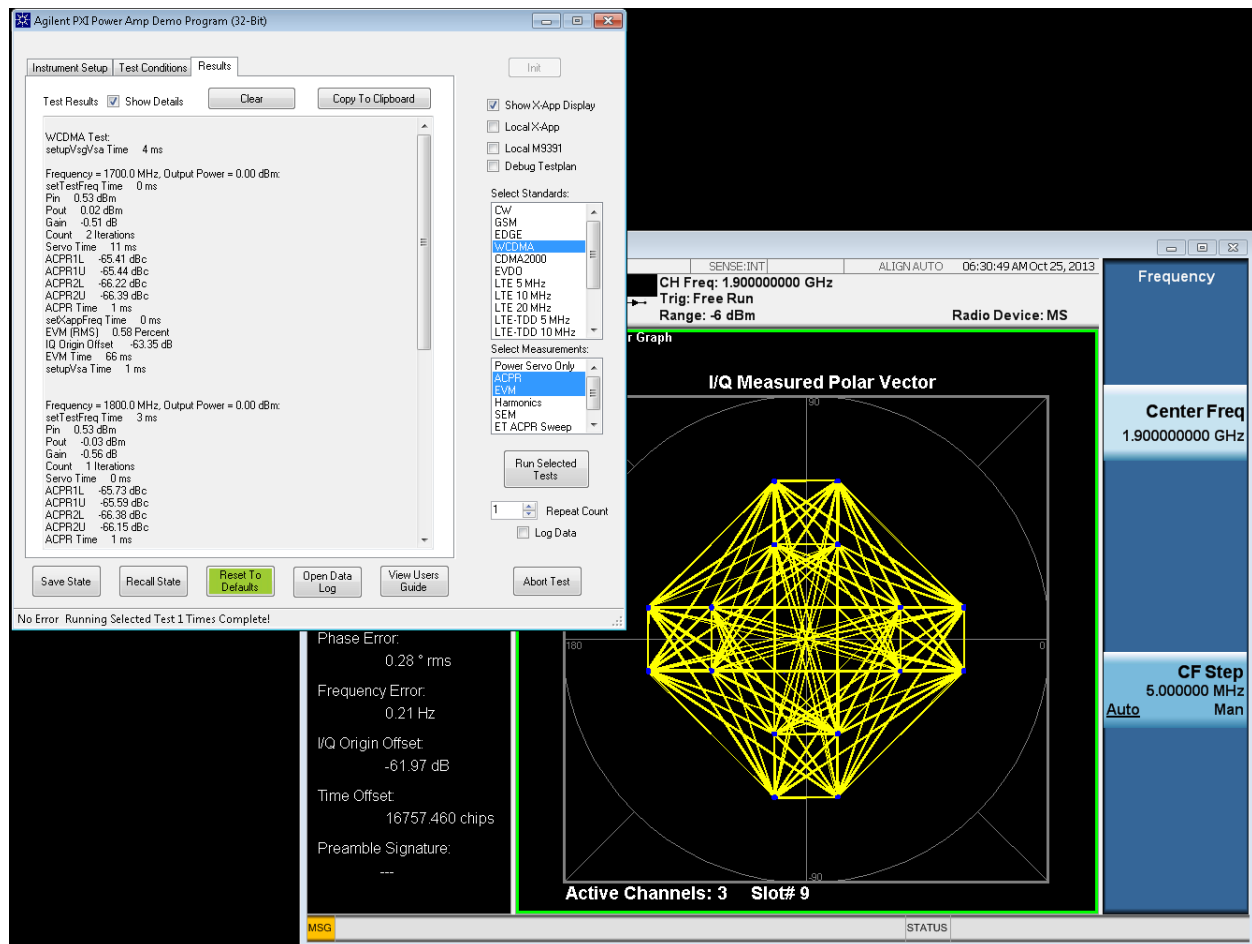


# Agilent PXI Power Amplifier Demo Program User Guide



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## Introduction

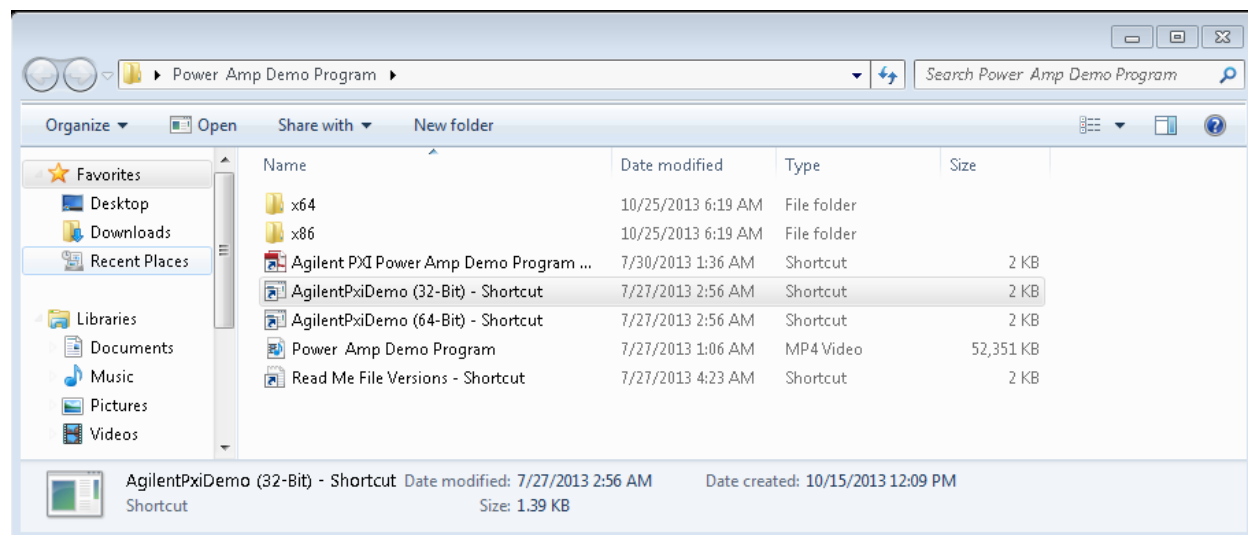
The Agilent PXI Power Amplifier Demo program uses the Agilent M9381A VSG, M9391A VSA and the M90XA Modular X-App programs to perform power amplifier measurements commonly used in the production test of these devices. The program supports multiple different measurements for cellular and wireless LAN standards. The program can be used to demonstrate the measurement speed, repeatability and ranges of measurements for the Agilent PXI instruments used in the program. The measurements can be performed on a wide range of amplifiers or on a through RF cable by configuring the settings in the user interface.

