Agilent
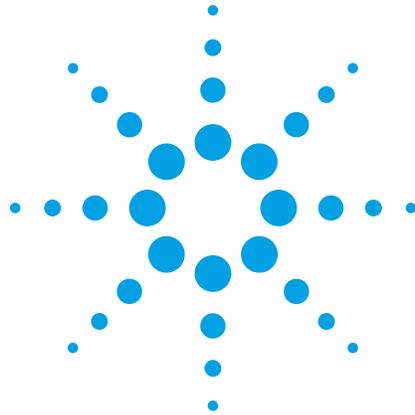# Measurement Wizard Assistant (MWA) Software for the ENA

Application Note

Agilent Technologies

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Introduction

In today's fast-paced testing environments, with increasing functionality supported in devices under test (DUTs), network analysis is becoming more and more complicated. Many components have multiple RF input and/or output ports making multiport measurement a requirement for total device characterization. Complex multiport devices also have more parameters that need to be measured requiring engineers to spend a lot of time setting up the measurement system, an expenditure that leads to a loss of efficiency in product development and manufacturing test. To accelerate time to market, device manufacturers need easy-to-use software that guides them through whole measurement procedure and minimizes the time spent on setup and measurements. Agilent Measurement Wizard Assistant (MWA) software for the Agilent ENA network analyzer simplifies measurement procedures. MWA software supports multiport measurement on the 4-port ENA using the E5092A configurable multiport test set(s).

This application note explains how using MWA software on the ENA simplifies measurements and reduces the setup time of complicated measurements. It provides you with a step-by-step guide to the MWA and useful measurement tips for using the software.

Product Overview

Figure 1 shows the overall concept of MWA software[1]. MWA consists of two main applications - the *Front-End* application handles complex parameter settings input with a PC and the *Back-End* application loads the setup file into the ENA and automatically sets the measurement parameters.

The Front-End application, running on the Microsoft® Excel, enables you to easily set up complex measurements. After you enter the parameters, the software automatically generates a setup file for the ENA that includes all parameters for network analysis such as power level, frequency range, IFBW or number of points. This application software is provided as a VBA macro on Excel and can be operated on any PC with Excel installed. Measurement parameters can now be entered using a PC, which reduces operating time and increases productivity.

The Back-End application runs on the ENA as a VBA macro. This macro provides the functions of spec sheet loading, calibration wizard, and limit test monitoring. The Back-End application imports the setup file (.mwa) generated by the Front-End application and uses it to automatically set up measurements on the ENA. The *Calibration Wizard* [2] takes you through the calibration steps necessary for all measurements. This wizard minimizes the number of required connections between the device under test (DUT) and calibration standards during the calibration procedure, eliminates the possibility of connecting to wrong ports, and saves operating time during calibration. Measurement procedures are fully controlled by the Back-End application. The software provides you with a wide variety of functions that allow you to customize your measurements for your applications. The Back-End application also provides detailed measurement results. You can view reports and get a detailed snapshot of your DUT's characteristics using a simple operation.

The following sections provide more details on the MWA's advanced functionality.

Front-End Application

- Software based on Microsoft Excel.
- Operates on any PC with Microsoft Excel installed.

Back-End Application

- Software based on a Microsoft VBA Macro working in the ENA.
- Option E5071C-790 for the ENA is required for full operation capability.

Setup file (.mwa)

Features
- Easy and fast measurement setup of the ENA.
- Generates one setup file (.mwa) that includes all measurement parameters.
- Step-by-step setup wizard with Excel-based user interface.

Features
- Recalls the .mwa setup file and sets all the parameters on the ENA automatically.
- Calibration wizard minimizes operation time.
- Automatic test procedures with go/no go limit test.

Figure 1. Overview of the Measurement Wizard Assistant software

1. ENA Option E5071C-790 ENA is required to enable full MWA software capability. Upgrade product (E5005A) is available as well. An evaluation version of the MWA software can be downloaded at: **www.agilent.com/find/mwa**
2. When using an ECal module with calibration wizard of the MWA, the 4-port ECal module (i.e. N4431B or N4433A) is required.

Front-End Application - Create the Spec Sheet

Before performing a measurement with the ENA, you must create a setup file. MWA software uses Excel spreadsheets to create this file via the Front-End application. When the Front-End application is opened, you will see that there are seven spreadsheets:

1. **Multiport Test Set**
2. **DUT**
3. **Mode**
4. **GPIB**
5. **Spec Sheet**
6. **Output**
7. **System**

This application note will go through these seven spreadsheets in succession starting with the *Multiport Test Set* sheet.

Step 1. Multiport Test Set setup

The *Multiport Test Set* sheet lets you select the appropriate instrument and measurement configuration (Figure 2).

1) Select configuration of the multiport test set[1] to be used for multiport network analysis (Figure 2a). Test set configurations can be customized for your application.

2) You can cascade two test sets for characterization of devices with a large number of ports (Figure 2b). In this case, port 1 to port 4 of the second test set are connected to the ports on the first test set by inputting each port number in the **Link** cell of the spreadsheet.

3) The available measurement paths are automatically displayed in the measurement connectivity matrix (Figure 2c). This provides the combination of ports on the ENA or the test set that is available for measurements. Note that measurements between ports cannot be performed if they share the same source or receiver port on the ENA. MWA software checks the internal architecture of the test set and automatically eliminates any configuration setup with this limitation.

(a) Select test set configuration **(c) Measurement connectivity matrix**

E5092A 22-Port

	1	2	3	4	Label	Link
5A	1				A1	
5B	1				A2	
6A	1				A3	
6B	1				A4	
1C	1				A5	
1D	1				A6	
8A		2			A7	
8B		2			A8	
2B		2			A9	
2C		2			A10	
2D		2			A11	
3A			3		B1	
9A			3		B2	
9B			3		B3	
10A			3		B4	
10B			3		B5	
3D			3		B6	
4A				4	B7	
4B				4	B8	
7A				4	B9	
7B				4	B10	
4D				4	B11	

(b) Select second test set (optional)

