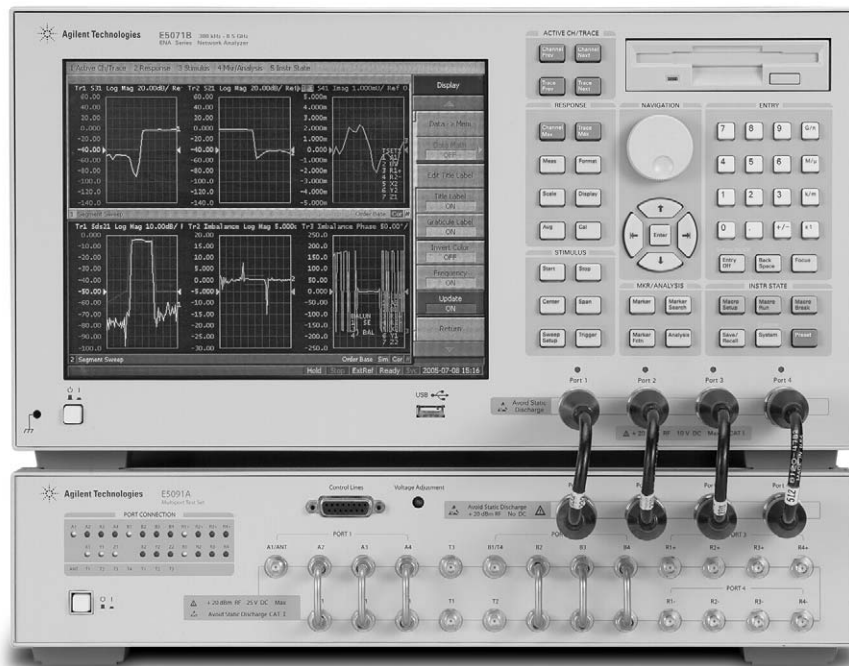


Agilent Measurement Wizard Assistant

software for ENA/E5091A

Application Note 1463-9



MWA software increases productivity in multiport device evaluation

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Introduction

With multiport devices and balanced circuit evaluations, not only are measurement parameters very complicated but also instrument setup conditions. Because of this complexity, engineers 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. The Measurement Wizard Assistant¹ (MWA) is setup software that enables you to easily set up measurement systems with a simplified interface. By using the MWA, you can easily set up measurement parameters and conditions without having knowledge of the ENA RF network analyzer architecture. This application note will walk you through the setup and use of the MWA using an actual multiport device measurement example (Figure 1) with the ENA and E5091A-016, 13/16-port configurable test set.

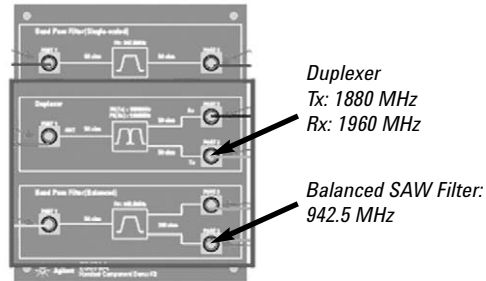


Figure 1. E5079A handset component DUT.

1. The Measurement Wizard Assistant software is provided as an Option E5070B/71B-790.

Product Overview

The MWA consists of two functions of software (Figure 2); one for the *Front-End* application which handles complex parameter settings with a PC and one for the *Back-End* application which loads the setup file into the ENA and sets parameters automatically.

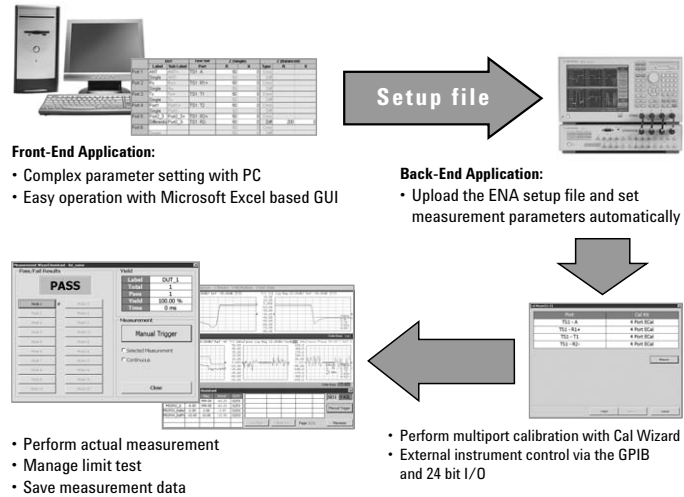


Figure 2. Overview of the Measurement Wizard Assistant software

The Front-End application has been developed using Microsoft® Excel VBA, which runs on an external PC. This software enables you to easily set up complex measurement parameters such as a segment sweep and a limit test, as well as control the multiport test set by entering the necessary parameters into the spreadsheet. After entering all parameters, the MWA automatically generates a setup file for the ENA.

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 calibration wizard assists with the operating procedure for multiport calibration by using the electronic calibration module (ECal) or mechanical calibration kits. The limit test monitoring function manages the limit test results in a production line.

Front-End Application

The Front-End application covers the following functionalities:

- Select multiport test set
- Define DUT ports and specify test set port connection
- Set control lines for DUT control (if applicable)
- Set GPIB commands for other instrument controls
- Set measurement paths and Go/No-go limits
- Create setup files for the Back-End application that runs on the ENA

Software installation

Step 1. Firmware version verification/installation

Before installing the MWA software, check the firmware version of the ENA. The firmware needs to be rev. A.06.01 or later. You can download the latest firmware from the Agilent.com website at, www.agilent.com/find/ena and click **Technical Support > Software Downloads & Utilities > Firmware Update**.

Step 2. Front-End application installation

The Front-End application, mwa_0100.xls, needs to be saved on the PC in the proper folder.

Step 3. Back-End application installation

The Back-End application, mwa_0100.vba, should be saved in (ENA USER) D:\VBA folder in order to launch the VBA macro from the **Load & Run** menu under the **[Macro Setup]** button.

Create the spec sheet with front-end application

The duplexer and the balanced SAW filter will be the multiport measurement example used to demonstrate the parameter settings with the PC and the easy operation with the Excel based GUI.

Step 1. Multiport test set setup

When the Front-End application (mwa_0100.xls) is opened, you will see that there are seven spreadsheets; Multiport Test Set, DUT, Mode, GPIB, Spec Sheet, Output, and System. This application note will go through these seven sheets in succession starting with Multiport Test Set sheet. See Figure 3.

1. Choose the E5091A 13-Port

2. Available measurement paths

E5091A 13-Port				
	1	2	3	
A	1			
T1	1	2		
T2	1	2		
T3	1	2		
T4		2		
R1+			3	R1+
R2+			3	R2+
R3+			3	R3+
R4+			3	R4+
R1-			4	R1-
R2-			4	R2-
R3-			4	R3-
R4-			4	R4-

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

	A	T1	T2	T3	T4	R1+	R2+	R3+	R4+	R1-	R2-	R3-	R4-		n/a	n/a	n/a	n/a
A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
T1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
T2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
T3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
T4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
R1+	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
R2+	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
R3+	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
R4+	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
R1-	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
R2-	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
R3-	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
R4-	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					

Figure 3. Multiport test set spreadsheet

3. You can change the test port label as you like

Choose the **E5091A 13-Port**¹ configuration from the drop down box (Figure 3-1)². The available measurement paths are automatically displayed (Figure 3-2). The test set port label can also be changed if so desired (Figure 3-3).

If you want to cascade two multiport test sets in order to extend the number of test ports, you can choose the second test set (Figure 4-1). Figure 4-2 shows how easy it is to configure the connection between the first and second test set by using **Link**.