In addition to the PXI VSA and VSG, the program can control a 335322B AWG to provide an analog input for Envelope Tracking measurements, an Agilent power meter or USB power sensor to perform a system calibration and a SignalCraft Scout Model SC4410 to provide an RFFE stimulus to the DUT. Each of these instruments is optional and is not required to perform the basic VSA/G tests.

The PA Demo Program is C# Windows form Application. Source code for the program can be provided. Contact your local Agilent representative to obtain the source code for the program.

## Installation

The program will be provided in a zip file. Log onto the demo system using the “Demo” account name and copy the zip file to the desktop. Unzip to the current location. A folder named “Power Amp Demo Program” will be placed on the desktop. This folder will contain the 32 and 64 bit versions of the program. The folder also includes several short cuts. The Short cuts assume that the folder is on the Desktop of the “Demo” user name. The following screen shot shows the contents of the folder:



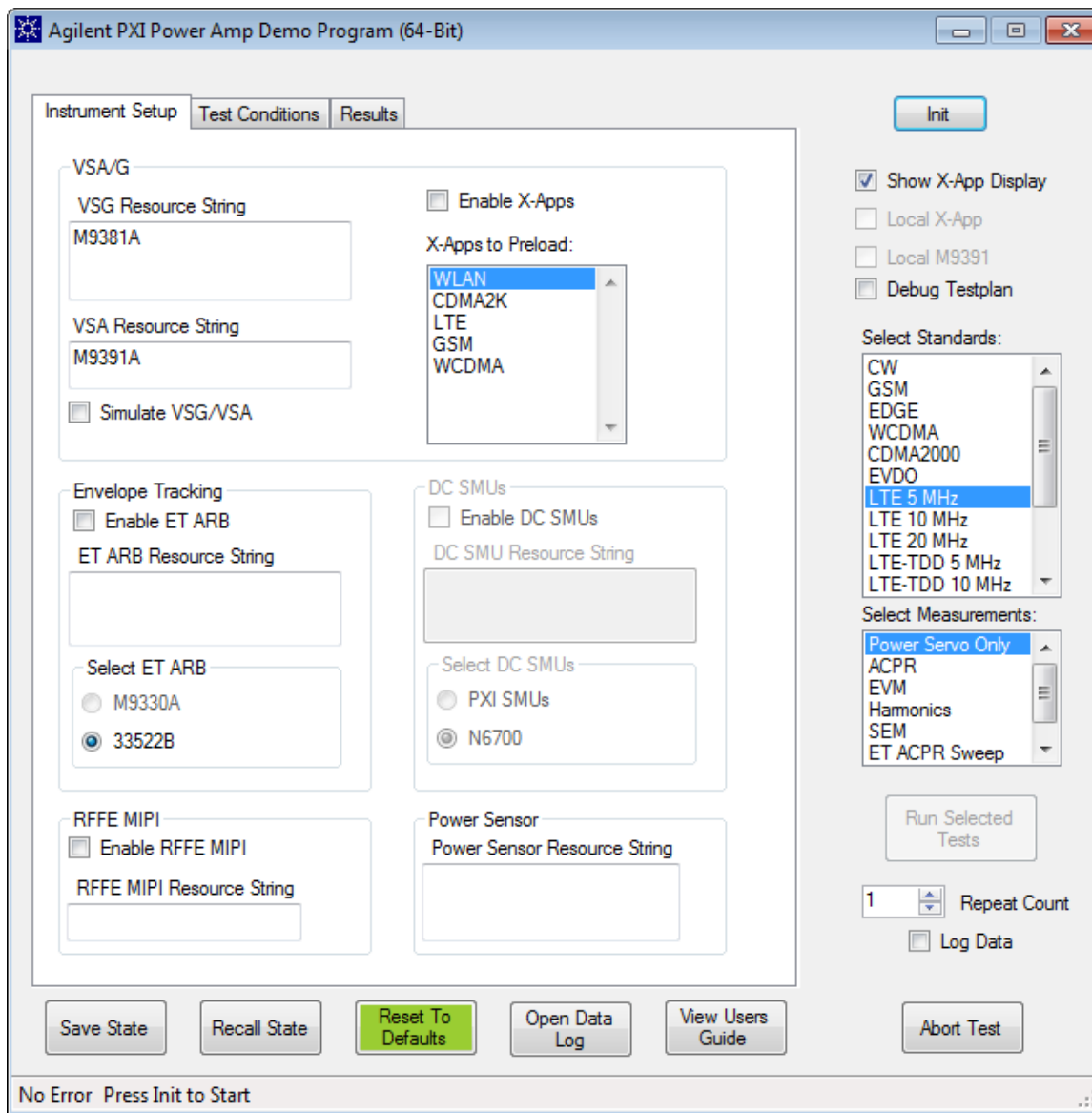
The M90XA X-App Software also requires licenses to run each X-App. The Power Amplifier Demo systems from Agilent will include the required licenses. To obtain a temporary license to run the program on a non-Agilent owned computer, please contact your local Agilent representative.

## Running the Power Amp Demo Program

The Power Amp Demo program provides a user interface to run the tests and display the results. The following is a screen capture of the GUI after the program is launched. Tool tip help is available for each control in the demo program by hovering the mouse over that control.

The Save State, Recall State and Reset to Default buttons will allow the user to save the current configuration of the user interface controls to a file, reload previous setting from a file or reset all of the values to a default condition.