None

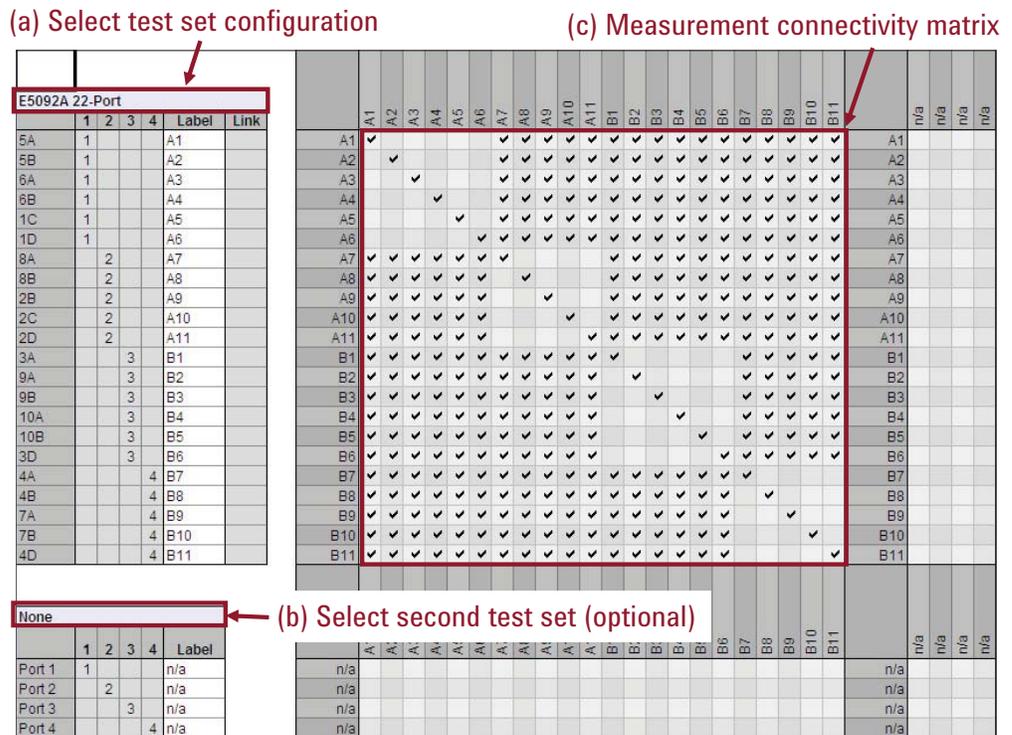|	1	2	3	4	Label
Port 1	1				n/a
Port 2		2			n/a
Port 3			3		n/a
Port 4				4	n/a

Figure 2. *Multiport Test Set* sheet (Front-End application)

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1. The Z5623A K64 and K66 multiport test sets only work with PNA-L Option 245.

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Step 2. DUT setup

1) The *DUT* sheet provides information on the device under test (DUT), connection to the ENA or multiport test set(s) ports, and testing parameters (Figure 3). You can assign names to the ports of the DUT (Figure 3a). When testing a component with differential ports, select **Differential** instead of **Single**. Use **Sub Label** to name each single-ended port of a differential pair (Figure 3b).

2) Select connection to the corresponding ports on the ENA or test set using the **Test Set Port** cells (Figure 3c).

3) All the parameters related to the *Fixture Simulator* functions of the ENA need be entered in this spreadsheet. These parameters are used to characterize the device ports or fixtures used in testing. Selecting the correct port impedance or port matching circuit of each port to increases the accuracy of DUT and fixture characterization. (Figure 3d).

(a) Assign port name of DUT

(d) Set parameters of the Fixture Simulator

(b) Name differential ports

(c) Assign ports of test set connected to DUT

Figure 3. *DUT* sheet (Front-End application)

Step 3. Mode setup

Components with integrated active devices require DC control line voltage
to select the active path of the device for testing. The *Mode* sheet defines
the operation mode of the DUT (Figure 4). The E5092A multiport test set has
4 independent DC sources that can supply DC control line voltage to a device
through a 15-pin or 25-pin D-sub connector on the front panel. Select **L** (low) or
H (high) voltage for each control bit in the spreadsheet to define the operating
mode of the DUT. ENA MWA software enables synchronized measurement of up
to 40 independent operation modes.

1) Assign a preferred mode name (Figure 4a). Test results for each mode are
    generated by the Back-End application after the measurements are performed.
    Turn the mode **ON** or **OFF** (Figure 4b). When a mode is turned off in this
    spreadsheet, you cannot set parameters in the Spec Sheet and measurements
    are not performed.

2) Set the **Control Line Voltage** for each control line. You can set up to 20 bits
    with the 4-independent DC sources (Group A to D) of the E5092A (Figure 4c).

3) Set the DC voltage for each **Group** (Figure 4d). DC control voltage is applied to
    the DUT from the internal DC sources of the E5092A.

Figure 4. *Mode* sheet (Front-End application)

Step 4. GPIB setup

The *GPIB* sheet is used to set GPIB commands for controlling other instruments. When the USB/GPIB interface (Agilent 82357B) is connected to the ENA you can use the ENA as a system controller to control external peripherals. This spreadsheet lets you set SCPI commands and specific measurement timing with the ENA. You can also set limit test values using the GPIB **Limit** cell. The ENA sends a query command to an instrument, the returned value is handled by the limit test in the ENA's Back-End application.

Figure 5 shows an example of GPIB command capability. This is a setup example of a DC voltage/current measurement using the Agilent 34410A digital multimeter connected to the ENA via the GPIB interface. The query command is given to the multimeter and the returned values are processed by the limit test in the Back-End application.

1) Set the GPIB address of the digital multimeter (Figure 5a).

2) Input the GPIB command for each mode (Figure 5b). GPIB commands registered in "INIT" mode are sent to peripherals when a spec sheet (.mwa) is recalled by the Back-End application. In this example, a "*RST" command is sent to the multimeter in advance of measurements.

3) Select the type of commands to be performed (Figure 5c). The returned value of a query command is used in the limit test by the Back-End application when **Limit** is selected. If **Pre** or **Post** is selected, the GPIB commands are executed before or after the measurement of the mode.

4) Define limit values used in limit test by the Back-End application (Figure 5d). SCPI commands can be sent to the ENA as well as peripherals, by assigning a GPIB address of "–1".

(a) Set GPIB address   (b) Input GPIB command   (c) Select type of command

Mode	Address	GPIB Command Command	Wait [ms]	Type	GPIB Limit Min	Max	Rank
INIT	23	*RST	0				
DUT1	23	INIT	0	Pre			1
	23	*TRG	0	Pre			1
	23	FETCH?	0	Limit		1000	1
DUT2	0		0	Pre			1
DUT3	0		0	Pre			1
DUT4	0		0	Pre			
DUT5	0		0	Pre			

(d) Define limit values

Figure 5. *GPIB* sheet (Front-End application)

Step 5. Spec Sheet setup

All the measurement parameters on the ENA and specified values for the limit test should be input into this spreadsheet. A detailed explanation for each parameter is given below.

1) Specify measurement paths by selecting input and output ports of the DUT (Figure 6a). The port names of the DUT were previously assigned in the DUT sheet. You can add more measurement paths to the mode of interest by double-clicking in the **Mode** cell.

