Measurement Guide

Agilent Technologies E7415 EMI Measurement Software

Agilent Technologies

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http://www.agilent.com/find/emc

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WARNING

The WARNING notice denotes a hazard. It calls attention to a procedure, practice, or the like, that, if not correctly performed or adhered to, could result in loss of important data. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

CAUTION

The CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in incorrect measurement results or loss of data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

Typeface Conventions

Italics

- Used to emphasize important information:
  Use this software *only* with the Agilent xxxx system.
- Used for the title of a publication:
  Refer to the *E7415A Measurement Guide*.

`User Entry`

- Used for examples of programming code:
  `#endif // ifndef NO_CLASS`

`Path Name`

- Used for a subdirectory name or file path:
  `Edit the file usr/local/bin/sample.txt`

Computer Display

- Used to show messages, prompts, and window labels that appear on a computer monitor:
  The **Edit Parameters** window will appear on the screen.
- Used for labeled keys on computer keyboard or for text you will enter using the computer keyboard:
  Press **Return**.
- Used for menus, lists, dialog boxes, and button boxes on a computer monitor from which you make selections using the mouse or keyboard:
  Double-click **EXIT** to quit the program.
- Used to specify a filename:
  Select **filename** and press **OK**.

Contents

1 Introduction

This Guide has been written to assist you in designing products that meet current international emissions standards at a precompliance level.

The Role of Precompliance in the Product Development Cycle

Strict compliance standards for electromagnetic emissions are now approved throughout most of the world. Designing a product to meet these standards does not need to greatly increase your costs as long as you design your product with these standards in mind.

It is important to have a strategy that will help you test for potential EMI problems throughout the product development cycle, as well as equipment and processes in place that will allow you to observe how close you are to compliance at any given time in the development cycle.

The processes described in this Guide are designed to help identify EMI problems during all phases of product development and to provide an inexpensive way to test for compliance before you start the much more costly, final compliance testing.

How to Use This Manual

This guide contains flowcharts and associated procedures for making conducted and radiated precompliance measurements. It is recommended that you use the flowcharts as a guide to making typical measurements. Refer to the sections within each chapter for detailed explanations on performing the flowchart procedures.

NOTE The order of the sections within each chapter follow the flowcharts.

Included within this guide are the following chapters outlining measurement procedures:

- Chapter 2 , "Conducted Emissions Examples" – Step-by-step procedures for setting up and performing precompliance conducted emissions measurements.
- Chapter 3 , "Radiated Emissions Example: Shielded Room" – Step-by-step procedures for setting up and performing precompliance radiated emissions measurements in a shielded room environment.
- Chapter 4 , "Radiated Emissions Example: Open Area Test Site" – Step-by-step procedures for setting up and performing a compliance or precompliance radiated emissions measurements on an open area test site.

In addition, the following chapters are included to serve as a reference for particular tasks, terminology, and regulations:

- Chapter 5 , "How Do I...?"
- "Glossary of EMC Acronyms and Terms"
- Appendix A , "Determining your Regulation Requirements"

The E7415A EMI Measurement Software is shipped with the following documentation:

- Getting Started Guide
- E7415A Measurement Guide
- Online Quick Tour (found in the E7415A software menu under **Help** | **Quick Tour...**)
- Online Help System (found in the E7415A software menu under **Help** | **Contents...**)

2 Conducted Emissions Examples

In This Chapter...

- “Evaluate Measurement Results” on page 52.

  Sorting the signals and evaluating the test results.

- “Save Test Data” on page 53.

  Saving test setups and test data.

Introduction

This chapter presents an example of how to prepare for and execute a conducted emissions test, create a report, and save the data.

Conducted emissions testing focuses on signals present on the power mains and signal paths that are generated by the EUT (equipment under test). The conducted signals are measured with a regulatory-defined transducer, a LISN (line impedance stabilization network).

A common source of conducted emissions are switch-mode power supplies, which produce both narrowband and broadband signals, the former from the switching frequency, the latter from the sharp rise and fall of the switch. Conducted emissions from these types of sources usually are highest in the lower end of the 150 kHz to 30 MHz band.

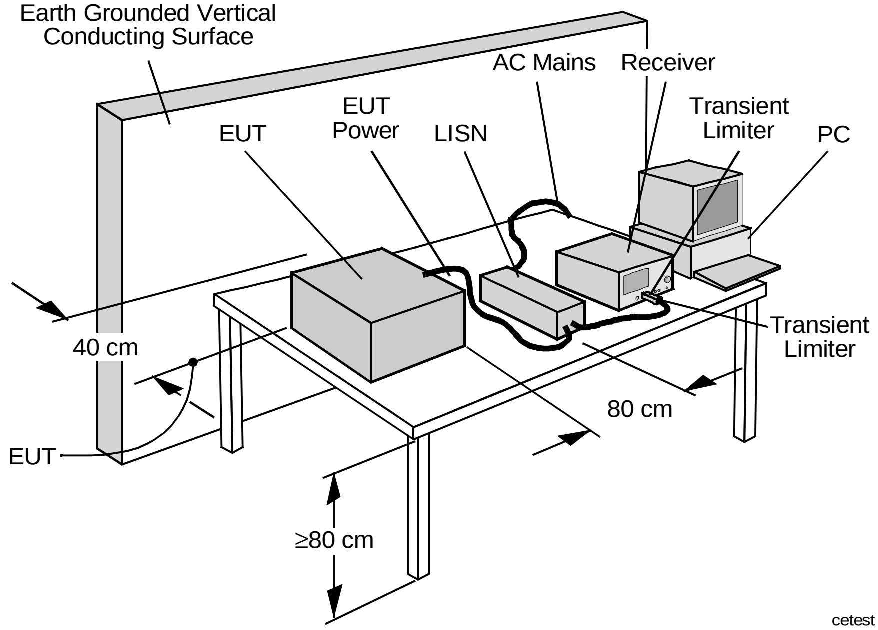
The regulatory limits specify the maximum EUT emission amplitudes expressed as the voltage (dBmV) measured on predefined lines. Two types of detectors are defined for measurements: Quasi-Peak and Average. The applicable regulation specifies the limits and the detector associated with limit. (Some regulations specify Quasi-Peak and Average limits, others specify a Quasi-Peak limit only.)

Conducted emissions measured by each detector must be below the corresponding limit. The frequency range for these measurements is typically 150 kHz to 30 MHz.

Metallic surfaces near the EUT will introduce coupling effects which cause test results to vary. Therefore, the regulations also specify the physical layout of the test setup including separation distance of the test items, non-metallic table, and vertical conductive surface behind the EUT setup.

A typical layout for desktop devices is shown in Figure 2-1.

Figure 2-1 Desktop Setup for Conducted Emissions Testing

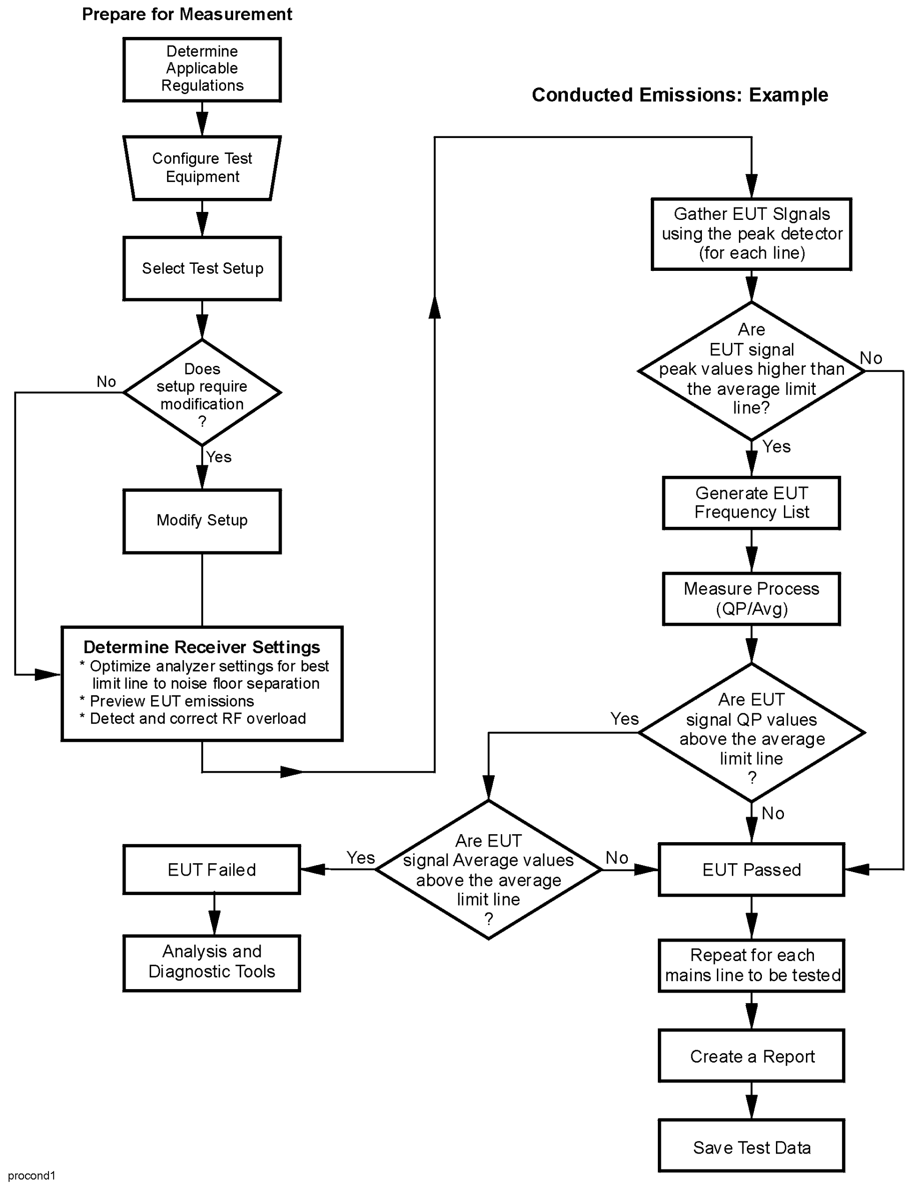


Conducted Process Flow Chart

Figure 2-2 is a flow chart that shows the process for making a measurement of conducted emissions.

The sections within this chapter closely follow the flowchart.

Figure 2-2 Precompliance Measurement of Conducted Emissions



Determine Applicable Regulations

Determine the regulations to which your EUT must comply.

For more information on EMC regulations and determining which regulations apply to your measurement see Appendix A , “Determining your Regulation Requirements,” on page 225.

Configure Test Equipment

The equipment used in the test is configured according to regulatory requirements, such as EN55022 Class B. Refer to the applicable regulation for specific configuration information. The regulation typically specifies the test environment, receiver characteristics, and transducer characteristics for a compliance test. If you do not know what regulation is applicable for your product see Appendix A , “Determining your Regulation Requirements,” on page 225.

The EUT is normally exercised in a way that represents its typical usage. Interconnect cables, if they are present, are oriented to maximize emissions.

The basic configuration for a commercial conducted emissions measurement consists of a PC with the E7415A software, a Line Impedance Stabilization Network (LISN), a transient limiter (optional), cables, and a receiver. The EUT receives its power through the LISN and any conducted emissions from the EUT are routed to the receiver by the LISN.

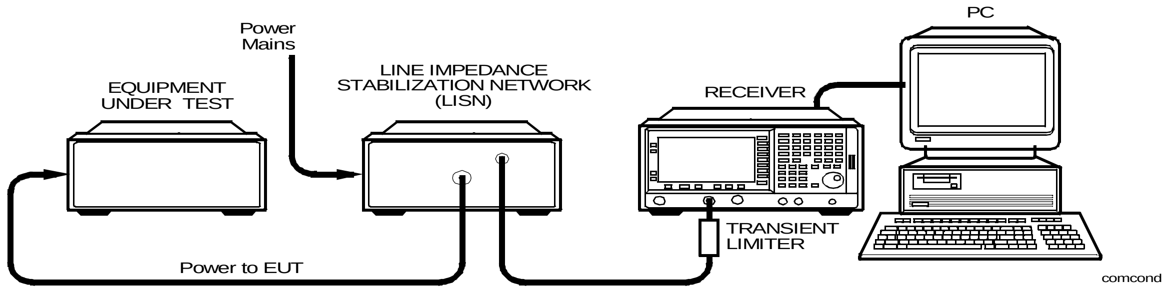
Typical Equipment

Equipment	Type
PC with E7415A software installed	See E7415A Getting Started Guide or the readme.txt file for PC requirements.
Receiver	85422E 8542E 85462A 8546A 859xEM E7400A-series Simulator (included with the E7415A software used to simulate test data)
Transient Limiter	11947A
Line Impedance Stabilization Network (LISN)	11967C 11967D 11967E
Cables	As Needed

Equipment Setup

Figure 2-3 illustrates the basic test configuration for conducted emissions testing.

Figure 2-3 Basic Conducted Emissions Test Configuration



CAUTION To prevent damage to the receiver from power line switching transients:

- Disconnect the receiver input (from the LISN or current clamp output) prior to connecting or disconnecting the mains to the EUT or prior to turning the EUT on or off, or prior to placing a current clamp around an EUT mains.
- If you are using a switchable LISN, disconnect the receiver input (from the LISN output) prior to switching the LISN between lines.

WARNING **For your safety, the LISN should be adequately earth grounded. Large leakage currents flow through the internal filter capacitors causing a potential shock hazard. To prevent injury, follow all precautions provided by the manufacturer of the LISN.**

Connect the equipment as follows:

	Step	Comments
1	Connect the power cord of the EUT to the LISN.	The LISN provides a known RF impedance (50 W) to any emissions from the EUT.
2	Connect the LISN to the power mains supply.	
3	Connect the emissions output port of the LISN to the transient limiter.	The LISN emissions output port is often labeled with “Monitor” or “50Ω”.
4	Connect the receiver INPUT to the transient limiter.	

About the LISN

The LISN performs several important functions:

It helps filter incoming power from the ac mains and prevents any noise on the lines from reaching the EUT.

It routes conducted emissions from the EUT to the receiver.

It presents a defined 50 W impedance to the receiver, allowing calibrated measurements.

It allows you to measure both the EUT line and the neutral lines independently.

About the Transient Limiter

During conducted emissions testing, a transient limiter can protect the receiver input from damage caused by high-level transients from LISNs or current clamps. Some receivers have limiter diodes placed before the first converter and the preamp to help protect both elements.

To provide additional protection to the receiver's input when performing conducted emissions, the use of an external (11947A) transient limiter is strongly recommended.

NOTE Using an Agilent E7403A, E7404A, or any E7400A Series EMC Analyzer with Option UKB

Measurements made below 100 kHz (10 MHz for E7405A) will have significant amplitude errors in AC coupled mode. The analyzer should be manually put into DC coupled mode prior to making measurements to avoid this roll off effect.

CAUTION To prevent damage to the input circuitry of the analyzer, please ensure that DC and transient signals are suppressed before selecting DC coupled mode. Because of this fact, the E7415A software will not do the switching automatically, you must do it manually.

Select Test Setup

Common test setups have been included with the E7415A application. When you first open the application the **New Test: Select Test Setup** dialog box appears, allowing you to select the regulation to which you normally test.

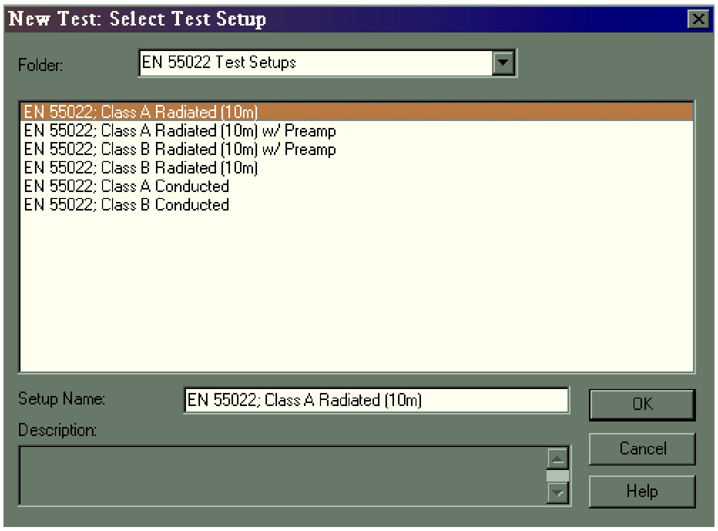
After you have selected a test setup, limit lines for the selected regulation are displayed on the graph.

Selecting a Test Setup

To select a predefined or previously saved test setup follow these steps:

Procedure 2-1 ***How to Select a Test Setup***

Step			Comments
1	Open the Select Test Setup dialog box.	• Open the E7415A application.	• If the application is currently open, select **File** | **New** from the menu. • Select New to open an existing test setup without data. • Select Open to open an existing test setup and data.



2	Select a set of compliance regulations	• Open the **Folder** drop-down list, and select the desired regulation folder. • Select the regulation to which to test. • Click **OK**.	• There are various folders under which are related compliance regulations, for example **EN 55022 Test Setups: EN 55022 Class B Conducted**.

Does Setup Require Modification?

Determine if the selected test setup requires modification for your particular test equipment (receiver, LISN, cables, limiters, etc.), limit line definitions, and ambient list. To view the test setup, select **Setup** | **Show Setup** from the Sidebar or menu.

A test setup is composed of the software settings required to perform a test. The E7415A software includes several example test setups. Setup settings include items like limit lines, equipment lists, correction factors, band settings and report output (see "Steps for Modifying Test Setups" on page 31 for a comprehensive list).

NOTE The most common modifications involve editing equipment setup information, such as the equipment used in a test and associated correction factors. The default equipment setup information contains characteristic correction factors for common test equipment. You will want to modify these correction factors or create new ones for your specific equipment for the greatest amplitude accuracy.

The following test setup parameters are particularly important, depending upon your test equipment and applicable regulations:

- Limit Lines
- Signal Path (The active signal path, including correction factors within the E7415A application, must correspond to your physical test equipment layout.)
- Equipment Corrections
- Graph Settings
- Signal List Settings (list columns)
- Receiver Settings (for Sweep and Measure)

If your test setup does require modification, continue on to "Modify Setup" on page 31 which includes a complete list of the modifiable test setup parameters.

If your test setup does not require modification, continue on to "Determine Receiver Settings" on page 33.

Modify Setup

Test setups can be modified to meet your specific test requirements or a new test setup can be created by defining the required test equipment, limit lines, and ambient list.

Save test setups for future use (see "Save Test Data" on page 53). Test setups may be added to an existing test setup folder or into a newly created test setup folder.

Steps for Modifying Test Setups

The following are the general steps for modifying an existing test setup:

1. Select a test setup (see "Selecting a Test Setup" on page 29)
2. Determine if the selected test setup meets your requirements (see "Does Setup Require Modification?" on page 30)
3. Modify the test setup as necessary. When modifying or creating a test setup, you can change and save the following parameters to accommodate your specific test needs or requirements:
   - Limit Lines (See "Use Limit Lines" on page 146)
   - Equipment Setup (See "Add and Setup Test Equipment" on page 155)
   - Signal Path (See "Use Signal Paths" on page 166)
   - Ambient Lists (See "Use Ambient Lists" on page 168)
   - Graph Settings (See "Customize Graph and Trace Data" on page 206)
   - Signal List Settings (See "Customize Signal Lists" on page 193)
   - Sweep Settings (See "Set Up and Perform Sweeps" on page 175)
   - Measure Settings (See "Make Measurements" on page 182)
   - Report Settings (See "Generate Reports" on page 189)
   - Receiver Settings (See "How to Add and Setup a New Receiver" on page 156)
4. Save the modified test setup (see "Save Test Data" on page 53)

NOTE After modification and saving of test setup parameters, these parameters become defaults for the new test setup.

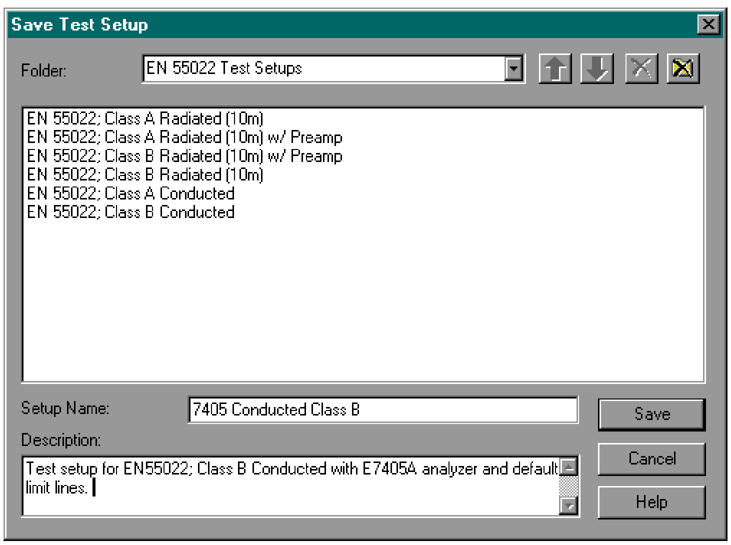
Save Test Setup

Use **Save as Setup...** to save test setup parameters *only*. No measurement data is saved. The name you give your newly defined test setup will appear in the **New Test: Select Test Setup** window when you restart the E7415A application or when you select **File** | **New**.

To save a test setup follow these steps:

Procedure 2-2 ***How to Select a Test Setup***

Step			Comments
1	Save the test setup.	a. From the menu, select **File** | **Save As Setup...** b. In the **Save Test Setup** dialog box, select the desired folder from the **Folder** drop-down list, or type a new folder name. c. In the **Setup Name** text box, enter in a name for your setup. d. (Optional) Enter a description for your test setup within the **Description** text box. e. Click **Save**.	• Tip: to access the new setup, select **File** | **New**. • A clear description of your test setup will make it easier to find for future testing.



Determine Receiver Settings

The receiver settings will alter the receiver noise floor and dynamic range. It is important to find the settings that will allow proper testing within the frequency range of the applicable regulation.

Before measurement sweeps can be taken with the software, the optimum receiver settings for performing the measurements must be determined and set in the software. Several receiver parameters may be set by the user when performing sweeps with the software. These settings, once specified, may be saved within the context of a test setup for easy reuse. The receiver settings you can change from the E7415A software are:

- Resolution Bandwidth
- Video Bandwidth
- Reference Level
- Attenuation
- Sweep Time
- Segment Size
- Stop/Start Frequencies
- Segment Overlap
- Dwell Time
- Detector (Peak/Quasi-Peak/Average)
- Preamp On/Off (854X and E7400A-series only)
- Number of Trace Points (E7400A-series only)

See the E7415A online Help or the Glossary for detailed information about these functions.

Some settings may need to be specified according to a regulation's requirements (for example, resolution bandwidth) and some settings depend on the equipment you have in the signal path you are measuring (for example, start/stop frequency may depend on a current clamp or LISN's useful frequency range), and need to be adjusted accordingly.

Noise Floor to Limit Line Separation

Prior to performing sweeps or measurements, you must optimize receiver settings to obtain the best noise floor to limit line separation (how far the noise floor is below the limit line) without encountering RF overload.

When varying attenuation and preamplification, always check to make sure that you do not encounter RF overload with the new settings. Refer to the manual for your receiver for instructions on checking for RF overload.

To do this, you will need to make a sweep with the E7415A software to determine the receiver’s noise floor to limit line separation, using the receiver settings that you will use during the EMC test. The software’s signal path definition should be the same as the signal path that will be used during the test. Measure the noise floor with the receiver (or external preamplifier if one is defined in the signal path) in a terminated state.

If the measured noise floor to limit line separation is not adequate, then the following receiver settings may require modification:

Input Attenuation

Increasing the attenuation increases the receiver noise floor and decreases the noise floor to limit line separation.

Decreasing the attenuation decreases the receiver noise floor and increases the noise floor to limit line separation.

Reference level

Increasing the reference level in some settings can decrease the limit line to noise floor separation.

Decreasing the reference level in some settings can increase the limit line to noise floor separation.

Preamplification with a low noise figure preamplifier (internal or external)

Adding preamplification decreases the receiver corrected noise floor and increases the noise floor to limit line separation.

Removing preamplification increases the receiver corrected noise floor and decreases the noise floor to limit line separation.

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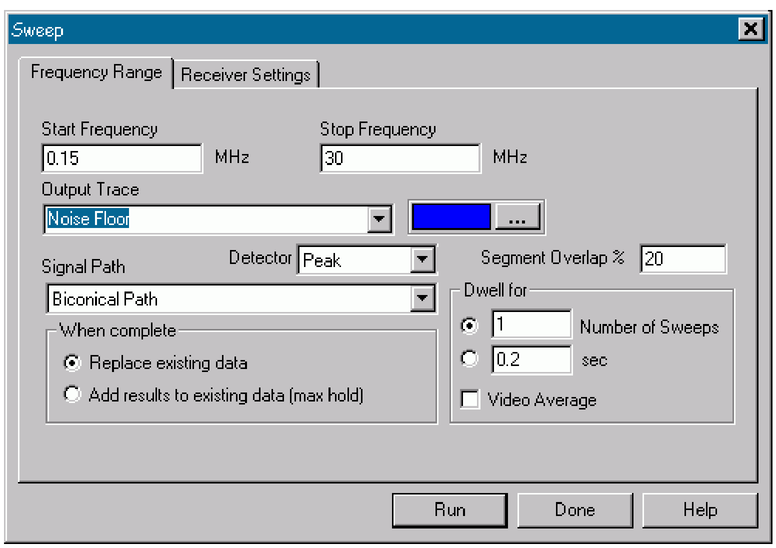
Measurements made below 100 kHz (10 MHz for E7405A) will have significant amplitude errors in AC coupled mode. The analyzer should be manually put into DC coupled mode prior to making measurements to avoid this roll off effect.

