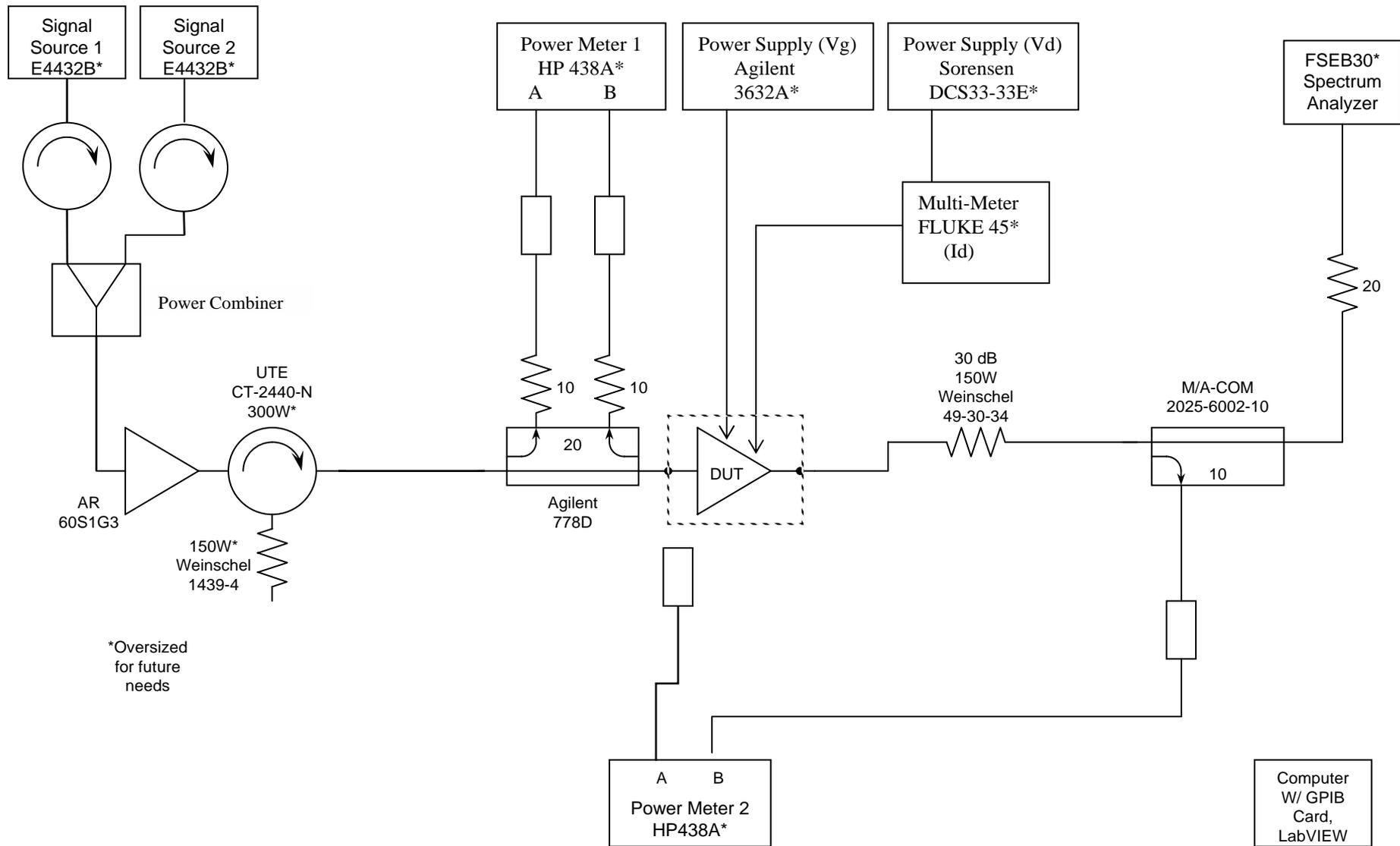




LDMOS RF Power Amplifier Automated Test System

- **This presentation provides a brief overview (excerpts) of an automated test system developed by R. A. Wood Associates**
- **Topics**
 - Test System Block Diagram
 - Main Test Panel
 - Calibration Panel
 - View Plots of Current Cal Data Panel
 - Configuration Panels
 - Various tests and parameters panels, test limits