The View Users Guide button will show this document. The program saves test result and time data to a .CSV file. The most recent data file can be opened by pressing the Open Data Log button



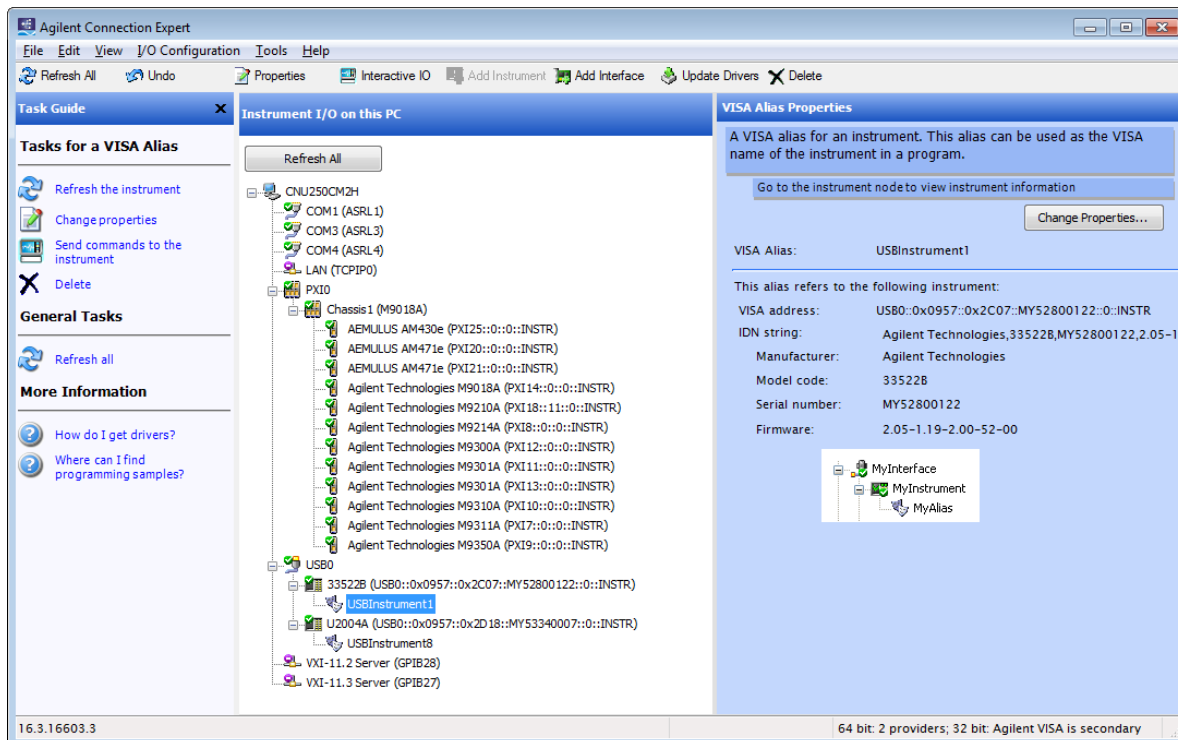
## Configuring the Instruments

The Instrument Setup tab includes fields to enter the VISA resource address for the VSG and the VSA and controls to configure the use of the M90XA X-App software. The VSG resource string can be either a list of the individual module addresses or the name of a saved configuration that was created with the M9381A SFP. The VSG will be controlled using the M938x IVI driver.

The VSA resource string is similar. However, if the X-App software is run, the resource string must be the name of a saved configuration from the M9391A SFP. The X-App software will be loaded if the Enable X-Apps check box is checked. In this case, the M9000 resource manager will be used to allow the VSA to be accessed both by the AgModularVsa IVI driver and by the X-App software. If the X-App software is not selected, the VSA will only be controlled by the AgModularVsa IVI driver. If the X-App software is loaded, one or more X-Apps can be selected from the list of applications to preload. The X-Apps in this list will be loaded as part of the initialization process. Other X-Apps can be used later in the program, but there will be a delay while they load. For best results, select the X-Apps to be used to be preloaded.

The 33522B Waveform Generator and Scout RFFE module can be enabled by checking the enable button for each and entering the VISA resource string. For the power sensor, enter the VISA resource string if the calibration procedure will be run.

The waveform generator and power sensor can be connected using USB. When using USB, use the Agilent Connection Expert to determine the VISA addresses for the instruments as shown in the following screen capture.