CAUTION Caution: To prevent damage to the input circuitry of the analyzer, please ensure that DC and transient signals are suppressed before selecting DC coupled mode. Because of this fact, the E7415A software will not do the switching automatically, you must do it manually.

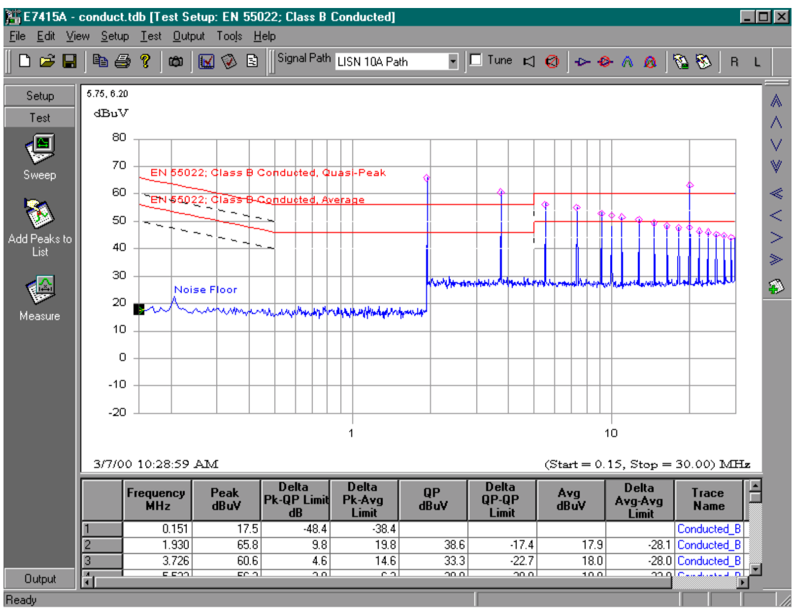
Procedure 2-3 How to Check for Adequate Noise Floor to Limit Line Separation

	Step		Comments
1	Setup test equipment.	a. Disconnect the RF input to your receiver. b. Terminate the RF input on your receiver.	• Use the appropriate termination for your receiver.
2	Select the signal path.	a. Choose the path including all cable loss, transducer and receiver corrections.	
3	Set the Sweep parameters within the E7415A software.	a. Select **Test** | **Sweep** from the Sidebar or the menu. b. Modify the **Start Frequency** and the **Stop Frequency** values if required.	• The **Sweep** dialog box can be opened by right-clicking the graph area, then selecting **Sweep**. • The Start and Stop frequencies are automatically set to the frequency range of the selected regulation, for example 0.15 MHz and 30 MHz respectively. The frequency range can be modified to meet your specific requirements.



Procedure 2-3 How to Check for Adequate Noise Floor to Limit Line Separation

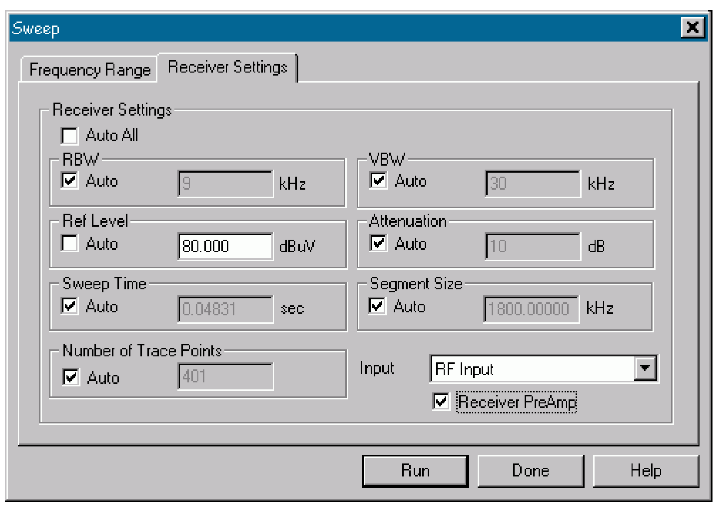
	Step		Comments
4	Name and define the trace.	a. In the **Output Trace** drop-down box, type a trace name (for example, Noise Floor). b. Click on the color bar and select a color for the trace. c. Click **OK** to close the color palette.	
5	Check noise floor.	1. Run sweep by clicking **Run** in the **Sweep** dialog box. 2. If the noise floor to limit line separation is not adequate go to “How to Adjust Receiver Settings” on page 37. 3. If the noise floor to limit line separation is adequate, go to the next step.	



6	Note test configuration and receiver settings.	Note the signal path (for example, whether an external limiter used) and the receiver settings (attenuation, reference level and internal preamplifier states). Go to “Check for and Remove RF Overload” on page 40.	This signal path and receiver settings will be used in the next step when checking for RF overload.

Procedure 2-4 How to Adjust Receiver Settings

	Step		Comments
1	Adjust the receiver settings to improve the noise floor to limit line separation.	If the noise floor to limit line separation is not adequate, adjust the following and run a new sweep after every adjustment: a. Reduce the receiver input attenuation by changing the attenuation setting in the **Sweep** dialog box under the **Receiver Settings** tab. b. Turn on the internal preamplifier, if the receiver you are using has one, by checking the **Receiver PreAmp** check box in the **Sweep** dialog box under the **Receiver Settings** tab. c. Lower the receiver reference level setting, by changing the **Ref Level** setting in the **Sweep** dialog box under the **Receiver Settings** tab. d. Add an external preamplifier.	• When the noise floor to limit line separation is adequate, continue to step 2. • If an external preamplifier is used, an external attenuator may also be required to check for RF overload. • Add the external preamplifier (with proper correction factors) to the active signal path (See "How to Add and Setup a Transducer (The procedure is similar for any other non-receiver test equipment)" on page 158).



2	Note test configuration and receiver settings.	1. Note the signal path (for example, whether an external preamplifier is used) and the receiver settings (attenuation, reference level and internal preamplifier states) 2. Go to "Check for and Remove RF Overload" on page 40.	This signal path and receiver settings will be used in the next step when checking for RF overload.

NOTE It may be necessary to segment the frequency range of the applicable regulation (performing multiple sweeps) to adequately adjust for noise floor and overload conditions.

Preview EUT Emissions

It is recommended that you preview the EUT emissions prior to beginning an EMI test. This allows you to quickly determine whether or not there are obvious areas of failing emissions that may need to be addressed, and if the receiver sweep settings are set appropriately.

Previewing emissions also provides a way to vary the operating state of the EUT and EUT cable orientations to determine which states or orientations may cause emission levels to increase.

In some instances, high-end emissions can cause overload conditions in your EUT. If you suspect this is the cause, refer to "How to Identify and Remove RF Overload Conditions" on page 40. Refer to the appropriate user manual for your receiver as needed.

Procedure 2-5 How to Preview EUT Conducted Emissions

	Step		Comments
1	Disconnect receiver INPUT from LISN.	• Disconnect the receiver INPUT from the transient limiter or LISN.	*CAUTION*: Failure to carry out this step may result in damage to the receiver.
1	Connect EUT to LISN and turn EUT power On.	• Connect the EUT to the LISN, then turn EUT power On.	• This step should be carried out with the receiver disconnected.
3	Select signal path.	• Choose the active signal path from the **Signal Path** drop down box in the **Receiver** tool bar.	• Select **View** | **Tool Bar** | **Receiver Bar** from the menu to enable the **Receiver Bar**.
4	Set up the receiver.	a. Connect receiver INPUT to the transient limiter or LISN output. b. Set the Receiver to Local mode by clicking **L** on the Receiver Bar (top right-hand corner). c. Set the receiver frequency range to the operating range for the signal path.	• Clicking **L** sends the total signal path correction and the active limit lines to the receiver.

Procedure 2-5 How to Preview EUT Conducted Emissions (Continued)

	Step		**Comments**
5	View EUT emissions.	a. Vary the operating state of the EUT while monitoring the receiver display, to determine which EUT state to use for your test. b. Set the receiver preamplifier state, reference level, and attenuation level as noted in "Determine Receiver Settings" on page 33.	
6	Check for RF overload.	a. Check for RF overload conditions. b. Correct for RF overload if necessary. c. Note the receiver settings; these will be used as the initial receiver settings during the following measurements.	• See "How to Identify and Remove RF Overload Conditions" on page 40 for more information on detecting and correcting overload conditions.
7	Display the receiver trace data in the E7415A graph area.	• From the E7415A Test menu, select **Get Receiver Trace**.	*Tip*: You can also simply click the **Get Receiver Trace** icon in the Receiver Bar.
8	Check for obvious failing emissions.	a. Compare the signal levels with the limit line on the E7415A graph or directly on the receiver. b. If there are obvious failing signals go to "Generate Reports" on page 189. c. If all signals are below the limit line, go to "Gather EUT Signals Using the Peak Detector" on page 42.	• If prescanning emissions directly on the receiver, it may be useful to enable Max Hold on the receiver trace.

Check for and Remove RF Overload

Since ambients are not present in a shielded room, high-level EUT emissions are the most common cause of RF overload.

Overload Conditions

Some signals within the measured frequency span may cause an overload condition. Prior to making measurements, determine that the receiver is not in an RF overload condition.

RF Overload Detection and Correction

RF overload occurs when the energy level at the input mixer of the receiver exceeds the mixer's linear operating range. This means that the mixer is in compression, which can cause amplitude measurement errors.

NOTE Refer to the appropriate user manual for your receiver as needed.

Procedure 2-6 How to Identify and Remove RF Overload Conditions

	Step		Comments
1	Set up the receiver.	a. Set the receiver in Local mode by clicking **L** on the receiver toolbar. b. Set the frequency range of the receiver. c. Set the receiver ref level, attenuation, preamplifier enable, etc. as noted in the "Determine Receiver Settings" on page 33.	• The receiver is put into local mode and continuous sweep. The trace is corrected for the active signal path, and the limit line is displayed. This allows the user to interact directly with the receiver. • Set to the frequency range of the regulation to which you are testing. • Refer to appropriate receiver manual.
2	Determine if the receiver is in overload condition.		• Refer to receiver manual.
3	Remove the RF overload.	• If an RF overload exists, remove the RF overload (usually by increasing the receiver's input attenuation) and record the revised settings. Refer to receiver or analyzer manual.	

Procedure 2-6 How to Identify and Remove RF Overload Conditions

	Step		Comments
4	Change sweep and measure receiver settings.	• Enter revised settings into sweep and measure dialog box receiver settings.	• See “Set Up and Perform Sweeps” on page 175 and “Make Measurements” on page 182.
5	Recheck the noise floor to ensure that the noise floor to limit line separation is adequate.		• See “Noise Floor to Limit Line Separation” on page 33.

Gather EUT Signals Using the Peak Detector

In this section, the analyzer's peak detector is used to measure the EUT emissions over a user-specified frequency range. An emission trace is then displayed on the applications graph window.

This graph of EUT emissions, measured using the peak detector, may be the final result in a compliance or precompliance EMI measurement process if all of the signals measured are below the appropriate limit line.

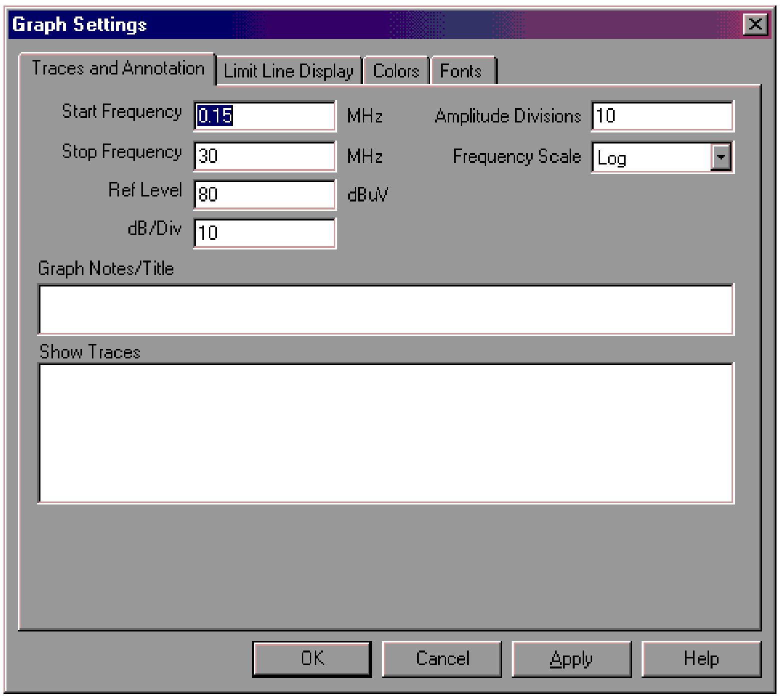
In this step you will develop a graph of the EUT emissions from a single LISN output line.

The following equipment is used in this example:

- E7415A EMI Measurement software
- E7400A-Series EMC Analyzer
- Agilent/HP 11967D (10A) LISN
- Agilent/HP 11947A Transient Limiter

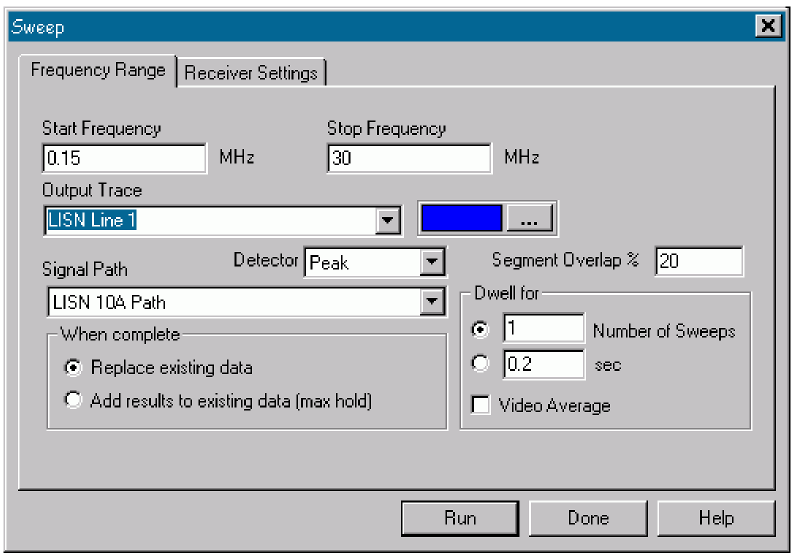
Procedure 2-7 How to Gather EUT Signals

	Step		Comments
1	Connect the LISN output line.	• Connect the LISN output line to be measured, to the receiver INPUT.	• *CAUTION*: To prevent damage to the receiver, review "Configure Test Equipment" on page 26.
2	Adjust the graph reference level.	a. Double click the graph to open the **Graph Settings** dialog box. b. Set the graph reference level and Start/Stop frequencies to those determined during the procedure "Preview EUT Emissions" on page 38. c. Click **OK** to close the **Graph Settings** dialog box.	• The **Graph Settings** dialog box can be opened by selecting **Setup** | **Graph Settings** from the menu. • **Graph Settings** and **Title** can be modified after the sweep has been taken for improved aperance.from the menu.



Procedure 2-7 How to Gather EUT Signals (Continued)

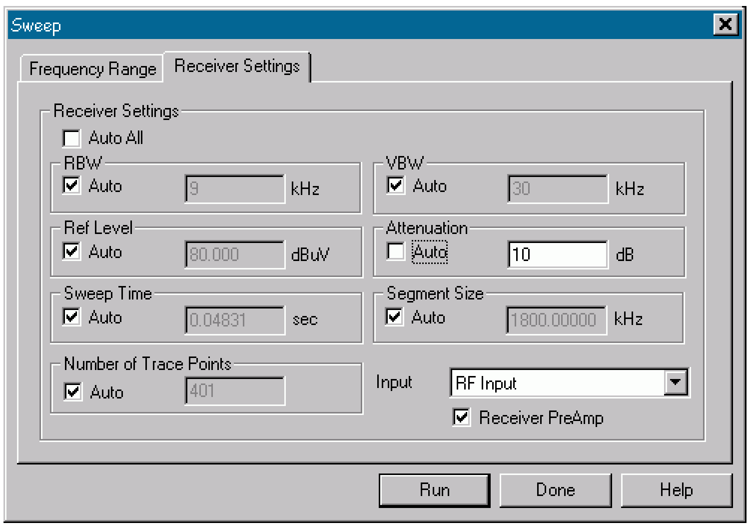
	Step		Comments
3	Set the Sweep parameters.	a. Select **Test** | **Sweep** from the Sidebar or menu. b. Modify the **Start Frequency** and the **Stop Frequency** values if required. c. Set **Dwell for Number of Sweeps** to 1 sweep.	• The **Sweep** dialog box can be opened by right-clicking the graph area, then selecting **Sweep**. • The Start and Stop frequencies are automatically set to the frequency range of the selected regulation, for example 0.15 MHz and 30 MHz respectively. The frequency range can be modified to meet your specific requirements. • *Tip*: Increase the **Dwell for** values to capture intermittent signals or signals with slow cycle times. For example if the EUT's operating state has a 10 second cycle time, set **Dwell for** to >10 seconds.



	Step		Comments
4	Name and define the trace.	a. In the **Output Trace** drop-down list, type a trace name (for example, LISN Line 1). b. Click on the color bar and select a color for the trace. c. Click **OK** to close the color palette.	

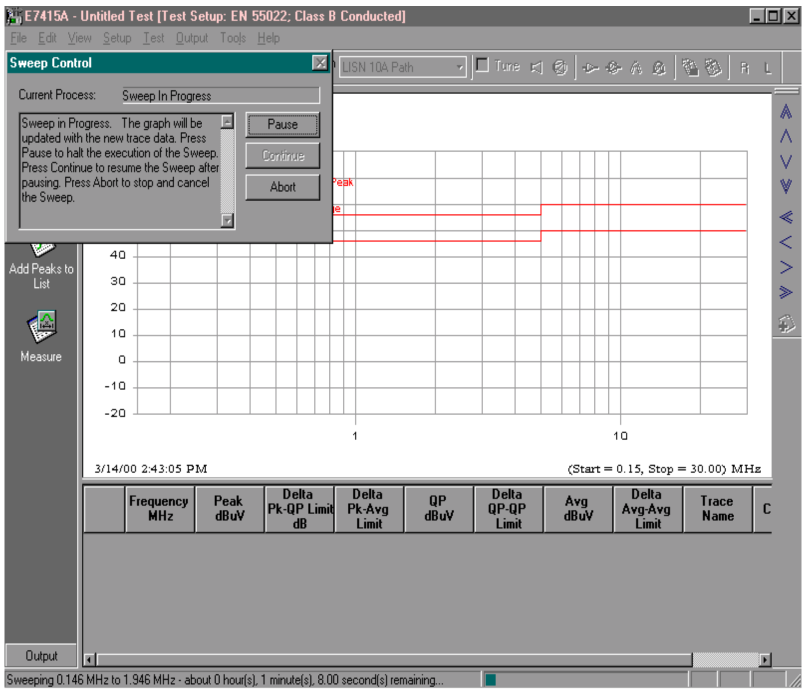
Procedure 2-7 How to Gather EUT Signals (Continued)

Step		Comments
5 Set up the receiver.	a. Open the **Receiver Settings** tab within the Sweep dialog box. b. Set the receiver settings (Ref Level, Attenuation, internal receiver amplifier, if applicable) as noted in “Preview EUT Emissions” on page 38.	• It may be necessary to segment the frequency range of the regulation to which you are testing and enter different attenuation values for each segment (performing multiple sweeps) to account for overload conditions, see “Determine Receiver Settings” on page 33. • **Auto All** sets the receiver settings to the receiver defaults for the specific CISPR band.



Procedure 2-7 How to Gather EUT Signals (Continued)

	Step		Comments
6	Start the sweep.	• Click **Run** to start the sweep.	The receiver is in remote mode, and the software is taking a sweep from 150 kHz to 30 MHz. You can monitor the status of the sweep in the status bar of the application window; you also can view the trace as it is updated on the graph. The sweep can be paused or aborted from the Sweep Control dialog box which appears during the sweep.



Are EUT Signal Peak Values Higher than the Average Limit?

In this section, you will compare your signal trace to the average limit line.

Procedure 2-8 How to compare your signal peak values to the average limit line

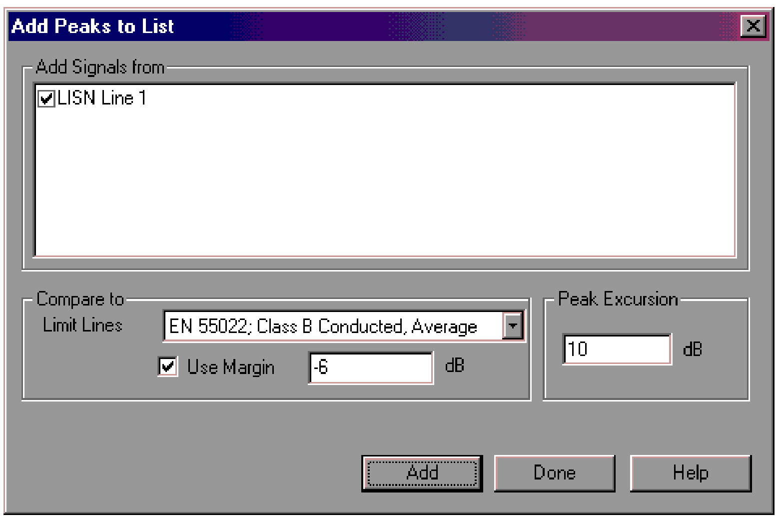
	Step		Comments
1	Compare the Peak trace to the average limit.	• Visually observe the peaks of the trace in the application graph window.	• If a signal is above the limit, further adjustments may be necessary. Refer to "Generate EUT Frequency List" on page 48.
2	Create a Report.	• Refer to "How to Create a Snapshot Report" on page 189 and "How to Create a Custom Report" on page 191.	• If you want to rearrange, add or delete columns in your list before creating a report, refer to "Customize Signal Lists" on page 193.
3	Repeat the Steps 1 and 2 for each limit line to be tested.		

Generate EUT Frequency List

If you have EUT emissions that are above the limit (or margin, if set), you can extract signal frequencies from the trace data and place them in a signal list table. The signal list data can then be used to make additional measurements.

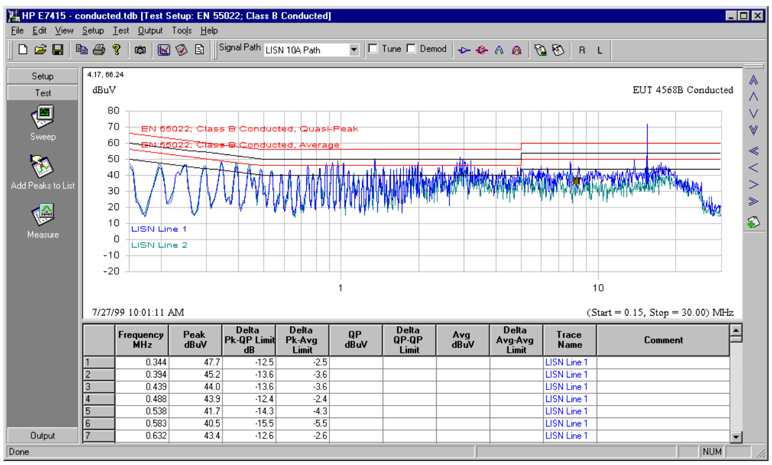
Procedure 2-9 How to Generate EUT Frequency List

	Step		Comments
1	Open the Add Peaks to List dialog box.	• In the Sidebar, select **Add Peaks to List**.	• Add Peaks to List can be opened by right-clicking the graph area. • Tip: Select and add signals from the trace to the list one at a time. Right-click the trace and from the pop-up select **Add Data Point to List**.



Procedure 2-9 How to Generate EUT Frequency List (Continued)

	Step		Comments
2	Select and add signals.	a. In the **Add Signals** from area, select the trace(s) that have signals above the limit line. b. In the **Compare to** area, choose the limit line to which to compare each signal. c. Set **Peak Excursion** to 10 dB (default setting). d. Click **Add**.	In general, the larger the excursion value, the fewer signals will be captured. The smaller the excursion value, the more signals will be captured. If the peak excursion value is set too low, noise will be captured and interpreted as a signal. It is best to select peak excursion values high enough so as not to capture noise, but low enough to ensure that you capture the signals of interest.



Measure Process

The Add Peaks to List operation adds the signals meeting the signal criteria to the signal list. For this example, the following headings (along with Frequency, Trace Name etc.) have been selected for the signal list:

- Peak dBuV
  The measured peak value
- QP dBuV
  The measured quasi-peak value
- Avg dBuV
  The measured average value
- Delta Pk-QP Limit dB
  Difference between the measured peak and the quasi-peak limit (positive for signals below the limit; negative for signals above the limit)
- Delta Pk-Avg Limit dB
  Difference between the measured peak and the average limit (positive for signals below the limit; negative for signals above the limit)
- Delta QP-QP Limit dB
  Difference between the measured quasi-peak and the quasi-peak limit (positive for signals below the limit; negative for signals above the limit)
- Delta Avg-Avg Limit dB
  Difference between the measured average and the average limit (positive for signals below the limit; negative for signals above the limit)

Measure Signals

At this point, the E7415A software has performed a measurement with the peak detector only. It may be necessary to measure signals with the quasi-peak and average detectors as well (as defined in the regulation to which you are testing).