2) Select the format type of measurement parameters (Figure 6b). You can select:
Transmission: **IL** (insertion loss), **Ripple**, **ATT** (attenuation), and **Isolation**
Reflection: **RL** (return loss) and **VSWR** (voltage standing wave ratio)
Transmission/reflection: **Phase**, **Group Delay**, **Lin Mag** (linear magnitude), **Real**, and **Imag** (imaginary)

Balanced (for differential): **BalAmp** (amplitude difference between balanced ports) and **BalPhase** (phase difference between balanced ports)

3) Set stimulus parameters such as frequency range, number of points, power level or IFBW on the ENA[1] (Figure 6c). Use the ENA frequency-offset mode when you need different frequency ranges for the source and receiver ports of the ENA. Enter the frequency range of the receiver in the **Rcvr Freq** cell.[2]

4) Enter the minimum and maximum threshold levels for limit test (Figure 6d). The Back-End application uses these limit values (DUT specifications) to perform the limit test returning measurement results for each path. If limit test measurements aren't required, these cells can be left blank. Blank cells are automatically interpreted as either –999 (MIN) or 999 (MAX).

(a) Set measurement paths   (b) Select format type   (c) Set stimulus parameters   (d) Define limit values

Mode	Path From		To	Type	Frequency [MHz] Start	Stop	Pts	Rcvr Freq [MHz] Start	Stop	Sweep Settings Power [dBm]	IFBW [Hz]	Sweep Mode	Spec Min	Max
DUT1	DUT1_In	->	DUT1_In	RL	50	18000	51			0.00	10,000	Std. Stepped	20	
	DUT1_In	->	DUT1_Out1	IL	50	18000	51			0.00	10,000	Std. Stepped		3
	DUT1_In	->	DUT1_Out2	IL	50	18000	51			0.00	10,000	Std. Stepped		5
	DUT1_Out1	->	DUT1_Out1	RL	50	18000	51			0.00	10,000	Std. Stepped	15	
	DUT1_Out1	->	DUT1_Out2	IL	50	18000	51			0.00	10,000	Std. Stepped		5
	DUT1_Out2	->	DUT1_Out2	RL	50	18000	51			0.00	10,000	Std. Stepped	15	
DUT2	DUT2_In	->	DUT2_In	RL	50	18000	51			0.00	10,000	Std. Stepped	20	
	DUT2_In	->	DUT2_Out1	IL	50	18000	51			0.00	10,000	Std. Stepped		3
	DUT2_In	->	DUT2_Out2	IL	50	18000	51			0.00	10,000	Std. Stepped		5
	DUT2_Out1	->	DUT2_Out1	RL	50	18000	51			0.00	10,000	Std. Stepped	15	
	DUT2_Out1	->	DUT2_Out2	IL	50	18000	51			0.00	10,000	Std. Stepped		5
	DUT2_Out2	->	DUT2_Out2	RL	50	18000	51			0.00	10,000	Std. Stepped	15	
DUT3	DUT3_In	->	DUT3_In	RL	50	18000	51			0.00	100,000	Std. Stepped		
DUT4	DUT4_In	->	DUT4_In	RL	50	18000	51			0.00	100,000	Std. Stepped		
DUT5	DUT5_In	->	DUT5_In	RL	50	18000	51			0.00	100,000	Std. Stepped		

Figure 6. *Spec Sheet* **(Front-End application)**

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1. If the value is out of the ENA's setting range, the Back-End application automatically sets it to the closet allowable value.

2. ENA Option E5071C-008 or upgrade product E5003A are required for this operation.

Step 6. Output setup

The *Output* sheet generates and saves a spec sheet (.mwa) that contains all the measurement parameters for the ENA. All the setup parameters input in the Front-End application are automatically assigned to the required channels of the ENA. This algorithm reduces errors and eliminates the need for independent allocation of the channels and traces on the ENA. It also minimizes the number of required traces by adopting a series of segment sweeps. This reduces the total throughput of testing and is especially beneficial in high-volume manufacturing environments. The number of allocated channels, traces and segments are displayed in this spreadsheet (Figure 7c). Note that the required maximum number of channels and traces must be selected in the ENA firmware before launching the Back-End application of the MWA.

1) Enter the maximum number of channels, traces and points on the ENA (Figure 7a).

2) Select **Save Spec Sheet** (Figure 7b) and a spec (.mwa) is generated and saved in a directory of the ENA.

(a) Set the maximum number of channels and traces on the ENA

(b) Generate and save a spec sheet

(c) Allocated channels and traces for measurement paths

Figure 7. *Output* sheet (Front-End application)

Step 7. System sheet

When a spec sheet is generated by a different version of the Front-End application, it may not be recalled properly by the software depending on software environment. The *System* sheet lets you save all the setup information as a .csv file so that it can be imported by a different version of the software.
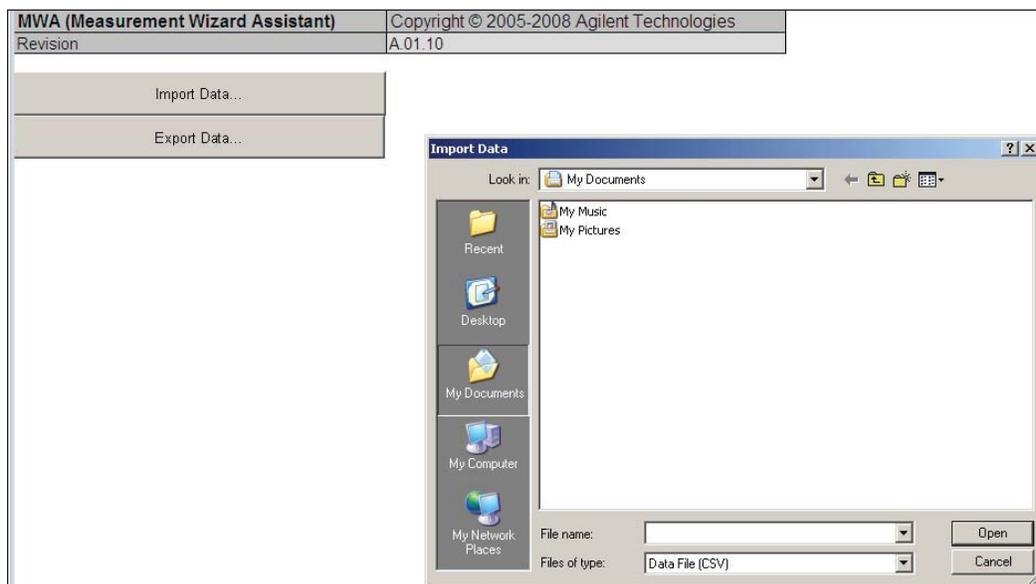

Figure 8. *System* **sheet (Front-End application)**

Back-End Application

The Back-End application runs on the ENA as a VBA macro program. This provides the following functionalities:

1. Import a spec sheet to the ENA for measurement setup
2. Perform calibration with the calibration wizard
3. Confirm connection between test system and DUT
4. Start measurements
5. Display measurement results

The necessary steps for measurements with the Back-End application will be described in detail in the following section.

Step 1. Import a spec sheet to the ENA for measurement setup

You must import a spec sheet (.mwa) to the Back-End application in advance of all measurement procedures.

