurement Plot B Measurement Plot Difference Plot Numeric Displays Date/Time 8/10/02 10:06

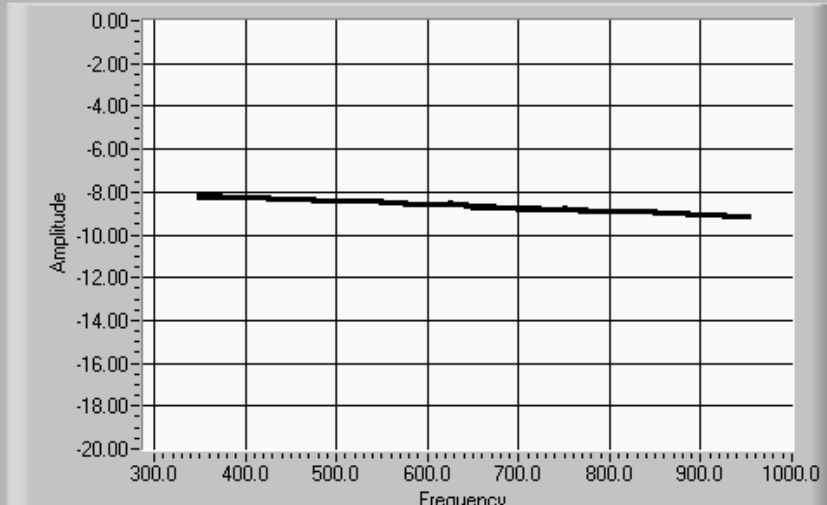
RF START Frequency (Mhz) 350.00

RF STOP Frequency (Mhz) 950.00


RF STEP Size (Mhz) 25.00


RF Power Level (dBm) 0.00

Label for Measurement B 4 dB State Meas



Frequency

Marker 1 650.00 -25.00 Measured 

Marker 2 650.00 -25.00 Best Fit Line 

Stat Start Freq B 0 Frequency Difference B(Marker 1 - Marker 2) 0.00

Stat Stop Freq B 2700 Amplitude Difference B(Marker 1 - Marker 2) 0.00

Statistics B

AVERAGE -8.64

MIN OF DATA -9.11

MAX OF DATA -8.16

P-P FLATNESS 0.96

RMS 8.65

STD DEV 0.29

Slope of Best Fit Line -0.95

Min Dev from BFL -0.09

Max Dev from BFL 0.06

P-P Variation from BFL 0.15

Difference Plot B - A

RUN A MEASUREMENT

RUN B MEASUREMENT SAVE DATA EXIT

Comments RF Micro Devices RF2420 Programmable Attenuator

Output File Path

RF Micro Devices RF2420 Attenuator IC

Variable Attenuator Example: 4 dB Attenuation Accuracy

Relative Isolation Test5.vi | File Edit Operate Tools Browse Window Help

Relative Measurement Test Time (s) 26.47

Configure Test Frequencies

RF START Frequency (Mhz)

RF STOP Frequency (Mhz)

RF STEP Size (Mhz)

RF Power Level (dBm)

A Measurement Plot | **B Measurement Plot** | Difference Plot | Numeric Displays

Date/Time 8/10/02 10:06

Difference Label

Marker 1

Marker 2

Stat Start Freq Difference Frequency Difference(Marker 1 - Marker 2)

Stat Stop Freq Difference Amplitude Difference(Marker 1 - Marker 2)