NOTE If EUT emissions are below the average limit line (if applicable) when measuring with a peak or quasi-peak detector, then there is no need to make a second measurement with the average detector. (That is, the EUT passes the average limit since measurements with the average detector will be at or below the peak and quasi-peak levels.)

Use the following procedure to measure signals with the quasi-peak detector. The procedure to measure signals with the average detector is similar.

Evaluate Measurement Results

Sort Signals and Evaluate Results

The signals can be sorted within the signal list by ascending or descending order of any signal list column. Use the following procedure to sort the signal list by delta-to-limit value and then evaluate the results.

Procedure 2-10 How to Sort Signals by Delta-to-Limit Values

	Step		Comments
1	Sort the signal list by highest peak amplitude.	• In the signal list area, double-click on a delta-to-limit column header (for example, Delta QP-QP dB) to sort the signal list by highest amplitude.	• Double-clicking once will sort the data in ascending order, double-clicking again will sort the data in descending order. • You can now easily determine the margin for the signal within the signal list. Signals below the limit line will have negative values; signals above the relative limit line will have positive values.
2	Evaluate the results.	• Use the flowchart (Figure 2-2 on page 24) to determine if the signals you have measured pass or fail.	
3	Create a Report.	• Refer to "How to Create a Snapshot Report" on page 189 and "How to Create a Custom Report" on page 191.	• If you want to rearrange, add or delete columns in your list before creating a report, refer to "Customize Signal Lists" on page 193.

Save Test Data

The current test (test setup with test data) can be saved for use at a later time. **Use File** | **Save** or **File** | **Save As...** to save your test setup with test data. Use **File** | **Save as Setup...** to save the test setup only.

The following test parameters and test data are associated with each test and will be saved:

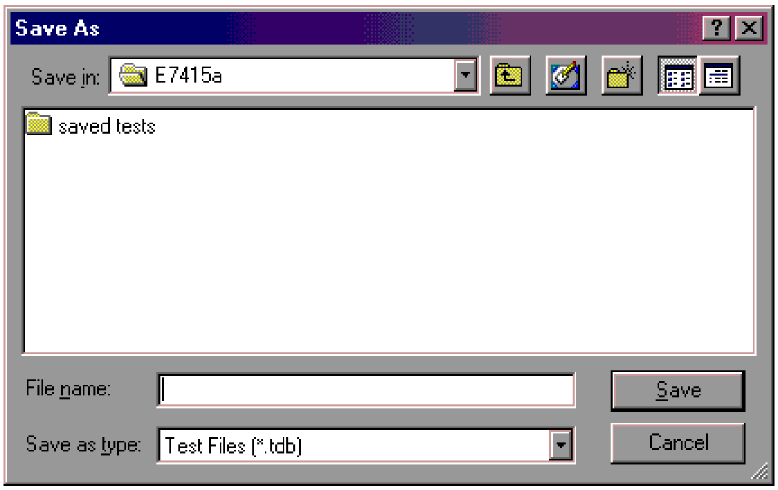
- Test Header Information
- Selected Limit Lines
- Equipment
- Equipment Setup (including corrections)
- Signal Path
- Graph Settings
- Signal List Settings
- Sweep Settings
- Measure Settings
- Trace Data
- Add Peaks to List Settings
- Signal List Data
- Report Settings

NOTE If you wish to save only the test setup parameters for future tests, select
File | **Save as Setup...** No measurement data will be saved and the name you give your newly defined test setup will appear in the **New Test** | **Select Test Setup** window when you restart or when you select **File** | **New**.

NOTE Files saved with data are considerably larger than saved test setups.

Procedure 2-11 How to Save a Test Setup with Data

	Step	Comments
1	Save the test setup and data.	• Select **File** | **Save As....** from the menu. • In the **Save As** dialog box, select a destination folder and enter file name for the saved test setup and data. • Click **Save**.



2	Recall the saved test setup and data.	• To access the test, select **File** | **Open** from the menu, then double-click on the file name.

NOTE If you wish to save your test setup without the data, use **Save Test Setup....**

NOTE A test database (.tdb) file is created when you select **Save** or **Save As...** from the File menu. A *.tdb file captures relevant data that you have acquired or changed since starting the E7415A software. This includes trace data, limit lines, equipment such as cables and transducers, and signal list data. Some of this information, such as limit line and equipment definitions, are also saved in the resource database file Resources.rdb.

CAUTION Use care when moving *.tdb files between computers. If you attempt to use a *.tdb file on a different computer, there is the possibility of conflict since the resource file on the target computer and the resource definition in the *.tdb file may differ. How the conflict is handled depends on the resource in question:

- If the *.tdb file contains a limit definition, and the limit is defined on the target computer, and the limit is marked as “in use” in the *.tdb file, then a warning dialog will appear asking you which version of the limit line you wish to use. Otherwise, the definition in the *.tdb file is ignored, and the resource file version is used instead.
- If the *.tdb file contains an equipment definition, and the equipment is defined on the target computer, and the equipment is marked as “in use” in the *.tdb file by virtue of being included in a signal path, then a warning dialog will appear asking you which version of the equipment you wish to use. Otherwise, the definition in the *.tdb file is ignored, and the resource file version is used instead.
- Because of the subtleties involved in moving data between computers, be sure to check that the data of interest is really being imported into the target computer.

3 Radiated Emissions Example: Shielded Room

In This Chapter...

Introduction

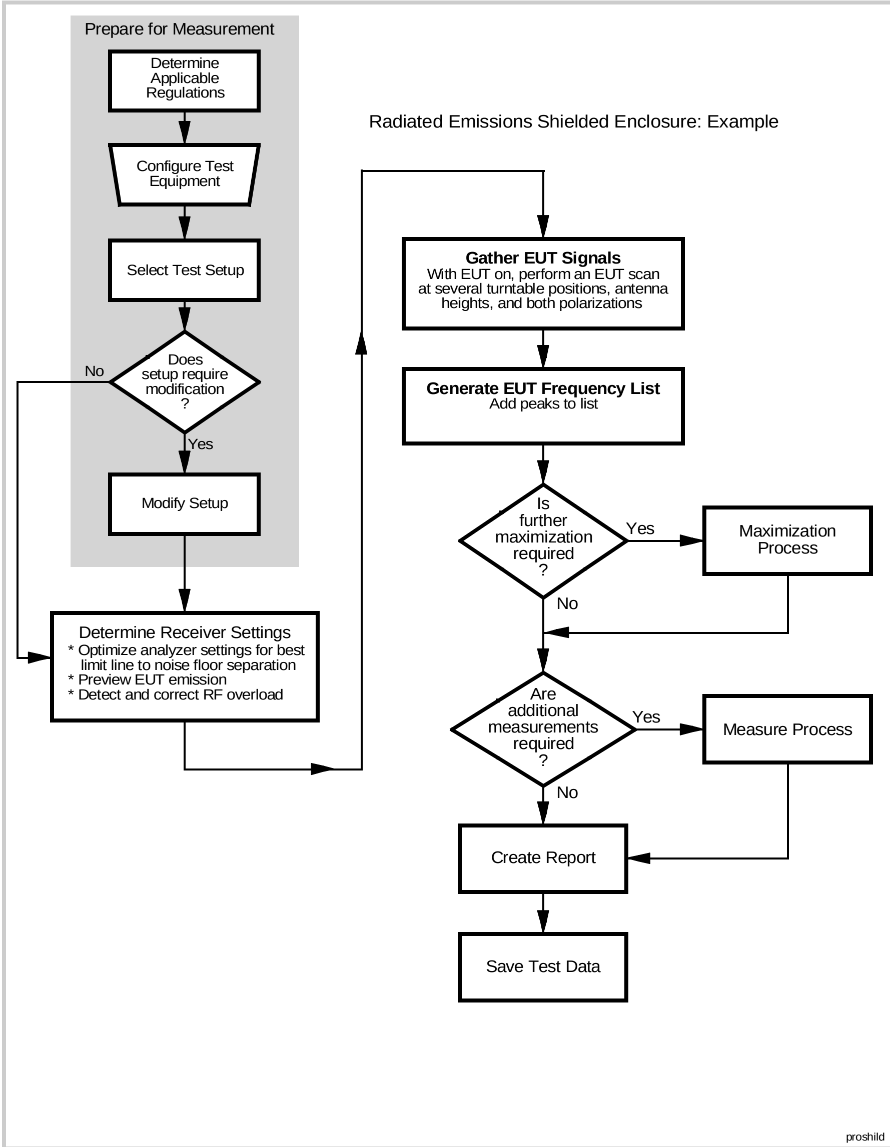
Even if you have access only to a small shielded room, you can still make valuable measurements of your device. Emissions signals found in the small chamber can save you a great deal of time on an open area test site (OATS), by providing valuable information about the EUT emissions.

Radiated Process Flow Chart Example: Shielded Room

Figure 3-1 on page 60 is a flow chart that shows an example process for making measurements of radiated emissions in a shielded room.

As you become familiar with the software, you may discover other methods of testing better suited to your specific application.

Figure 3-1 Precompliance Measurement of Radiated Emissions in a Shielded Room



Determine Applicable Regulations

Determine the regulations to which your EUT must comply. If you do not know the applicable regulation for your product see Appendix A , "Determining your Regulation Requirements," on page 225.

Configure Test Equipment

The equipment used in the test is configured according to regulatory requirements, such as in EN55022 Class B. Refer to the applicable regulation for specific configuration information. The regulation typically specifies the test environment, measurement distance and applicable limits for a compliance test.

In most radiated emissions tests, antenna height and polarization is varied, and the equipment under test (EUT) is rotated to find the configuration resulting in the maximum measured signal amplitude.

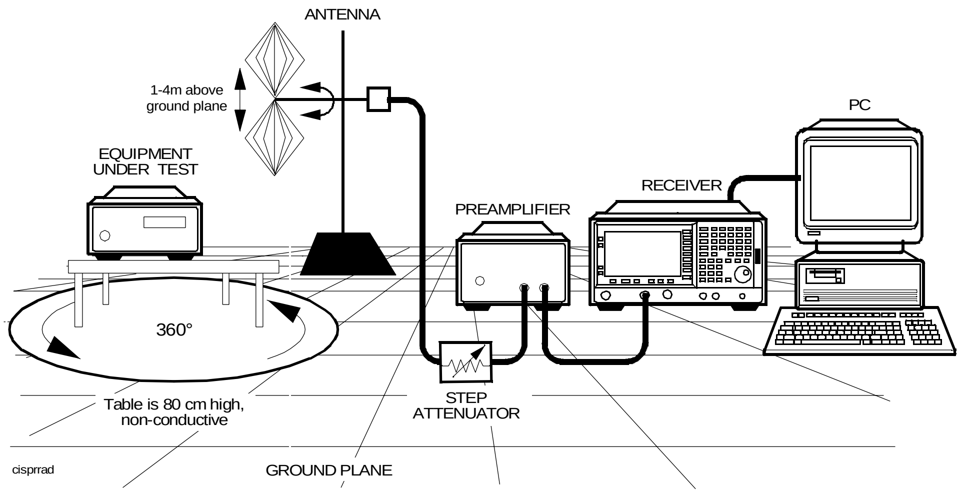
The EUT is operate in the state producing worst case emissions, and interconnect cables, if they are present, are oriented to maximize the emissions.

Typical Equipment

Equipment	Type
PC Controller with E7415A software installed	See E7415A Getting Started Guide or the readme.txt file for PC requirements.
Receiver	85422E 8542E 85462A 8546A 859xEM E7400A-series Simulator (included with the E7415A software used to simulate test data)
Preamplifier	11909A
Biconical Antenna	11966C
Log Periodic Antenna	11966D
BiLog Antenna	11966P
Antenna Tripod	11968C
10 Meter coax cable	11966L

A typical radiated EMI measurement setup is shown in Figure 3-2 on page 63.

Figure 3-2 CISPR Radiated-Emissions Test Setup



The Shielded Room

A shielded room is a chamber made with conductive walls, floor, and ceiling. Though typically made of welded or bolted sections of steel, shielded rooms can also be made of wire mesh, or even conductive wallpaper. Generally, the EUT is placed inside the room with the antenna. The rest of the test equipment is typically located outside the room. (Shielded rooms are also often used to perform conducted emission measurements.)

Shielded rooms provide a quiet, ambient-free environment and protection from the weather at a moderate cost. The major drawback of shielded rooms is that, since the surfaces are conductive, EUT signals can experience multiple reflections and resulting standing waves within the chamber. These room resonances can cause extremely large variations in the amplitude of the measured signals, depending on the size of the room and location of the EUT and antenna within the room. Often anechoic material is applied to the walls and floors of a shielded room to minimize the effects of these reflections.

The signals measured within the shielded room can be used at an OATS to facilitate the identification of EUT signals.

Select Test Setup

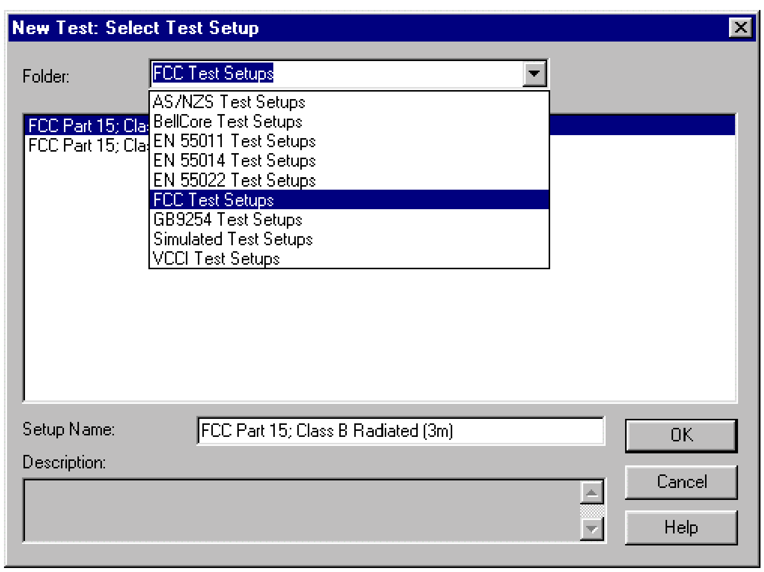
Common test setups have been included with the E7415A application. When you first open the application the **New Test: Select Test Setup** dialog box appears, allowing you to select the regulation to which you normally test. After you have selected a test setup, limit lines for the selected regulation are displayed on the graph.

Select a Test Setup

To select a predefined or previously saved test setup follow these steps:

Procedure 3-1 *How to Select a Test Setup*

Step		Comments
1 Open the Select Test Setup dialog box.	• Open the E7415A application.	• If the application is currently open, select **File** | **New** from the menu. • Select **New** to open an existing test setup without data. • Select **Open** to open an existing test setup and data.



2 Select a set of compliance regulations	• Open the **Folder** drop-down list, and select the desired regulation folder. • Select the regulation to which to test. • Click **OK**.	• There are various folders that contain related compliance regulations, for example **FCC Test Setups: Part 15; Class B Radiated (3m)**.

Does Setup Require Modification?

Determine if the selected test setup requires modification for your particular test equipment (receiver, transducer, cables, limiters, and so on), limit line definitions and ambient lists. To view the test setup, select Setup | Show Setup.

The most common test setup modifications involve editing equipment setup information, such as the equipment used in a test and associated correction factors. Note that the default equipment setup information contains characteristic correction factors for common test equipment. Modifying these correction factors or creating new ones for your specific equipment is recommended for greatest amplitude accuracy.

If your test setup does require modification, continue to “Modify Setup” on page 66.

If your test setup does not require modification, skip to “Determine the Receiver Settings for a Sweep” on page 68.

The following test setup parameters are particularly important, depending upon your test equipment and applicable regulation:

- Limit Lines
- Equipment Corrections
- Signal Path (equipment selected and path of correction)
- Receiver Settings (for sweep and measure)
- Signal List Settings (list columns and filters)
- Graph Settings (appearance of output)

Modify Setup

The existing test setups can be modified to meet your particular requirements.

Modified test setups can be saved for future use (see “Save Test Setup” on page 67). The saved test setups are added to an existing test setup folder or into a newly created test setup folder.

As an option, you can create a new test setup by defining the required test equipment, limit lines, and ambient list.

Steps for Modifying Test Setups

The following are the general steps for modifying an existing test setup:

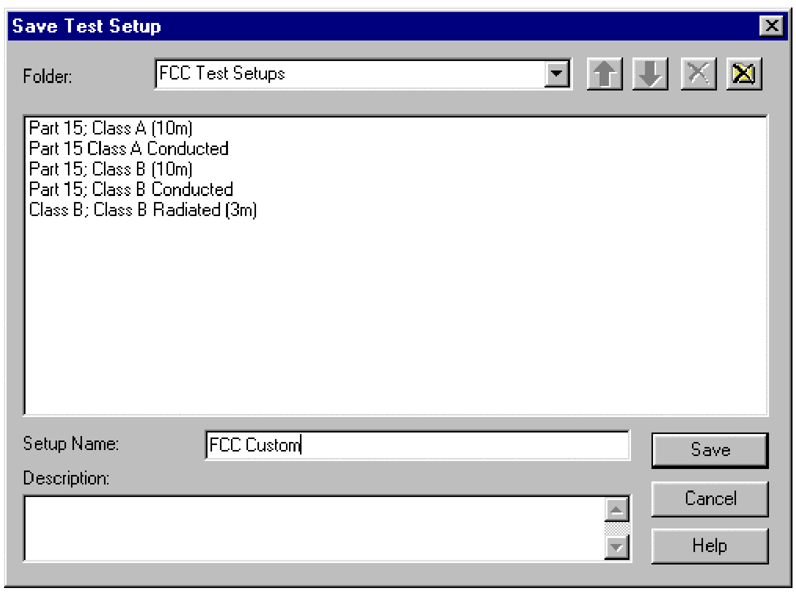
1. Select a test setup (see “Select Test Setup” on page 64)
2. Determine if the selected test setup meets your requirements (see “Does Setup Require Modification?” on page 65)
3. Modify the test setup as necessary. When modifying or creating a test setup, you can change and save the following parameters to accommodate your specific test needs or requirements:
   - Limit Lines (See “Use Limit Lines” on page 146)
   - Equipment Setup (See “Add and Setup Test Equipment” on page 155)
   - Signal Path (See “Use Signal Paths” on page 166)
   - Ambient Lists (See “Use Ambient Lists” on page 168)
   - Graph Settings (See “Customize Graph and Trace Data” on page 206)
   - Signal List Settings (See “Customize Signal Lists” on page 193)
   - Sweep Settings (See “Set Up and Perform Sweeps” on page 175)
   - Measure Settings (See “Make Measurements” on page 182)
   - Report Settings (See “Generate Reports” on page 189)
   - Receiver Settings (See “How to Add and Setup a New Receiver” on page 156)
4. Save modified test setup (see “Save Test Setup” on page 67)

NOTE For cable characterization techniques, see “Characterize Cables” on page 220.

Save Test Setup

Procedure 3-2 How to Save a New or Modified Test Setup

	Step		Comments
1	Save the test setup.	a. From the menu bar, select **File** | **Save As Setup...**. b. In the **Save As Setup** dialog box, select the desired folder from the drop-down list or type in a new folder name c. In the **Setup Name** text box, enter a name for your setup. d. (Optional) Enter a description for your test setup in the **Description** text box. e. Click **Save**.	• The **Save Test Setup** dialog box is displayed. • *Tip*: Entering a new name in the folder text box will create a new test setup folder. • To later access the new setup, select **File** | **New**. Select the folder and highlight the setup name, then click **OK**.



Determine the Receiver Settings for a Sweep

Before measurement sweeps can be taken with the software, the optimum receiver settings for performing the measurements must be determined and set in the software. Several receiver parameters may be set by the user when performing sweeps with the software. These settings, once set, may be saved within the context of a test setup for easy reuse. The sweep setting options are listed below:

- Detector (Peak/Quasi-Peak/Average)
- Dwell Time
- Resolution Bandwidth
- Video Bandwidth
- Reference Level
- Attenuation
- Sweep Time
- Segment Size
- Stop/Start Frequencies
- Segment Overlap
- Receiver Preamp On/Off (854X and E7400A-series only)
- Number of Trace Points (E7400A-series only)

Some settings may need to be set according to a regulation's requirements (e.g. resolution bandwidths) and some settings may need to be set dependent on the equipment you have in the signal path you are using (e.g. start/stop frequency may depend on an antenna's useful frequency range).

Noise Floor to Limit Line Separation

Prior to performing measurements sweeps, you will want to optimize the receiver settings to obtain the best noise floor to limit line separation (how far the noise floor is below the limit line) without encountering RF overload.

NOTE When varying attenuation and preamplification, always check to make sure that you do not encounter RF overload with the new settings. Refer to the manual for your receiver for instructions to check for RF overload.

To do this, you will need to take a sweep with the E7415A software to measure receiver noise floor to limit line separation using the receiver settings that you wish to use during the EMC test. The software signal path definition should be the same as the signal path that will be used during the test. With the application, the noise floor of the receiver should then be measured with the receiver (or external preamplifier if one is defined in the signal path) terminated in 50 ohms. If the measured noise floor to limit line separation is not adequate, then the following receiver settings may require modification.

The following equipment settings can affect the noise floor limit line separation.

- Input Attenuation

  Increasing the attenuation increases the receiver noise floor and decreases the noise floor to limit line separation.

  Decreasing the attenuation decreases the receiver noise floor and increases the noise floor to limit line separation.

- Preamplification with a low noise figure preamplifier (internal or external)

  Adding preamplification decreases the receiver corrected noise floor and increases the noise floor to limit line separation.

  Removing preamplification increases the receiver corrected noise floor and decreases the noise floor to limit line separation.

- Reference Level

  Increasing the reference level in some settings can decrease the limit line to noise floor separation.

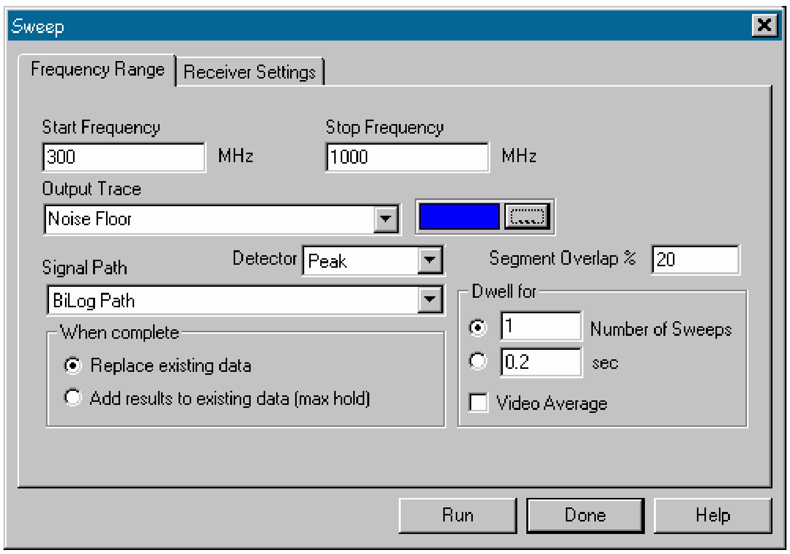
  Decreasing the reference level in some settings can increase the limit line to noise floor separation.

Procedure 3-3 How to Check for Adequate Noise Floor to Limit Separation

	Step		**Comments**
1	Setup test equipment.	a. Disconnect the RF input to your receiver. b. Terminate the RF input on your receiver. c. Power EUT Off.	• If the receiver has more than one input, select the appropriate input for the frequency range of interest. • Use the appropriate 50 ohm termination for your receiver.
2	Select the signal path.	a. Select **Test** | **Sweep**. b. From the **Signal Path** drop-down box, choose the signal path which includes the appropriate receiver, cable loss and transducer factors.	• The signal path determines which correction factors are used to calculate total correction.

Procedure 3-3 How to Check for Adequate Noise Floor to Limit Separation

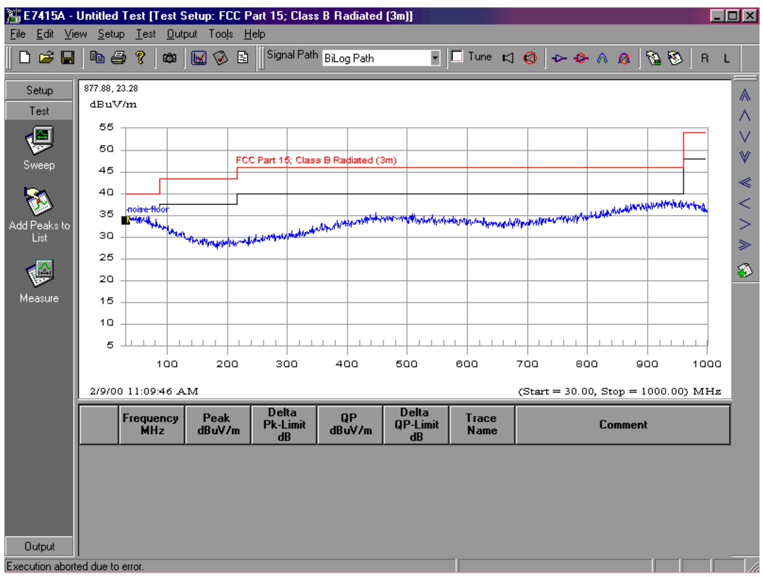
Step			Comments
3	Set the Sweep parameters within the E7415A software.	• Modify the **Start Frequency** and the **Stop Frequency** values if required.	• Tip: the **Sweep** dialog box can be opened by right-clicking the graph area, then selecting **Sweep**. • The Start and Stop frequencies are automatically set to the frequency range of the selected regulation, for this example 30 MHz and 1000 MHz respectively, with a BiLog signal path. Typically, the frequency range is determined by the transducer's operating range, but the frequency range can be modified to meet your specific requirements.