1) Launch the Back-End application on the ENA by selecting **[Macro Setup]** > **Load Project** > select the latest version of MWA > **[Marco Run]**. The main MWA window appears on the ENA's display (Figure 9).
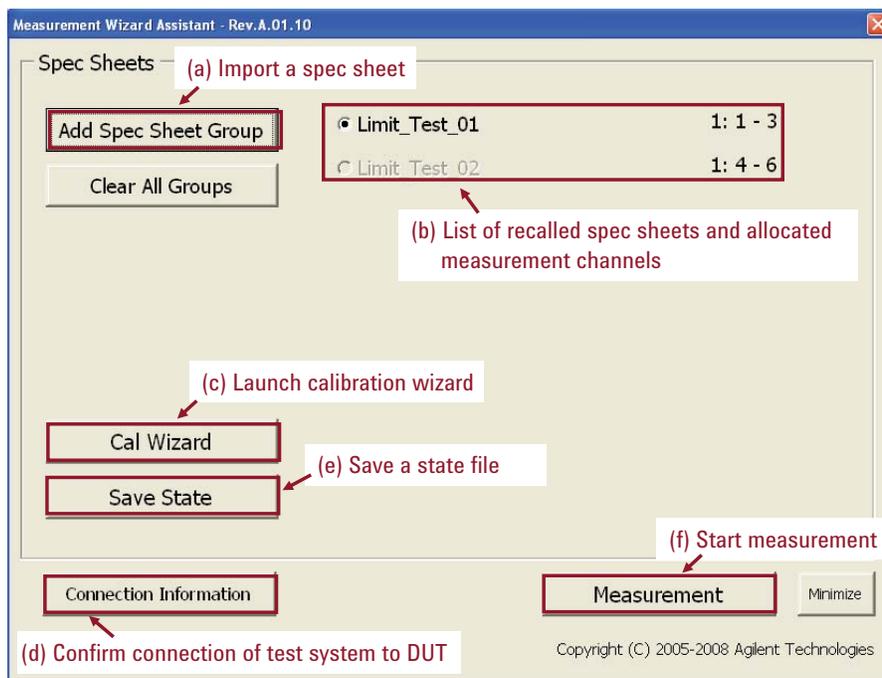

Figure 9. Main MWA window (Back-End application)

2) Click on **Add Spec Sheet Group** in the main window to select the spec sheet settings (Figure 9a).
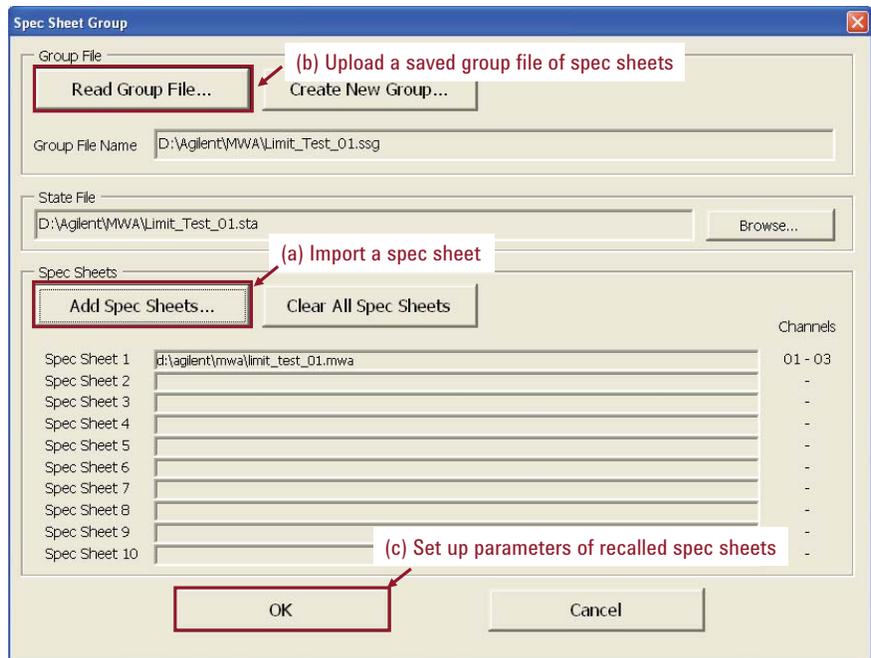
Figure 10. Spec Sheet dialog box (Back-End application)

1) A spec sheet generated by the Front-End application is recalled by selecting the **Add Spec Sheets** (Figure 10a). The recalled spec sheet is uploaded into a spec sheet group. Up to 10 independent spec sheets can be bundled within one group in the Back-End application so that you can perform measurements with different conditions (i.e. different limit values for limit test) on the same devices. Upload multiple spec sheets with **Add Spec Sheets** and click **OK**. The group file *.ssg is automatically generated. The generated group file can be uploaded for future use by clicking on **Read Group File** (Figure 10b).

2) Click **OK** (Figure 10c) in the dialog box to have the ENA download all the information on measurement parameters and automatically set them up on the ENA. This may take a few minutes if many parameters have to be set and a number of measurement channels are allocated for measurement. After this operation is completed, a state file (.sta) for the group is generated and automatically saved in the designated directory of the ENA. The number of groups and automatically-allocated channels of the ENA will be displayed on the main window (Figure 9b).

Step 2. Perform calibration using the calibration wizard

The calibration wizard function provided by the Back-End application gives instructions for the calibration procedure and computes all the error coefficients on all the allocated channels on the ENA. A software algorithm optimizes the sequence of connections between the ports and calibration standards reducing the number of required connections.

1) Select **Cal Wizard** in the main window (Figure 9b) and the Cal Wizard dialog box is displayed (Figure 11).

2) Select the type of calibration and the calibration standard: **Mechanical Cal Kit**, **4 Port ECal**, **Power Cal** or **Receiver Cal** (Figure 11a). A number of Agilent Technologies mechanical calibration standards can be used with the calibration wizard on the ENA. Agilent's electronic calibration module, 4 Port ECal, allows you customize the calibration procedure with user-defined characteristics (User 1 to 5). This ECal module enables accurate characterization of devices with different types of connectors.