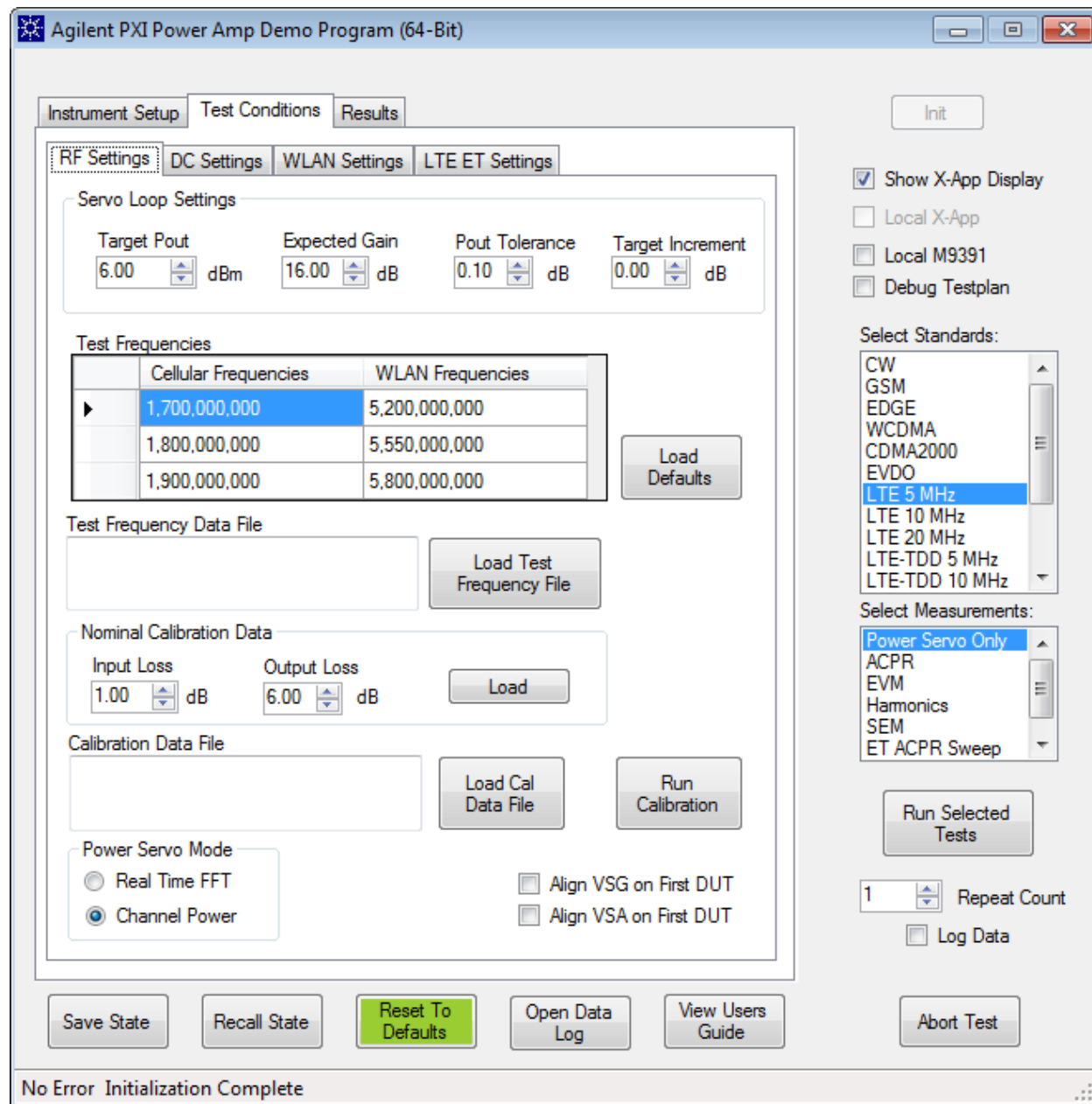


After the controls in the instrument setup have been set to the desired values, press the “Init” button to open the sessions to the instrument drivers and start the X-App software.

At the completion of using the demo program, the instruments will be closed by pressing the red X in the upper right corner of the user interface.

## Configuring the DUT Parameters

After the instruments are initialized, the program will switch to the DUT setup tab as shown in the following screen shot:



The controls in the Servo Loop Settings section are used to configure the power level setup for the tests. At the beginning of each test, the program will perform a servo loop to set the DUT output power level to the value in the Target Pout field. The Expected Gain parameter is used to set the RF Output Power from the VSG. The RF power level is set to the value that is 3 dB above the required output power of the VSG to achieve the Target Pout of the DUT. The VSG baseband power offset is set to – 3 dB. The baseband power offset value is varied in during the servo loop to achieve the correct power level at the DUT output. Using the baseband power offset function during the servo loop provides the fastest execution time. The Pout Tolerance field is used to determine how close the DUT output needs to be to the target output power for the servo loop to complete. The program will record the number of steps required to achieve the correct DUT output power. If the servo loop is not able to set the DUT to the correct value, the baseband power offset will be set to 0 dB and the step count will be set to -1.

The Target Increment field normally will be set to 0 dB. However, this field does allow the program to perform power level sweeps on the DUT when used in conjunction with the Repeat Count field. For example, with the above settings, if the Target increment field was changed to 1 dB and the Repeat count field was set to 10, the DUT tests would run ten times, each time at a target Pout level 1 dB above the previous run, providing data for DUT output power levels from -5 to + 4 dBm.

The program has two sets of default test frequencies. The values in the Cellular Frequencies column are used for all of the cellular standards, such as WCDMA and LTE. The WLAN frequencies are used for all of the 802.11x measurements. The frequencies can also be loaded from a CSV data file. The user can add any number of frequencies to a file. A sample frequency file is included in the program directory.

Input and output loss data can be specified in two manners. The Nominal Calibration Data values are used at all frequencies. To change these values, change the input and/or output loss values and then press the Load button. Calibration data can also be read from a CSV file, allowing different calibration values by frequency. When a calibration data file is used, the values will be interpolated so it is not necessary to supply calibration data for each test frequency. A sample calibration data file is also included in demo program directory. The Calibration data can also be calculated with an automated calibration routine that uses an Agilent power meter or USB power sensor. Press the “Run Calibration” button to begin the calibration procedure. There will be several prompts during the calibration procedure to connect the power sensor and the input and output cables. When the calibration procedure is complete a CSV data file described above will be generated and loaded, allowing the calibration to be used again at a later time.

WLAN and LTE have additional settings to enable and configure the envelope signal for LTE and the PA Enable signal used for Dynamic EVM measurements in WLAN. For WLAN the settings shown in the following screen capture are available to adjust the test conditions:

RF Settings DC Settings WLAN Settings **LTE ET Settings**

Pulse Settings

RF Duty Cycle: 50.0 % ☒ Dynamic EVM

Pulse Voltage: 2.50 V

DC Lead Time: 10.0 us

Trigger Delay: 200.0 ns

DC Lag Time: 10.0 us

Green = PA EnableSignal (ET ARB Generator)  
 Blue = RF Waveform Envelope  
 $\text{Duty Cycle} = T2 \cdot 100 / (T2 + T4)$   
 DC Lead Time = T1  
 DC Lag Time = T3

EVM Averages: 1 SEM Averages: 5

The Trigger delay is set to a nominal value allowing for the internal delays of the VSG and 33522B Waveform Generator. This value should not need to be changed, but could require slight changes under unusual cable setups.

For LTE Envelope tracking, the program supports adjusting the amplitude and offset of the envelope signal, allowing different drive levels from the 33522B that would be connected to the Envelope modulator near the DUT. The timing between the RF and envelope signals is set to the correct values for each sample rate used in the program. The IQ Delay Offset control allows for changes from the default setting.

RF Settings DC Settings WLAN Settings **LTE ET Settings**

Pulse Settings

☒ Enable ET

Amplitude: 0.432 Vpp

Offset Voltage: 0.440 V

IQ Delay Offset: 0.00 ns

The WLAN tests use waveforms with 100% duty cycle with off time added in a sequence to create the requested duty cycle. Different waveforms can be substituted by changing the data in the waveforms.csv file located in the demo program folder for either the x86 or x64 programs. The following screen capture shows the default values for the waveforms.