Statistics 3

AVERAGE

MIN OF DATA

MAX OF DATA

P-P FLATNESS

RMS

STD DEV

Slope of Best Fit Line

Min Dev from BFL

Max Dev from BFL

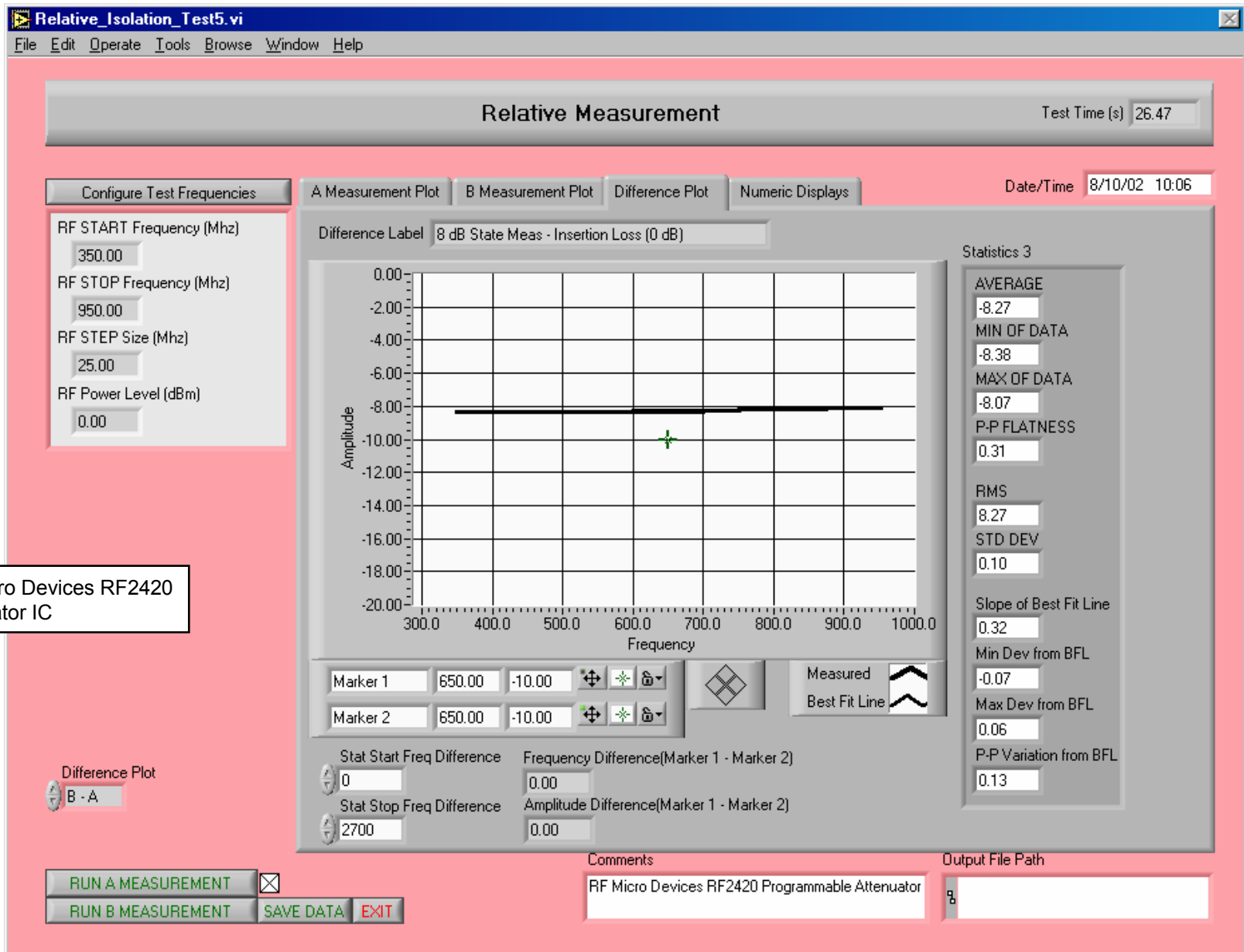
P-P Variation from BFL

Difference Plot B - A

Comments Output File Path

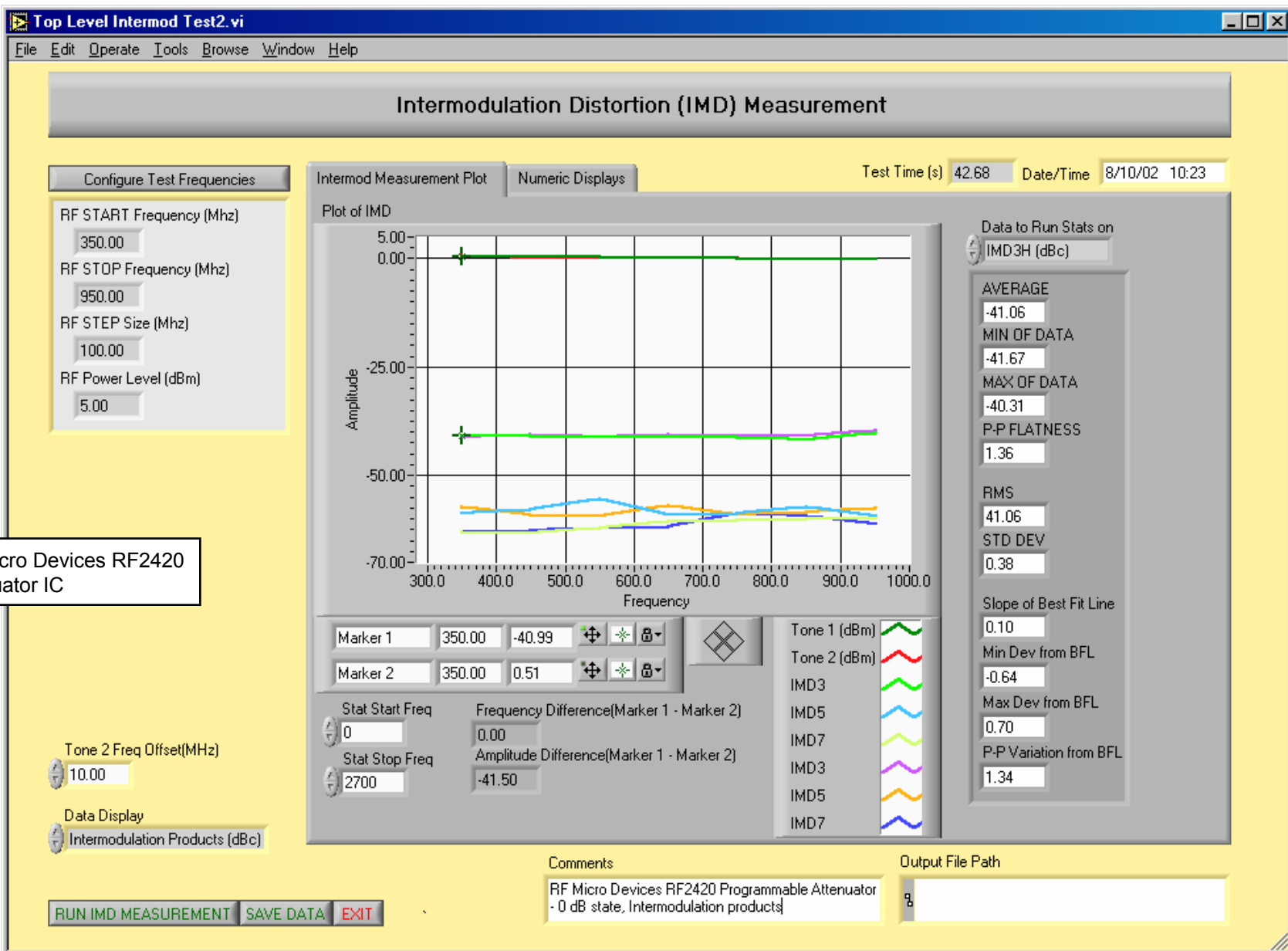
RF Micro Devices RF2420 Attenuator IC

Variable Attenuator Example: 8 dB Attenuation Accuracy



RF Micro Devices RF2420
Attenuator IC

Variable Attenuator: Intermodulation Distortion (dBc)



Measurements with RFSpecTest – Transmitter Chip Sets with Up Conversion

- **Gain vs. frequency (through up conversion)**
- **1 dB gain compression vs. frequency**
- **Intercept points vs. frequency**

Statistical parameters are available for each test parameter across a defined frequency range

Other Tests Available – Local Oscillators

- **Output Power vs. frequency**
 - Assumes digital or analog control available

Statistical parameters are available for each test parameter across a defined frequency range

Measurements with RFSpecTest – Couplers

- **Insertion loss vs. frequency**
- **Coupling vs. frequency**
- **Isolation vs. frequency**
- **Directivity vs. frequency**