LDMOS RF Power Amp Test System



*Oversized for future needs

*GPIB Controlled

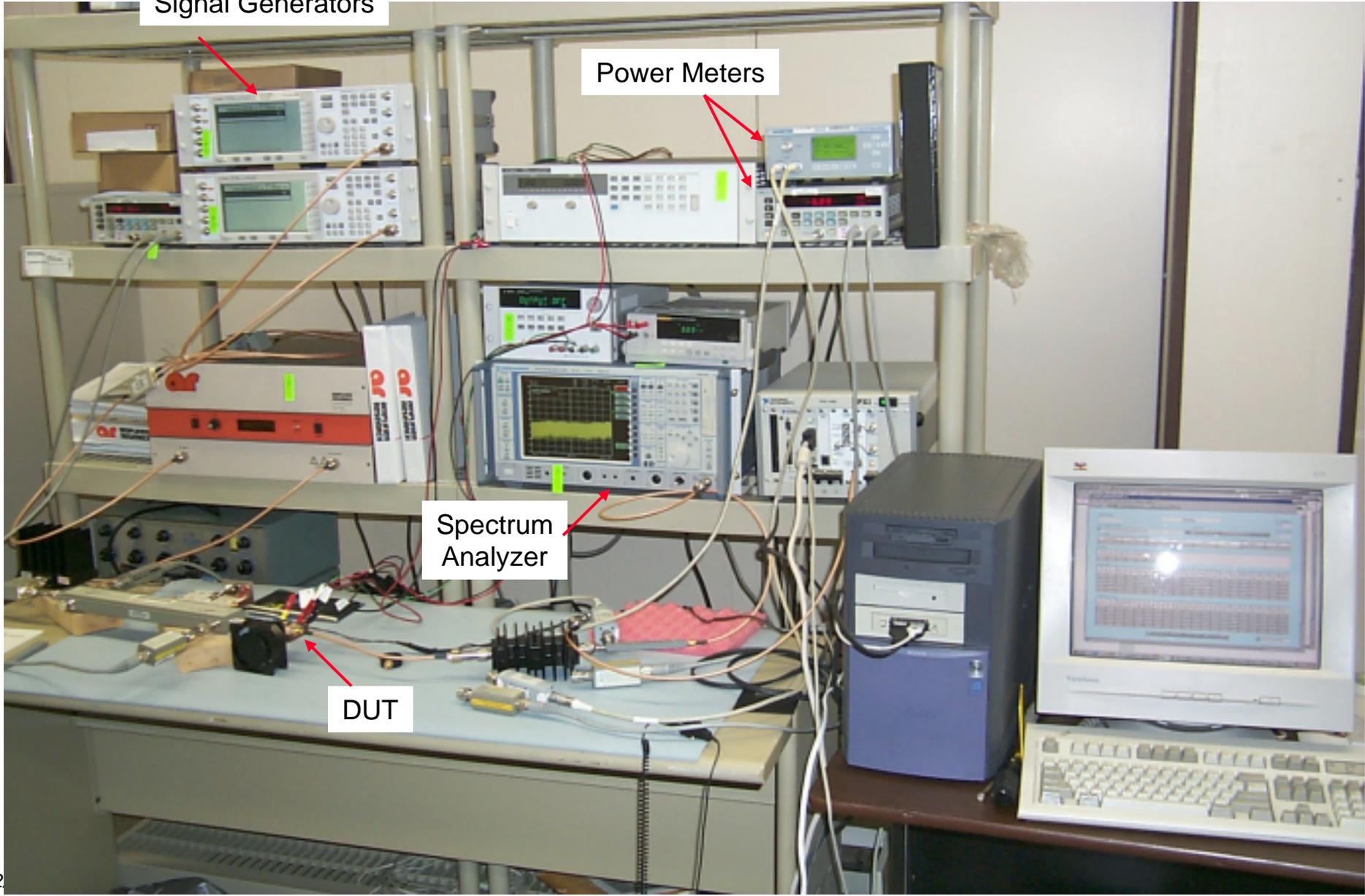
LDMOS Power Amplifier Test Setup (during software development)

Signal Generators

Power Meters

Spectrum Analyzer

DUT



- **2 Types of Main Test Panel Interfaces, selectable from a pull-down menu**
 - **“View Full Test Data”** Interface
 - Shows full-page test results for each part tested
 - Used primarily for Engineering tests
 - No Pass/Fail determination
 - Can also be used to view previous device measurements (administrator level)
 - **“View Summary Results”** Interface
 - Shows a line by line summary of each measurement in a text window
 - Pass/Fail determination is made for each test
 - Used primarily for Production tests
 - Shows history of each part in a Lot test (scrolling text window)
 - Yields and failure bins are also shown as the Lot test progresses