	A	B	C	D	E	F
1	gsmArb	.\	GSM 1 Frame.wfm			
2	edgeArb	.\	EDGE 1 Frame.wfm			
3	evDoArb	.\	evDO Reverse_WFM1.wfm			
4	wcdmaArb	C:\Program Files (x86)\Agilent\M938x\Example Waveforms\	WCDMA_UL_DPDCH_2DPDCH_1C.wfm			
5	cdma2000Arb	.\	cdma2000, R-Pilot, R-FCH, R-SCH.wfm			
6	//lte1_4MhzArb	.\	LTE_UL_FDD_RMC_1_4MHz_16QAM.wfm			
7	lte5MhzArb	C:\Program Files (x86)\Agilent\M938x\Example Waveforms\	LTE_UL_FDD_RMC_5MHz_16QAM.wfm			
8	lte10MhzArb	C:\Program Files (x86)\Agilent\M938x\Example Waveforms\	LTE_UL_FDD_RMC_10MHz_16QAM.wfm			
9	lte20MhzArb	C:\Program Files (x86)\Agilent\M938x\Example Waveforms\	LTE_UL_FDD_RMC_20MHz_16QAM.wfm			
10	lteTdd5MhzArb	C:\Program Files (x86)\Agilent\M938x\Example Waveforms\	LTE_UL_TDD_5MHz_64QAM.wfm			
11	lteTdd10MhzArb	.\	LTETU_QPSK_10M50RB.WAVEFORM			
12	WlanN20MhzArb	.\	80211nMCS7_20MHz.wfm			
13	WlanN40MhzArb	C:\Program Files (x86)\Agilent\M938x\Example Waveforms\	WLAN_11n_64QAM_40MHz.wfm			
14	WlanAC40MhzArb	.\	WLAN_11ac_40MHz_256QAM.wfm			
15	WlanAC80MhzArb	.\	WLAN_11ac_80MHz_256QAM.wfm			
16	WlanAC160MhzArb	.\	WLAN_11ac_160MHz_256QAM.wfm			
17						
18						

Column A contains the internal waveform description and should not be changed. Column B is a full or relative path to the waveform file. Column C contains the waveform name. .wfm files are generated by the Agilent Signal Studio programs. .WAVEFORM files are common to user generated files for the Agilent MXG. When using this file type there should also be a .MARKER and .HEADER file with the same base name. The default files are located either in the program folder or in the example waveform folder for the M9381A VSG. Files can be located anywhere as long as a valid path is specified in column B.

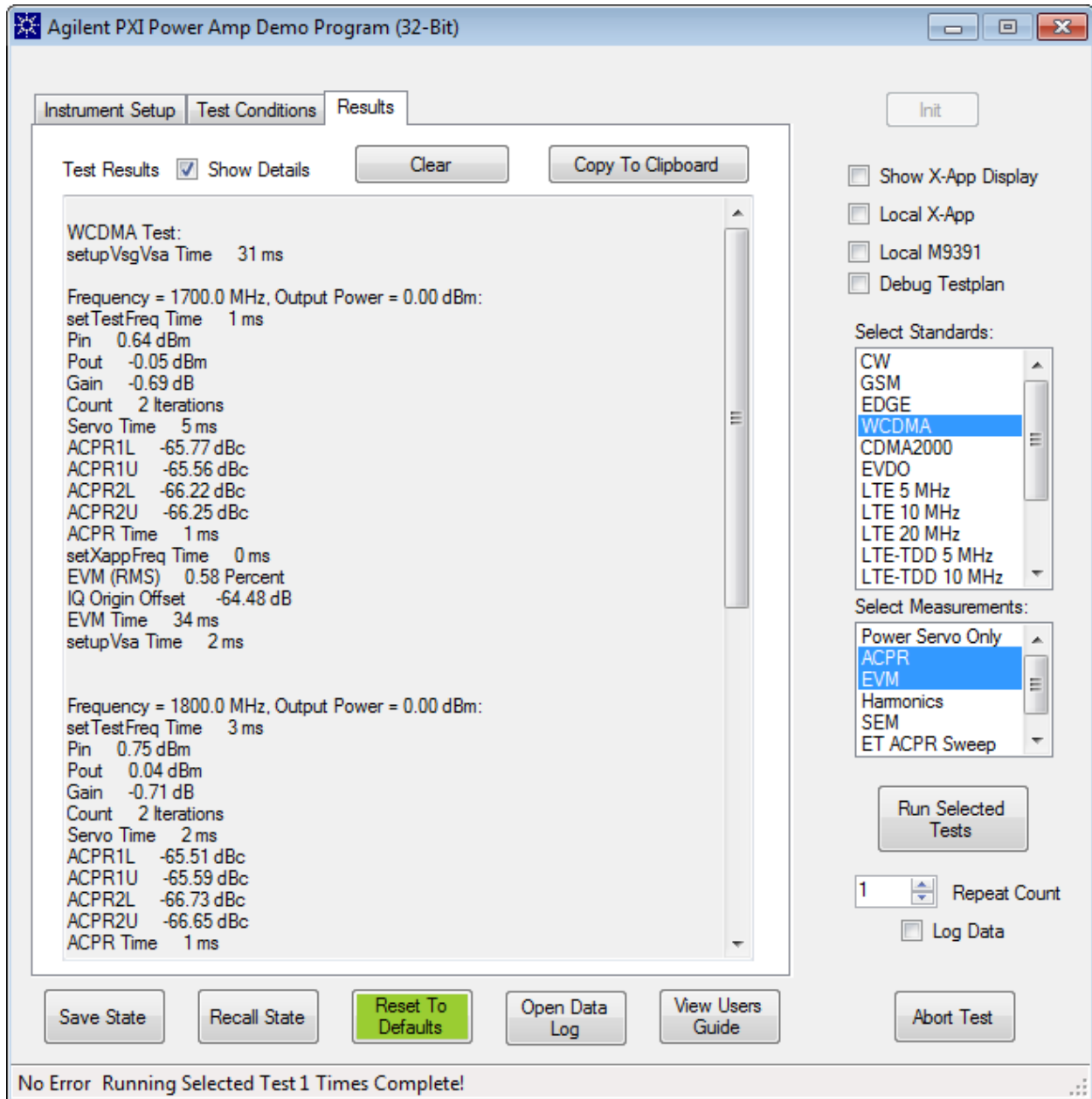
## Running Tests

The tests to be run are selected from the “Select Standards” and “Select Measurements” lists. Both lists allow selection of multiple items. The items do not need to be consecutive in the lists. For example, WCDMA and LTE 5 MHz can be selected from the standards list and ACPR and Harmonics can be selected from the measurement lists.