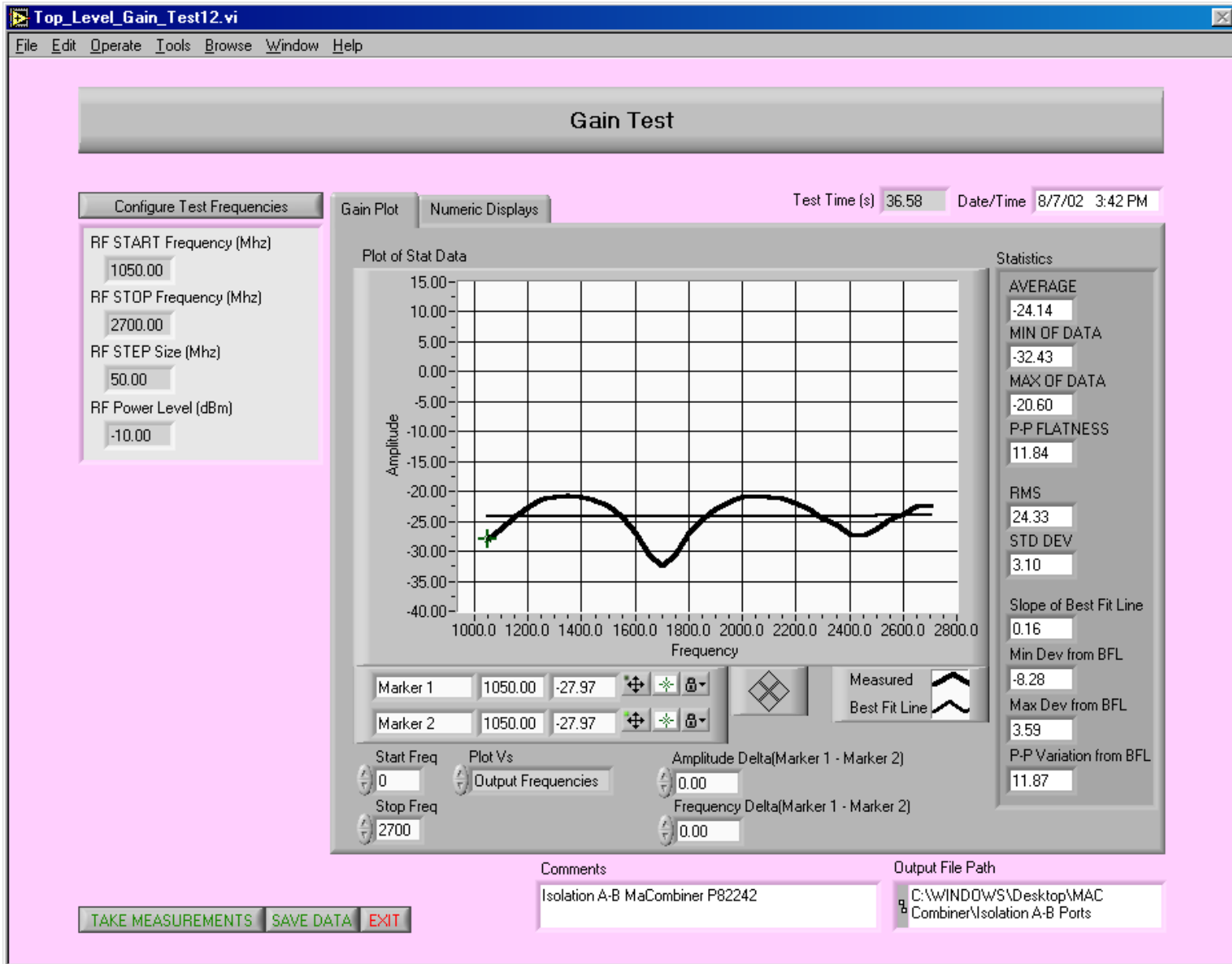
Statistical parameters are available for each test parameter across a defined frequency range