- **The program has two levels of operation: “Administrator” and “Operator”**
- **Operator Level:**
 - Primarily for running tests, for production personnel or technicians
 - Does not provide capability to set up test conditions
 - Calibration allowed
- **Administrator Level:**
 - Can be used for running tests or setting up test parameters and conditions
 - Configuration Panels allowed
 - Calibration allowed
 - Utilities Panel allowed
 - Capability to view previous part data allowed

Main Test Panel >> View Full Test Data Display (Administrator Level, before test start)

MultiPointDataPanel95.vi

File Edit Operate Tools Window Help

Serial Number: Test Time(sec):

Data Folder Location: Select Part: Units Tested:

User Data

User Name	Date	Time	Part #	Serial #	Lot	Data File	Config File

DC Tests

Vdd	Idq	Vgg	Ronq	Ronh	Gmq	Gmh	Comments
[Volts]	[Amps]	[Volts]	[V/A]	[V/A]	[A/V]	[A/V]	

Linear Tests

Freq	Pin	PoutLo	Rloss	Gain	Idd	Eff	Pae	-2ACP	-1ACP	-ACP	+ACP	+1ACP	+2ACP	IMD7L	IMD5L	IMD3L	IMD3H	IMD5H	IMD7H	
[Mhz]	[dBm]	[dBm]	[dB]	[dB]	[Amps]	[%]	[%]	[dBc]												

Compression Tests

Freq	Pin	PoutHi	Rloss	GC	Idd	Eff	Pae	-2ACP	-1ACP	-ACP	+ACP	+1ACP	+2ACP	IMD7L	IMD5L	IMD3L	IMD3H	IMD5H	IMD7H	
[Mhz]	[dBm]	[dBm]	[dB]	[dB]	[Amps]	[%]	[%]	[dBc]												

START LOT TEST UTILITIES CALIBRATION CONFIG STOP

Pull-down menu to select which test panel to display

Main Test Panel >> View Full Test Data Display (Administrator Level, after test)

Note: Some measured data blurred to protect customer info

MultiPointDataPanel95 vi

File Edit Operate Tools Window Help

Serial Number: Test Time(sec):

Data Folder Location: Select Part: Units Tested:

User Data

User Name	Date	Time	Part #	Serial #	Lot	Data File	Config File
administrator	12/7/01	3:52 PM	30w2aa	1	3232323	30w2aa_1_12-7-01	C:

DC Tests

Vdd	Idq	Vgg	Ronq	Ronh	Gmq	Gmh	Comments
(Volts)	(Amps)	(Volts)	(V/A)	(V/A)	(A/M)	(A/M)	
28.000	0.555	12.414	1.173	1.839	0.358	0.303	

Linear Tests

Freq	Pin	PoutLo	Rloss	Gain	Idd	Eff	Pae	-2ACP	-1ACP	-ACP	+ACP	+1ACP	+2ACP	IMD7L	IMD5L	IMD3L	IMD3H	IMD5H	IMD7H
(Mhz)	(dBm)	(dBm)	(dB)	(dB)	(Amps)	(%)	(%)	(dBc)											
1930.0	16.757	29.976	22.320	13.220	0.762	4.961	44.29	-61.19	-68.77	-63.53	-62.05	-68.10	-61.58	-65.80	-69.37	-65.14	-67.51	-70.89	-66.95
1960.0	16.984	30.008	27.115	12.924	0.773	4.629	43.98	-61.21	-68.68	-63.49	-62.00	-68.68	-61.21	-66.44	-67.26	-65.27	-67.21	-69.28	-67.24
1990.0	17.049	29.979	18.645	12.828	0.759	4.983	44.44	-62.12	-69.36	-63.53	-62.05	-68.77	-61.42	-68.12	-71.80	-65.17	-67.50	-71.68	-67.69