4	Name and define the trace.	a. In the **Output Trace** drop-down box, type a trace name, for example, **`Noise Floor`**. b. Click on the color bar and select a color for the trace. c. Click **OK** to close the color palette.	

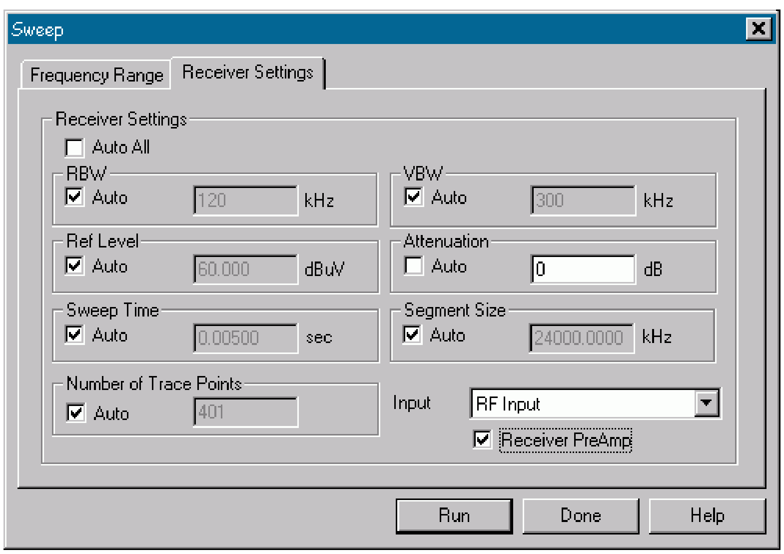
Procedure 3-3 How to Check for Adequate Noise Floor to Limit Separation

Step		Comments
5 Check noise floor.	a. Run the sweep by clicking **Run** in the **Sweep** dialog box. b. If the noise floor to limit line separation is inadequate, go to the step "Adjusting the receiver settings to improve the noise floor to limit line separation." on page 72. c. If the noise floor to limit line separation is sufficient, go to the step "Note test configuration and receiver settings." on page 72.	• The limit margin can be changed in the limit property sheet (see "Use Limit Lines" on page 146). The default margin is –6 dB. Or, set the margin within the Graph Settings dialog box (see "How to Modify the Graph Settings" on page 207.)



Procedure 3-3 How to Check for Adequate Noise Floor to Limit Separation

Step		Comments
6 Adjusting the receiver settings to improve the noise floor to limit line separation.	a. If the noise floor to limit line separation is not adequate you may try changing the following: b. Reduce attenuation by changing the attenuation setting in the **Sweep** dialog box under the **Receiver Settings** tab. c. If the receiver has a built-in preamplifier, enable the preamplifier by checking the **Receiver PreAmp** check box in the **Sweep** dialog box under the **Receiver Settings** tab. d. Reduce the receiver reference level setting by changing the **Ref Level** setting in the **Sweep** dialog box under the **Receiver Settings** tab. e. Add an external preamplifier.	• Run a new sweep after every change to determine its effect on the noise floor. When the noise floor to limit line separation is adequate, continue to step 7. • For best results, add the external preamplifier as close to the antenna output as possible. • If an external preamplifier is used, an external attenuator may be required; check for RF overload. • Add the external preamplifier (with proper correction factors) to the active signal path (See “How to Add and Setup a Transducer (The procedure is similar for any other non-receiver test equipment)” on page 158).



Step		Comments
7 Note test configuration and receiver settings.	• Note the signal path (for example, whether an external preamplifier is used) and the receiver settings (attenuation, reference level and internal preamplifier states).	• This signal path and receiver settings will be used in the next steps when previewing EUT emissions and checking for RF overload.

Preview EUT Emissions

It is recommended that you preview the EUT emissions prior to beginning an EMI test. This allows you to determine quickly whether or not there are obvious areas of failing emissions that may need to be addressed, and if the receiver sweep settings are set appropriately.

Previewing emissions also provides a way to vary the operating state of the EUT and EUT cable orientations to determine which states or orientations may cause emission levels to increase.

Use the following procedures to preview EUT emissions:

1. Preview the EUT emissions.
2. Detect and correct overload conditions.

NOTE Refer to the appropriate User Manual for your receiver as needed.

Procedure 3-4 How to Preview Radiated EUT Emissions

	Step		Comments
1	Select signal path.	a. Choose the active signal path from the **Signal Path** drop down box in the **Receiver** tool bar.	• Click **View** > **Tool bar** > **Receiver Bar** to enable the **Receiver Bar**.
2	Set up the receiver.	a. Connect receiver INPUT. b. Set the Receiver to Local mode by clicking L on the Receiver Bar (top right-hand corner). c. Set the receiver frequency range to the operating range of the transducer in the signal path.	• Clicking **L** sends the total signal path correction and the active limit lines to the receiver.

Procedure 3-4 How to Preview Radiated EUT Emissions (Continued)

	Step		Comments
3	Turn on EUT and view EUT emissions.	a. Power ON the EUT. b. Vary the operating state of the EUT and EUT cable orientations while monitoring the receiver display, to determine which EUT state to use for your test. c. Set the receiver preamplifier state, reference level, and attenuation level as noted in the "Determining the Receiver Settings During a Sweep" process.	
4	Check for RF overload.	a. Check for RF overload conditions. b. Correct for RF overload if necessary. c. Note the receiver settings; these will be used as the initial receiver settings during the following measurements.	• See "Check for and Remove RF Overload" on page 75 for more information on detecting and correcting overload conditions.
5	Check for obvious failing emissions.	a. Compare the signal levels with the limit line on the HP E7415A graph or directly on the receiver. • If there are obvious failing signals, go to "Generate Reports" on page 189. • If all signals are below the limit line, go to "Gather EUT Signals Using the Peak Detector" on page 77.	• If prescanning emissions directly on the receiver, it may be useful to enable Max Hold on the receiver trace.

Check for and Remove RF Overload

Since ambients are not present in a shielded room, high-level EUT emissions are the most common cause of RF overload.

Overload Conditions

Some signals within the measured frequency span may cause an overload condition. Prior to making measurements, determine that the receiver is not in an RF overload condition.

RF Overload Detection and Correction

RF overload occurs when the energy level at the input mixer of the receiver exceeds the mixer's linear operating range. This means that the mixer is in compression, which can cause amplitude measurement errors.

NOTE Refer to the appropriate User Manual for your receiver as needed.

Procedure 3-5 How to Identify and Remove RF Overload Conditions

	Step		Comments
1	Set up the receiver.	a. Set the receiver in Local mode by clicking **L** on the receiver toolbar. b. Set the frequency range of the receiver. c. Set the receiver ref level, attenuation, preamplifier enable, etc. as noted in the "Determine the Receiver Settings for a Sweep" on page 68.	• The receiver is put into local mode and continuous sweep. The trace is corrected for the active signal path, and the limit line is displayed. This allows the user to interact directly with the receiver. • Set to the frequency range of the regulation to which you are testing. • Refer to appropriate receiver manual.
2	Determine if the receiver is in overload condition.	• Refer to receiver manual.	
3	Remove the RF overload.	• If an RF overload exists, remove the RF overload (usually by increasing the receiver's input attenuation) and record the revised settings. Refer to receiver or analyzer manual.	

Procedure 3-5 How to Identify and Remove RF Overload Conditions

	Step		Comments
4	Change sweep and measure receiver settings.	• Enter revised settings into sweep and measure dialog box receiver settings.	• See "How to Setup and Perform a Sweep" on page 177 and "How to Setup and Perform a Measurement" on page 185.
5	Recheck noise floor.	• After correcting for RF overload conditions, recheck the noise floor to ensure that the noise floor to limit line separation is adequate.	

Gather EUT Signals Using the Peak Detector

An EUT Signal List generated in a shielded enclosure may be the final result in a precompliance EMI measurement process, or it may be used as the EUT suspect list for further measurements.

In order to develop a list of EUT emissions to measure, you will need to use the software to take sweeps with the EUT in place in the enclosure and powered on. The list will include EUT signals discerned from the traces resulting from these sweeps.

It is best to gather the EUT signals with the EUT oriented to several different turntable positions and the antenna positioned to several different heights and polarities. This improves the probability of capturing an EUT emission.

The procedure, "How to Gather EUT Signals" on page 78, uses typical settings to capture signals. You may want to modify these settings to optimize your test procedure.

For this example procedure, two traces will be generated with the E7415A software:

- Horizontal antenna polarization (With various turntable positions)
- Vertical antenna polarization (With various turntable positions)

For each trace, the following four sweeps will be performed:

- Antenna tower at 1 meter
  — Turntable at 0 degrees
  — Turntable at 90 degrees
  — Turntable at 180 degrees
  — Turntable at 270 degrees

For each trace, the maximum amplitude value from the 4 turntable positions will be retained (Max Hold).

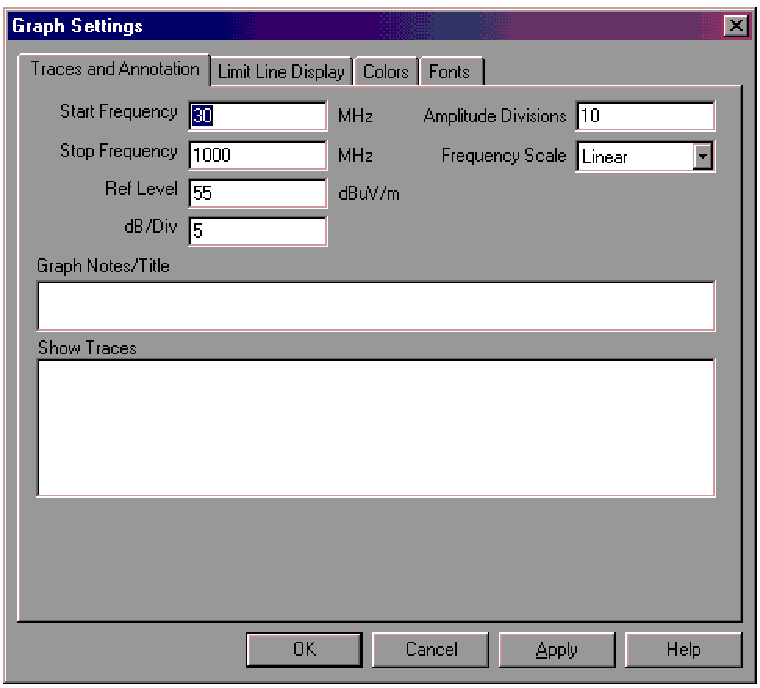
The following equipment is used in this example:

- E7415A EMI measurement software
- E7405A EMC analyzer
- 11966P BiLog antenna
- 11966L 10 meter coaxial cable
- Manual antenna tower
- Manual turntable

NOTE The tower height will not be changed for this example. The number of sweeps can be modified to best fit your processes. Refer to Chapter 4 , "Radiated Emissions Example: Open Area Test Site," on page 93, for an example using 24 sweeps.

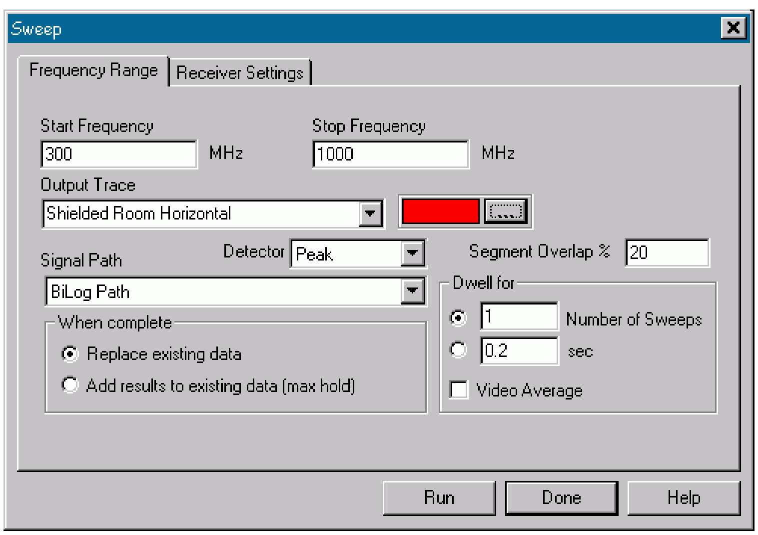
Procedure 3-6 How to Gather EUT Signals

Step		Comments
1 Set antenna polarity, tower, and turntable positions.	a. Position the antenna in the horizontal polarization. b. Manually position the tower to 1 meter. c. Manually position the turntable to 0 degrees.	• The antenna will be in the vertical polarization for the second trace.
2 Set the graph reference level.	a. Double-click in the graph area of the EMI measurement software to open the **Graph Settings** dialog box. b. Set the graph reference level, and start/stop frequencies to those determined during “Preview EUT Emissions” on page 73. Click **OK** to close the Graph Settings dialog box.	• The **Graph Settings** dialog box can be opened from the menu bar (**Setup** | **Graph Settings...**) or the toolbar. • **Graph Settings** and **Title** can be modified after the Sweep for improved appearance.



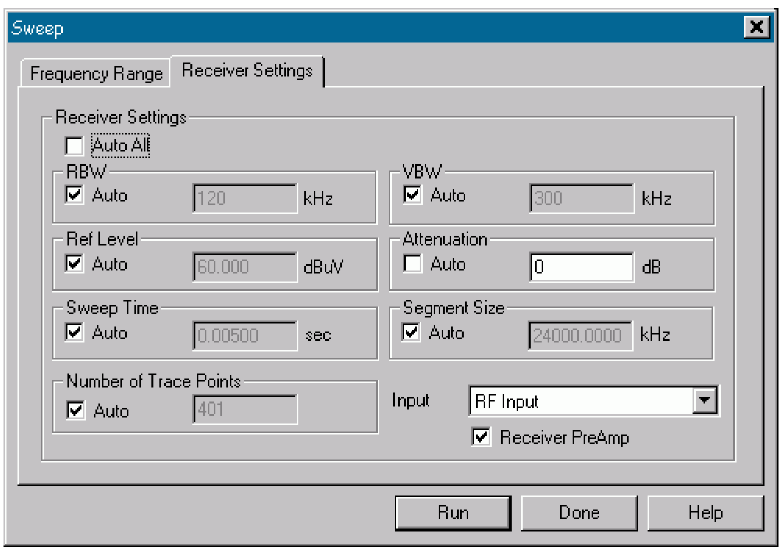
Procedure 3-6 How to Gather EUT Signals (Continued)

Step		Comments
3 Set the Sweep parameters.	a. Power on the EUT. b. In the Sidebar, select **Test** | **Sweep**. c. In the Sweep dialog box, set the start frequency and the stop frequency to the range of the antenna you are using. d. Select "Replace existing data" for the first of the 4 sweeps.	• *Tip*: The Sweep dialog box can be opened by right-clicking the graph area, then selecting Sweep (or by selecting Sweep from the Test menu). • For this example, a Bilog antenna is used with a frequency range of 30 MHz to 1000 MHz. • More than one antenna may be needed to cover the frequency range of the regulation to which you are testing. • For example: Set the start frequency to 30 MHz and the stop frequency to 200 MHz for a biconical antenna. Set the start frequency to 200 MHz and the stop frequency to 1000 MHz for a log periodic antenna. • *Tip*: Increase "Dwell for" values to capture intermittent signals or signals with slow cycle times. For example, if the EUT's operating state has a 10 second cycle time, set Dwell for to 15 or 20 seconds.



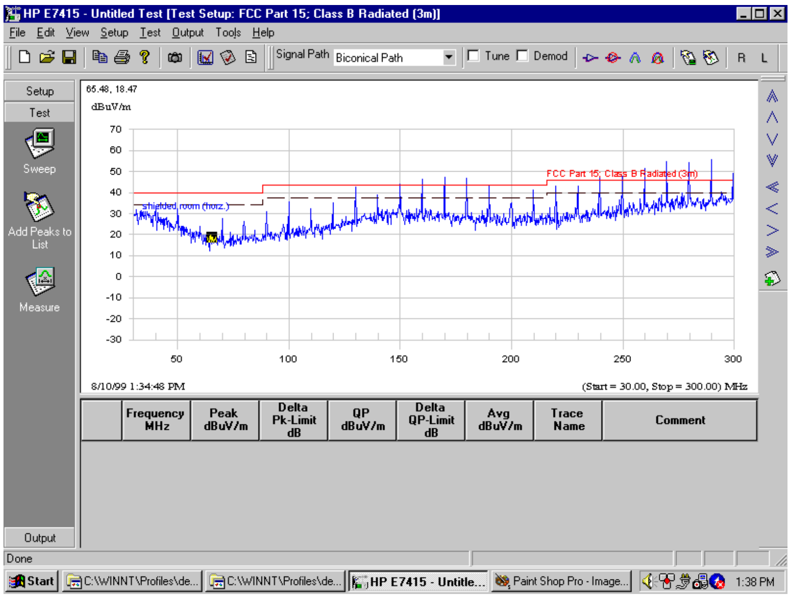
Procedure 3-6 How to Gather EUT Signals (Continued)

	Step		Comments
4	Name and define the trace.	a. In the **Output Trace** drop-down box, enter a trace name (for example, **`Shielded Room Horizontal`**). b. Click on the color bar and select a color for the trace. c. Click **OK** to close the color palette.	• Give the vertical trace a different name, (for example **`Shielded Room Vertical`**). • For example, select red for horizontal antenna and blue for vertical antenna polarization.
5	Set up the receiver.	a. Open the **Receiver Settings** tab within the **Sweep** dialog box. b. Set the receiver settings (Ref Level, EUT Attenuation, and internal Receiver preamplifier if applicable) as noted in the "Preview EUT Emissions" on page 73. c. If the receiver has more than one input, select the correct input.	• It may be necessary to segment the frequency span further to correctly account for overload conditions due to high-level signals while not masking low-level signals at different frequencies. See "Overload Conditions" on page 75. • Enabling Auto RBW and VBW sets these values as per the CISPR 16 specification.



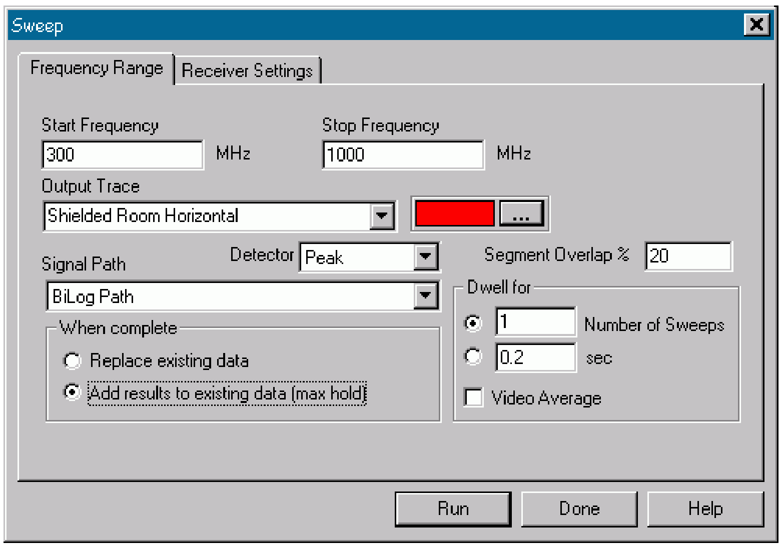
Procedure 3-6 How to Gather EUT Signals (Continued)

Step		Comments
6 Start the sweep.	• Click **Run** to start the sweep.	• The receiver is in remote mode, and the software is taking a sweep from 30 MHz to 1000 MHz comprised of several segments. • You can monitor the status of the sweep in the status bar of the application window; you also can view the trace as it is updated on the graph. • The Sweep can be paused or aborted from the Sweep Control dialog box which appears during the sweep.



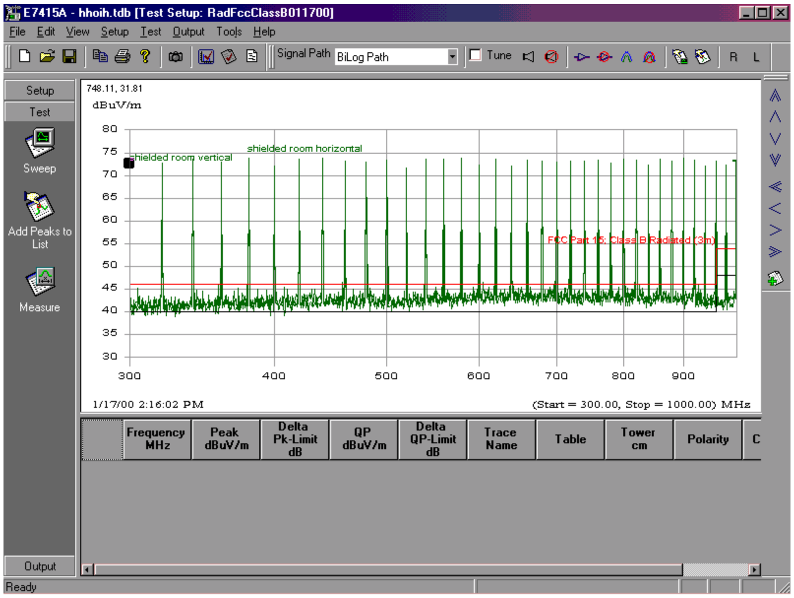
Procedure 3-6 How to Gather EUT Signals (Continued)

	Step		Comments
7	Set the trace data to Max Hold.	a. After the software has completed the first sweep, open the **Sweep** dialog box by clicking on the **Sweep** icon. b. Select **Add results to existing data (max hold)**.	• The resulting graph trace from multiple sweeps will retain and display the maximum value at each frequency point when “Add results to existing data (max hold)” is selected.



Procedure 3-6 How to Gather EUT Signals (Continued)

Step		Comments
8 Run sweeps for other turntable positions.	a. Adjust the turntable position to 90 degrees. b. Click **Run** in the **Sweep** dialog box. c. Adjust the turntable position to 180 degrees. d. Run sweep. e. Adjust the turntable position to 270 degrees. f. Run sweep.	• When this step is complete, four sweeps will have been performed. The maximum points from the sweeps make up the “Shielded Room Horizontal” trace on the graph.
9 Repeat sweep process for vertical antenna.	a. Position antenna with vertical polarization. b. Repeat steps 1 through 8.	• Different reference levels may be required for vertical antenna polarization, see “Preview EUT Emissions” on page 73. • Choose a different name for the vertical trace, for example, **Shielded Room Vertical**. • Choose a different color for the vertical trace. • After completing steps 1 through 8, two traces will appear on the graph. One for horizontal and the other for vertical antenna polarization.

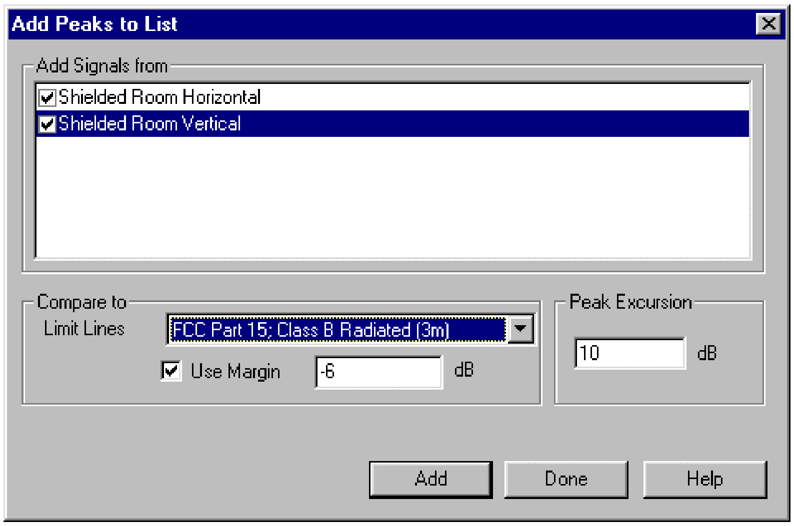


Generate EUT Signal List

Now that you have EUT signal traces, you can identify the peaks from the trace data and place them in the signal list table. The signal list data can then be used as a basis for future measurements and signal comparisons.

Procedure 3-7 Generate EUT Signal List

	Step		Comments
1	Open the Add Peaks to List dialog box.	• In the Sidebar, click on the **Add Peaks to List**.	• Or, right-click the graph area and select **Add Peaks to List**.