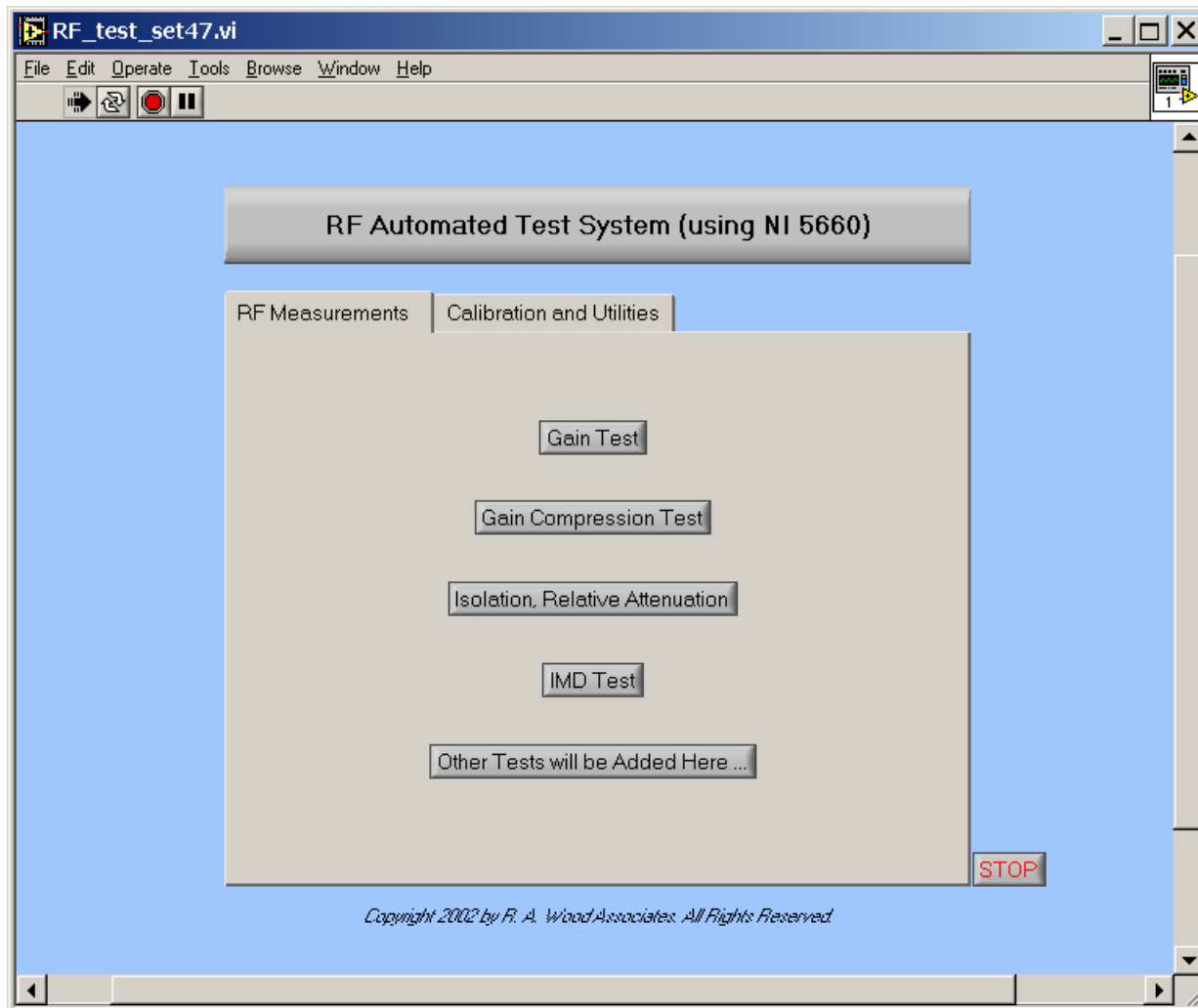
Measurements with RFSpecTest – Power Dividers

- **Insertion loss vs. frequency**
- **Isolation vs. frequency**
- **Output port matching vs. frequency**