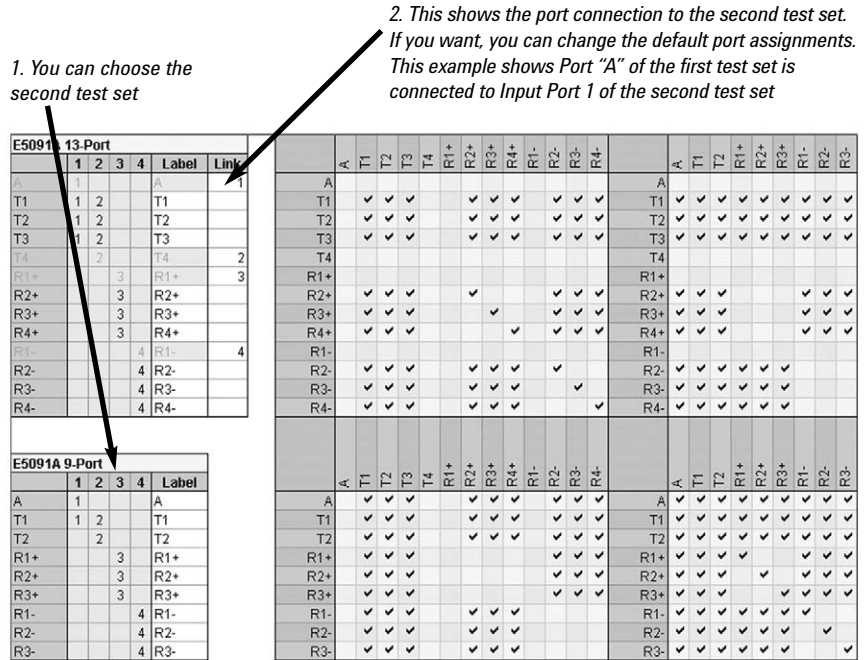


Figure 4. Second test set configuration.

Step 2. DUT setup

Using the *DUT* spreadsheet (Figure 5), you can not only easily setup the connection between the test set and the DUT, but also the parameters of the DUT, such as port impedance ($R + jX$)³, port **Extension**, and **Port Matching** circuit.

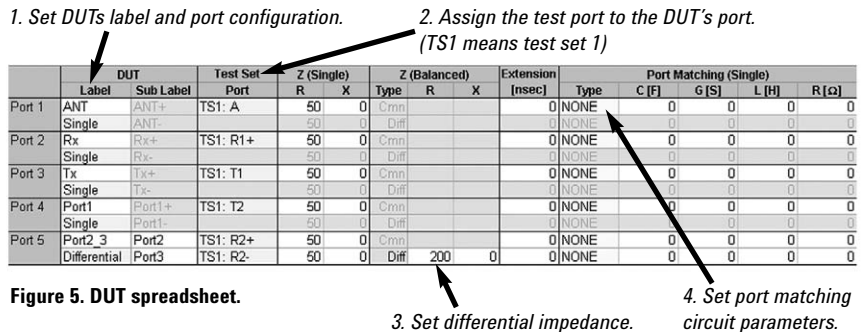


Figure 5. DUT spreadsheet.

1. The Z5623A K66 and K64 only work with the PNA.
 2. The hyphen number following the figure number refers to the dialogue box on that figure. This syntax will be used throughout this application note.
 3. Complex port impedance conversion function is supported in ENA firmware version A.06.01 and later.

Using the multiport device measurement example (Figure 6), set the label and port configuration (single, differential, or common) of the DUT (Figure 5-1). The DUT name was assigned based on Figure 6. Next, assign the test port to the DUT port (Figure 5-2). For the bandpass filter, a differential impedance of 200 ohms is applied to Port2_3 (Figure 5-3).

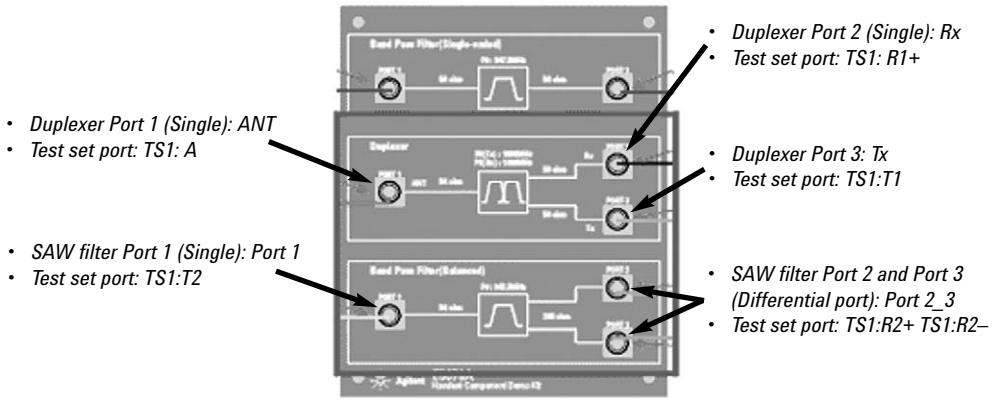


Figure 6. DUT port name assignment.

In order to use the matching circuit to enter port matching parameters, double-click the cell under Type in the **Port Matching (Single)** block (Figure 5-4), and the dialog box to set up the port matching circuit appears (Figure 7). In this figure, “S” stands for Series, “P” stands for Parallel, “L” stands for Inductor, and “C” stands for Capacitor. Hence, SLPC means, “series inductor parallel capacitor.” Values can also be entered directly into the cells without using the dialog box.

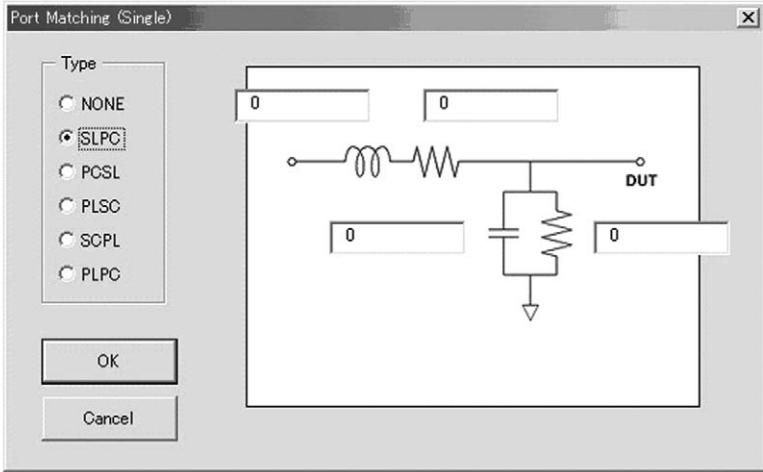


Figure 7. Port matching (single) circuit.

Step 3. Mode setup

With the *Mode* spreadsheet (Figure 8), you can easily set the control line voltage (High or Low) of the test set. The control line is used to change the measurement mode of the DUT. In Figure 8, Mode 1 of our multiport device is assigned to the Duplexer and Mode 2 is assigned to the Bandpass Filter (balanced SAW filter). It is important to remember that, if any Mode is not turned on in this spreadsheet, no parameters can be set in the *Spec Sheet* spreadsheet. A mode can be labeled (Figure 8-3) to distinguish it from any other mode. These mode labels are used as the labels in the other spreadsheets, *the Back-End application, and the Lot_name.csv file*. Modes can be turned-on and named per the following procedure.

Using the multiport device as our example, toggle the mode ON or OFF by double-clicking the cell in Figure 8-1. You can also enter a 1 or 0 in the cells to turn the mode ON or OFF. Set the logic for the Control Line Voltage by entering either an L or an H. Simply double-click the cell to set the logic of each bit of the control line (Figure 8-2). This mode selection is applied to other spreadsheets.