Procedure 3-7 Generate EUT Signal List (Continued)

	Step		Comments
2	Select and add signals.	a. In the **Add Signals** from area, select the **Shielded Room Horizontal** and **Shielded Room Vertical** traces. b. In the **Compare to** area, choose the limit line to which you are testing, (for this example, **FCC part 15; Class B (3m)**). c. Optional: Check the **Use Margin** box; set the margin to –6 dB (default setting). d. Set **Peak Excursion Criteria** to 10 dB (default setting). e. Click **Add**.	• The signals above the limit line margin (except duplicate signals) which meet the peak excursion are added to the list. The Trace Name column in the Signal List table shows the trace from which each signal is generated. • The larger the peak excursion value, the fewer signals will be captured. The smaller the excursion value, the more signals will be captured. If the peak excursion is set too low, noise will be captured and interpreted as a signal. It is best to set peak excursion high enough not to capture noise, but low enough to capture the signals of interest. See Peak Excursion in the glossary for more information. • *Tip*: If Limit Lines “None” is selected, then all peaks in the selected trace(s) meeting the peak excursion criteria will be added to the Signal List; if Peak Excursion is also set to 0 dB, then all the Trace points are added to the list.

Maximization and Measure Process

This section is composed of two basic steps that must be performed on each signal in the signal list sequentially. These steps are signal maximization and then measuring.

1. Maximization

   In this step you will rotate the turntable and vary the antenna height and polarization until the EUT emission is at its highest amplitude. You will then record the turntable orientation, antenna height and polarization in the Table, Tower and Polarity columns of the list. This process is typically repeated for each suspect EUT emission.

2. Measure

   In this step you will measure the EUT emission amplitude using the appropriate detectors (usually Peak and Quasi-Peak) and dwell times appropriate for your emissions characteristics.

The following steps detail an example process to maximize and measure suspect signal in the list. As you become familiar with the E7415 application, you may discover procedures that better fit your requirements.

Preparation

Table 3-8 Prepare to Perform the Maximization and Measure Process

	Step		Comments
1	Add antenna height, polarity and turntable position columns to signal table.	a. Open the **List Settings** dialog box; click **Setup** | **List Settings...** b. Click on the right arrow key to add to the **Selected Columns** list. c. Reorder the columns if desired. d. Click **OK**.	• When you have maximized each signal, edit these columns with the appropriate information. • Refer to “Customize Signal Lists” on page 193 for more information.

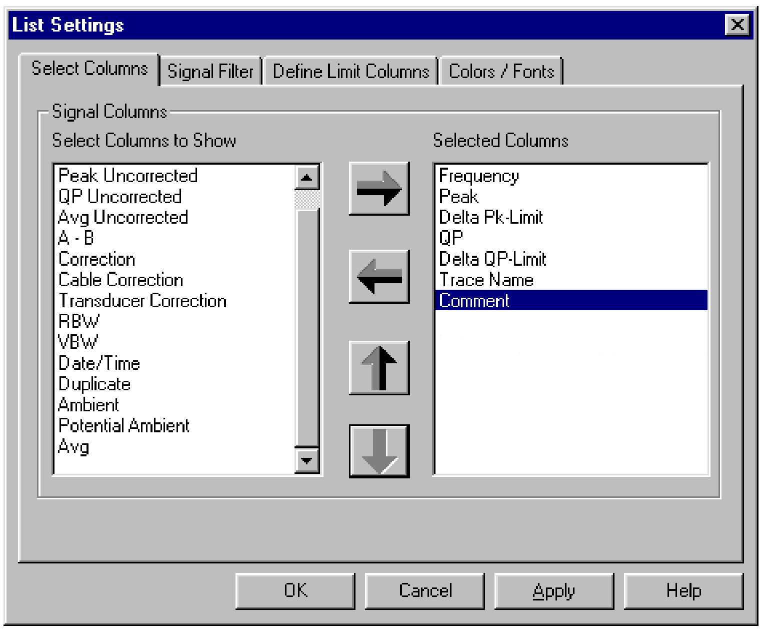
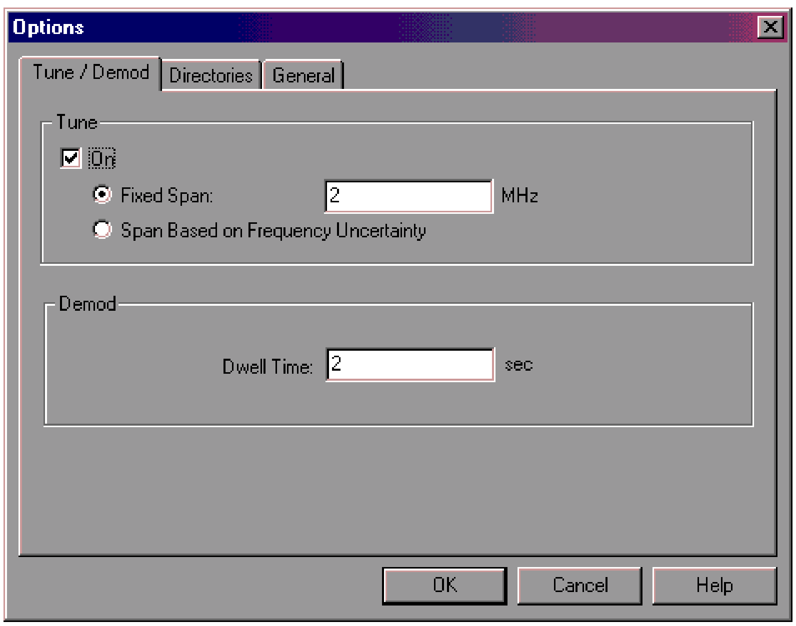


Table 3-8 Prepare to Perform the Maximization and Measure Process

Step		Comments
Set the span for automatic tuning of the receiver to 2 MHz.	a. Select **Tools** | **Options...** | **Tune/Demod**. b. Select the **Tune** box. c. Select **Fixed Span** and set to 2 MHz. d. Click **OK**.	• Other spans may be used if they are more useful for your application. Note that if **Span Based on Frequency Uncertainty** is selected that the span will vary based on the frequency uncertainty of the receiver when that specific signal was last measured. • The tune function can be enabled and disabled quickly by selecting and deselecting the **Tune** box in the **Receiver Bar**.



Maximization

The maximization process is performed to determine antenna, tower, and turntable orientation that will find the maximum amplitude EUT signal.

In this step you will rotate the turntable and vary the antenna height and polarization until the EUT emission is at its highest amplitude. You will have the opportunity to reposition the marker on the signal to update the signal frequency if necessary. You will then record the turntable orientation, antenna height and polarization in the Table, Tower and Polarity columns of the list.

Table 3-9 Maximization Process

	Step		Comments
1	Position the turntable, antenna height and polarity.	• Position the turntable, antenna height and polarity to the position where you are most likely to observe the EUT emission.	
2	Tune to a signal.	• Highlight a signal in the signal list. (Click on the number column.)	• The receiver tunes to the selected signal, center frequency set to the signal list frequency, and frequency span to 2 MHz. The receiver goes to local mode.
3	Rotate the turntable from 0-360 degrees to find the maximum response.	a. Move the turntable to maximize the signal on the receiver. b. Select Max Hold on the Receiver bar to assist you in finding the maximum response.	• Leave the turntable in the position with the maximum response. • Clicking **Max Hold** on the receiver bar leaves Trace 1 as the active trace, and sets Trace 2 to Max Hold.
4	Adjust the antenna polarization and height to find the maximum response.	a. Adjust the antenna polarization and height for the maximum signal response. b. Select **Max Hold** on the Receiver bar to assist you in finding the maximum response.	• Leave the antenna polarization and height in the position with the maximum response.
5	Reposition the marker to update the list frequency if required for measurement.	a. If the marker needs to be re-centered on the signal before measurement, do these steps. Otherwise skip to the next step. b. Use the receiver knob (or peak search) to position the marker on the signal. c. Click **Get Receiver Marker** on the receiver bar to add the new marker position to the list. d. Press the **Delete** key to delete the old signal in the list. e. Click on the new signal added to the list to tune the receiver to the updated signal frequency.	• Sometimes the marker will need to be repositioned on the signal to measure due to EUT frequency drift or receiver frequency uncertainties. • *Tip*: From the receiver's front panel, the marker can be placed on the max held trace. • The new marker frequency will be placed in the list just below the highlighted signal that you are currently tuned to. • Make certain that the old signal is highlighted before pressing **Delete**. • *Tip*: You may find it convenient to disable Tune on the Receiver bar prior to selecting and deleting old signals in the list.

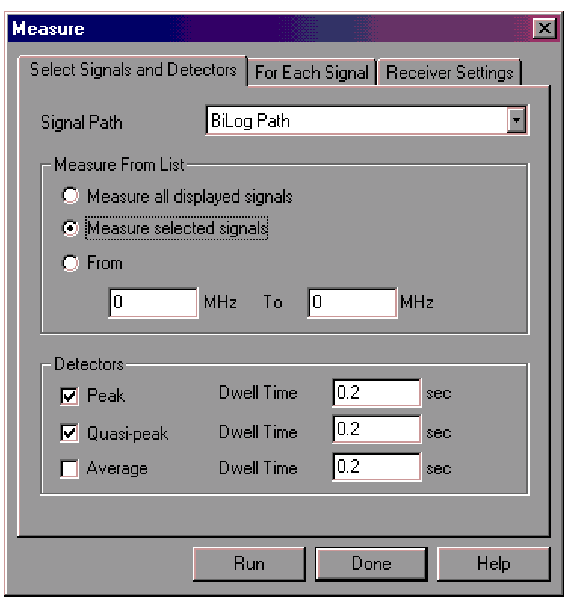
Measure

In this step you will measure the EUT emission amplitude using the appropriate detectors (usually Peak and Quasi-Peak) and dwell times appropriate for your emissions characteristics.

During a measurement, the reference level must be adjusted such that the signal being measured is below the top display graticule to prevent IF overload. If the signal being measured is above the top display graticule, increase the receiver reference level until the signal falls below the top of the graticule.

Procedure 3-10 Measure Process

Step			Comments
1	Measure the signal.	a. Open the **Measure** dialog box by clicking the **Measure** icon in the Sidebar. b. In the **Measure From List** area, select the **Measure selected signals** option. c. In the **Detectors** area, select the appropriate detectors (for example, Peak and Quasi-Peak). d. In the Detectors area, set the **Dwell Time** for each detector selected. e. Click **Run** to begin the measurement.	• The default dwell times are adequate for measuring most emissions. If the signal that you are measuring has a low repetition rate or is intermittent in nature you may need to increase the dwell time to capture at least two repetitions in order to accurately measure it. If the dwell time is increased for any of the detectors, you must also increase the **Autorange Sweep Time** to be equal to or greater than the longest dwell time of the selected detectors. The **Autorange Sweep Time** may be set by clicking the **Receiver Settings** tab in the **Measure** dialog box and setting in the **Autorange Sweep Time**.



Continue to Next Signal

Continue with the next signal and repeat procedures 3-9 and 3-10 for every signal in your list.

When complete, you should have a list of only your identified, maximized and measured EUT emissions.

- If you wish to rearrange or add or delete columns in your list before creating a report refer to "Customize Signal Lists" on page 193.
- To create a report refer to "Generate Reports" on page 189.
- To save your test data, refer to "Setup Tests" on page 141. A test file containing a list of EUT emissions identified in a shielded enclosure can be the starting point for performing compliance tests on an OATS reducing the overall time spent on the OATS.

4 Radiated Emissions Example: Open Area Test Site

In This Chapter...

- "Example Process for Measurement of Radiated Emissions on an Open Area Test Site (OATS)" on page 96.

  Shows the process flow for typical radiated precompliance measurements performed on an OATS (Open Area Test Site).

- "Configure Test Equipment" on page 98.

  Explains the configuration of the test equipment and EUT.

- "Does Setup Require Modification?" on page 101.

  Determine if the selected test setup requires modification for your particular test environment.

- "Modify Setup" on page 102.

  Explains how to modify a setup to meet your specific test requirements.

- "Determine the Receiver Settings for a Sweep" on page 104.

  Explains how to determine the optimum receiver settings for performing the measurements.

- "Create Ambient Signal List" on page 112.

  Describes how to create a list that will be used to compare against ambient + EUT scans to help determine what signals are due to the EUT alone.

- "Gather EUT + Ambient Signals Using the Peak Detector (Several Orientations)" on page 119.

  Explains how to gather EUT + Ambient signals on an OATS to compare against ambient signals.

- "Generate EUT Signal List" on page 126.

  Explains how to extract the signals from the trace data and place them in the signal list table

- "Reduce Data (Initial Data Reduction)" on page 128.

  Explains the initial steps used to delete known ambients and hide lower duplicates.

- "Signal Identification, Maximization and Measure Process" on page 131.

  Demonstrates the three basic steps to accomplish signal identification, maximization and measuring.

Introduction

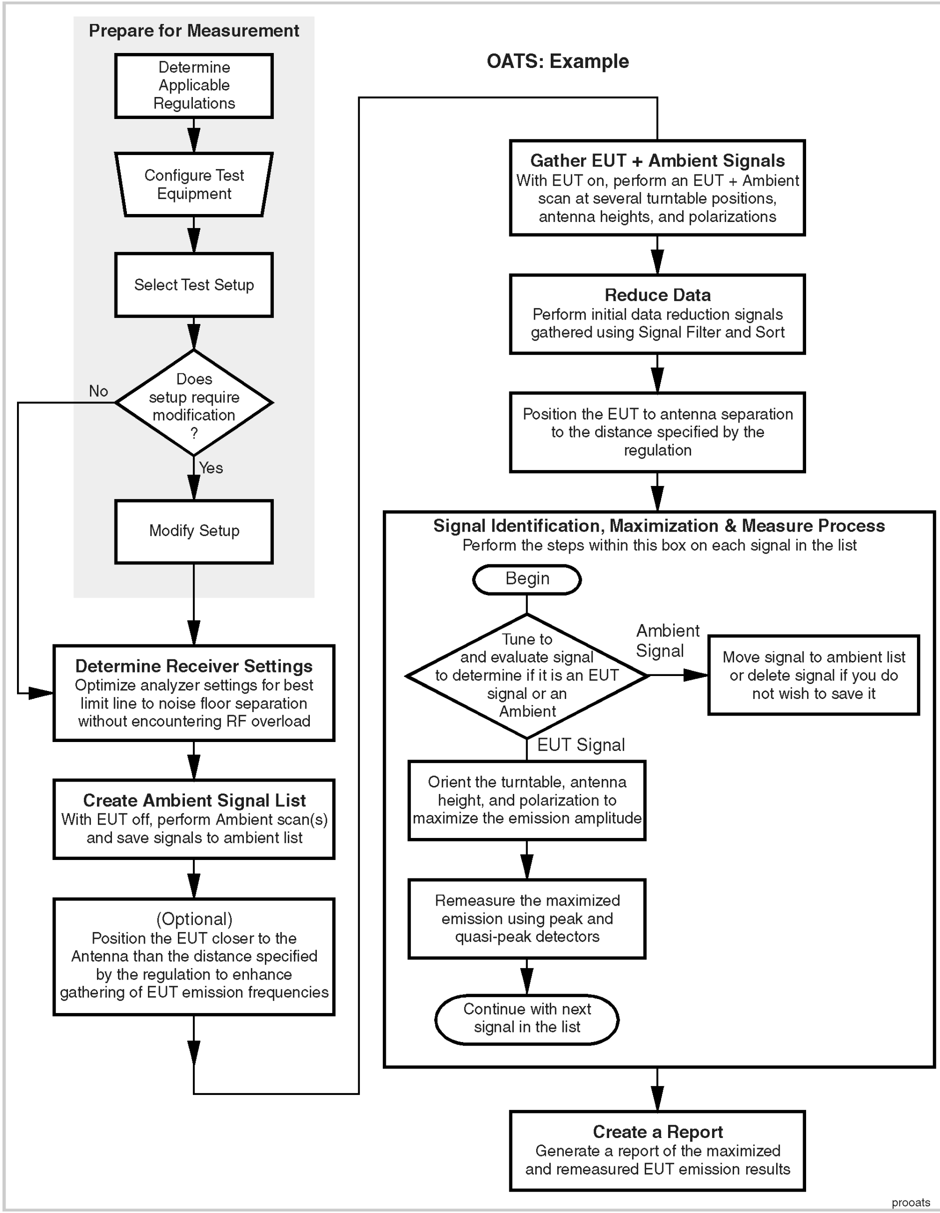
The E7415A software may be used on an Open Area Test Site (OATS) to perform compliance tests when using an 8542E or 8546A EMI receiver. It may also be used on an OATS to perform precompliance tests when using one of the E7400A-Series or 8590EM Series analyzers.

When performing tests on an OATS it is generally preferable to first gather a list of EUT emission frequencies in a shielded room. A shielded room will allow you to gather emissions that are only due to your equipment under test (EUT) without having to concern yourself with the local ambient (for example, FM or TV broadcasts) environment. Of course, not everyone will have access to a shielded room.

This example process assumes that you do not have access to a shielded room and are performing radiated emissions tests utilizing only an OATS. If you do have access to a shielded room, you will find that a great portion of this process will still be useful to you. You will just have the added advantage of knowing what your EUT emission frequencies are prior to moving to the OATS.

Radiated Process Flow Chart Example: Open Area Test Site Figure 4-1 on page 96 is a flow chart that shows an example process for making measurements of radiated emissions with an OATS facility. This is only an example. As you learn to use the software, you may find other methods of testing that will better suit your specific application.

Figure 4-1 Example Process for Measurement of Radiated Emissions on an Open Area Test Site (OATS)



Determine Applicable Regulations

Determine the regulations to which you must comply. If you do not know the applicable regulation for your product see Appendix A , "Determining your Regulation Requirements," on page 225.

Configure Test Equipment

In this example, the equipment used in the test is configured to perform an EN55022 Class B test. Refer to the applicable regulation to determine your specific configuration requirement. The regulation typically specifies the test environment, receiver characteristics, and transducer characteristics for a compliance test. If you do not know what regulation is applicable for your product see Appendix A , “Determining your Regulation Requirements,” on page 225.

During most radiated emissions tests, antenna height and polarization is varied, and the equipment under test (EUT) is rotated to find the configuration resulting in the maximum measured signal amplitude. The EUT is normally exercised in a way that represents its typical usage. Interconnect cables, if present, are oriented to maximize the amplitude of emissions.

The basic configuration for a radiated emissions measurement consists of a transducer, an internal/external preamplifier (optional), an external attenuator (optional), an external preselector (optional), cables, and a receiver. A PC and software, such as the E7415A with some or all of the options listed in “Common Test Equipment” on page 99, are often used to enhance measurement efficiency, and report generation.

The Open Area Test Site

Comité International Spécial des Perturbations Radioélectriques (CISPR) has established a standard for Open Area Test Sites (OATS). (Refer to CISPR publication 16.) An OATS must meet the standards of the applicable regulations.

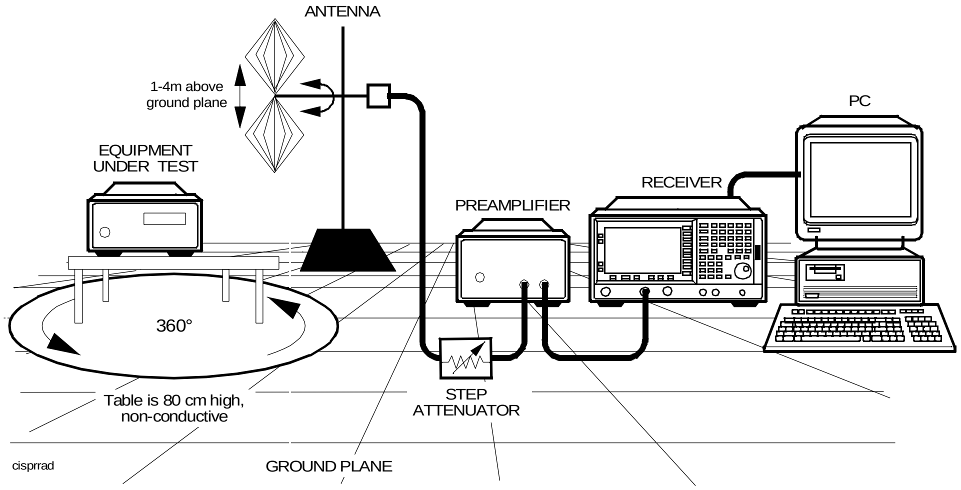
It is useful to characterize the ambient signals at your OATS prior to testing your EUT. This will greatly facilitate the identification of suspect EUT signals. (An ambient signal list will be generated as part of the test process, see “How to Generate Ambient Signal List” on page 113.)

Common Test Equipment

Equipment	Type
PC Controller with E7415A software installed	See E7415A Getting Started Guide or the readme.txt file for PC requirements.
Receiver	85422E 8542E 85462A 8546A 859xEM E7400A-series Simulator (included with the E7415A software used to simulate test data)
Preamplifier	11909A
Biconical Antenna	11966C
Log Periodic Antenna	11966D
BiLog Antenna	11966P
Antenna Tripod	11968C
10 Meter coax cable	11966L
Optional	
Post-Process Report	E7415A 001

A typical radiated EMI measurement setup is shown in Figure 4-2 on page 99.

Figure 4-2 **Typical OATS Radiated-Emissions Test Setup**



Select Test Setup

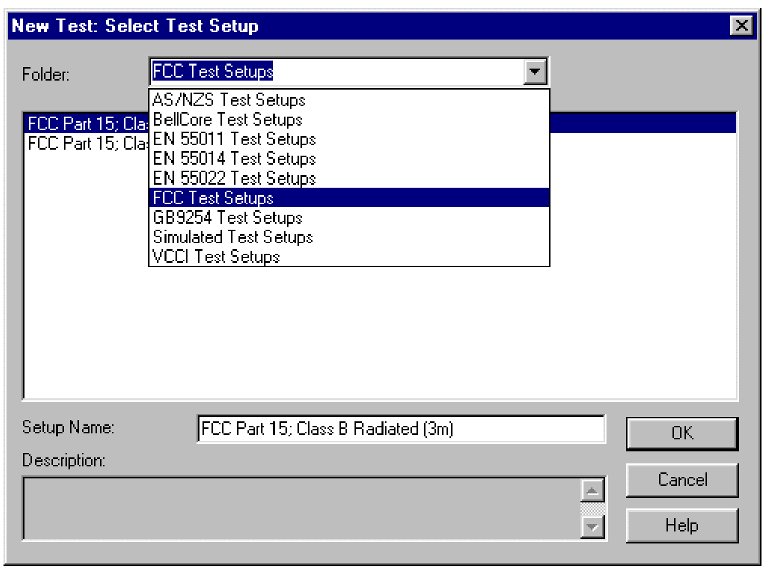
Common test setups have been included with the E7415A application. When you first open the application the **New Test: Select Test Setup** dialog box appears, allowing you to select the regulation to which you normally test. After you have selected a test setup, limit lines for the selected regulation are displayed on the graph.

Select a Test Setup

To select a predefined or previously saved test setup follow these steps:

Procedure 4-1 ***How to Select a Test Setup***

	Step		Comments
1	Open the Select Test Setup dialog box.	• Open the E7415A application.	• If the application is currently open, select **File** | **New** from the menu. • Select **New** to open an existing test setup without data. • Select **Open** to open an existing test setup and data.



	Step		Comments
2	Select a set of compliance regulations	a. Open the **Folder** drop-down list, and select the desired regulation folder. b. Select the regulation to which to test. c. Click **OK**.	• There are various folders that contain related compliance regulations, for example **EN 55022 Test Setups**: **EN 55022; Class B Radiated, (10m) w/Preamp**.

Does Setup Require Modification?

Determine if the selected test setup requires modification for your particular test equipment (receiver, transducer, cables, limiters, and so on), limit line definitions and ambient lists. To view the test setup, select Setup | Show Setup.

A test setup is composed of the software settings required to perform a test. These software settings include items like limit lines, equipment to be used, correction factors, band settings and report output (see "Use Limit Lines" on page 146 for a more comprehensive list). The software comes with several example test setups.

The most common test setup modifications involve editing equipment setup information, such as the equipment used in a test and associated correction factors. Note that the default equipment setup information contains characteristic correction factors for common test equipment. Modifying these correction factors or creating new ones for your specific equipment is recommended for greatest amplitude accuracy.

If your test setup does require modification, continue to "Modify Setup" on page 102 which includes a complete list of the modifiable test setup parameters.

If your test setup *does not* require modification, skip to "Configure Test Equipment" on page 98.

The following test setup parameters are particularly important, depending upon your test equipment and applicable regulation:

- Limit Lines
- Signal Path (The active signal path, including correction factors within the E7415A application, which must correspond to your physical test equipment layout.)
- Equipment Corrections
- Graph Settings (appearance of output)
- Signal List Settings (list columns and filters)
- Receiver Settings (for sweep and measure)

Modify Setup

The E7415A application comes with several example test setups. These test setups can be modified to meet your specific test requirements. As an option, you can create a new test setup by defining the required test equipment, limit lines, and ambient list.

Test setups can be saved for future use (see"Save Test Setup" on page 103). Test setups may be added to an existing test setup folder or into a newly created test setup folder.