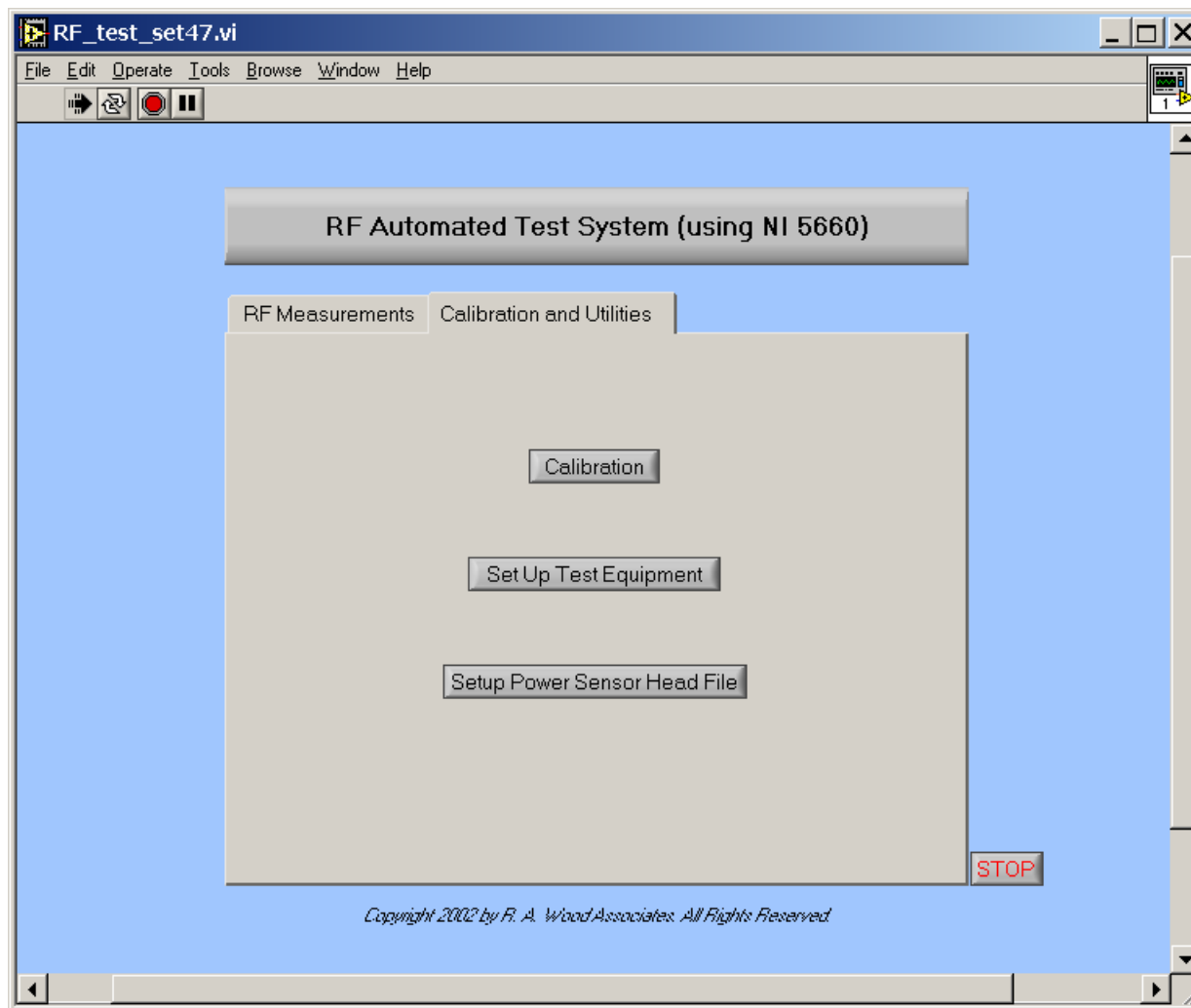
Statistical parameters are available for each test parameter across a defined frequency range

Power Divider Example – Isolation Between Output Ports





Top Level Test Panel >> Calibration and Utilities



Configure Test Frequencies: Same Input/Output Freq's

Configure Test Frequencies5.vi

Configure Test Frequencies

Frequency Options

Same Input/ Output Freq's

RF START Frequency (Mhz) RF Power Level (dBm)

RF STOP Frequency (Mhz)

RF STEP Size (Mhz)

Input Frequencies	LO Frequencies	Output Frequencies
<input type="text" value="1000.00"/>	<input type="text" value="1000.00"/>	<input type="text" value="1000.00"/>
<input type="text" value="1100.00"/>	<input type="text" value="1000.00"/>	<input type="text" value="1100.00"/>
<input type="text" value="1200.00"/>	<input type="text" value="1000.00"/>	<input type="text" value="1200.00"/>
<input type="text" value="1300.00"/>	<input type="text" value="1000.00"/>	<input type="text" value="1300.00"/>
<input type="text" value="1400.00"/>	<input type="text" value="1000.00"/>	<input type="text" value="1400.00"/>
<input type="text" value="1500.00"/>	<input type="text" value="1000.00"/>	<input type="text" value="1500.00"/>
<input type="text" value="0.00"/>	<input type="text" value="0.00"/>	<input type="text" value="0.00"/>
<input type="text" value="0.00"/>	<input type="text" value="0.00"/>	<input type="text" value="0.00"/>
<input type="text" value="0.00"/>	<input type="text" value="0.00"/>	<input type="text" value="0.00"/>
<input type="text" value="0.00"/>	<input type="text" value="0.00"/>	<input type="text" value="0.00"/>
<input type="text" value="0.00"/>	<input type="text" value="0.00"/>	<input type="text" value="0.00"/>
<input type="text" value="0.00"/>	<input type="text" value="0.00"/>	<input type="text" value="0.00"/>
<input type="text" value="0.00"/>	<input type="text" value="0.00"/>	<input type="text" value="0.00"/>
<input type="text" value="0.00"/>	<input type="text" value="0.00"/>	<input type="text" value="0.00"/>
<input type="text" value="0.00"/>	<input type="text" value="0.00"/>	<input type="text" value="0.00"/>