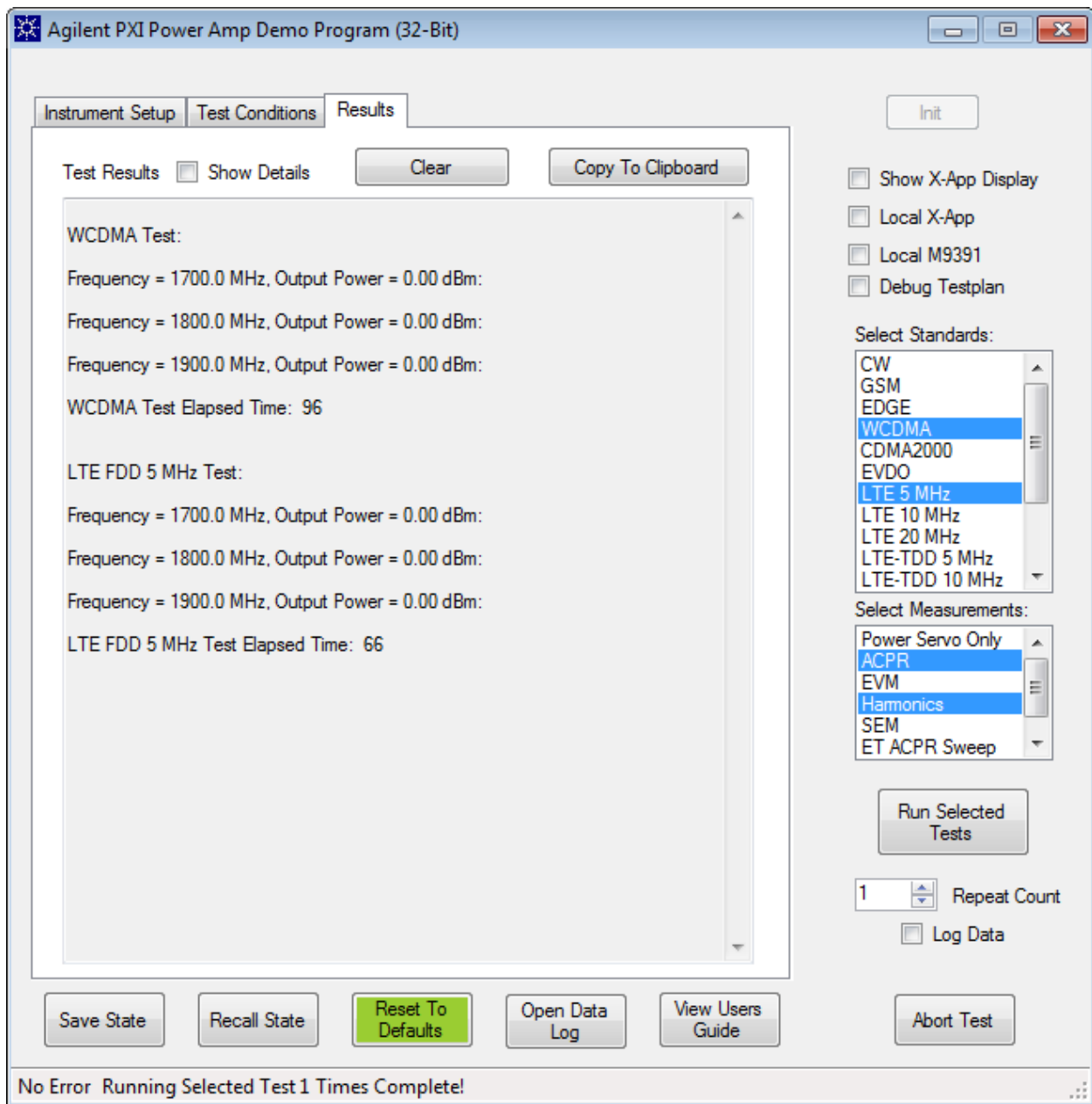
The program uses both the AgM9391 IVI driver and the M90XA Modular X-App software for measurements. Power Servo, ACPR and Harmonics measurements are performed using the IVI driver. EVM measurements for all standards and SEM measurements for WLAN standards are performed using the X-App software. For GSM and EDGE, if ACPR and EVM are selected, the X-App Combined Measurement will be used for EVM and ORFS.

When using X-App software, the X-App display can optionally be shown. If shown, the X-App display will be visible in a separate window. To obtain the best throughput the display should not be visible. The option to select the visibility can be changed at any time that tests are not running.

After selecting the desired values from these lists, the tests are performed by running the “Run Selected Tests” button. After running the tests, the user interface will switch to the test results tab as shown in the following screen shot:



For each test, the test conditions, measured values and test times will be shown in the results display. The total test time for each standard is shown at the end of the results for that standard. The detailed results can be omitted by unchecking the Show Details box. This will improve the test time and should be used to correctly measure throughput. The following screen shot shows the results display with the details not shown:



The Repeat Count field and Log Data option can be used to record measurement results and statistical variations of measured values.