3) Click on **Next** for the next step of the calibration procedure (Figure 11b). After clicking **Next**, this procedure may need to be repeated in order to assure that all necessary calibrations[1] have been performed.
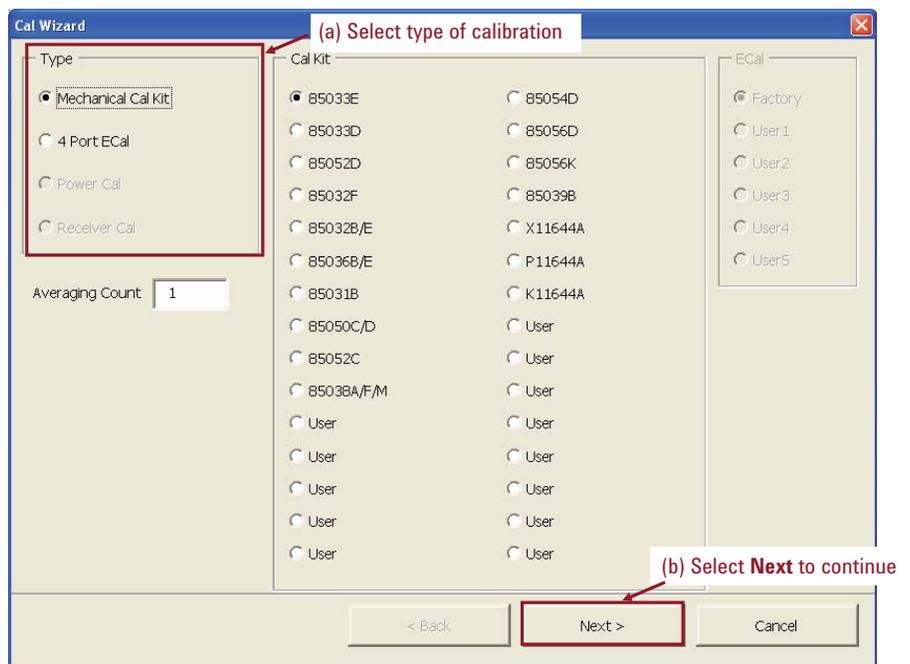
Figure 11. Calibration wizard dialog box (Back-End application)

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1. Calibration of the ENA is limited to 4 ports at one time.

As previously mentioned, the calibration wizard provides step-by-step instructions of the calibration procedure while minimizing the number of connections to calibration standards. When a connection is "grayed out" during the procedure, it means that you don't need to disconnect the standard from the port or change any settings before the next measurement sweep for calibration is made (Figure 12a). The current step and the total number of calibration steps are displayed in the title bar of the dialog box (Figure 12b).

The state file of the group is overwritten after all the calibration steps are completed.

(b) Calibration step (1 out of 2)

(b) Calibration step (2 out of 2)

Cal Wizard [1/2]

Port	Cal Kit
TS1 - 7 (1D)	4 Port ECal
TS1 - 4 (9COM)	4 Port ECal
TS1 - 5 (7COM)	4 Port ECal
TS1 - 10 (3D)	4 Port ECal

Measure

< Back   Next >   Cancel

Cal Wizard [2/2]

Port	Cal Kit
TS1 - 7 (1D)	4 Port ECal
TS1 - 8 (2D)	4 Port ECal

*Unnecessary to reconnect the gray colored Port/Cal Kit.

Measure

(a) DUT port is grayed out, no need to disconnect from ECal

< Back   Done   Cancel

Figure 12. Calibration wizard dialog box (Back-End application)

Step 3. Confirm connections between the test system and the DUT

The Back-End application offers a unique functionality which confirms correct connection between the DUT and the instrument ports. Select **Connection Information** on the main window (Figure 9d), to display connection information in the dialog box (Figure 13). This dialog box shows the ENA and multiport test set connected correctly (In this figure, "NA" stands for the ENA network Analyzer and "TS1" stands for the E5092A configurable multiport test set). This eliminates the possibility of connection between incorrect ports, and facilitates multiple connections for multiport network analysis.

Once all the steps have been completed, the state file for the group can be overwritten using **Save State** button in the main window (Figure 9e). This should be completed before testing begins.
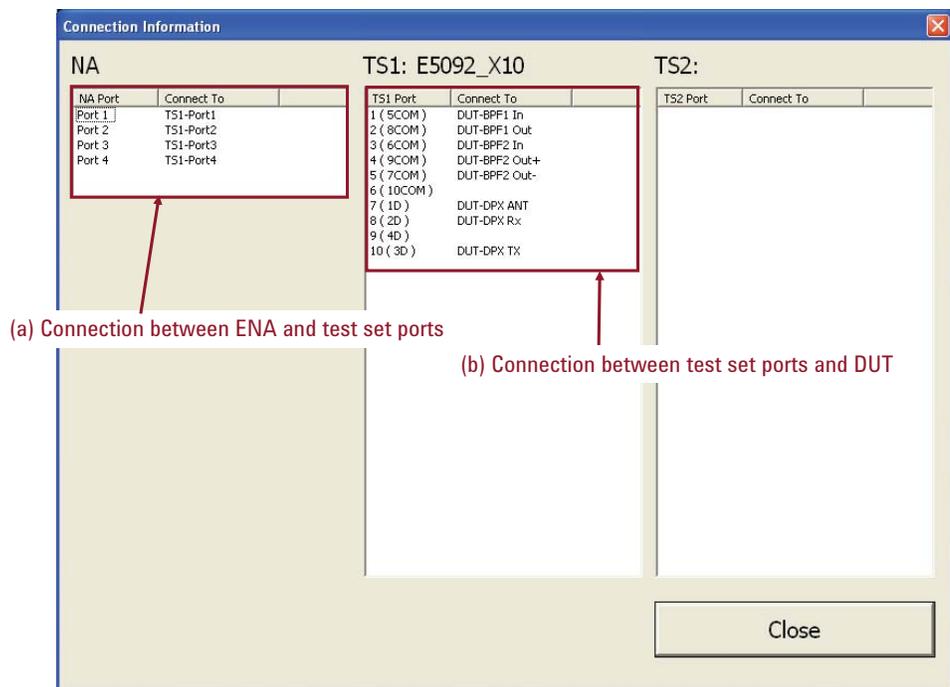
Figure 13. Connection Information dialog box (Back-End application)

Step 4. Start measurements

The Back-End application controls the overall measurement sequence of spec sheets. The software features a wide variety of measurement functionalities allowing you to easily customize measurement conditions for your application in the spec sheets.

1) Select **Measurement** on the main window of the Back-End application (Figure 9f) to start the measurement sequence and display the measurement window for all spec sheets (Figure 14). Measurement results for each spec sheet including overall pass/fail results, yield rates and approximate total testing time are summarized in measurement window (Figure 14a).