Configure Test Frequencies: Down Conversion Example Fixed IF Frequency, Stepped RF and LO

Configure Test Frequencies5.vi

Configure Test Frequencies

Frequency Options

Mixer - Down Conversion

Mixer Options

Fixed IF, Stepped RF and LO

Down Conversion Options

I = L - R

RF START Frequency (Mhz) RF Power Level (dBm)

1900.00 -10.00

RF STOP Frequency (Mhz)

2100.00

RF STEP Size (Mhz)

50.00

IF Frequency (Mhz) LO Power Level (dBm)

300.00 10.00

Input Frequencies	LO Frequencies	Output Frequencies
1900.00	2200.00	300.00
1950.00	2250.00	300.00
2000.00	2300.00	300.00
2050.00	2350.00	300.00
2100.00	2400.00	300.00
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00

SAVE AND EXIT CANCEL

Input Output Cal19.vi

File Edit Operate Tools Browse Window Help

Calibration

Calibration Panel | View Calibration Arrays Date/Time 4/5/02 12:16 AM

Power Meter Model
HP 436A

Waiting

Cal Step 1
Signal Generator 1 Input Cal

Input Cal Sig Gen 1 Power: -10.00

View Plots of Input Cal Data

Cal Step 2
Signal Generator 2 Input Cal

Input Cal Sig Gen 2 Power: -10.00

View Plots of Input Cal Data

Cal Step 3
Signal Generator LO Cal

Input Cal Sig Gen LO Power: 10.00

View Plots of LO Cal Data

Cal Step 4
Output Cal

Output Cal Sig Gen 1 Power: -10.00

Frequency Tolerance (MHz): 0.20

View Plots of Output Cal Data

Setup_Cal_Freq3.vi

Set Up Calibration Frequencies

Input START Freq (MHz)

Input Cal STOP Freq (MHz)

Input Cal STEP Freq (MHz)

Output START Freq (MHz)

Output STOP Freq (MHz)

Output STEP Freq (MHz)

LD START Freq (MHz)

LD STOP Freq (MHz)

LD STEP Freq (MHz)

Input Frequency Array	Output Frequency Array	LO Frequency Array
<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
<input type="text" value="700.00"/>	<input type="text" value="700.00"/>	<input type="text" value="1950.00"/>
<input type="text" value="710.00"/>	<input type="text" value="710.00"/>	<input type="text" value="1960.00"/>
<input type="text" value="720.00"/>	<input type="text" value="720.00"/>	<input type="text" value="1970.00"/>
<input type="text" value="730.00"/>	<input type="text" value="730.00"/>	<input type="text" value="1980.00"/>
<input type="text" value="740.00"/>	<input type="text" value="740.00"/>	<input type="text" value="1990.00"/>
<input type="text" value="750.00"/>	<input type="text" value="750.00"/>	<input type="text" value="2000.00"/>
<input type="text" value="760.00"/>	<input type="text" value="760.00"/>	<input type="text" value="2010.00"/>
<input type="text" value="770.00"/>	<input type="text" value="770.00"/>	<input type="text" value="2020.00"/>
<input type="text" value="780.00"/>	<input type="text" value="780.00"/>	<input type="text" value="2030.00"/>
<input type="text" value="790.00"/>	<input type="text" value="790.00"/>	<input type="text" value="2040.00"/>
<input type="text" value="800.00"/>	<input type="text" value="800.00"/>	<input type="text" value="2050.00"/>
<input type="text" value="810.00"/>	<input type="text" value="810.00"/>	<input type="text" value="2060.00"/>
<input type="text" value="820.00"/>	<input type="text" value="820.00"/>	<input type="text" value="2070.00"/>
<input type="text" value="830.00"/>	<input type="text" value="830.00"/>	<input type="text" value="2080.00"/>
<input type="text" value="840.00"/>	<input type="text" value="840.00"/>	<input type="text" value="2090.00"/>

Note: Separate calibration frequencies can be used for Input Frequencies, Output Frequencies, and LO Frequencies.