To collect measurement repeatability data, set the repeat count to the desired value, check the Log Data box and set the Target Increment in the Servo Loop Settings section to 0 dB. The program will generate a CSV file that includes headers, all test results and formulas for statistics. The data files will be C:\Temp. A new file is generated each time the “Run Selected Tests” button is pressed if the log data box is checked. The file names will be logFile[TimeStamp]. The most recent data file can be loaded by pressing the “Open Data Log” button. This will launch the default program for .CSV files on the PC. The following screen shot shows the file loaded into Microsoft Excel:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Test	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA
2	Freq (MHz)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1850	1850	1850
3	Step	Pin	Pout	Gain	Count	Servo Tim	ACPR1L	ACPR1U	ACPR2L	ACPR2U	ACPR Tim	Second Har	Third Har	Harmonic	Pin	Pout	Gain
4	MAX	-17.06	-4.96	12.24	4	6	-64.35	-64.34	-65.2	-65.23	8	-63.2	-67.63	19	-16.43	-4.96	11.53
5	MIN	-17.21	-5.04	12.02	2	2	-64.67	-64.74	-65.42	-65.53	5	-63.65	-67.96	16	-16.52	-5.03	11.43
6	AVERAGE	-17.152	-4.991	12.16	2.6	2.9	-64.554	-64.543	-65.302	-65.329	6	-63.408	-67.834	17.9	-16.482	-5.006	11.478
7	STDEV	0.04638	0.026854	0.058119	0.699206	1.197219	0.098342	0.127806	0.066299	0.09712	0.942809	0.120536	0.100797	0.994429	0.028597	0.021187	0.032592
8	RANGE	0.15	0.08	0.22	2	4	0.32	0.4	0.22	0.3	3	0.45	0.33	3	0.09	0.07	0.1
9		-17.18	-4.99	12.19	2	3	-64.67	-64.54	-65.28	-65.28	6	-63.48	-67.85	17	-16.47	-5.02	11.45
10		-17.15	-4.99	12.16	3	3	-64.58	-64.39	-65.35	-65.23	5	-63.65	-67.81	19	-16.46	-5.03	11.43
11		-17.21	-4.97	12.24	3	3	-64.67	-64.58	-65.35	-65.4	6	-63.43	-67.96	18	-16.5	-5.02	11.48
12		-17.17	-5	12.17	2	2	-64.47	-64.51	-65.34	-65.38	5	-63.47	-67.86	19	-16.5	-4.96	11.53
13		-17.16	-4.99	12.17	3	3	-64.56	-64.64	-65.29	-65.26	6	-63.42	-67.91	18	-16.52	-5.01	11.51
14		-17.12	-4.96	12.16	3	3	-64.35	-64.46	-65.31	-65.25	6	-63.31	-67.69	19	-16.49	-5	11.5
15		-17.2	-5.03	12.17	2	2	-64.57	-64.7	-65.22	-65.25	5	-63.32	-67.88	17	-16.49	-5.01	11.48
16		-17.06	-5.04	12.02	2	2	-64.52	-64.34	-65.26	-65.3	7	-63.2	-67.86	18	-16.43	-4.98	11.46
17		-17.17	-4.96	12.2	4	6	-64.51	-64.74	-65.42	-65.53	8	-63.43	-67.89	18	-16.45	-5.02	11.44
18		-17.1	-4.98	12.12	2	2	-64.64	-64.53	-65.2	-65.41	6	-63.37	-67.63	16	-16.51	-5.01	11.5
19																	
20																	
21																	
22																	
23																	
24																	

Each column will include the measured values for one measurement at one test condition. Rows 1-3 include the test name, frequency and parameter name. Rows 4-8 include statistics. Each row below row 8 will include the data for one repetition of the measurements.

To collect data for different DUT output power levels, set the Target Increment value to the desired value, such as 1 dB. The following screen shot shows the log file from these test conditions:

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Test	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA
2	Freq (MHz)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1850	1850
3	Step	Pin	Pout	Gain	Count	Servo Tim	ACPR1L	ACPR1U	ACPR2L	ACPR2U	ACPR Tim	Second H	Third H	Harmonic	Pin	Pout
4	MAX	-7.98	3.96	12.22	5	5	-52.71	-53.07	-63.03	-63.07	7	-42.92	-55.91	21	-7.28	4
5	MIN	-17.18	-5.01	11.94	2	2	-64.51	-64.68	-65.4	-65.42	5	-63.58	-67.71	16	-16.5	-5.02
6	AVERAGE	-12.572	-0.5	12.069	2.6	2.7	-59.929	-60.099	-64.528	-64.592	5.9	-53.961	-64.355	17.8	-11.867	-0.509
7	STDEV	3.105689	3.019363	0.100161	0.966092	1.05935	4.0207	3.96562	0.749441	0.793541	0.567646	7.108137	4.146482	1.398412	3.118875	3.029692
8	RANGE	9.2	8.97	0.28	3	3	11.8	11.61	2.37	2.35	2	20.66	11.8	5	9.22	9.02
9		-17.18	-5.01	12.17	3	5	-64.51	-64.68	-65.04	-65.42	6	-63.58	-67.62	17	-16.5	-5.02
10		-16.21	-4.04	12.17	2	2	-63.84	-63.82	-64.85	-64.94	5	-62.17	-67.7	17	-15.59	-4.01
11		-15.1	-2.96	12.14	2	2	-63.86	-64.1	-65.4	-65.42	7	-60.08	-67.71	18	-14.32	-3
12		-14.21	-1.99	12.22	5	4	-62.72	-62.91	-65.02	-65.08	5	-57.92	-67.67	16	-13.45	-2
13		-13.02	-0.96	12.06	3	3	-60.7	-60.86	-63.03	-63.07	6	-55.64	-66.45	18	-12.32	-1.03
14		-12.02	0.02	12.03	2	2	-60.18	-60.23	-63.69	-63.8	6	-53.11	-65.8	18	-11.27	-0.01
15		-10.98	1.02	12	3	3	-58.58	-58.95	-63.9	-63.88	6	-50.51	-63.7	17	-10.45	1.01
16		-9.95	2	11.94	2	2	-57.09	-56.83	-64.63	-64.61	6	-48.05	-61.64	17	-9.29	1.99
17		-9.07	2.96	12.02	2	2	-55.1	-55.54	-64.62	-64.43	6	-45.63	-59.35	19	-8.2	2.98
18		-7.98	3.96	11.94	2	2	-52.71	-53.07	-65.1	-65.27	6	-42.92	-55.91	21	-7.28	4
19																
20																
21																
22																
23																
24																