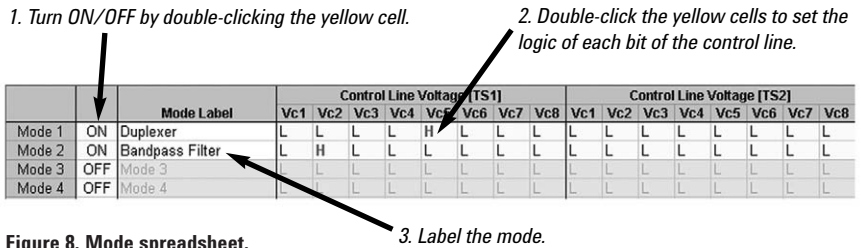


Figure 8. Mode spreadsheet.

Step 4. GPIB setup

The *GPIB* spreadsheet is used to set GPIB commands for controlling external instruments such as digital multimeters or power supplies. You can also set limit test values with the GPIB Limit menu. For example, if you want to perform a limit test with a voltage level that is read out from an external instrument via the GPIB interface, you can set maximum and/or minimum values and limit test rank¹ with this menu.

Using an Agilent 34401A digital multimeter, let's look at how control is achieved using this spreadsheet.

Begin by initializing the instrument using the "INIT" mode. The "INIT" mode always appears at the top of this sheet (Figure 9-1). In this example, a "*RST" command is sent to the 34401A (GPIB address:7). GPIB commands set in the "INIT" mode are executed only when the spec sheet is read in the Back-End application and no **Type** selection is available for GPIB commands in the *INIT* mode.

Set the GPIB commands for each test mode (Figure 9-2). By using the **Type**, you can specify how each GPIB command is used (Figure 9-3). One of the following choices needs to be selected.

- **Limit:** Execute the query GPIB command and perform the limit test. If the result fails, similarly to the limit test specified in the measurement path, the rank value is recorded.
- **Pre or Post:** GPIB commands are executed before or after the measurements in the mode. The GPIB limit values are ignored in this case.

1. As for the rank, please refer to the "Step 5. Spec sheet overview".

Set the limit value for the measured data of each instrument (Figure 9-4). Select **Limit** as **Type** and then enter the limit values. Blank cells are regarded as either -999 or +999. If the Type is not Limit, the values are not used. In this example, the limit value is set from -999 to 1000 (DC voltage).

The sequence of the limit test is performed as follows:

Initialize the 34401A with ***RST** command > Wait for trigger with **INIT** command > Trigger the 34401A with ***TRG** command > Perform the limit test > Sending the **FETCH?** command transfers readings (stored in internal memory by the **INIT** command) to the multimeter's output buffer > Comparing a read out value to the GPIB limit value > Output the rank based on this result.

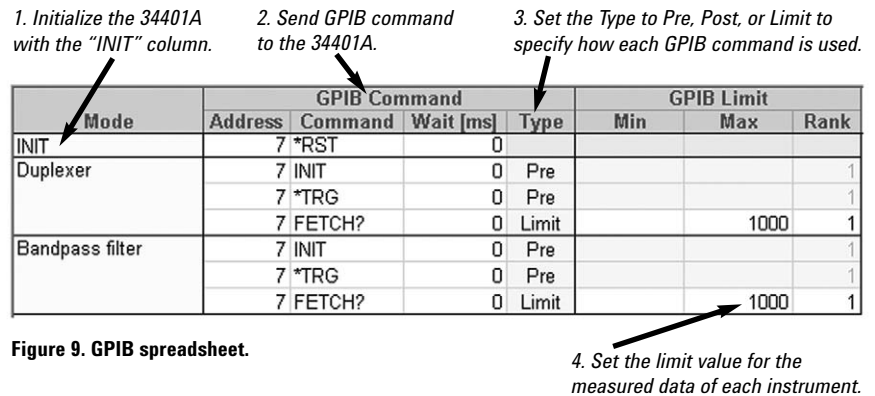


Figure 9. GPIB spreadsheet.

Step 5. Spec sheet overview

The *Spec Sheet* spreadsheet allows you to set various measurement parameters and limit values while at the same time keeping the operation from becoming tedious. An examination of each column of the spreadsheet will provide a better understanding of the parameters entered.

- **Mode:** The mode name is automatically assigned to the Mode column (Figure 10-1) based on what was entered into the Mode spreadsheet.
- **Path:** Specify the measurement path. Double-clicking the cell in this column activates a drop-down box where you can select the appropriate ports from the DUT ports assigned in the DUT spreadsheet (Figure 10-2). Paths can be added by double-clicking the yellow cells. All the information in the path listed at the bottom of the mode is copied to the new one. Also, right-clicking on a path allows you to add or delete a measurement path from the right-click menu. *If a number smaller than the number of the current path is set, the paths that exceed the specified number will be automatically removed.*
- **Type:** Double-click a cell (Figure 10-3) to select from a list of measurement parameters. Available measurement parameters are automatically assigned based on information in the measurement path. **Type just indicates the measurement parameter. So, for example, if you set IL, Ripple, ATT, and Isolation in the same frequency range, you should get the same measurement results.**

Type	Parameter	Format	Limit ¹
IL (Insertion Loss)	Transmission	LogMag	Inverse
Ripple	Transmission	LogMag	
VSWR	Reflection	VSWR	
RL (Return Loss)	Reflection	LogMag	Inverse
ATT (Attenuation)	Transmission	LogMag	Inverse
Isolation	Transmission	LogMag	Inverse
BalAmp	Transmission	LogMag	
BalPhase	Transmission	Phase	

- Stimulus parameters:** Set the stimulus parameters such as frequency, number of points, power, and IFBW by using these columns (Figure 10-4). If frequency-offset mode is desired, you can set the receiver frequency under the *Rcvr Freq [MHz]* menu. In addition, sweep mode can be chosen under the *Sweep Mode* menu. Values outside of the analyzer's allowable setting range can be entered. This is because this macro program is used with other Agilent network analyzers. If the value is out of the analyzer's setting range, the Back-End application automatically sets it to the closet allowable value, which may not meet your measurement requirement.

1. Mode column

2. Specify measurement paths.

Mode	Path			Type	Frequency [MHz]			Rcvr Freq [MHz]		Sweep Settings		
	From	To			Start	Stop	Pts	Start	Stop	Power	IFBW [Hz]	Sweep Mode
Duplexer	ANT	->	Rx	IL	1940	1980	11			0	100,000	Fast Swept
	ANT	->	Rx	ATT	1880	1900	11			0	100,000	Fast Swept
	ANT	->	Tx	IL	1880	1900	11			0	100,000	Fast Swept
	ANT	->	Tx	ATT	1940	1980	11			0	100,000	Fast Swept
	ANT	->	Port2	Isolation	1940	1980	11			0	100,000	Fast Swept
Bandpass Filter	Port1	->	Port2_3	IL	932.5	952.5	21			0	70,000	Std. Stepped
	Port1	->	Port2_3	IL	932.5	952.5	21			0	70,000	Std. Stepped
	Port1	->	Port2_3	BalAmp	932.5	952.5	21			0	70,000	Std. Stepped
	Port1	->	Port2_3	BalPhase	932.5	952.5	21			0	70,000	Std. Stepped
	Port1	->	Port2_3	ATT	440	850	21			0	70,000	Fast Swept
	Port1	->	Port2_3	ATT	850	920	5			0	70,000	Fast Swept
	Port1	->	Port2_3	ATT	980	1100	5			0	70,000	Fast Swept
	Port1	->	Port2_3	ATT	1100	1500	21			0	70,000	Fast Swept

3. Specify measurement parameters.

4. Set stimulus parameters.

Figure 10. Spec sheet spreadsheet.

- Spec:** Enter test limit values (Figure 11-1). The Back-End application judges whether all the measurement data is within the range specified here. Blank cells are automatically interpreted as either -999 (MIN) or 999 (MAX).
- Corr. Multiplier/Corr. Offset:** These parameters are used to compensate actual measurement data that is used in the limit test (Figure 11-2). For example, when you want to loosen or tighten the limits by compensating the measurement data, instead of setting different test limits, specify the compensation factor as $Ax+B$ (A: multiplier, B: offset). Entering different factors at the start and stop frequency, causes the factor between the two frequencies to be linearly interpolated.