Steps for Modifying Test Setups

The following are the general steps for modifying an existing test setup:

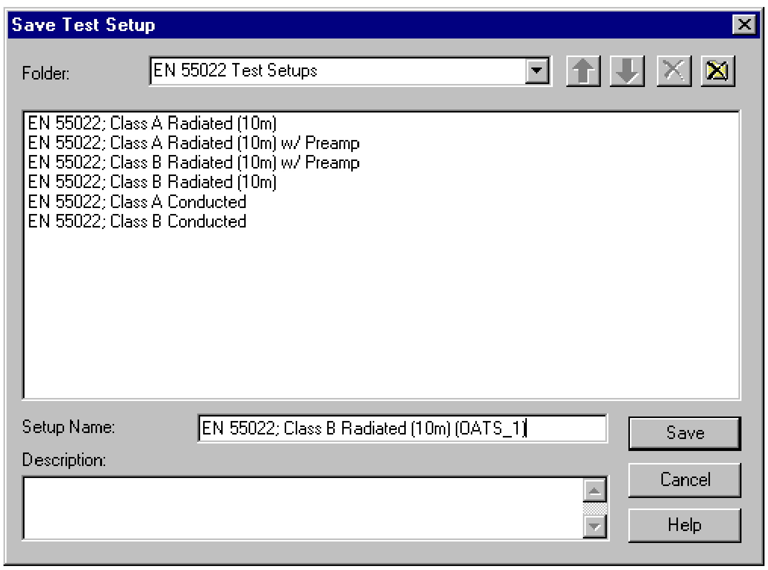
1. Select a test setup (see "Select Test Setup" on page 100)
2. Determine if the selected test setup meets your requirements (see "Does Setup Require Modification?" on page 101)
3. Modify the test setup as necessary. When modifying or creating a test setup, you can change and save the following parameters to accommodate your specific test needs or requirements:
   - Limit Lines (See "Use Limit Lines" on page 146)
   - Equipment Setup (See "Add and Setup Test Equipment" on page 155)
   - Signal Path (See "Use Signal Paths" on page 166)
   - Ambient Lists (See"Use Ambient Lists" on page 168)
   - Graph Settings (See "Customize Graph and Trace Data" on page 206)
   - Signal List Settings (See "Customize Signal Lists" on page 193)
   - Sweep Settings (See"Set Up and Perform Sweeps" on page 175)
   - Measure Settings (See"Make Measurements" on page 182)
   - Report Settings (See "Generate Reports" on page 189)
   - Receiver Settings (See "How to Add and Setup a New Receiver" on page 156)
4. Save modified test setup (see "Save Test Setup" on page 103)

NOTE After modification and saving of test setup parameters, these parameters become defaults for the associated test setup.

Save Test Setup

Procedure 4-2 How to Save a New or Modified Test Setup

Step			Comments
1	Save the test setup.	a. From the menu bar, select **File** | **Save As Setup....** b. In the **Save As Setup** dialog box, select the desired folder from the drop-down list or type in a new folder name c. In the **Setup Name** text box, enter a name for your setup. d. (Optional) Enter a description for your test setup in the **Description** text box. e. Click **Save**.	• The **Save Test Setup** dialog box is displayed. • Enter a new name in the **Folder** text box to create a new folder. • To later access the new setup, select **File** | **New**. Select the folder and highlight the setup name, then click **OK**.



Determine the Receiver Settings for a Sweep

Before measurement sweeps can be taken with the software, the optimum receiver settings for performing the measurements must be determined and set in the software. Several receiver parameters may be set by the user when performing sweeps with the software. These settings, once set, may be saved within the context of a test setup for easy reuse. The sweep setting options are listed below (refer to the How Do I... chapter for definitions):

- Resolution Bandwidth
- Video Bandwidth
- Reference Level
- Attenuation
- Sweep Time
- Segment Size
- Stop/Start Frequencies
- Segment Overlap
- Dwell Time
- Detector (Peak/Quasi-Peak/Average)
- Receiver Preamp On/Off (854X and E7400A-series only)
- Number of Trace Points (E7400A-series only)

Some settings may need to be set according to a regulatory requirements (for example, resolution bandwidths) and some settings may need to be set dependent on the equipment you have in the signal path you are using (for example, start/stop frequency may depend on an antenna’s useful frequency range).

Noise Floor to Limit Line Separation

Prior to performing measurements sweeps, you will want to optimize the receiver settings to obtain the best noise floor to limit line separation (how far the noise floor is below the limit line) without encountering RF overload.

NOTE When varying attenuation and preamplification, always check to make sure that you do not encounter RF overload with the new settings. Refer to the manual for your receiver for instructions to check for RF overload.

To do this, you will need to take a sweep with the E7415A software to measure receiver noise floor to limit line separation using the receiver settings that you wish to use during the EMC test. The software signal path definition should be the same as the signal path that will be used during the test. With the application, the noise floor of the receiver should then be measured with the receiver (or external preamplifier if one is defined in the signal path) terminated in 50 ohms.

If the measured noise floor to limit line separation is not adequate, then the following receiver settings may require modification.

The following equipment settings can affect the noise floor limit line separation.

- Input Attenuation

  Increasing the attenuation increases the receiver noise floor and decreases the noise floor to limit line separation.

  Decreasing the attenuation decreases the receiver noise floor and increases the noise floor to limit line separation.

- Preamplification with a low noise figure preamplifier (internal or external)

  Adding preamplification decreases the receiver corrected noise floor and increases the noise floor to limit line separation.

  Removing preamplification increases the receiver corrected noise floor and decreases the noise floor to limit line separation.

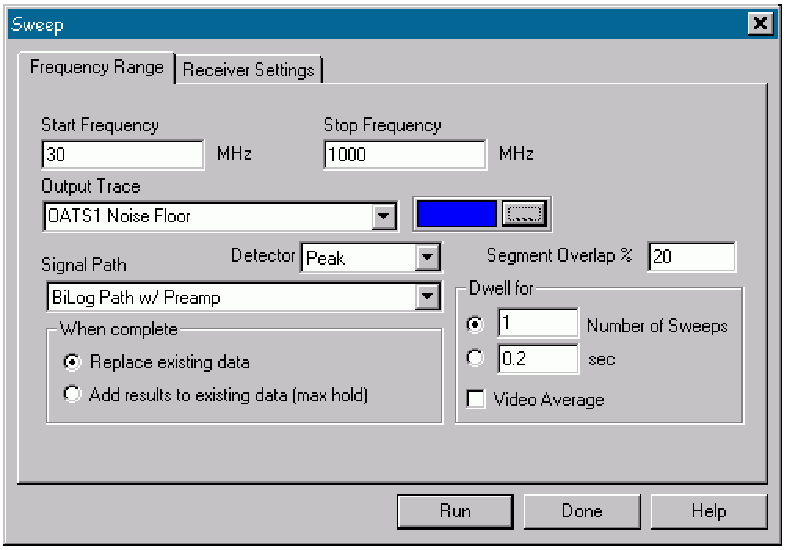
- Reference Level

  Increasing the reference level in some settings can decrease the limit line to noise floor separation.

  Decreasing the reference level in some settings can increase the limit line to noise floor separation.

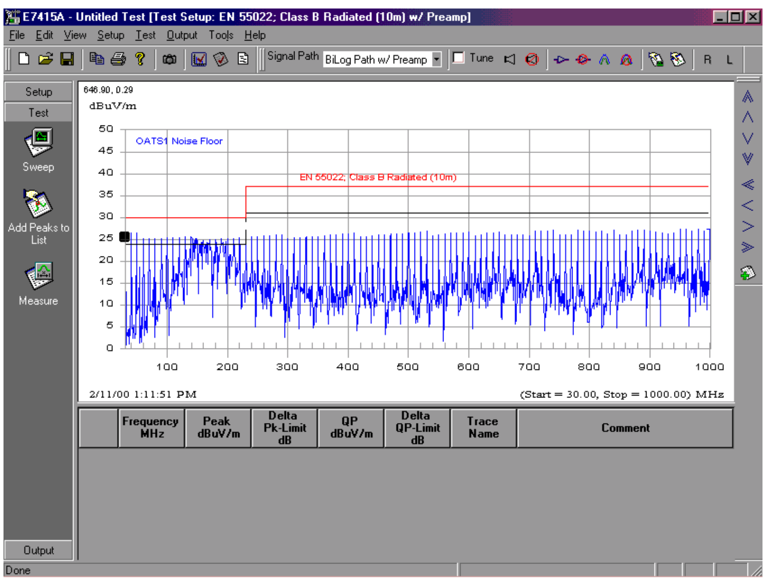
Procedure 4-3 How to Check for Adequate Noise Floor to Limit Separation

	Step		Comments
1	Setup test equipment.	a. Disconnect the RF input to your receiver. b. Terminate the RF input on your receiver.	• Use the appropriate termination for your receiver.
2	Select the signal path.	a. Select **Test** | **Sweep**. b. From the Signal Path drop-down box, choose the signal path which includes the appropriate receiver, cable loss and transducer factors.	• The signal path determines which correction factors are used to calculate total correction.
3	Set the Sweep parameters within the E7415A software.	a. In the Sidebar, select Test | Sweep. b. Modify the **Start Frequency** and the **Stop Frequency** values if required.	• The **Sweep** dialog box can be opened by right-clicking the graph area, then selecting **Sweep**. • The Start and Stop frequencies are automatically set to the frequency range of the selected regulation, for this example 30 MHz and 1000 MHz respectively, with a BiLog signal path. Typically, the frequency range is determined by the transducer's operating range, but the frequency range can be modified to meet your specific requirements.



Procedure 4-3 How to Check for Adequate Noise Floor to Limit Separation

	Step	Comments
4	Name and define the trace.	a. In the **Output Trace** drop-down box, type a trace name, for example, **`OATS_1 Noise Floor`**. b. Click on the color bar and select a color for the trace. c. Click **OK** to close the color palette.
5	Check noise floor.	a. Run the sweep by clicking **Run** in the Sweep dialog box. b. If the noise floor to limit line separation is not adequate, go to the step Adjusting the receiver settings to improve the noise floor to limit line separation. on page 72. c. If the noise floor to limit line separation is sufficient, go to the next step.

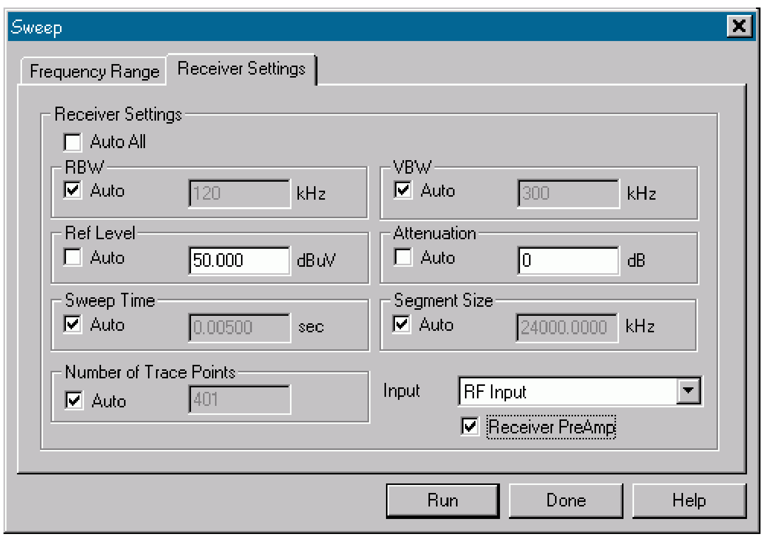


Procedure 4-3 How to Check for Adequate Noise Floor to Limit Separation

	Step		Comments
6	Note test configuration and receiver settings.	a. Note the signal path (for example, whether an external preamplifier is used) and the receiver settings (attenuation, reference level and internal preamplifier states). b. Go to "Check for and Remove RF Overload" on page 110.	• This signal path and receiver settings will be used in the next steps when previewing EUT emissions and checking for RF overload.

Procedure 4-4 How to Adjust Receiver Settings

	Step		Comments
1	Adjusting the receiver settings to improve the noise floor to limit line separation.	If the noise floor to limit line separation is not adequate you may try changing the following: • Reduce the receiver input attenuation by changing the attenuation setting in the **Sweep** dialog box under the **Receiver Settings** tab. • Turn on the internal preamplifier if the receiver you are using has one by checking the **Receiver PreAmp** check box in the **Sweep** dialog box under the **Receiver Settings** tab. • Lower the receiver reference level setting by changing the **Ref Level** setting in the **Sweep** dialog box under the **Receiver Settings** tab. • Add an external preamplifier.	• Run a new sweep after every change to determine its effect on the noise floor. When the noise floor to limit line separation is adequate, continue to step 2. • For best results, add the external preamplifier as close to the antenna output as possible. • If an external preamplifier is used, an external attenuator may also be required to check for RF overload. • Add the external preamplifier (with proper correction factors) to the active signal path (See “How to Add and Setup a Transducer (The procedure is similar for any other non-receiver test equipment)” on page 158).



2	Note test configuration and receiver settings.	• Note the signal path (for example, is external preamplifier used) and the receiver settings (attenuation, reference level and internal preamplifier states).	• This signal path and receiver settings will be used in the next step when checking for RF overload.

Check for and Remove RF Overload

On an OATS, strong ambients are the most common cause of overload.

Overload Conditions

Some signals within the measured frequency span may cause an overload condition. Prior to making measurements, determine that the receiver is not in an RF overload condition.

RF Overload Detection and Correction

RF overload occurs when the energy level at the input mixer of the receiver exceeds the mixer's linear operating range. This means that the mixer is in compression, which can cause amplitude measurement errors.

NOTE Refer to the appropriate User Manual for your receiver as needed.

Procedure 4-5 How to Identify and Remove RF Overload Conditions

	Step		Comments
1	Set up the receiver.	a. Set the receiver in Local mode by clicking **L** on the receiver toolbar. b. Set the frequency range of the receiver. c. Set the receiver ref level, attenuation, preamplifier enable, etc. as noted in the "Determine the Receiver Settings for a Sweep" on page 104.	• This allows the user to interact directly with the receiver. • Set to the frequency range of the regulation to which you are testing. • Refer to appropriate receiver manual.
2	Determine if the receiver is in overload condition.	• Refer to receiver manual.	
3	Remove the RF overload.	• If an RF overload exists, remove the RF overload and record the revised settings. Refer to receiver or analyzer manual.	

Procedure 4-5 How to Identify and Remove RF Overload Conditions

	Step		**Comments**
4	Change sweep and measure receiver settings.	• Enter revised settings into sweep and measure dialog box receiver settings.	• See "How to Setup and Perform a Sweep" on page 177 and "How to Setup and Perform a Measurement" on page 185.
5	Recheck noise floor.	• After correcting for RF overload conditions, recheck the noise floor to ensure that the noise floor to limit line separation is adequate.	

Create Ambient Signal List

For OATS testing it is useful to generate a list of ambient signals for your OATS location. This list can then be used to compare against ambient + EUT scans to help determine what signals are due to the EUT alone.

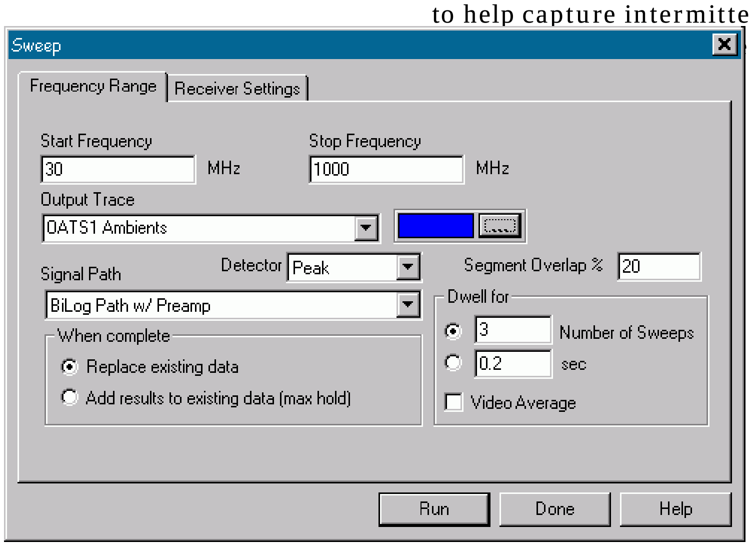
For this procedure, a single trace will be generated from sweeps with the antenna in horizontal and vertical polarizations. Only the highest value from either polarization will be retained in the trace. The regulation used in this example is EN55022 Class B.

The following equipment is used in this example:

- E7415A EMI measurement software
- E7405A EMC Analyzer
- 11966P bilog antenna
- Manual antenna tower
- Manual turntable
- 11966L 10 meter coaxial cable.

Procedure 4-6 How to Generate Ambient Signal List

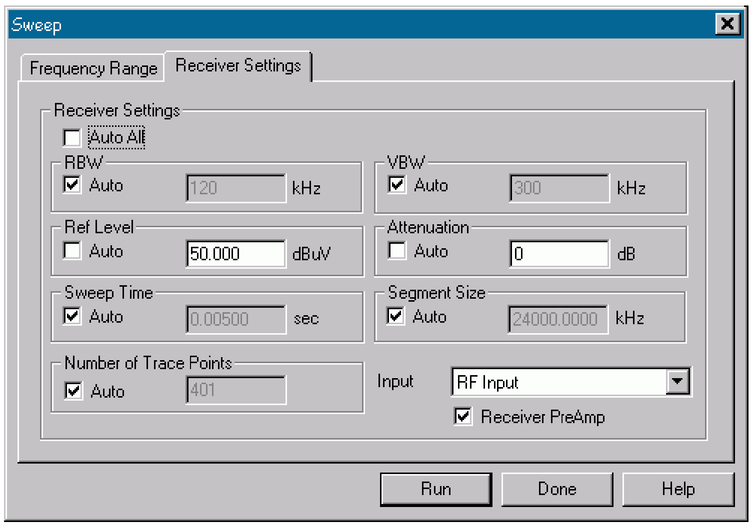
	Step		Comments
1	Set the Sweep parameters.	a. In the Sidebar, select **Test | Sweep**. b. In the **Sweep** dialog box, set the start frequency and the stop frequency to the range of the antenna you are using. c. Set **Dwell for** to 3 sweeps.	• Alternately, the **Sweep** dialog box can be opened by right-clicking the graph area, then selecting **Sweep**. • For this example, a bilog antenna is used with a frequency range of 30 MHz to 1000 MHz. • More than one antenna may be needed to cover the radiated frequency range of the regulation to which you are testing. • For example: — Set the start frequency to 30 MHz and the stop frequency to 200 MHz for a biconical antenna. — Set the start frequency to 200 MHz and the stop frequency to 1000 MHz for a log periodic antenna. • Three sweeps are used in this example to help capture intermittent ambients. ... used.



2	Name and define the trace.	a. In the **Output Trace** combo box, type a trace name (for example, **`OATS_1 Ambients`**). b. Click on the color bar and select a color for the trace. c. Click **OK** to close the color palette.	

Procedure 4-6 How to Generate Ambient Signal List (Continued)

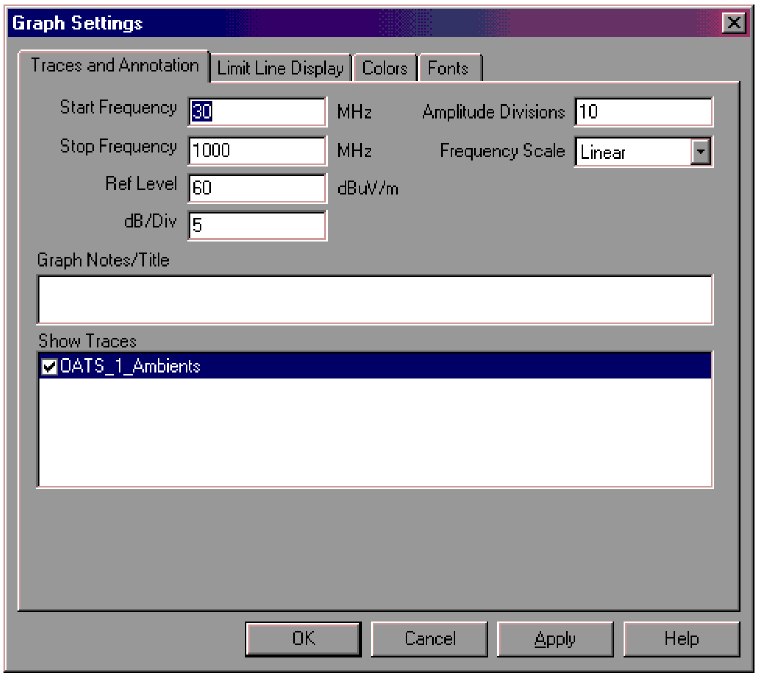
	Step		Comments
3	Set up the receiver.	a. Open the **Receiver Settings** tab within the **Sweep** dialog box. b. If the reference and attenuator levels from "Determine the Receiver Settings for a Sweep" on page 104 are different from the Ref Level Auto and Attenuation Auto settings, enter the appropriate levels.	• It may be necessary to segment the frequency span further to correctly account for overload conditions due to high-level signals while not masking low-level signals at different frequencies. See "Determine the Receiver Settings for a Sweep" on page 104.



4	Set antenna position.	a. Position the antenna in the horizontal polarization. b. Position the tower to 2.5 meters.	• The antenna will be in the vertical position for the second sweep. • The tower height will not be changed for this process.
5	Start the sweep.	• Click **Run** to start the sweep.	• The receiver is in remote mode, and the software is taking a sweep from 30 MHz to 1000 MHz. • You can monitor the status of the sweep in the status bar of the application window; you also can view the trace as it is updated on the graph. • The sweep can be paused or aborted from the Sweep Control dialog box which appears during the sweep.

Procedure 4-6 How to Generate Ambient Signal List (Continued)

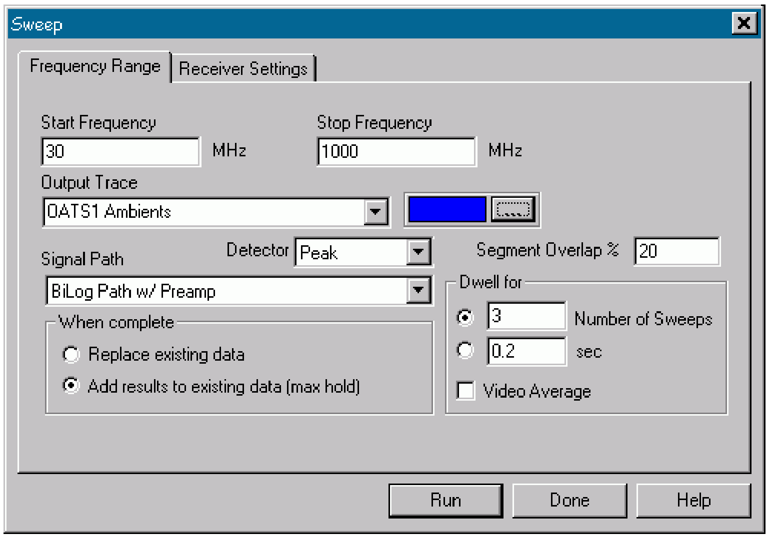
	Step		Comments
6	Adjust the graph reference level.	a. Double click the graph to open the **Graph Settings** dialog box. b. Set the **dB/Div**, **Amplitude Divisions**, and **Frequency Scale** as needed to view the trace. c. Click **OK**.	• For this example, Ref Level = 60 dBuV/m dB/Div = 5 Amplitude Divisions = 10 Frequency Scale = Linear



	Step		Comments
7	Reorient the antenna for vertical polarization.	• Set the antenna to vertical.	

Procedure 4-6 How to Generate Ambient Signal List (Continued)

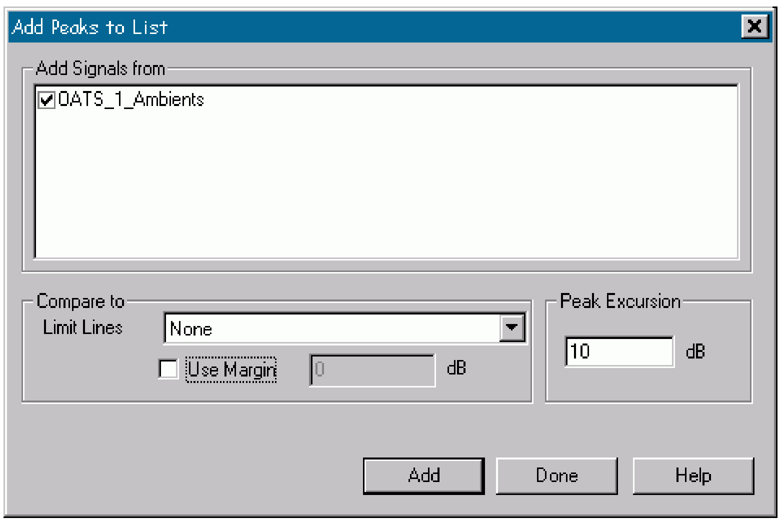
	Step		Comments
8	Set the trace data to Max Hold.	a. Open the **Sweep** dialog box (click the **Sweep** icon). b. Select **Add results to existing data** (max hold) and set the **Dwell for** to 3 sweeps.	• The resulting graph trace from multiple sweeps will keep and display the maximum value at each frequency point.



9	Run sweep for vertical antenna polarization.	• Click **Run**.	• This is to capture intermittent ambient signals. • Two sweeps have been performed; the maximum points form the trace OATS_1_Ambients. (To generate separate ambient lists for each polarization, create two separate traces with two names).