2) Select **Manual Trigger** to initiate the measurement using a manual trigger (Figure 14b). The summary of measurement results (Figure 14a) is updated after the measurement is performed.
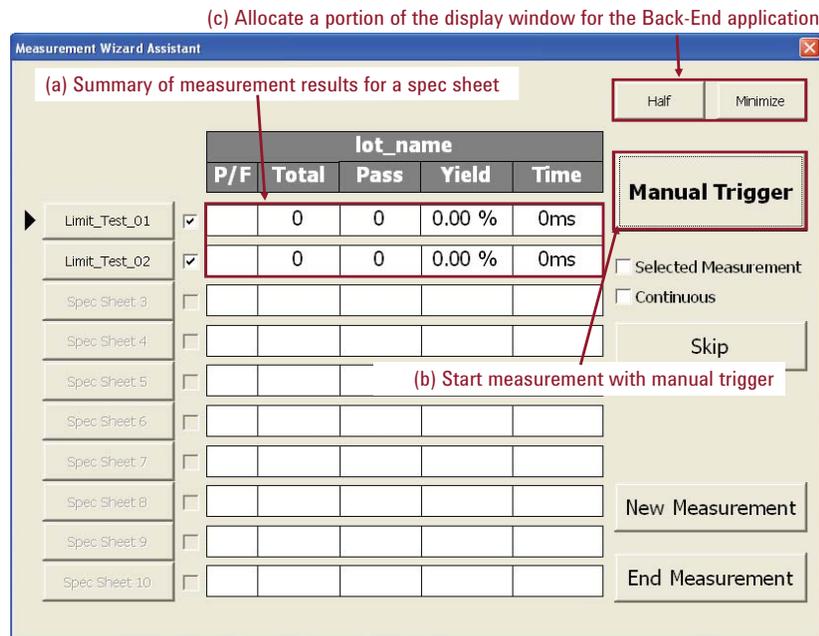
Figure 14. Measurement window for all spec sheets (Back-End application)

Step 5. Analyze measurement results

The Back-End application provides you with detailed measurement reports for more accurate analysis of DUTs. You can analyze the result of each measurement path of the DUT with different specifications using multiple spec sheets, and capture all the characteristics of the device with a single measurement.

1) Select the name of the spec sheet (Figure 15a), and the dialog box which is used for measurement by the spec sheet is displayed (Figure 15).

2) Select **Manual Trigger** (Figure 15b) to initiate measurement of the mode sheets. The total pass/fail result for the spec sheet is highlighted at the top of the dialog box (Figure 15c), and a detailed report is given for each operation mode.

3) Select a mode (Figure 15d) to display a detailed analysis report of the mode (result verification by mode). This contains the pass/fail result for each measurement path in the selected mode. Note that the limit test is performed with parameters retrieved from external peripherals as well.

(a) Select a spec sheet

(c) Total pass/fail result for the spec sheet

(d) Select a mode

(b) Start measurement by mode

Measurements of all
spec sheets

Dialog box for measurement
by spec sheet

Dialog box for
result verification
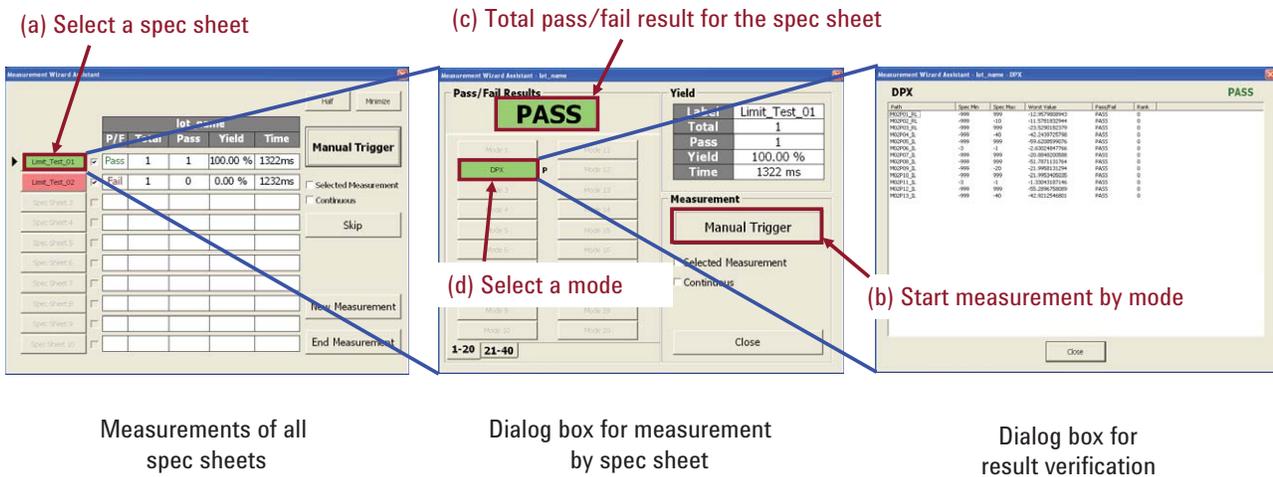
Figure 15. Measurement analysis with MWA software

In order to evaluate an actual trace of the DUT, there are **Half** and **Minimize** keys on top of the measurement window for all spec sheets (Figure 14c). This function allows you to re-arrange the measurement channel locations on the ENA. This provides you with better visibility of measurement traces and easy access to them for further investigation. When you select the **Half** button, the window of the Back-End application is located at the bottom half of the ENA display (Figure 16a). You can view the behavior of measured traces on the ENA display and easily examine the margin of the limit line tests. (Note you need to customize and define the channel scale on the ENA as this function is not supported by the MWA.) The bottom half of the window displays the number of channels and traces of failed measurement paths (Figure 16b), which you can refer to for more detailed information. If the check box of **Disp Enable** (Figure 16c) is selected in the dialog box, the display update function is activated; this updates images on the display of the ENA. This function should be disabled when fast testing speeds are required.

(a) Half window of Back-End application

(b) Failed result of measurement paths

(c) Checkbox of **Display Enable** function

(d) Minimized window of Back-End application
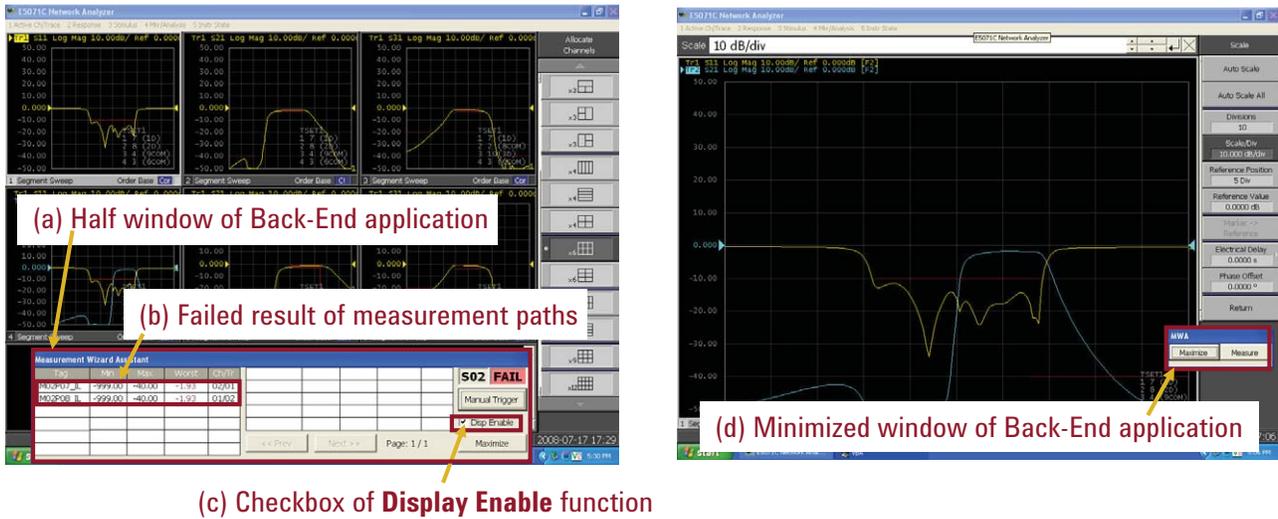
Figure 16. Half (left) and minimized (right) display window of the Back-End application

Measurement Example

A measurement example of the MWA Front-End application is provided in this section.