1. Inverse limit means that the specification values in the same spreadsheet are used inversely. For example, if you specify 5 as the max specification value for IL, it means that the insertion loss needs to be 5 at maximum. The program interprets that the S-parameter measurement data needs to be -5 at a minimum, and the limit test is done with this S-parameter limit value.

- **Corr. (Diff):** Diff is used for harmonic measurements with frequency-offset mode (Figure 11-3). When you make a harmonic measurement, set a measurement path for the fundamental signal at the top of the mode and specify the harmonic measurement paths by double-clicking the yellow cells. This function subtracts the compensated measurement data of the path listed at the top of the mode (Diff “X”) from the compensated data in the path as the reference data (Diff “v”) so that dBc data is easily obtained. *Diff X* is automatically set on the top path of the mode.
- **Rank:** Set Rank values which give the tests priority of each measurement path in each mode (Figure 11-4). The Rank is handled as follows:
 - Rank can be set from 1 to 255 (8 bit value)
 - If a limit test is passed, rank “0” is output from the 24 bit I/O Handler I/F
 - Rank can be set for each measurement path
 - Smaller rank provides higher priority. This means that the measurement path to which is applied the smallest rank, has highest priority compared to the rest of the measurement paths
 - If all the limit tests are passed, the rank of the DUT will be “0”

For example, when all the limit tests end, the Back-End program compares the rank value of all the measurement paths in each mode and the highest rank (the smallest rank value) in each mode is output as the measurement (limit test) result via the 24 bit I/O Handler I/F. Also, passed DUTs can be sorted by using the rank. If the max fail rank (max. fail rank can be set in the Back-End application, see Figure 20) is set as 10, DUTs that fail the test of a measurement path ranked at 1 thru 10 are sorted as failed devices and the rest of the DUTs are handled as “Pass”. This function can be used to loosen the test limit without changing the test limit value. If a low value is set as the max fail rank value, then only DUTs that come with a lower rank value in one of the modes other than the max fail rank value are sorted out as failed devices in the particular mode.
- **Selected:** Paths checked as *Simple* cells (Figure 11-5) are also used as Selected Measurement paths when *Selected Measurement* is checked in the Back-End application. Only the selected measurement paths are measured. This allows the testing of certain kinds of DUTs that only require a subset of the measurement paths. It can be used as pre-test before starting manufacturing test.
- **Tag Name:** The default of the second half of each path name is the measurement parameter (type) which can be renamed as desired (Figure 11-6). Whenever the measurement parameter (type) is changed, it is overwritten with the new parameter (type). The first half of each path name is automatically determined by the mode and the path and it cannot be changed.

1. Set the min. and max. limit values.
2. Measured values are compensated as follows:
Start data: $a \times 1 + 0$ Stop data: $b \times 1 - 50$
(a, b: measured value at start/stop frequency point.)
3. Diff is used by harmonic measurement.

Spec		Corr. Multiplier		Corr. Offset		Corr.	Rank	Selected	Tag Name
Min	Max	Start	Stop	Start	Stop	Diff			
	5	1	1	0	0	X	1		M01P01_IL
40		1	1	0	0		1		M01P02_ATT
	5	1	1	0	0		1		M01P03_IL
40		1	1	0	0		1		M01P04_ATT
40		1	1	0	0		2		M01P05_Isolation
40		1	1	0	0		2		M01P06_Isolation
	8	1	1	0	0	X	1		M02P01_IL
	6	1	1	0	0		5		M02P02_IL
-2	2	1	1	0	0		2		M02P03_BalAmp
-10	10	1	1	0	0		2		M02P04_BalPhs
50		1	1	10	0		2		M02P05_ATT
50		1	1	0	-50		2		M02P06_ATT
50		1	1	-50	0		2		M02P07_ATT
50		1	1	0	0		2		M02P08_ATT

Figure 11. Spec sheet spreadsheet (cont.)

4. Rank is used by device sorting with limit test.

5. Set selected measurement paths.

6. Set tag name for each measurement path.

Step 6. Spec sheet setup

From our multiport device example, measurement parameters are entered into the spec sheet based on Table 2. In this example, the following paths are being measured:
 Duplexer: ANT → Rx, ANT → Tx Bandpass Filter: Port 1 → Port 2_3 (Balanced port)

Mode	Path			Frequency [MHz]			Sweep Settings			Spec		Multiplier		Corr. Offset		
	From	To	Type	Start	Stop	Pts	Power [dBm]	IFBW [Hz]	Sweep Mode	Min	Max	Start	Stop	Start	Stop	
Duplexer	ANT	→ Rx	IL	1940	1980	11	0	100,000	Fast Swept		5	1	1	0	0	
	ANT	→ Rx	ATT	1860	1900	11	0	100,000	Fast Swept	40		1	1	0	0	
	ANT	→ Tx	IL	1860	1900	11	0	100,000	Fast Swept		5	1	1	0	0	
	ANT	→ Tx	ATT	1940	1980	11	0	100,000	Fast Swept	40		1	1	0	0	
Bandpass Filter	Port1	→ Port2_3	IL	932.5	952.5	21	0	70,000	Std. Stepped		8	1	1	0	0	
	Port1	→ Port2_3	IL	932.5	952.5	21	0	70,000	Std. Stepped		2	1	1	0	0	
	Port1	→ Port2_3	BalAmp	932.5	952.5	21	0	70,000	Std. Stepped		-2	2	1	1	0	0
	Port1	→ Port2_3	BalPhs	932.5	952.5	21	0	70,000	Std. Stepped	-10	10	1	1	0	0	
	Port1	→ Port2_3	ATT	440	850	21	0	70,000	Fast Swept	50		1	1	0	0	
	Port1	→ Port2_3	ATT	890	920	5	0	70,000	Fast Swept	50		1	-50	0	0	
	Port1	→ Port2_3	ATT	980	1100	5	0	70,000	Fast Swept	50		-50	1	0	0	
	Port1	→ Port2_3	ATT	1100	1500	21	0	70,000	Fast Swept	50		1	1	0	0	

Table 2. Spec sheet for multiport device example

Step 7. Output the spec sheet

The *Output* spreadsheet (Figure 12), allows for easy summarization of the channel number, trace number, and segment number that is assigned to each measurement path (Figure 12-1). The maximum number of channels, traces, and number of points (NOP) can be specified for the ENA (Figure 12-2). Each measurement path is automatically assigned to an appropriate trace and NOP in an appropriate channel based on the three numbers. If parameters set in the spec sheet exceed these numbers, an error message will appear. After confirming whether the measurement parameters are set correctly, click **Save Spec Sheet** (Figure 12-3). When **Save Spec Sheet** is clicked, the file dialog box appears and you can save the spec sheet file to the floppy disk.

3. Press this button and the setup file (*.mwa) is automatically generated.

2. Specify the maximum number of channels, traces, and NOP of the ENA.

1. Summarize measurement parameter setup information.

	A	B	C	D	E	F	G	H
1								
2		Save Spec Sheet	Max Channel	Max Trace	Max Point			
3			9	9	1601			
4	Mode	Tag	Channel	Trace	Segment	Parameter		
5	Duplexer	M01P01_IL		1	1	1 S31		
6		M01P02_ATT		1	1	2 S31		
7		M01P03_IL		1	2	2 S21		
8		M01P04_ATT		1	2	1 S21		
9	Bandpass Filter	M02P01_IL		2	1	1 SDS21		
10		M02P02_IL		2	1	1 SDS21		
11		M02P03_BalAmp		2	2	1 IMB		
12		M02P04_BalPhs		2	3	1 IMB		
13		M02P05_ATT		2	1	2 SDS21		
14		M02P06_ATT		2	1	3 SDS21		
15		M02P07_ATT		2	1	4 SDS21		
16		M02P08_ATT		2	1	5 SDS21		
17								
18	Channel 1							
19			Test Set	Port	Freq Mult	Freq Offs		
20		Port 1		1	1			
21		Port 3		1	6			
22		Port 2		1	2			
23								
24			Parameter	Format				
25		Trace 1	S31	MLOGarithmic				
26		Trace 2	S21	MLOGarithmic				
27								
28			Start	Stop	Points	Power	IFBW	Sweep Mode
29		Segment 1	1940000000	1980000000	11	0	1000000	FANalog
30		Segment 2	1860000000	1900000000	11	0	1000000	FANalog

Figure 12. Output spreadsheet.