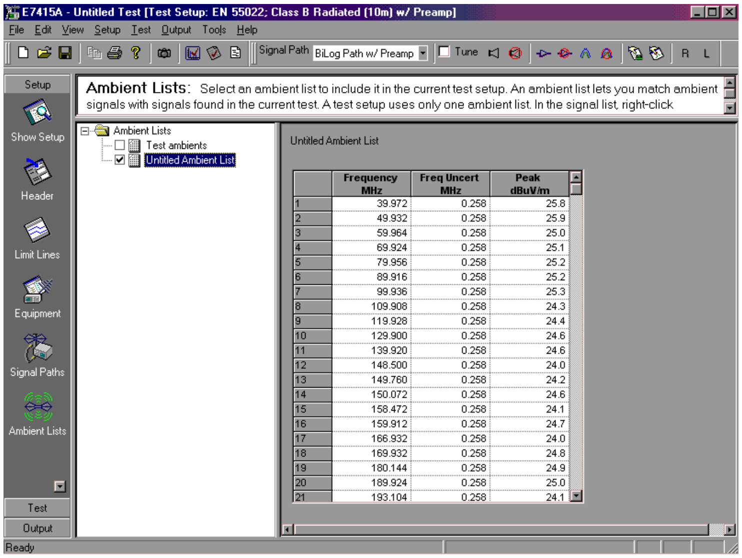
Procedure 4-6 How to Generate Ambient Signal List (Continued)

	Step		Comments
10	Generate Signal List.	a. Click **Add Peaks to List** in the Sidebar. b. Set the **Peak Excursion** level. c. Click **Add**.	• In general, the larger the excursion value, the fewer signals will be generated. The smaller the excursion value, the more signals will be generated. If the peak excursion value is set too low, noise will be captured as a signal. It is best to select peak excursion values >10dB to prevent capturing noise. For the purpose of capturing ambients 10 to 15 dB is reasonable. See "Peak Excursion" in Glossary for Peak Excusions algorithms.



Procedure 4-6 How to Generate Ambient Signal List (Continued)

	Step		Comments
11	Add Signals to Active Ambient List.	a. Highlight entire list. b. Right click the signal list and select **Save to Ambient List**. c. Verify ambient list under **Setup** | **Ambient Lists**.	• Click in upper left corner of list. • Saves signals to active (checked) ambient list. If no list is active, an ambient list (Untitled Ambient List) is created and the ambient signals are placed within that list. The list is then activated. • To rename the ambient list, right-click on the name and select **Rename**. • The graph displays the highlight markers for the signals in the list. To turn off the markers, select **View** | **Highlight Markers**.



Gather EUT + Ambient Signals Using the Peak Detector (Several Orientations)

The most efficient method for performing OATS measurements is to first develop an EUT signal list in a shielded room and to then take this signal list out to an open site for measurement. In this way, you do not need to be as concerned about finding your EUT emissions in a crowded OATS ambient environment because you know the EUT emission frequencies. If you do not have access to a shielded room, the following process will help you find your EUT emissions using only an OATS.

In order to develop a list of EUT emissions to measure, you will use the software to take sweeps with the EUT in place on the open site and turned on. These sweeps will be composed of EUT and Ambient (EUT + Ambient) signals. After the EUT + Ambient sweeps have been created, you will then compare their content to the Ambient sweeps. In this way, you will be able to determine if individual signals are due to your EUT and should be measured or if the signal is an Ambient and can be ignored.

It is best to gather EUT + Ambient signals with the antenna positioned closer to the EUT than is specified by the regulation (for example, 3 meters instead of 10 meters). This will generally cause the emission signal strength to measure higher and aid in capturing EUT emission frequencies. When the final measurement is performed, the EUT to antenna spacing should be moved back to the distance specified by the regulation. Of course, if you prefer, you can always leave the antenna to EUT spacing as specified by the regulation to gather the EUT + Ambient signals.

It is best to gather the EUT + Ambient signals with the EUT oriented to several different turntable positions and the antenna positioned to several different heights and polarities. This improves the probability of capturing an EUT emission.

For this example procedure, 16 traces will be generated with the E7415A software:

- Antenna to EUT spacing is 3 meters
- Horizontal antenna polarization

  With antenna tower at 1 meter, 1.9 meters with the following table positions for each tower settings

  — Table at 0 degrees

  — Table at 90 degrees

  — Table at 180 degrees

  — Table at 270 degrees

- Vertical antenna polarization

  With antenna tower at 1 meter, 1.9 meters with the following table positions for each tower settings

  — Table at 0 degrees

  — Table at 90 degrees

  — Table at 180 degrees

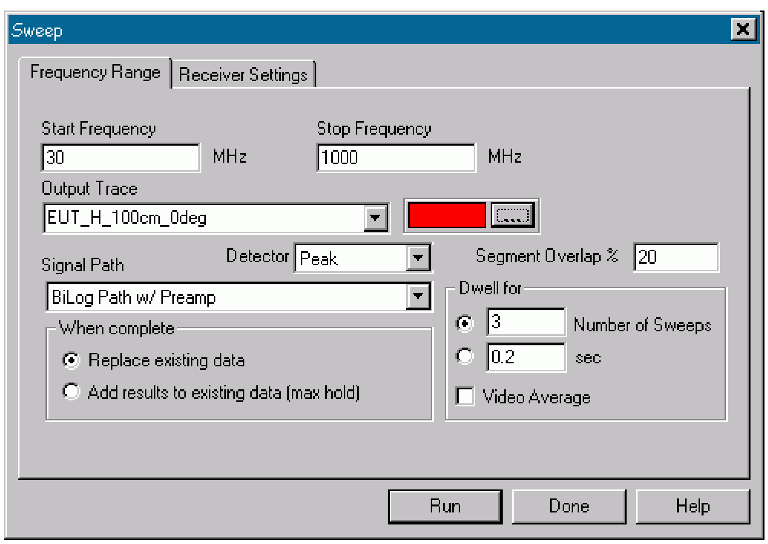
  — Table at 270 degrees

The following equipment is used in this example:

- E7415A EMI measurement software
- E7405A EMC Analyzer
- 11966P bilog antenna
- Manual antenna tower
- Manual turntable
- 11966L 10 meter coaxial cable

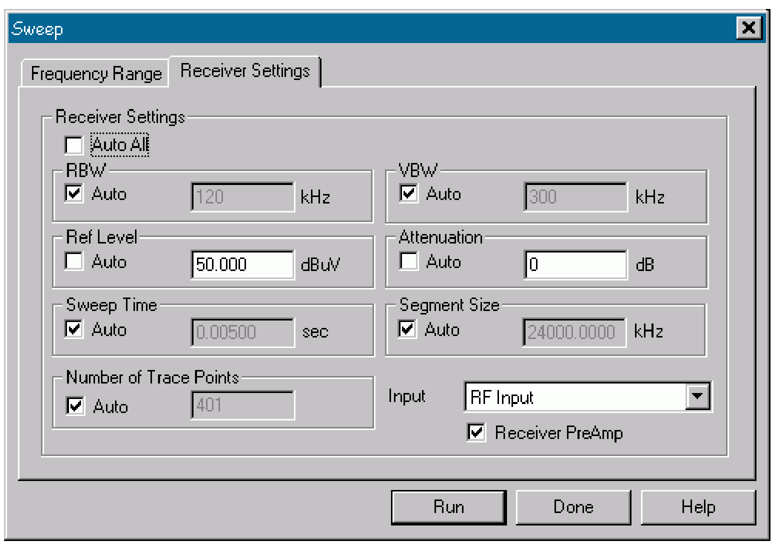
Procedure 4-7 How to Generate EUT + Ambient Traces Using the Peak Detector

	Step		**Comments**
1	Place EUT near antenna.	• Place the EUT 3 meters from the antenna.	• Placing the EUT closer to the antenna than specified in the regulation, results in enhancing the probability of capturing EUT emissions.
2	Set the Sweep parameters.	a. In the Sidebar, select **Test** | **Sweep**. b. In the **Sweep** dialog box, set the start frequency and the stop frequency to the range of the antenna you are using. c. Set **Dwell for** to 3 sweeps. d. Select **Replace existing data**.	• The **Sweep** dialog box can also be opened by right-clicking the graph area, then selecting **Sweep** (or from the menu). • For this example, a bilog antenna is used with a frequency range of 30 MHz to 1000 MHz. • More than one antenna may be needed to cover the frequency range of the regulation to which you are testing. • For example: — Set the start frequency to 30 MHz and the stop frequency to 200 MHz for a biconical antenna. — Set the start frequency to 200 MHz and the stop frequency to 1000 MHz for a log periodic antenna. • This is to capture intermittent EUT signals. The dwell time may be set to meet your EUT needs.



Procedure 4-7 How to Generate EUT + Ambient Traces Using the Peak Detector

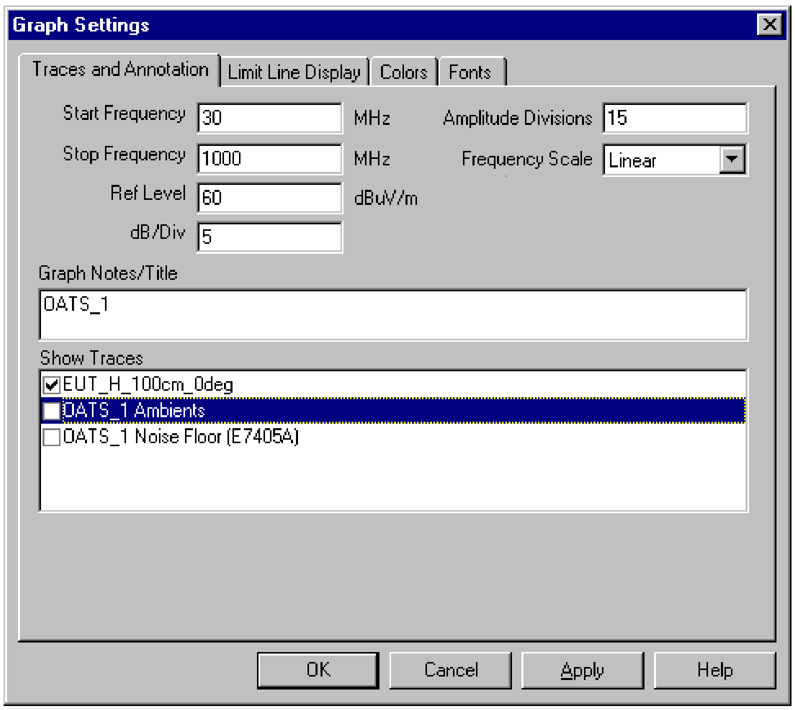
	Step		Comments
3	Name and define the trace.	a. In the **Output Trace** combo box, type a trace name (for example, **EUT_H_100cm_0deg**). b. Click on the color bar and select a color for the trace. c. Click **OK** to close the color palette.	• Use a different color for each trace.
4	Set up the receiver.	a. Open the **Receiver Settings** tab within the **Sweep** dialog box. b. Set the receiver settings as noted in the “Determine the Receiver Settings for a Sweep” on page 104.	• It may be necessary to segment the frequency span further to correctly account for overload conditions due to high-level signals while not masking low-level signals at different frequencies. See “Determine the Receiver Settings for a Sweep” on page 104.



5	Set antenna, tower and turntable positions.	a. Position the antenna in the horizontal polarization. b. Position the tower to 1 meter. c. Position the turntable to 0 degrees.	
6	Start the sweep.	• Click **Run** to start the sweep.	

Procedure 4-7 How to Generate EUT + Ambient Traces Using the Peak Detector

Step		Comments
7	Adjust the graph reference level.	a. Double click the graph to open the **Graph Settings** dialog box. b. Set the Ref Level as appropriate (usually the same as the receiver reference level) to view the complete trace. c. Clear the ambient trace check box if you do not want to view it on the graph.

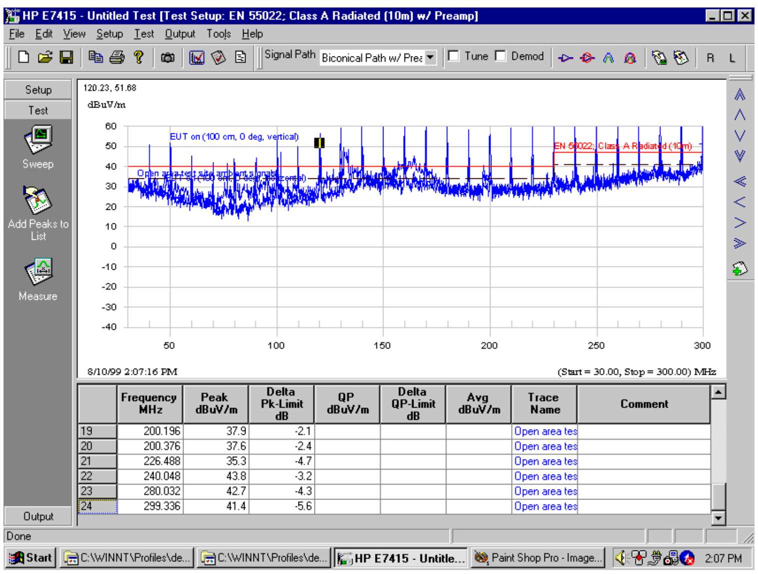


Procedure 4-7 How to Generate EUT + Ambient Traces Using the Peak Detector

	Step		Comments
8	Run sweep for other 1 meter horizontal tower/turntable positions.	a. Adjust turntable to 90 degrees. b. Repeat steps 2 and 3. Name the trace **EUT_H_100cm_90deg**. c. Click **Run**. d. Adjust turntable to 180 degrees. e. Repeat steps 2 and 3. Name the trace **EUT_H_100cm_180deg**. f. Run sweep. g. Adjust turntable to 270 degrees. h. Repeat steps 2 and 3. Name the trace **EUT_H_100cm_270deg**. i. Run sweep.	
9	Run sweep for 1.9 meter horizontal tower/turntable positions.	• Adjust tower to 1.9 meters and run sweeps for all four turntable positions.	• Name the traces **EUT_H_190cm_xxxdeg**.

Procedure 4-7 How to Generate EUT + Ambient Traces Using the Peak Detector

	Step		Comments
10	Repeat sweep process for vertical antenna.	a. Position antenna with vertical polarization. b. Repeat steps 1 through 9.	• Different reference levels may be required for vertical antenna polarization. • Choose a different name for each vertical trace, for example, **`EUT_V_100cm_0deg`**. • Choose a different trace color for each vertical trace. • After completing steps 1 through 10, sixteen traces will appear on the graph. Eight for horizontal antenna polarization, and eight for vertical antenna polarization. (Four traces, generated with the tower height = 1 meter, are shown on the graph below).



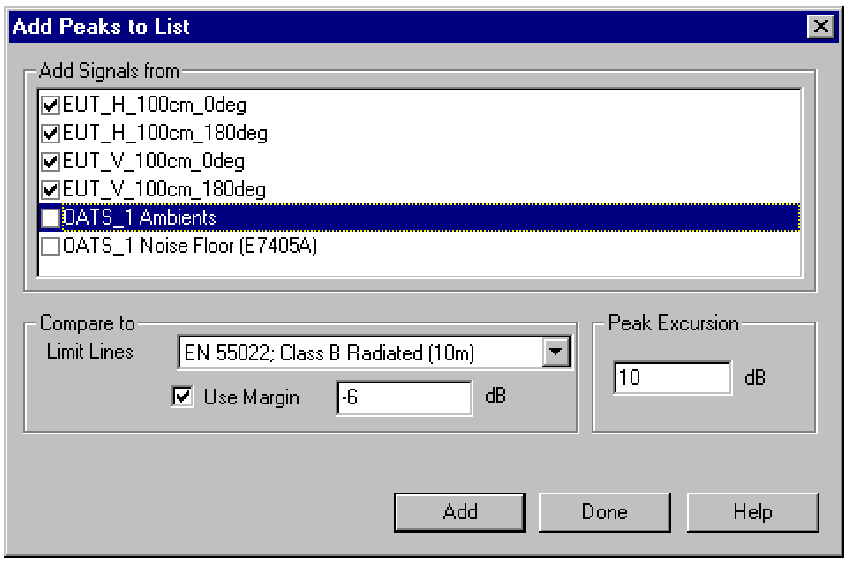
	Step		Comments
	Save your results	• Select **File**, **Save As**, then enter a file name.	• Periodically saving your results can prevent inadvertent data loss.

Generate EUT Signal List

Now that you have EUT + Ambient signal traces, you can extract the signals from the trace data and place them in the signal list table. The signal list data can then be reduced and used as a basis for future measurements.

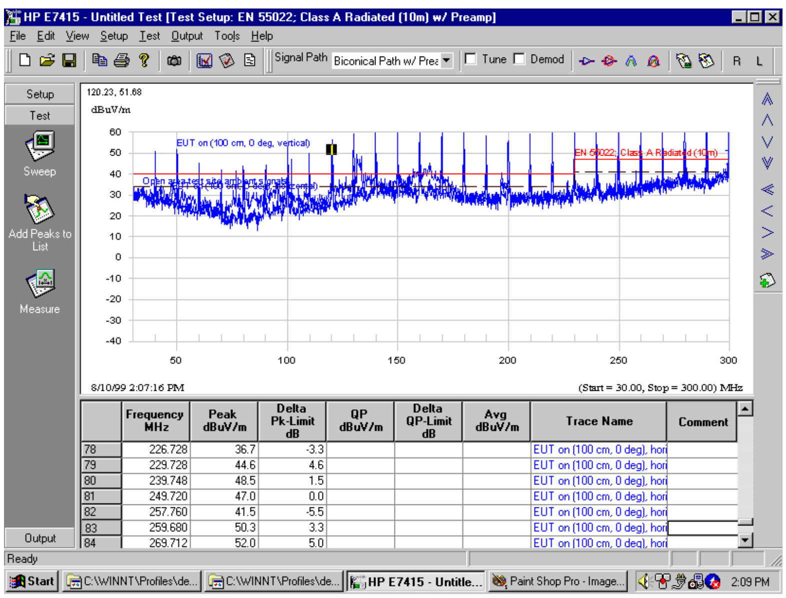
Procedure 4-8 ***How to Generate EUT Signal List***

	Step		Comments
1	Open the Add Peaks to List dialog box.	• In the **Sidebar**, click on the **Add Peaks to List**.	• Or, right-click the graph area and select **Add Peaks to List**.



Procedure 4-8 How to Generate EUT Signal List (Continued)

	Step		Comments
2	Select and add signals.	a. In the **Add Signals from** area, select all traces except the ambients. b. In the **Compare to** area, choose the limit line to which you are testing. c. Check the **Use Margin** box; set the margin to the desired level (–6 dB is the default setting). d. Set **Peak Excursion** to the desired level (10 dB is the default setting). e. Click **Add**.	• For this example, **EN 55022; Class B Radiated (10 m) w/preamp**. The signals above the limit line margin are added to the list. The Trace Name column in the Signal List table shows the trace from which each signal is generated. • The larger the excursion value, the fewer signal will be captured. The smaller the excursion value, the more signals will be captured. If the peak excursion value is set too low, noise will be captured and interpreted as a signal. It is best to select peak excursion values high enough not to capture noise but low enough to still capture the signals of interest.



Reduce Data (Initial Data Reduction)

The signal list contains ambient signals and EUT emissions.

The initial data reduction process consists of two steps:

1. Delete all known ambients
2. Hide all lower duplicates

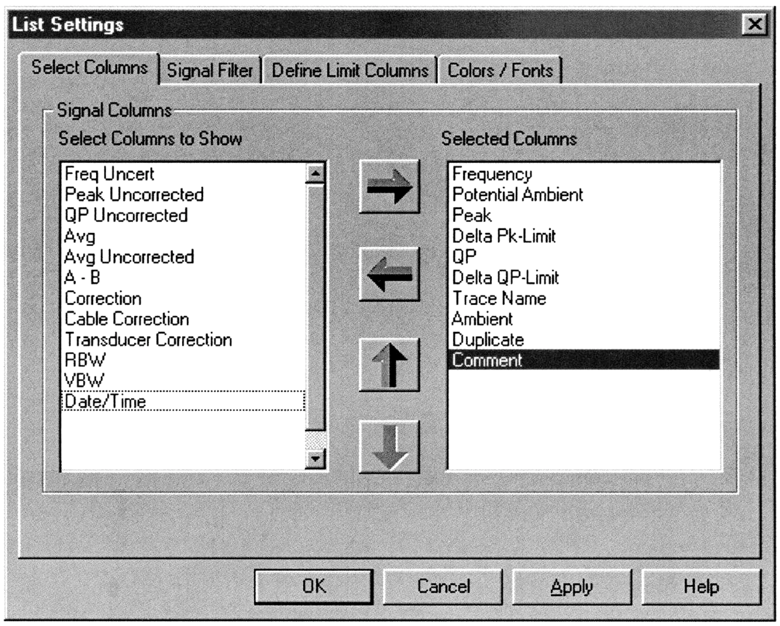
Further data reduction will be performed during the "Signal Identification, Maximization and Measure Process" on page 131.

Procedure 4-9 How to Reduce Data

	Step		Comments
1	Activate Ambient List	Select **Setup**, **Ambient List**. Check the ambient list you want to be active.	Choose the ambient list that corresponds to your test site.

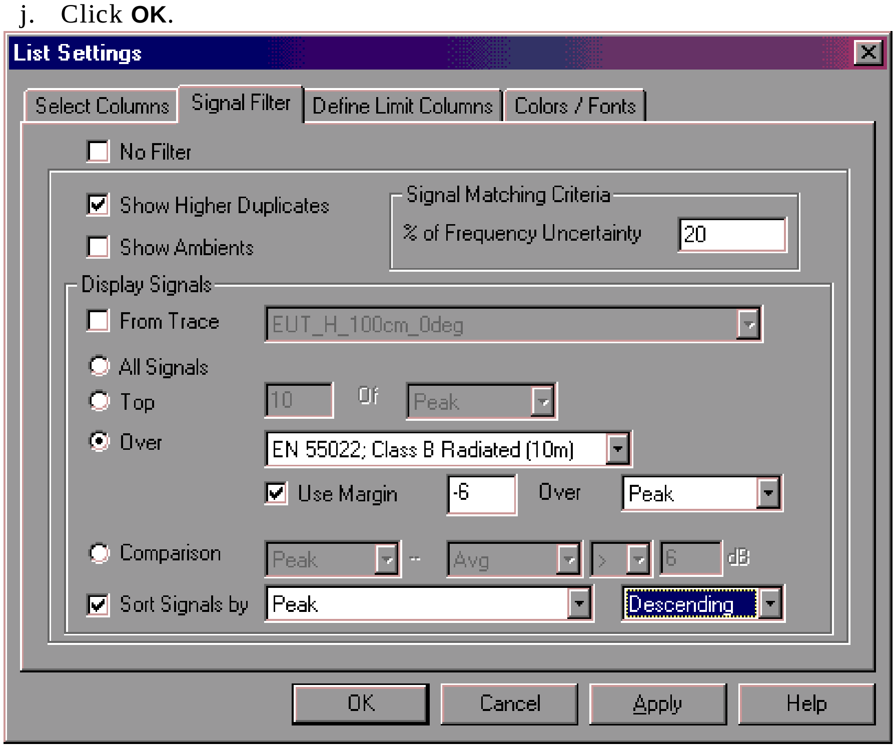
Procedure 4-9 How to Reduce Data (Continued)

	Step		Comments
2	Add signal attributes to the signal list.	a. Open the **List Settings** dialog box; **Setup** | **List Settings....** b. Use the right and left arrow buttons to move highlighted attributes from one side to the other. c. Highlight **Potential Ambient**, **Ambient**, and **Duplicate** in the **Select Columns to Show** list and click the right arrow button. d. Reorder as desired. e. Click **OK**.	• A double-click will also move highlighted attributes from one side to the other. • The right-hand list (**Selected Columns**) hold attributes that will be displayed in the signal list table. Use the up and down button to arrange the columns in the list. • For a Potential Ambient, a Yes is placed in the signal row if the signal matches (within the frequency uncertainty) an ambient in the active ambient list. The ambient list was created in a previous step.



Procedure 4-9 How to Reduce Data **(Continued)**

	Step		Comments
3	Sort and filter signals.	a. Open the **List Settings** dialog box **Setup** | **List Settings....** b. Click on the **Signal Filter** tab. c. Clear (uncheck) the **No Filter** check box. d. Check **Show Higher Duplicates**. e. Set **% of Frequency Uncertainty**. f. Clear **Show Ambients**. g. Select **Display Signals** | **Over**. h. Select the limit line, set Use Margin to –6 dB, and use the **Peak** detector. i. Check the **Sort Signals by** check box. Choose **Peak** and **Descending**. j. Click **OK**.	• Only the highest amplitude duplicate signals are displayed in the signal list. • Default = 20%. The higher the percentage setting, the more likely signals will match as duplicates. Therefore, the higher the setting, the greater the data reduction with increased risk of masking an EUT signal. • The signal list is reduced to show only suspect EUT signals and to hide lower duplicates.



Signal Identification, Maximization and Measure Process

This section is composed of three basic steps that must be performed on each signal in the signal list sequentially. These steps are signal identification, maximization and then measuring.

1. Signal Identification

   In this step you will use various means to attempt to identify if the signal in the list is an ambient or is an emission from your EUT. If this signal is an ambient, of course you can choose to ignore it, but if it is a signal from your EUT you will want to maximize and measure it. The basic techniques to identify a signal are turning the EUT power on and off, listening to the signal using the demodulation capabilities of the receiver and rotating the turntable to see if table rotation changes the behavior of the emission.