In this example, the DUT is an RF SP9T (single-pole, nine-throw) multiport switch (Figure 17). These switches are typically installed in cellular handsets with multi-band functionality. S-parameter measurements are performed on all paths out of the 10 ports while switching the output port of the DUT. The connected output port is determined by 4-bit logic control signals to Vc1 to Vc4 inputs. Power supply voltage is applied to the Vdd pin of the DUT. Both DC control voltages and power supply voltage are applied from the E5092A via a control line connector.
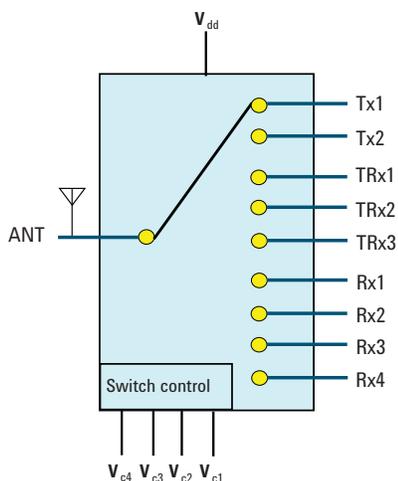
Figure 17. Block diagram of an SP9T multiport switch

(1) Configuration setup

A full crossbar measurement is required for this DUT, so the 10-port full crossbar configuration of the E5092A (E5092A X10-Port) should be selected in *Multiport Test Set* sheet of the Front-End application. The block diagram of the configuration is indicated in Figure 18. This configuration lets you make any 2-port measurement between the 10 ports of the DUT. See the measurement connectivity matrix (Figure 19).

Figure 18. Block diagram of a 10-port full crossbar configuration

Figure 19. Setup example of a *Multiport Test Set* sheet for a multiport switch

(2) DUT information

Characteristics for all ports of the DUT are entered into the *DUT* sheet. The effect of the fixtures used in the test can be eliminated by using functions on the ENA such as port extension de-embedding or port matching.

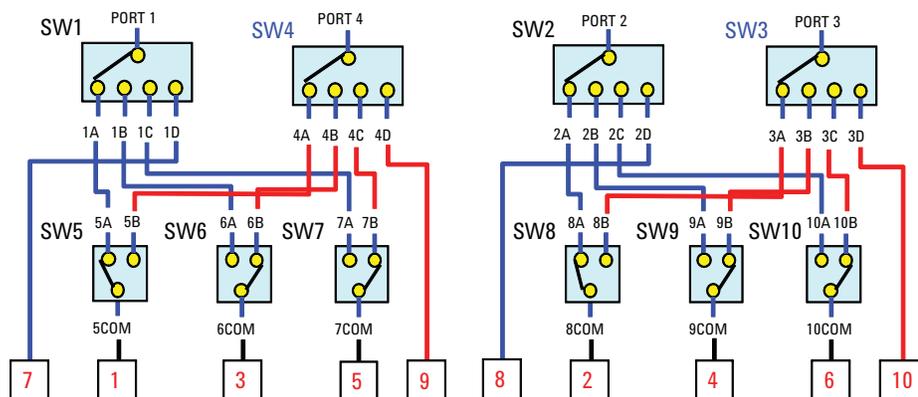|	DUT		Test Set	Z (Single)		Z (Balanced)			Extension	Embedding File	De-Embedding File		Port Mat
	Label	Sub Label	Port	R	X	Type	R	X	[nsec]	(s2p file in an NA)	(s2p file in an NA)	Type	C [F]
Port 1	ANT	ANT+	TS1: 1	50	0	Cmn			0		Fixture_ANT_port_file.s2p	NONE	0
	Single	ANT-		50	0	Diff			0			NONE	0
Port 2	Tx1	Tx1+	TS1: 2	50	0	Cmn			0.45			NONE	0
	Single	Tx1-		50	0	Diff			0			NONE	0
Port 3	Tx2	Tx2+	TS1: 3	50	0	Cmn			0.45			NONE	0
	Single	Tx2-		50	0	Diff			0			NONE	0
Port 4	TRx1	TRx1+	TS1: 4	50	0	Cmn			0.50			NONE	0
	Single	TRx1-		50	0	Diff			0			NONE	0
Port 5	TRx2	TRx2+	TS1: 5	50	0	Cmn			0.50			NONE	0
	Single	TRx2-		50	0	Diff			0			NONE	0
Port 6	TRx3	TRx3+	TS1: 6	50	0	Cmn			0.50			NONE	0
	Single	TRx3-		50	0	Diff			0			NONE	0
Port 7	Rx1	Rx1+	TS1: 7	50	0	Cmn			0			SLPC	1E-08
	Single	Rx1-		50	0	Diff			0			NONE	0
Port 8	Rx2	Rx2+	TS1: 8	50	0	Cmn			0			SLPC	1E-08
	Single	Rx2-		50	0	Diff			0			NONE	0
Port 9	Rx3	Rx3+	TS1: 9	50	0	Cmn			0			SLPC	1E-08
	Single	Rx3-		50	0	Diff			0			NONE	0
Port 10	Rx4	Rx4+	TS1: 10	50	0	Cmn			0			SLPC	1E-08

Figure 20. Setup example of a *DUT* sheet for a multiport switch

(3) Operating mode

The operating mode of the DUT during measurement is defined in the *Mode* sheet. Power supply voltage and DC control voltage for the selected operating mode of the DUT are supplied by the E5092A. The 4-bit signals of 2.8V from **Group A** are applied to the Vc1 to Vc4 inputs of the DUT for the control voltage, and 1-bit signal of 2.8V from **Group B** is applied to the Vdd input for power supply.