It's very easy to make a complex spec sheet (setup file) like the multiport measurement with the Front-End application. You no longer need to worry about the assignment of measurement paths, channels, and traces in the ENA.

Back-End Application

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

- Display the port connection information
- Calibration wizard
- Control via 24 bit I/O IF
- Control with GPIB commands
- Perform limit test on all measurement paths and output the test results via 24 bit I/O IF
- Display measurement results and save data files
- Measurement data in every spec sheet is saved as file *lot_name – sheet_name.csv*
- Summary data including the pass/fail status of all the spec sheets is saved as *lot_name.csv*

Measurement setup with Back-End application

Step 1. Launch the Back-End application

The Back-End application is launched as follows:

[Macro Setup] > Load & Run > choose *mwa_0010.vba* from the Load & Run menu (Figure 13).



Figure 13. Load & Run menu on the ENA

Step 2. Import the spec sheet to the ENA with Back-End application

Figure 14 shows the Back-End application. Import the spec sheet by clicking **Add Spec Sheet Group** (Figure 14-1). If multiple spec sheets are needed, up to ten can be added. In our example, sheet 1 and sheet 2 are in Group 1 and sheet 3 is in Group 2. The calibration wizard and save state are only performed for activated groups. A group can be activated by checking the radio button (Figure 14-2).

1. Import spec sheet by clicking Add Spec Sheet Group 2. Activate the group file with radio button.

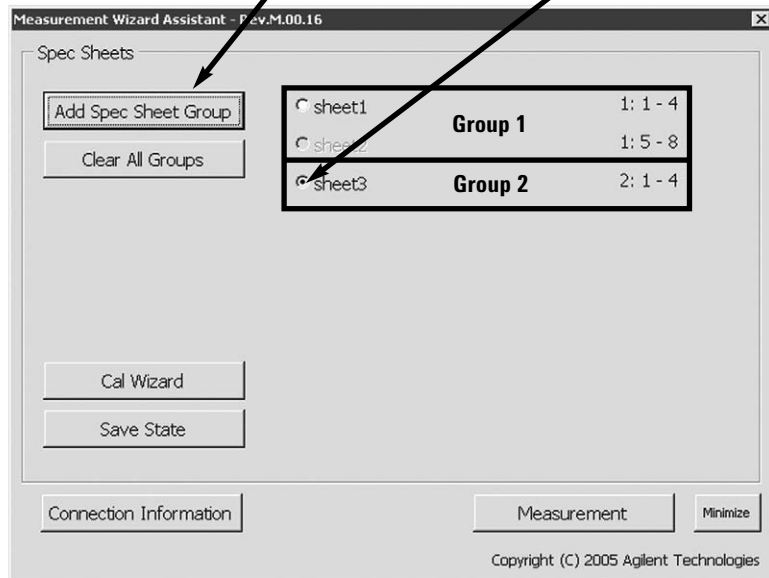


Figure 14. Back-End application

When **Add Spec Sheet Group** is clicked, the following menu appears (Figure 15).

2. Upload group file by clicking Read Group File. 1. Add spec sheet by clicking Add Spec Sheets.

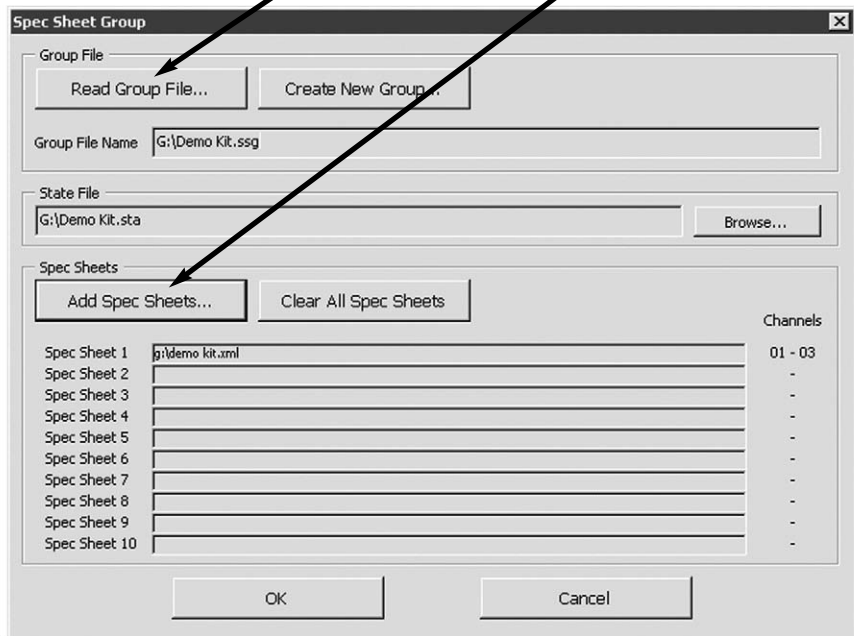


Figure 15. Spec sheet group menu

From this menu, a spec sheet can be uploaded from the floppy disk by clicking **Add Spec Sheets** (Figure 15-1). A group file can be made which contains two or more spec sheets. Upload multiple spec sheets with **Add Spec Sheets** and click **OK**. The group file *.ssg is automatically generated. Once the group file is created, it can be uploaded by clicking **Read Group File** (Figure 15-2).

Step 3. Connect the DUT cables to the test set

Continuing with our multiport measurement device example, the test cables are connected to the test set based on Figure 16. At this point, the cables are not connected to the DUT since calibration has not yet been performed..

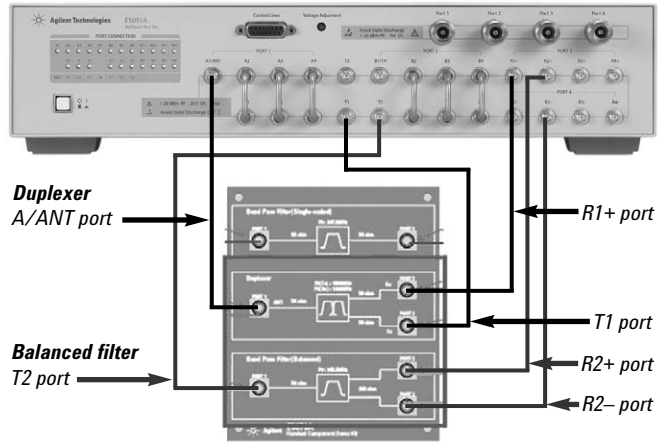


Figure 16. Connection of cables to test set

Step 4. Perform multiport calibration with Calibration Wizard

The Back-End application provides calibration wizard function (Figure 17) that assists with the operating procedure for the multiport calibration. When **Cal Wizard** is clicked (Figure 17-1) in the Back-End application, the *Cal Wizard* menu opens up.