Compression Tests

Freq	Pin	PoutHi	Rloss	GC	Idd	Eff	Pae	-2ACP	-1ACP	-ACP	+ACP	+1ACP	+2ACP	IMD7L	IMD5L	IMD3L	IMD3H	IMD5H	IMD7H
(Mhz)	(dBm)	(dBm)	(dB)	(dB)	(Amps)	(%)	(%)	(dBc)											
1930.0	30.365	43.036	22.433	0.659	2.744	26.185	24.770	-46.98	-42.57	-34.67	-34.33	-42.15	-47.69	-52.91	-43.50	-34.42	-24.18	-48.33	-55.80
1960.0	30.725	43.005	19.365	0.633	2.726	25.607	24.052	-47.22	-42.28	-34.31	-33.98	-41.85	-47.79	-54.46	-43.57	-23.66	-23.09	-48.49	-55.91
1990.0	30.903	43.007	14.535	0.662	2.698	26.523	24.889	-47.88	-42.06	-34.28	-34.02	-41.97	-48.46	-55.14	-45.65	-23.78	-23.95	-42.09	-56.93

START LOT TEST UTILITIES CALIBRATION CONFIG STOP View Full Test Data

Main Test Panel >> View Summary Results Display (Administrator Level, after test)

MultiPointDataPanel96.vi

File Edit Operate Tools Window Help

Serial Number: **Waiting ...** Test Time(sec):
 Units Tested:

User Data

User Name	Date	Time	Part #	Serial #	Lot	Data File	Config File
administrator	12/26/01	8:09 PM	30w2aa	5	1234567890	30w2aa_5_12-26-0	C:\WINDOWS\

Test Results

Data Results for Shop Flow Lot No. 1234567890 Serial No. 5

ldi Number	Test Descriptors	Unit	low limit	Measured	hi limit	P/F
00000000055.0000	Eff Low 1930	%	0.000000e+00	0.000000e+00	6.200000e+00	P
00000000095.0100	Eff High 1930	%	0.000000e+00	0.000000e+00	3.500000e+01	P
00000000056.0000	Eff Low 1960	%	0.000000e+00	0.000000e+00	6.200000e+00	P
00000000095.0200	Eff High 1960	%	0.000000e+00	0.000000e+00	3.500000e+01	P
00000000057.0000	Eff Low 1990	%	0.000000e+00	0.000000e+00	6.200000e+00	P
00000000095.0300	Eff High 1990	%	0.000000e+00	0.000000e+00	3.500000e+01	P

Summary Info

Summary Info for Shop Flow Lot No. 1234567890

Bin	Count	Percent
1.00	5.00	100.00

START LOT TEST UTILITIES CALIBRATION CONFIG **STOP** View Summary Results

- Calibration Panel is used to calibrate the test station losses
- All Cal Steps must be run
- Use default signal levels shown if possible
- During Calibration, the software provides prompts and tells the operator what to connect

Top_Level_Calibration2.vi

File Edit Operate Tools Browse Window Help

Calibration Panel **Waiting** Note: All powers are in units of dBm

Cal Step 1: Loss to Input Power Meters Most Recent Cal 1 Date 7/3/01 1:02 PM

Cal 1 Sig Gen 1 Power: -33.00 Cal 1 PM 1A Min Power: -35.00 Cal 1 PM 1A Max Power: -13.00 View Plots of Cal Data 1

Cal Step 2: Signal 1 vs Signal 2 Balance Most Recent Cal 2 Date 7/3/01 1:20 PM

Note: Program uses same settings as Cal Step 1 View Plots of Cal Data 2

Cal Step 3a: 0 dB Return Loss Reference (Short) Most Recent Cal 3a Date 7/3/01 2:08 PM

Cal 3a Sig Gen 1 Power: -13.00 View Plots of Cal Data 3a

Cal Step 3b: 0 dB Return Loss Reference (Open) Most Recent Cal 3b Date 7/3/01 2:20 PM

Cal 3b Sig Gen 1 Power: -13.00 View Plots of Cal Data 3b

Cal Step 4: DUT Output Calibration Most Recent Cal 4 Date 7/3/01 2:45 PM

Cal 4 Sig Gen 1 Power: -20.00 Frequency Tolerance (MHz): 0.20 View Plots of Cal Data 4

Set Up Cal Frequencies
 View Test Setup
 View Plots of Current Cal Data
 Run Selected Calibrations
 Save Cal Data
 EXIT

Calibration Panel

Select Cal Step 1

Use default values for Cal

Select Cal Step 2

Select Cal Step 3a

Select Cal Step 3b

Select Cal Step 4

Top_Level_Calibration2.vi

File Edit Operate Tools Browse Window Help

Calibration Panel **Waiting** Note: All powers are in units of dBm

Cal Step 1: Loss to Input Power Meters Most Recent Cal 1 Date 7/3/01 1:02 PM

Cal 1 Sig Gen 1 Power: -33.00
 Cal 1 PM 1A Min Power: -35.00
 Cal 1 PM 1A Max Power: -13.00 View Plots of Cal Data 1