Configured?

ViewData2.vi

File Edit Operate Tools Browse Window Help

View Calibration Data

XY Graph

Plot 0 

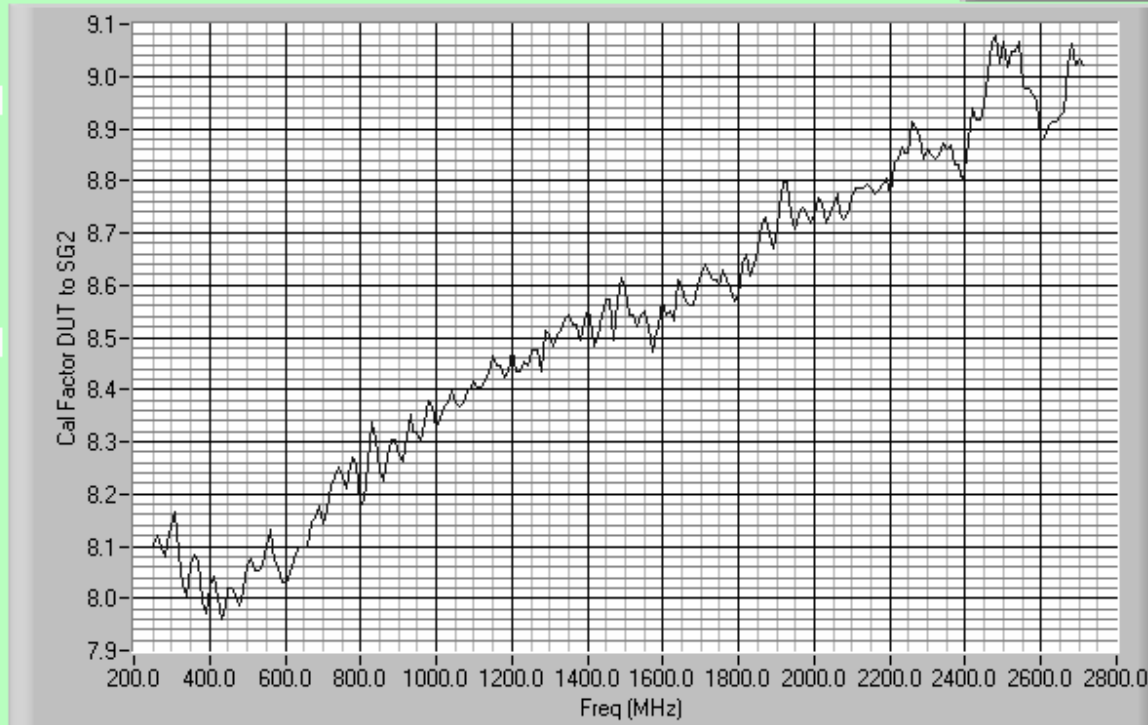
Calibration File

CAL_SG2_to_DUT.gbl 1

Last Cal Date: 8/13/02 11:05

Y Axis

Cal Factor DUT to SG2 3



AVERAGE

8.52

MIN OF DATA

7.96

MAX OF DATA

9.08

P-P FLATNESS

1.12

SLOPE

1.03

X-Axis

Freq (MHz) 0

EXIT

Set_up_test_equipment.vi

File Edit Operate Tools Browse Window Help

Set Up Test Equipment

Date/Time 4/5/02 12:16 AM

<p>Primary Signal Source for Gain, Gain Compression Tests</p> <p>Signal Generator 1 Model SG1 GPIB Address</p> <p>HP 8648C 18</p>	<p>Measurement Source (Spectrum Analyzer)</p> <p>Spectrum Analyzer Model SA GPIB Address</p> <p>NI 5660 18</p>
<p>Secondary Signal Source for Intermodulation Tests</p> <p>Signal Generator 2 Model SG2 GPIB Address</p> <p>HP 8648C 19</p>	<p>Calibration Source</p> <p>Calibration Source Model Cal GPIB Address</p> <p>HP 438A 16</p>
<p>Third Signal Source for Local Oscillator (LO)</p> <p>Signal Generator 3 Model SG3 GPIB Address</p> <p>HP 8648C 20</p>	

Comments Output File Path

LOAD SETUP SAVE SETUP EXIT

- Additional equipment (drivers) can be added and selected in this panel
- Once the drivers are added, this menu can be used to select your test setup

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