1. Cal Wizard supports multiport calibration procedure.

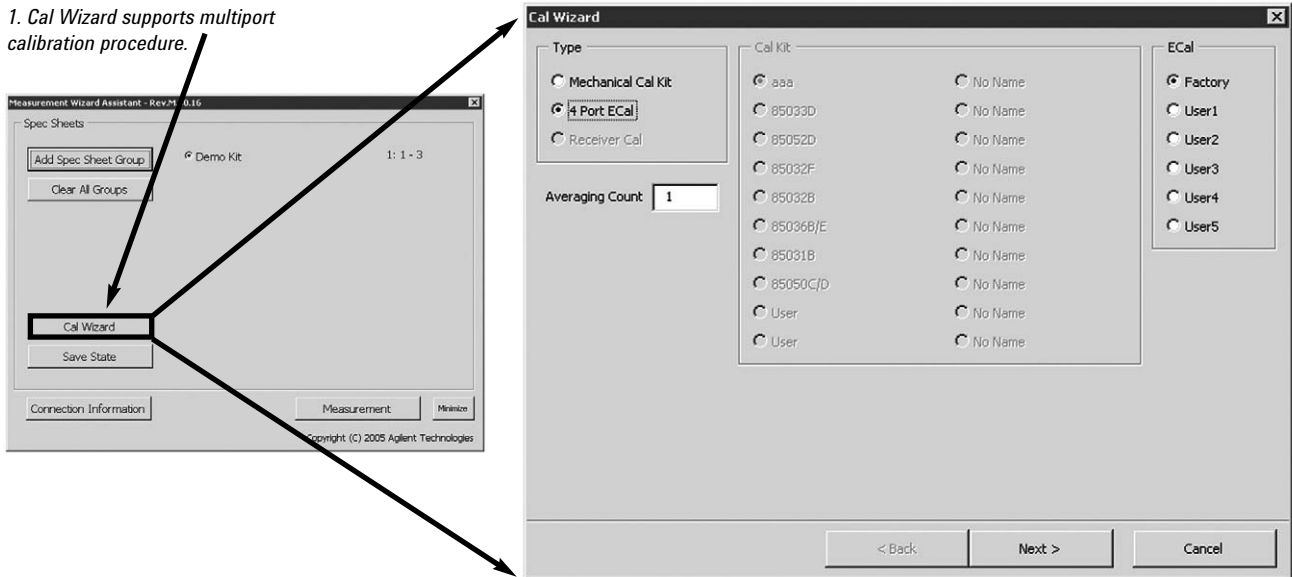


Figure 17. Cal Wizard menu (1)

For our example, we will choose the **4 Port ECal** radio button and then click **Next**. Another *Cal Wizard* menu (1/2) opens. Connect each cable from the test set to the ECal based on the information in this menu (Figure 18-1). Once the cables are connected to the ECal, click on **Measure** (Figure 18-2) to start the calibration. If port connections are inappropriate, an error message is displayed. As soon as the calibration is done, the **Next** button (Figure 18-3) is highlighted. After clicking **Next**, this procedure may need to be repeated in order to assure that all necessary calibrations have been performed. Even though some ports are grayed out (Figure 18-4), they should be connected to the ECal module.

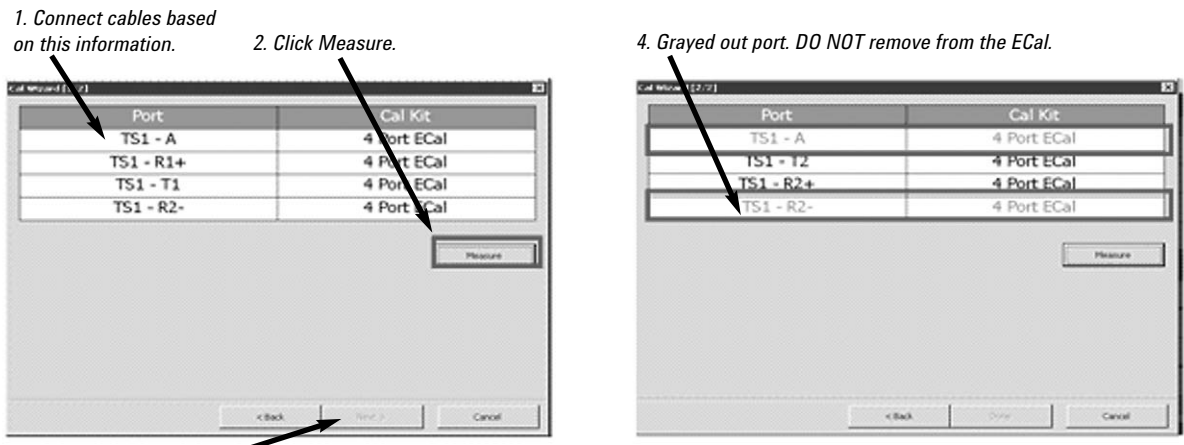


Figure 18. Cal Wizard menu (2)

Step 5. Connect the DUT to the test ports

It's now time to connect the DUT to the test set by referring to the *Connection Information* menu (Figure 19). The Connection Information menu should call out the connections that were shown in Figure 16.

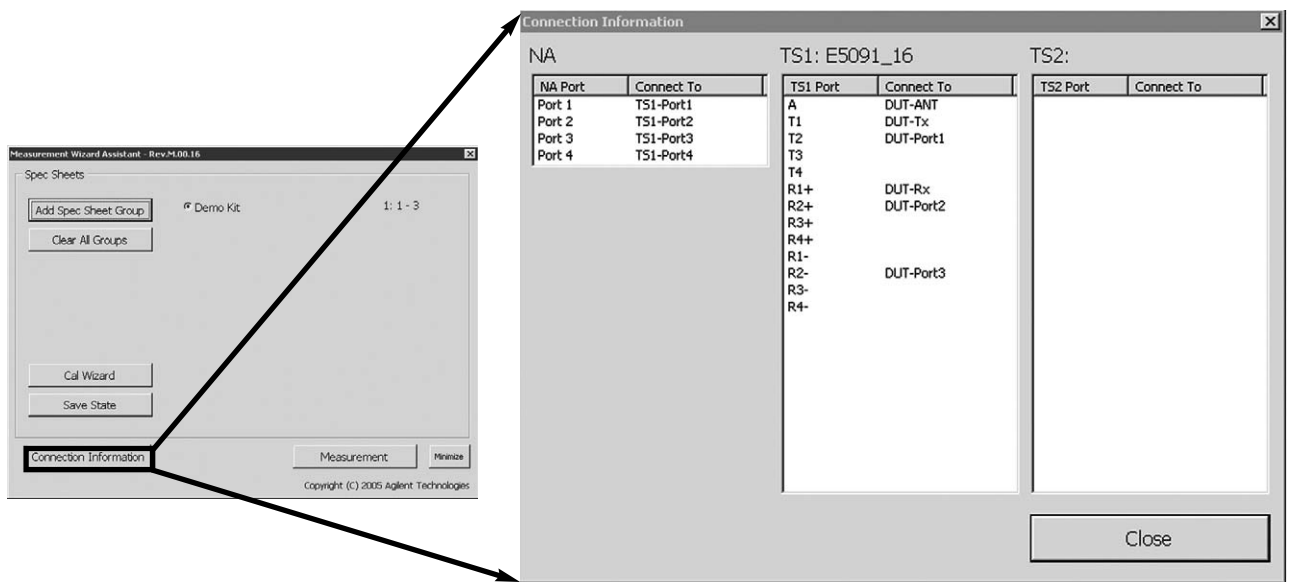
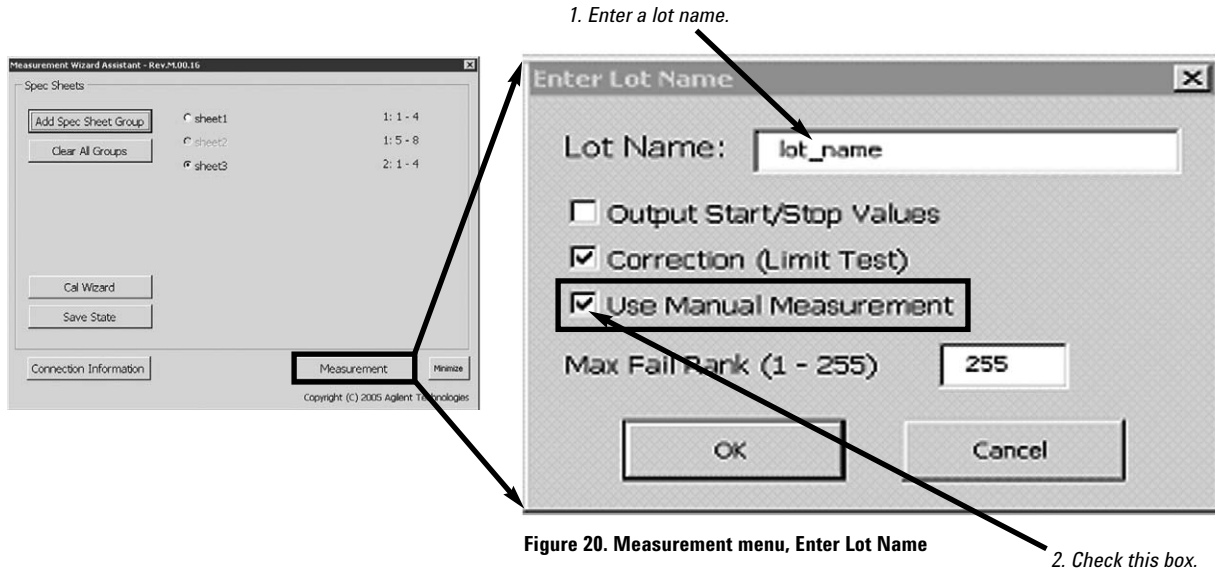