Cal Step 2: Signal 1 vs Signal 2 Balance Most Recent Cal 2 Date 7/3/01 1:20 PM

Note: Program uses same settings as Cal Step 1 View Plots of Cal Data 2

Cal Step 3a: 0 dB Return Loss Reference (Short) Most Recent Cal 3a Date 7/3/01 2:08 PM

Cal 3a Sig Gen 1 Power: -13.00 View Plots of Cal Data 3a

Cal Step 3b: 0 dB Return Loss Reference (Open) Most Recent Cal 3b Date 7/3/01 2:20 PM

Cal 3b Sig Gen 1 Power: -13.00 View Plots of Cal Data 3b

Cal Step 4: DUT Output Calibration Most Recent Cal 4 Date 7/3/01 2:45 PM

Cal 4 Sig Gen 1 Power: -20.00
 Frequency Tolerance (MHz): 0.20 View Plots of Cal Data 4

Set Up Cal Frequencies View Test Setup View Plots of Current Cal Data Run Selected Calibrations Save Cal Data EXIT

Most Recent Cal Date for current Cal Data

View Cal Data after Step 1

View Cal Data after Step 2

View Cal Data after Step 3a

View Cal Data after Step 3b

View Cal Data after Step 4

Calibration >> View Plots of Current Cal Data Panel

Cal_data_plot.vi

File Edit Operate Tools Browse Window Help

Select the Cal file to be viewed

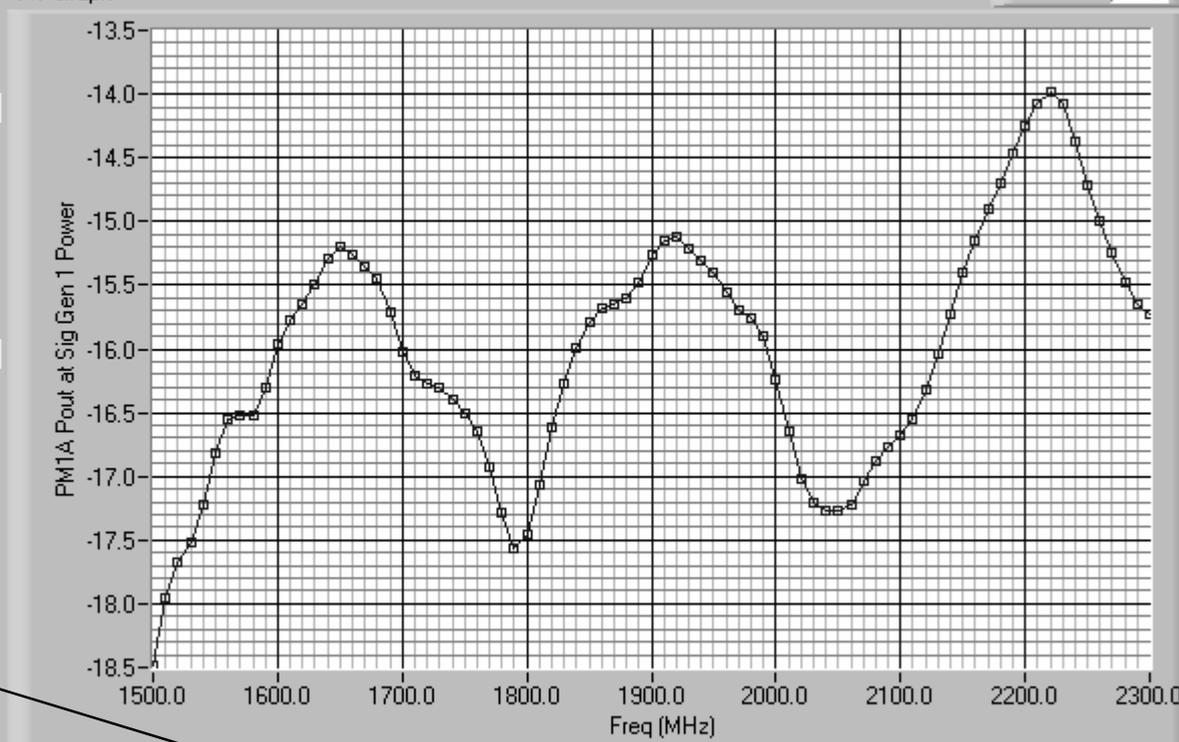
Calibration File
CAL_SG1_to_PM1A.gbl 0

Last Cal Date: 7/3/01 1:02 PM

Y Axis
PM1A Pout at Sig Gen 1 Power 2

View Calibration Data Utility

XY Graph Plot 0



Statistics of Cal Data

AVERAGE -16.01

MIN OF DATA -18.48

MAX OF DATA -13.98

P-P FLATNESS 4.50

SLOPE 1.56

Any column of data can be viewed for any Cal File

X-Axis
Freq (MHz) 0

EXIT

LDMOS RF Power Amp System Automated Measurements

- The Configuration Panel allows tests to be selected and defines the test parameters
- RF Measurements are performed at low power and high power
- Currently available tests are shown
- All test information and parameters are stored in Configuration files

Configure_Tests6.vi

Select and Configure Tests to be Run

Select	Test Name	Test Setup	Limits?
<input type="checkbox"/>	DC Tests	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Ronq	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Ronh	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Gmq Transconductance	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Gmh Transconductance	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Idq Setup	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	RF Tests Pout Low	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Pout Low Power Set	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Idq	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	ACP Pout Low	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	IMD 3 5 7 Pout Low	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Efficiency	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	PAE	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Return Loss	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	RF Tests Pout High	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	Pout High / X dB Gain Comp	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Idq	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	ACP Pout High	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	IMD 3 5 7 Pout High	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Efficiency	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	PAE	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Return Loss	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Other Setups	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Freq Band/Freq List	<input type="checkbox"/>	<input type="checkbox"/>