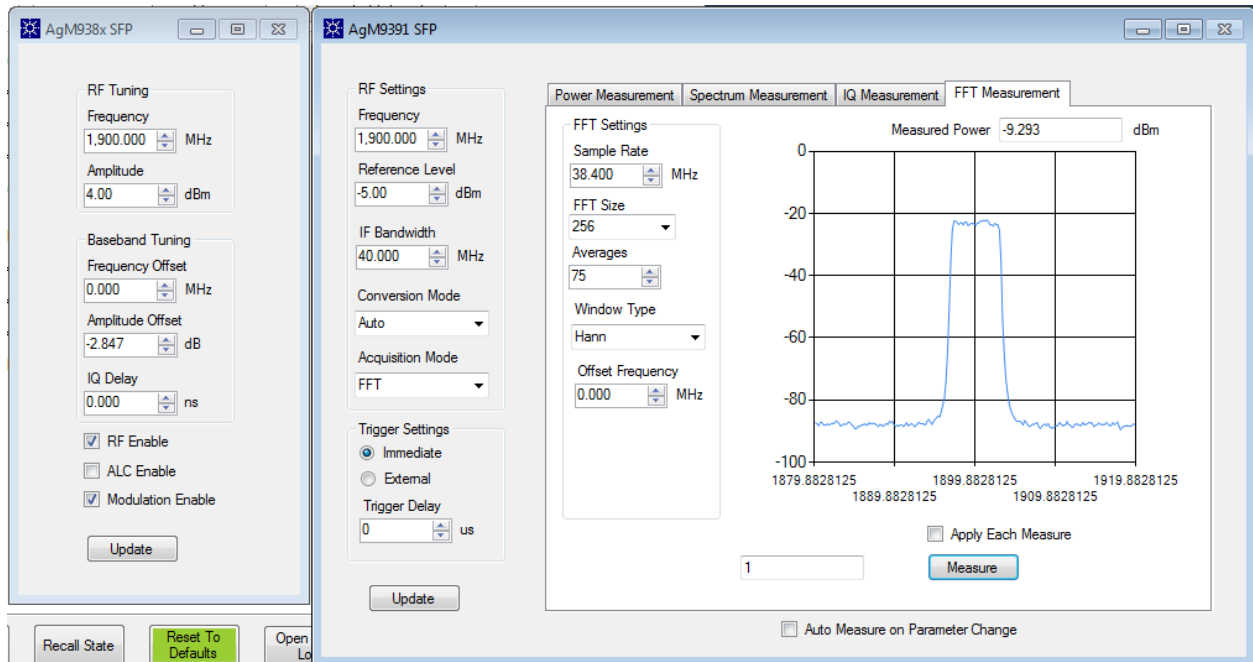
Note that the statistics are still calculated in this test, however the values will not be a true indication of measurement repeatability since the test condition is different for each repetition of the tests.

The Abort Button can be used to terminate the tests. The tests will be terminated at the completion of the current repetition, not immediately after the Abort Button is pressed.

### Local Control of Instruments

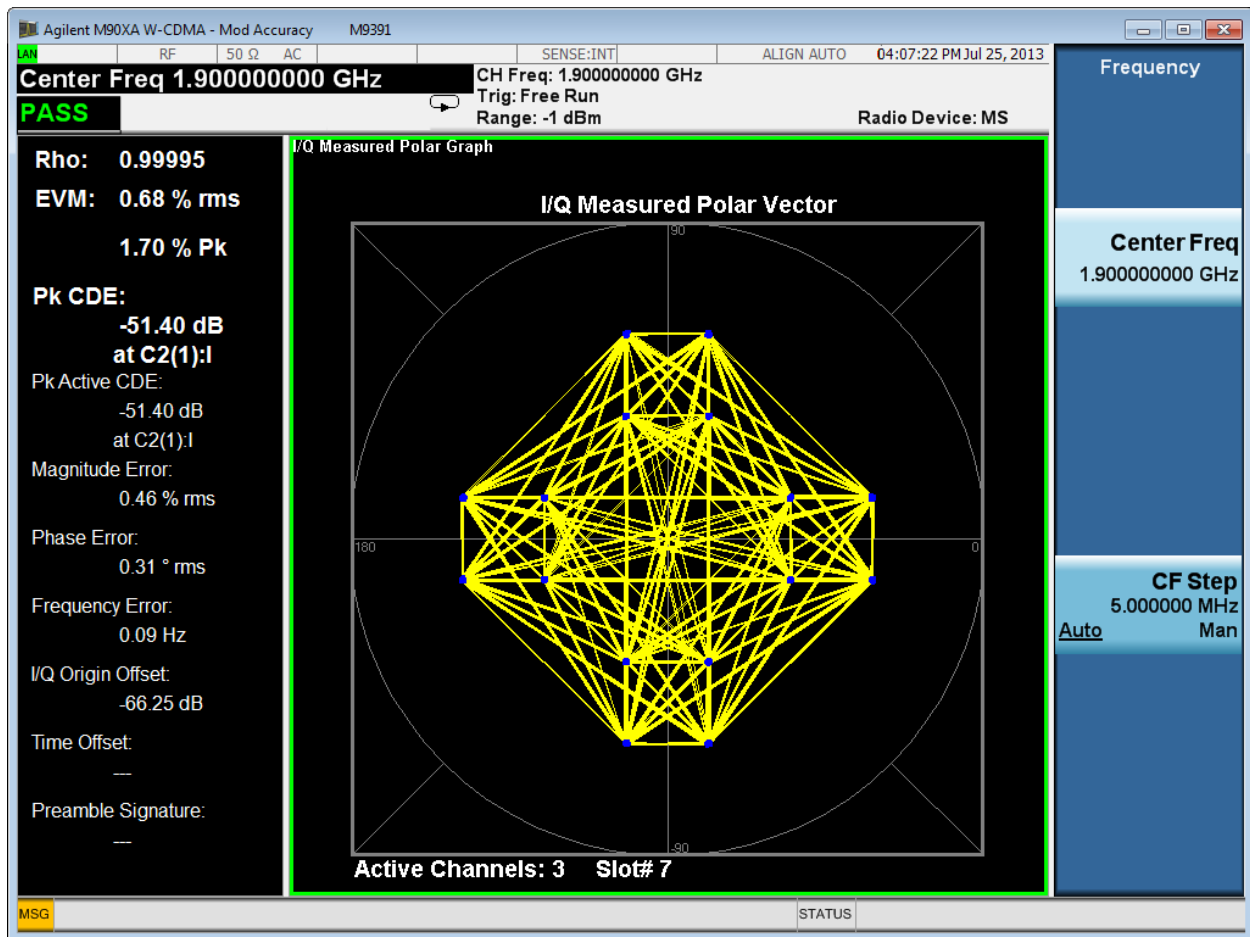
The power amp demo program allows interactive use of the VSG, VSA and X-App program. After the selected tests are run, the program will maintain the conditions of the last measurement. To go into local mode, select either the Local X-App or Local M9391 check boxes.

When the Local M9391 box is checked two windows will be shown. The first window will show the state of the M9381A and allow the displayed settings to be modified. The second window will show the state of the M9391A, allow settings to be changed and allow measurements to be performed in the each of the acquisition modes. The tabbed area of the AgM9391 SFP will automatically change to the selected Acquisition mode. The following screen shots show the two windows:



While local mode is enabled, the Run Selected Tests button is disabled. To end local control, uncheck the Local M9391 box.

When the Local X-App box is checked, the VSG display will be shown as above and the X-App display will be shown and the X-App will be put in continuous sweep mode, as shown in the following screen shot.



While local mode is enabled, the Run Selected Tests button is disabled. To end local control, uncheck the Local X-App box.