Figure 19. Connection Information menu

Multipoint measurement of DUT

Step 6. Start the measurement

From the Back-End application menu, launch the *Enter Lot Name* menu by clicking **Measurement**. Enter a Lot Name of choice (Figure 20-1). The program saves both measurement data and summary data files with this lot name. For our example, we will check the *Use Manual Measurement* check box, Figure 20-2, because the DUT will be measured manually.



Descriptions of the rest of the menu items in this dialog box are as follows.

- *Output Start/Stop Values*: When this check-box is marked, the *lot_name – sheet_name.csv* file will include not only measurement data but also Start/Stop frequency data.
- *Correction (Limit Test)*: When this check-box is marked, data correction ($ax + b$) will be applied to the measurement data for the limit test.
- *Use Manual Measurement*: When this check-box is marked, the manual measurement mode will be used.
- *Max Fail Rank (1 - 255)*: This is the max. fail rank value. If, for example, it is set at 10, only DUTs that fail the test of a measurement path ranked at 1 thru 10 are handled as a Fail. For more information, see Figure 11-4.

Step 7. Monitoring the measurement results

Measurement results can be checked using the measurement dialog boxes. Figure 21 shows an overview of the measurement dialog. As the figure demonstrates, the measurement dialog can be split into three layers: main, sheet, and mode dialogs. The “Main dialog” manages the overall limit test results. This dialog box clearly presents the actual conditions of pass/fail results and yield rate of all the limit tests at a glance. The “Sheet dialog” displays limit test results with respect to each setup file. The “Mode dialog” indicates further details of the limit test such as limit values and pass/fail results of each measurement mode.

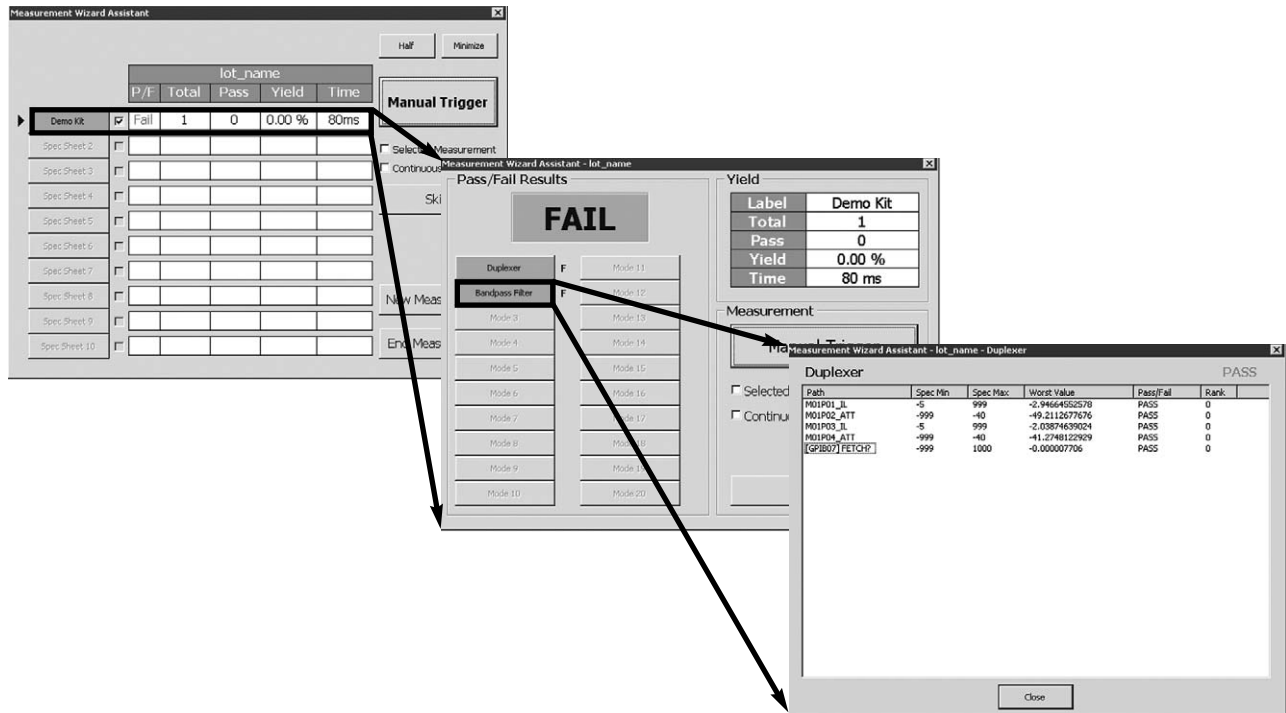


Figure 21. Overview of measurement dialog boxes

Let's measure our example DUT using *Manual Trigger*. Clicking **Manual Trigger** in the Main dialog box (Figure 22-1), will cause all the measurements on the spec sheet to be performed automatically. From the Main dialog box, pass/fail results, total number of measurements, pass count, yield rate, and measurement time can all be viewed.

2. Move to the Sheet Dialog box when Demo Kit is clicked.

1. Measurement is started when Manual Trigger is clicked.

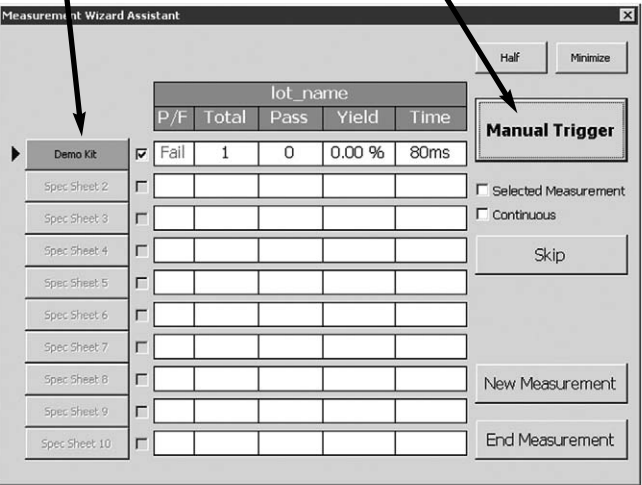


Figure 22. Main dialog box

Following is an explanation of the rest of the buttons and check-boxes in the main dialog menu.

- *Half or Minimize*: Adjust the display size of the dialog box. Select either **Half** size display mode or **Minimize** mode which places the main dialog box on the Task Bar.
- *Selected Measurement*: Measure only the selected paths that are defined in the spec sheet.
- *Continuous*: Measure the DUT continuously with internal trigger.
- *Skip*: Skip to the next spec sheet.
- *New Measurement*: If another lot of DUTs needs to be tested using the same spec sheet, use this choice.
- *End Measurement*: End the measurement and go back to the display to read the spec sheet files.