Stop on First Failure

SETUP FAILURE ALARM

Servoed Output Power High

LOAD CONFIGURATION FILE

SAVE CONFIGURATION FILE

RETURN

Configuration File

J:\Upload\Agere\Phase 3\baseline.cfg

Main Test Panel >> Configuration Panel

Configure_Tests6.vi

Select and Configure Tests to be Run

Select	Test Name	Test Setup	Limits?
DC Tests			
<input type="checkbox"/>	Ronq	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Ronh	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Gmq Transconductance	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Gmh Transconductance	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Idq Setup	<input type="checkbox"/>	<input type="checkbox"/>
RF Tests Pout Low			
<input type="checkbox"/>	Pout Low Power Set	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Idq	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	ACP Pout Low	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	IMD 3 5 7 Pout Low	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Efficiency	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	PAE	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Return Loss	<input type="checkbox"/>	<input type="checkbox"/>
RF Tests Pout High			
<input type="checkbox"/>	Pout High / X dB Gain Comp	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Idq	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	ACP Pout High	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	IMD 3 5 7 Pout High	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Efficiency	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	PAE	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Return Loss	<input type="checkbox"/>	<input type="checkbox"/>
Other Setups			
<input type="checkbox"/>	Freq Band/Freq List	<input type="checkbox"/>	<input type="checkbox"/>

Stop on First Failure

SETUP FAILURE ALARM

Servoed Output Power High

LOAD CONFIGURATION FILE

SAVE CONFIGURATION FILE

RETURN

Configuration File
J:\Upload\Agere\Phase 3\baseline.cfg

These buttons are used to select the tests to be run

These buttons show if the test has been configured

Stop tests after the first test fails or continue testing after failure

Configure the Failure Alarm

These tests are already configured, or do not need to be configured

This indicates whether the Pout High Test is servoed for a certain power level, or for X dB of gain compression

Load a file with test configurations already defined

Save all test configurations to a file for loading later

Current configuration file

Example Configuration >> IMD 3 5 7 Low Test Setup

Configure IMD 3 5 7 Low

Two Tone IMD Low Test Setup

Two Tone Low Start Gain (dB)
15.00

Two Tone Low Desired Output Power (dBm)
34.00

Two Tone Low Output Power Tolerance (+/-dB)
0.10

Two Tone Low Frequency Offset (MHz)
5.00

Two Tone Low Power Offset(dBm)
0.00

Max # of Iterations
0

Note: "Two Tone Low Desired Output Power (dBm)" is based on "Output Power Low Desired Output Power (dBm)" setting in the "Pout Low Power Set" configuration.

Define IMD Low Test Limits and More...

Test Limits Configured?

SAVE and EXIT CANCEL Test Setup Configured?