		Mode Label	Control Line Voltage Group A [TS1]								Control Line Voltage Group B [TS1]				Control Line Voltage Group C [TS1]				Control Line Voltage Group D [TS1]				DC Source Output Voltage [TS1] [V]			
			Vc1	Vc2	Vc3	Vc4	Vc5	Vc6	Vc7	Vc8	Vc1	Vc2	Vc3	Vc4	Vc1	Vc2	Vc3	Vc4	Vc1	Vc2	Vc3	Vc4	A	B	C	D
Mode 1	ON	Tx1	H	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	2.80	2.80	1.00	1.00
Mode 2	ON	Tx2	L	H	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	2.80	2.80	1.00	1.00
Mode 3	ON	TRx1	H	H	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	2.80	2.80	1.00	1.00
Mode 4	ON	TRx2	L	L	H	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	2.80	2.80	1.00	1.00
Mode 5	ON	TRx3	H	L	H	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	2.80	2.80	1.00	1.00
Mode 6	ON	Rx1	L	H	H	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	2.80	2.80	1.00	1.00
Mode 7	ON	Rx2	H	H	H	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	2.80	2.80	1.00	1.00
Mode 8	ON	Rx3	L	L	L	H	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	2.80	2.80	1.00	1.00
Mode 9	ON	Rx4	H	L	L	H	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	2.80	2.80	1.00	1.00

Figure 21. Setup example of a *Mode* sheet for a multiport switch

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(4) GPIB command setup

SCPI commands registered in the *GPIB* sheet are sent to a digital voltmeter at GPIB address 7 during measurement on the ENA. Returned query values are used for limit tests by the Back-End application.

Mode	GPIB Command				GPIB Limit		
	Address	Command	Wait [ms]	Type	Min	Max	Rank
INIT	7	*RST	0				
Tx1	7	INIT	0	Pre			1
	7	*TRG	0	Pre			1
	7	FETCH?	2	Limit		1e-3	1
Tx2	7	INIT	0	Pre			1
	7	*TRG	0	Pre			1
	7	FETCH?	2	Limit		1e-3	1
TRx1	0		0	Limit			1
TRx2	0		0	Limit			1
TRx3	0		0	Limit			1
Rx1	0		0	Limit			1
Rx2	0		0	Limit			1
Rx3	0		0	Limit			1
Rx4	0		0	Limit			1

Figure 22. Setup example of a *GPIB* sheet for a multiport switch

(5) Parameter setup

All the stimulus parameters for the measurement including frequency range, number of points, output power level and IFBW are set up in the *Spec Sheet* spreadsheet. Specification values of the DUT are entered for the limit tests in the Back-End application.

Mode	Path		Type	Frequency [MHz]			Rcvr Freq [MHz]		Sweep Settings			Spec		Co
	From	To		Start	Stop	Pts	Start	Stop	Power [dBm]	IFBW [Hz]	Sweep Mode	Min	Max	St
Tx1	ANT -> ANT		RL	800	930	51			0.00	100,000	Std. Stepped	20		
	Tx1 -> Tx1		RL	800	930	51			0.00	100,000	Std. Stepped	20		
	ANT -> Tx1		IL	800	930	51			0.00	100,000	Std. Stepped		1.5	
	ANT -> Tx2		Isolation	800	930	51			0.00	100,000	Std. Stepped	35		
	ANT -> TRx1		Isolation	800	930	51			0.00	100,000	Std. Stepped	35		
	ANT -> TRx2		Isolation	800	930	51			0.00	100,000	Std. Stepped	35		
	ANT -> TRx3		Isolation	800	930	51			0.00	100,000	Std. Stepped	35		
	ANT -> Rx1		Isolation	800	930	51			0.00	100,000	Std. Stepped	35		
	ANT -> Rx2		Isolation	800	930	51			0.00	100,000	Std. Stepped	35		
	ANT -> Rx3		Isolation	800	930	51			0.00	100,000	Std. Stepped	35		
	ANT -> Rx4		Isolation	800	930	51			0.00	100,000	Std. Stepped	35		
	Tx1 -> Tx2		Isolation	800	930	51			0.00	100,000	Std. Stepped	25		
	Tx1 -> TRx1		Isolation	800	930	51			0.00	100,000	Std. Stepped	25		
	Tx1 -> TRx2		Isolation	800	930	51			0.00	100,000	Std. Stepped	25		
	Tx1 -> TRx3		Isolation	800	930	51			0.00	100,000	Std. Stepped	25		
	Tx1 -> Rx1		Isolation	800	930	51			0.00	100,000	Std. Stepped	40		
	Tx1 -> Rx2		Isolation	800	930	51			0.00	100,000	Std. Stepped	40		
	Tx1 -> Rx3		Isolation	800	930	51			0.00	100,000	Std. Stepped	40		
	Tx1 -> Rx4		Isolation	800	930	51			0.00	100,000	Std. Stepped	40		
Tx2	ANT -> ANT		RL	1710	1920	51			0.00	100,000	Std. Stepped			
TRx1	ANT -> ANT		RL	800	960	51			0.00	100,000	Std. Stepped			
TRx2	ANT -> ANT		RL	1850	2000	51			0.00	100,000	Std. Stepped			
TRx3	ANT -> ANT		RL	1920	2170	51			0.00	100,000	Std. Stepped			
Rx1	ANT -> ANT		RL	820	925	51			0.00	100,000	Std. Stepped			
Rx2	ANT -> ANT		RL	925	960	51			0.00	100,000	Std. Stepped			
Rx3	ANT -> ANT		RL	1805	1880	51			0.00	100,000	Std. Stepped			
Rx4	ANT -> ANT		RL	1930	1990	51			0.00	100,000	Std. Stepped			

Figure 23. Setup example of a *Spec Sheet* spreadsheet for a multiport switch

Summary

This application note showed you how to simplify multiport measurements using MWA software with the ENA network analyzer and multiport test set. In most cases, measurement speed of the network analyzer is not the only factor in increasing throughput in testing. The time spent connecting the devices to measurement instruments, calibrating the instrument and setting up of the measurement parameters is much longer than actual measurement time of the network analyzer. Using the MWA software saves you a lot of setup and calibration time and eliminates many of the operator errors that can result in network analysis failure.

Required Hardware and Software for the ENA Multiport Solution

E5071C	ENA network analyzer
E5092A	Configurable multiport test set
E5071C-790 or	Measurement Wizard Assistant software
E5005A	Measurement Wizard Assistant software (upgrade product)

References

ENA Series Web page: **www.agilent.com/find/ena**

Multiport test sets Web page: **www.agilent.com/find/multiport**

MWA Web page: **www.agilent.com/find/mwa**

Related Literature

ENA Network Analyzers and E5092A Configurable Multiport Test Set Brochure, Literature number **5989-5478EN**

ENA Network Analyzers and E5092A Configurable Multiport Test Set Data Sheet, Literature number **5989-5479EN**

ENA Network Analyzers and E5092A Configurable Multiport Test Set Configuration Guide, Literature number **5989-5480EN**

Comprehensive Multiport Solution for the ENA Network Analyzer Application Note, Literature number **5989-8737EN**

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Revised: July 17, 2008

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Printed in USA, September 30, 2008
5989-4855EN

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