Move to the Sheet dialog box by clicking **Demo Kit** (Figure 22-2) which is the name of our example DUT. Figure 23 shows that the measurement results of each mode, Duplexer and Bandpass Filter, can be displayed. A Pass/Fail result can be quickly and easily seen.

1. Click either Duplexer or Bandpass Filter to move to the Mode dialog box.

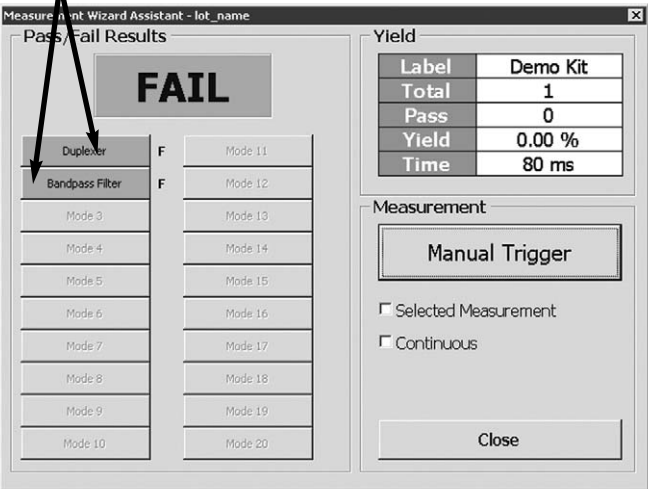


Figure 23. Sheet dialog box

Move to the mode dialog box by clicking Duplexer or Bandpass Filter in the sheet dialog box. In the mode dialog box, the measurement results of each measurement path for each mode can be checked. Figure 24 shows that the mode dialog box displays the measurement path, spec min, spec max, worst value, pass/fail result, and rank information. By using this sheet, the customer can easily figure out how different measurement results are from the limit values on a measurement path by measurement path basis.

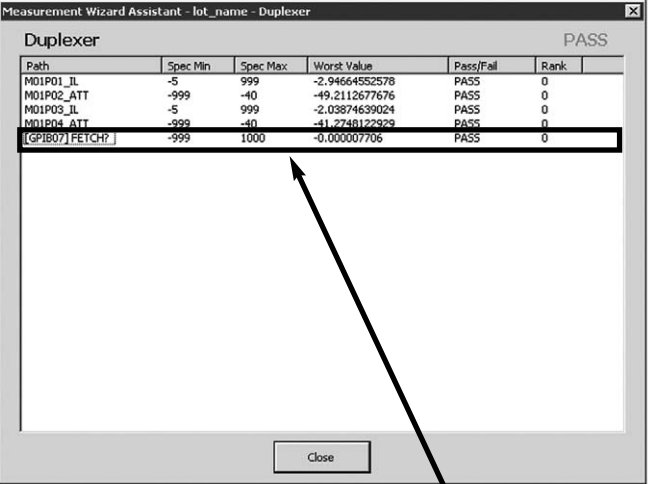


Figure 24. Mode dialog box

Limit test results using the 34401A.

Step 8. Check the measurement results on the ENA screen

Return to the main dialog box (Figure 22) and click Half. Figure 25 shows an example of measurement results by using half screen mode. In Half mode, only the failed measurement paths are displayed under the screen. The display setting of the ENA should be defined by the customer since the MWA software doesn't care about channel and trace layout.

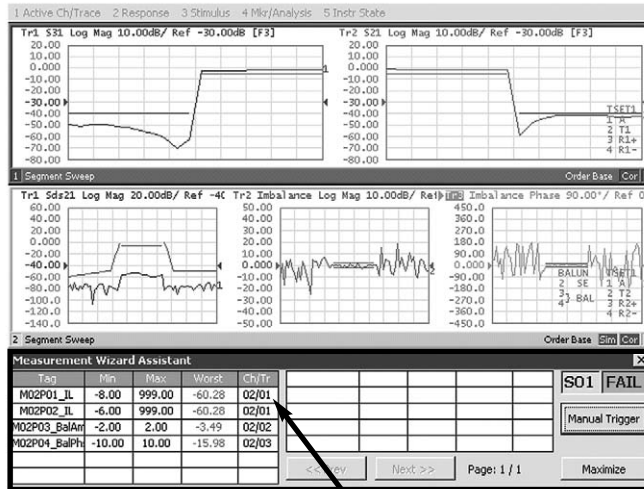


Figure 25. Half screen mode *Displays only the failed measurement paths.*

Step 9. Save measurement results

The measurement results can be saved by clicking **End Measurement** in the main dialog box (Figure 22). When this selection is made, two different files are generated automatically. One is the summary data file and the other is the measurement data file of each spec sheet. Summary data including the pass/fail status of all the spec sheets is saved in a *lot_name.csv* file as follows:

Spec Sheet	Total Pass	Fail
Demo Kit	4	0 Duplexer 4 Bandpass Filter 0

Measurement data in every spec sheet is saved in a *lot_name - sheet_name.csv* file as follows:

Index	Rank	M01P01_IL_Rx	M01P02_ATT_Rx	M01P03_IL_Tx	M01P04_ATT_Tx
1	1	-200	-68.68211976	-76.19651999	-67.95837399
2	1	-76.43829268	-65.2196478	-83.27928526	-62.98795911
3	1	-76.48191007	-65.59056737	-77.23724883	-70.77077445
4	1	-200	-67.29543848	-83.24462275	-69.1663587

Summary

When it comes to multiport device testing, choosing a test set that can be used not only for current devices but also for future applications is the best use of your capital. In the technical area, more DUT ports mean more complicated measurement parameter setups and that makes it difficult to evaluate device accuracy in the short term. The solution is not only hardware but also software (MWA) that can dramatically improve both measurement efficiency and productivity of multiport device evaluation.

This is best illustrated by what MWA can do in a production line test environment. As shown in Figure 26, by using the MWA, an entire measurement system can be built in production. The MWA controls external instruments such as power supplies and DMMs via the GPIB. Also, the handler system can be controlled via the 24 bit I/O in order to sort the DUTs based on Go/No-go test results. In addition, MWA controls DUTs via the 8 bit control line of the multiport test set.

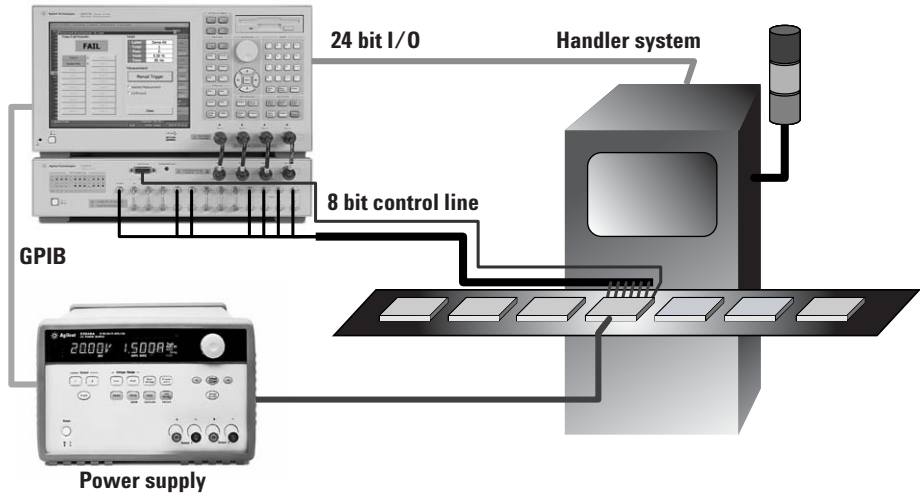


Figure 26. MWA contribution in production test environment

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www.agilent.com/find/ena

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Printed in USA, April 19, 2006
5989-4855EN



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