2. Maximization

   In this step you will rotate the turntable and vary the antenna height and polarization until the EUT emission is at its highest amplitude. You will then record the turntable orientation, antenna height and polarization in the Table, Tower and Polarity columns of the list.

3. Measure

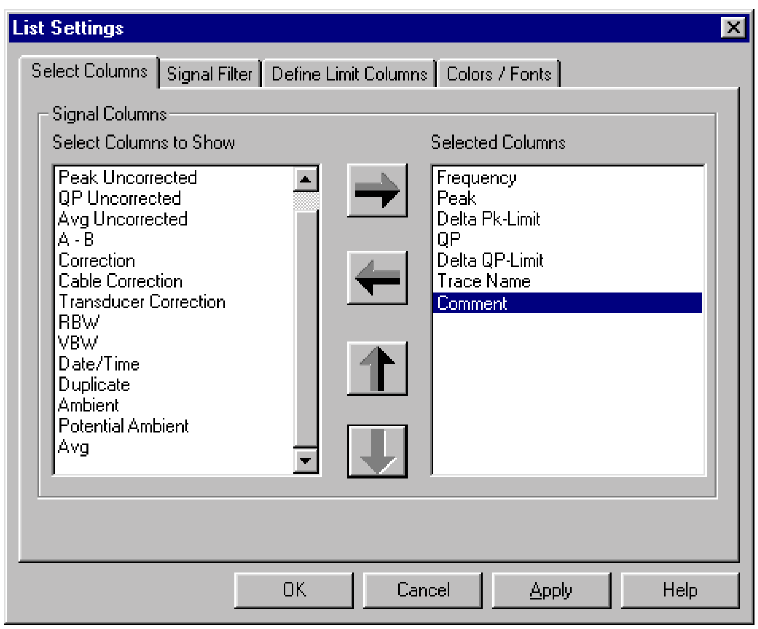
   In this step you will measure the EUT emission amplitude using the appropriate detectors (usually Peak and Quasi-Peak) and dwell times appropriate for your emissions characteristics.

Each signal in the list should go through each of these steps using the following procedure.

Preparation

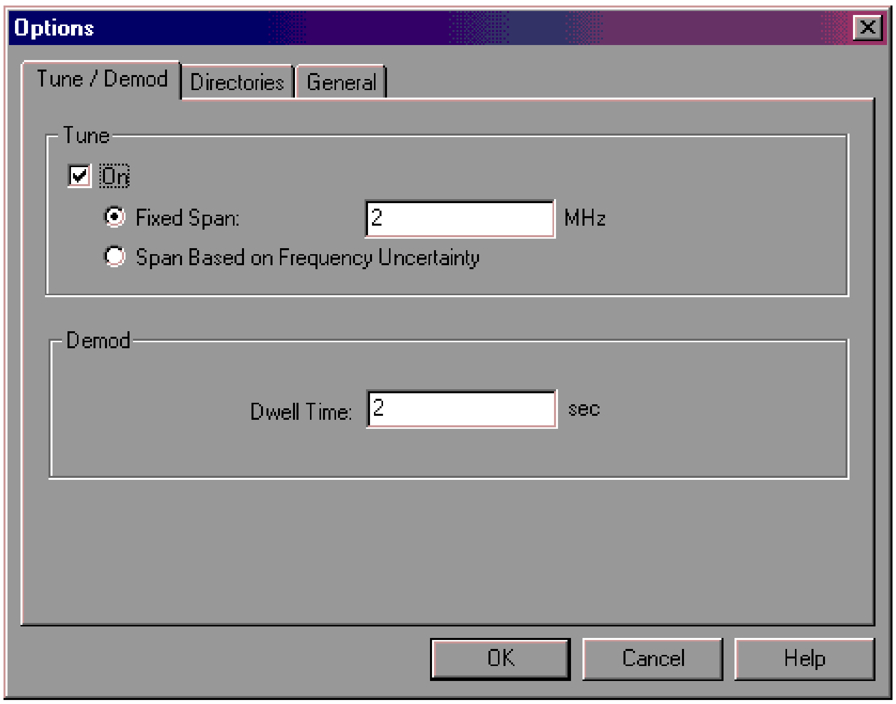
Procedure 4-10 Preparing to Perform the Signal Identification, Maximization and Measure Process

	Step		Comments
1	Move the EUT to the distance specified by the regulation.	Move the EUT to the distance specified by the regulation.	
2	Add antenna height, polarity and turntable position columns to signal table.	a. Open **Setup** | **List Settings...** b. Hold the **[Ctrl]** key, highlight **Table**, **Tower**, and **Polarity** in the **Select Columns to Show** list. c. Click on the right arrow key to add to the **Selected Columns** list. d. Reorder the columns if desired. e. Click **OK**.	• When you have maximized each signal, edit these columns with the appropriate information.



Procedure 4-10 Preparing to Perform the Signal Identification, Maximization and Measure Process (Continued)

Step			Comments
3	Set the span for automatic tuning of the receiver to 2 MHz.	a. **Select Tools | Options... | Tune/Demod**. b. **Select Tune | On | Fixed Span**, and set to 2 MHz. c. Click **OK**.	• Other spans may be used if they are better for your application. Note that if Span Based on Frequency Uncertainty is selected that the span will vary based on the frequency uncertainty of the receiver when that specific signal was last measured.



Signal Identification

The following process outlines three basic steps that may be used to identify if the signal in your list is an ambient or if it is an EUT emission. If the signal is an ambient it may simply be deleted. If it is an EUT emission, you will want to proceed on to the maximization process.

Procedure 4-11 Signal Identification Process

	Step		Comments
1	Enable automatic tuning in the application.	• Check the **Tune** box.	• When the **Tune** box is checked, if you click on a signal in the list, the receiver will automatically be tuned to that signal.
2	Position the turntable, antenna height and polarity.	• Position the turntable, antenna height and polarity to the position where you are most likely to observe the EUT emission.	• If you have used the trace naming convention suggested in these examples, the turntable angle, antenna height and polarity where the maximum emissions was observed will be captured in the trace name. • The next three steps are optional steps that will help you identify whether the signal is an ambient or an EUT emission.
3	Turn the EUT Off then On.	a. Turn the EUT off then on while observing the signal. If the signal is an EUT emission, it should disappear when the unit is off and reappear when the unit is on. b. If the signal is an EUT emission go to Procedure 4-12, “Maximization Process”.	• Note that this technique may not be possible to use if the device that you are testing has a long power up time or if the emission is due to a specific instrument state that is not repeatable upon power up.
4	Listen to the signal by activation Demod.	a. Check the **Demod** box on the receiver. b. Click on the signal in the list to activate the Demod function (click on the column number). c. Listen to the signal to determine if it is a local TV or radio signal. d. If the signal is an EUT emission go to Procedure 4-12, “Maximization Process”.	• You may turn demod off by unchecking the **Demod** box and clicking on the signal in the list. • You may need to turn the volume knob up on the receiver.

Procedure 4-11 Signal Identification Process (Continued)

	Step		Comments
5	Vary the turntable orientation.	a. Vary the turntable angle while observing the amplitude of the signal. b. If the signal is and EUT emission go to Procedure 4-12, “Maximization Process”.	• If the signal is an emission from the EUT and the radiation pattern exhibits lobes, the amplitude of the signal will vary in a way that correlates to the turntable angle.
6	If the signal is an ambient, add it to the ambient list or delete it.	a. To add the signal to the active ambient list: Highlight the signal in the list. **Right click** and choose **Save to Ambient List**. b. If you simply wish to delete the signal: Highlight the signal in the list then press the **Delete** key. c. If the signal is an ambient, continue to next signal.	

Maximization

In this step you will rotate the turntable and vary the antenna height and polarization until the EUT emission is at its highest amplitude. You will have the opportunity to reposition the marker on the signal to update the signal frequency if necessary. You will then record the turntable orientation, antenna height and polarization in the Table, Tower and Polarity columns of the list.

Procedure 4-12 Maximization Process

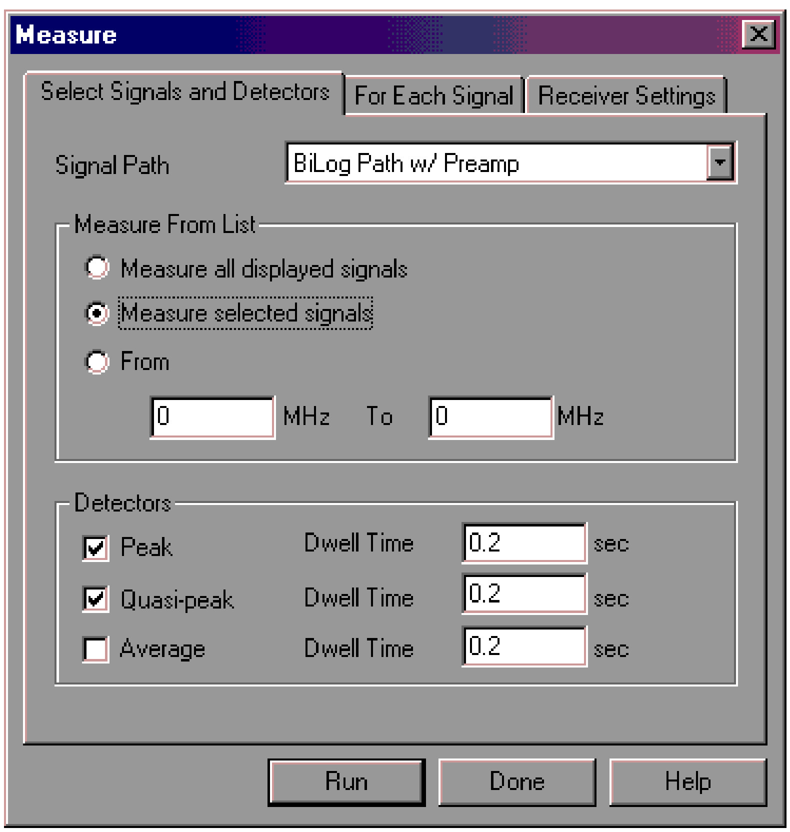
Step		Comments
Position the turntable, antenna height and polarity.	• Position the turntable, antenna height and polarity to the position where you are most likely to observe the EUT emission.	• If you have used the trace naming convention suggested in these examples, the turntable angle, antenna height and polarity where the maximum emission was observed will be captured in the trace name.
Rotate the turntable from 0-360 degrees to find the maximum response.	a. Move the table to maximize the signal on the receiver. b. You may use **Max Hold** on the receiver bar as an aid to find the maximum response.	• Leave the table in the position with the maximum response.
Adjust the antenna polarization and height to find the maximum response.	a. Adjust the antenna polarization and height for the maximum signal response. b. You may use **Max Hold** on the receiver bar as an aid to find the maximum response.	• Leave the antenna polarization and height in the position with the maximum response.
Reposition the marker to update the list frequency if required for measurement.	a. If the marker needs to be re-centered on the signal before measurement, do these steps. Otherwise skip to the next step. b. Use the receiver knob to position the marker on the signal. c. Click **Get Receiver Marker** on the receiver bar to add the new marker position to the list. d. Press the **Delete** key to delete the old signal in the list. e. Click on the new signal added to the list to tune the receiver to the updated signal frequency.	• Sometimes the marker will need to be repositioned on the signal to measure due to EUT frequency drift or receiver frequency uncertainties. • The new marker frequency will be placed in the list just below the highlighted signal that you are currently tuned to.

Measure

In this step you will measure the EUT emission amplitude using the appropriate detectors (usually Peak and Quasi-Peak) and dwell times appropriate for your emissions characteristics.

Procedure 4-13 Measure Process

Step		Comments
Measure the signal.	a. **Open Test** | **Measure**. b. Select **Measure From List** | **Measure selected signals**. c. Select **Peak** and **Quasi-Peak** detectors. d. Set the **Dwell Time** for each detector selected. e. Click **Run** to begin the measurement.	• The default dwell time will be adequate of measuring most emissions. If the signal that you are measuring has a low repetition rate or is intermittent in nature, you may need to increase the dwell time to capture at least two repetitions in order to accurately measure it. If the dwell time is increased for any of the detectors, you must also increase the **Autorange Sweep Time** to be equal to or greater than the longest dwell time of the selected detectors. The **Autorange Sweep Time** is set on the **Receiver Settings** tab in the **Measure dialog** box.



Continue to Next Signal

Continue with the next signal and repeat procedures 4-11, 4-12, and 4-13 for every signal in your list.

When complete, you should have a list of only your identified, maximized and measured EUT emissions.

- If you wish to rearrange or add or delete columns in your list before creating a report, refer to "Customize Signal Lists" on page 193.
- To create a report, refer to "Generate Reports" on page 189.

5 How Do I...?

In This Chapter...

Setup Tests

Open and Save Test Setups

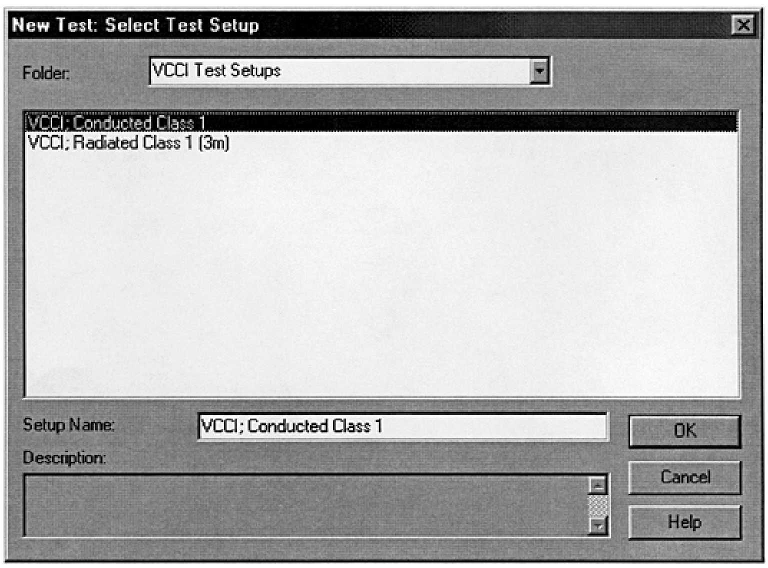
Test setups contain the operational test parameters. Several test setups are included with E7415A application. Additional test setups can be created (or existing test setups modified) to meet your particular requirements.

Each Test Setup contains:

- Limit Lines
- Equipment Setup
- Signal Path
- Ambient Lists
- Graph Settings
- Signal List Settings
- Sweep Settings
- Measure Settings
- Report Settings
- Receiver Settings

Procedure 5-1 ***How to Open a Test Setup***

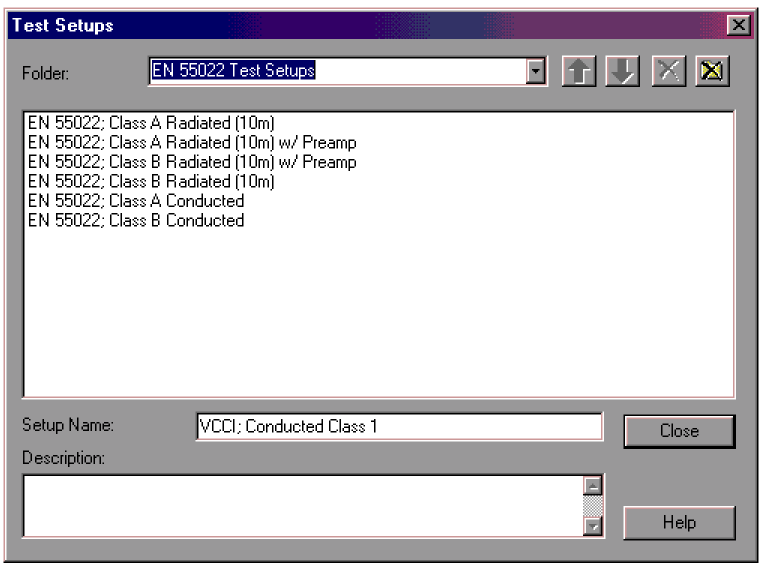
	Step		Comments
1	Open the Select Test Setup dialog box.	• Open the E7415A application.	• If the application is currently open, from the main menu, click **File** | **New**. • If the application is currently open, from the main menu, click **File** | **Open**. • Select **New** to open an existing test setup without data. (Use the test setup only.) • Select **Open** to open an existing test setup with data. (Use the test setup and data from a previous test.)



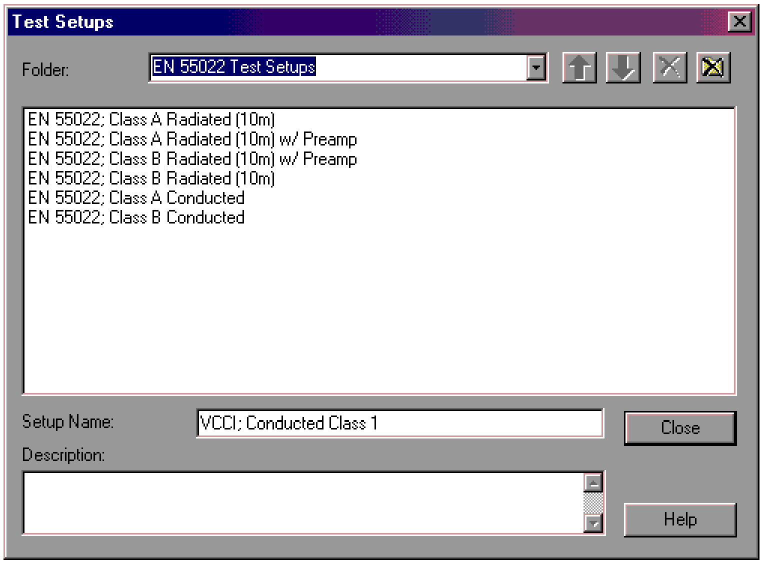
2	Select a set of compliance regulations	a. From the **Folder** drop-down box, select a set of compliance regulations (folder). b. Select the regulation to which to test. c. Click **OK**.	• There are various folders under which are related compliance regulations, for example **`VCCI Setups: VCCI; Conducted Class 1`**. • The applicable limit lines will display on the graph.

Procedure 5-2 How to Save a Test Setup

	Step		Comments
1	Save the test setup.	a. From the menu, select **File** | **Save As Setup....**	• The **Save Test Setup** dialog box displays.
		b. In the **Save Test Setup** dialog box, select the desired folder from the drop-down list or type in a new folder name	• To later access the new setup, select **File** | **New**. Select the folder and highlight the setup name, then click **OK**.
		c. In the **Setup Name** text box, enter a new name for your test setup or select a test setup from the list, then press **Save**.	• Use **Save As Setup...** to save test-setup without data. Setup parameters include: limit lines, equipment, signal path definitions, ambient lists (if any), graph and signal list settings, and sweep and measure settings associated with the test setup. • Use **Save As...** to save the current test, which includes the test data and the test setup.



Procedure 5-3 *How to Maintain a Test Setup*

Step		Comments
1	Open Test Setup Maintenance Window.	a. From the menu select **File** | **Test Setup** | **Maintenance**. b. Open the folder that contains test setups to be maintained. 
2	Perform maintenance tasks.	a. Highlight the test setup: b. Use the **Move Up** or **Move Down** arrow buttons to reposition. c. Use the **Delete Setup** button to remove a selected test setup. *This cannot be undone.* d. Use the **Delete Folder** button to remove a test folder selected form the drop-down list box. *This cannot be undone.* e. Add a description in the **Description** text box (optional).

Enter Test Header Information

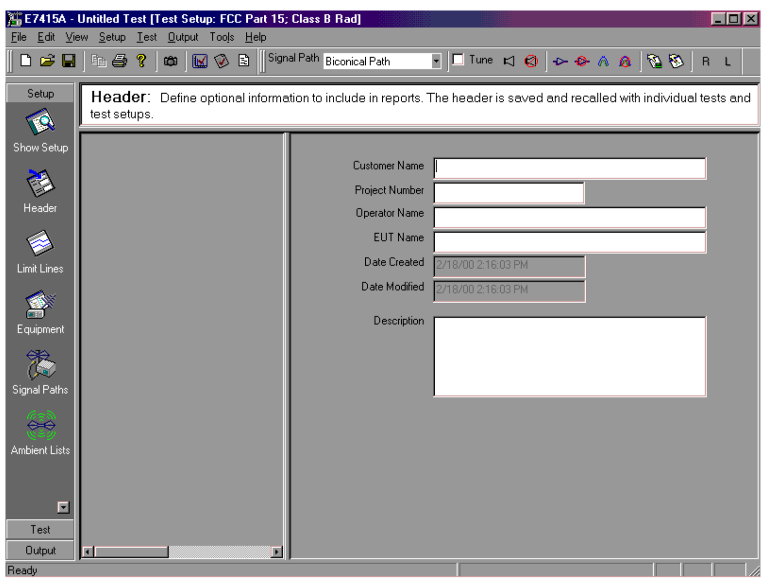
Test header information is saved with a test and can be included in reports.

Fields include:

- **Customer Name**
- **Project Number**
- **Operator Name**
- **EUT Name**
- **Date Created** (non-editable)
- **Date Modified** (non-editable)
- **Description**

Procedure 5-4 *How to Create a Test Header*

Step		Comments
Open the Test Header window.	• Select **Setup** | **Header** from the Sidebar.	• The header information can be included in a report and saved with a test.



Step		Comments
Fill in the test header fields.	• Enter the information in each field.	
Verify header settings.	• Click on **Show Setup** in the Sidebar to verify header settings.	

Use Limit Lines

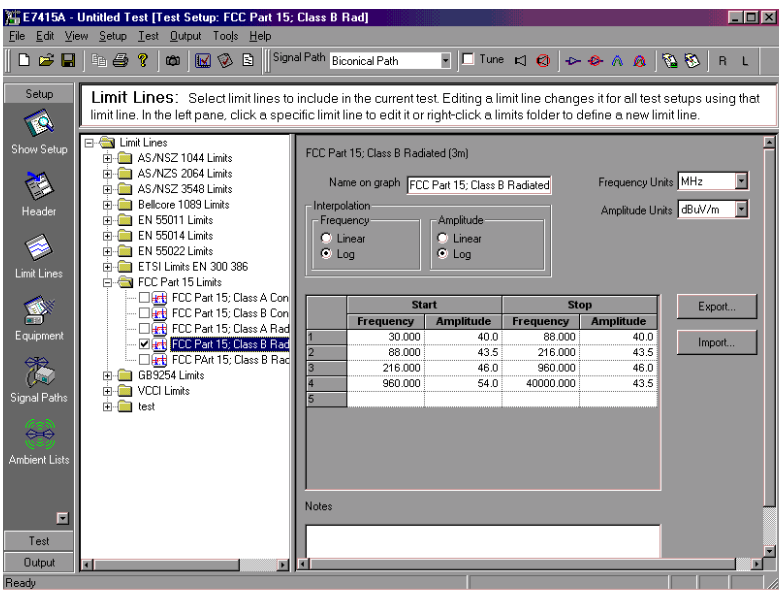
Limit lines provide the capability to compare measured signal data to a specified limit and determine if the signals pass or fail. Limit lines (or limit line margins) can also be used as thresholds to eliminate unwanted noise or signals that are below a particular amplitude.

A library of the most common limit lines is provided with the measurement application; however, you can create your own custom limit lines that best suit your needs.

NOTE Limit lines are associated with test setups. Associated limit lines are loaded when a test setup is selected.

Procedure 5-5 ***How to Select Limit Lines***

Step	Comments	
Open the Limit Lines folder.	• Select **Setup** | **Limit Lines** from the Sidebar.	



Step	Comments	
Select limit lines.	• Click the boxes proceeding each limit line to check (include) or clear (do not include) the limit line within the current test setup.	• See "How to Create a New Limit Line" on page 147 for information on adding or modifying limit lines.

Procedure 5-6 ***How to Create a New Limit Line***

Step		Comments
Open the Limit Lines folder.	• Select **Setup** | **Limit Lines** from the Sidebar.	• The left pane contains subfolders that are named for the different regulations (for example, FCC Part 15 Limits). Inside each subfolder are the limit line names supplied with the application. You can create new subfolders for additional limit line names and add new limit line names under new or existing subfolders. • The right pane is the property sheet for the limit line highlighted in the left pane. You can view the parameters of an existing limit line, modify applicable parameters of an existing limit line to create a new limit line, or define a new limit line starting with a blank property sheet.
(Optional) Create a new Limit Line subfolder.	a. Highlight the **Limit Lines** folder, then right-click and select **New Folder**. b. Right-click **Untitled Folder** and select **Rename**. c. Type a name for the new subfolder. d. Press **[Enter]**.	• A new folder (Untitled Folder) is added under the **Limit Lines** folder. • Or, click once to enter edit mode. • For example, **Custom Limit Lines**.
Create and name the new limit line.	a. Right-click the subfolder to add a new limit line and select **New Limit Line**. b. Right-click **Untitled Limit Line** and select **Rename**. c. Type a name for the new limit line. d. In the **Name on graph** text box, replace Untitled Limit Line with a name for the new limit line name.	• An "Untitled Limit Line" placeholder is added under the selected subfolder and a blank limit line property sheet appears in the right pane. • Or, click once to enter edit mode. • For example, **`Measurement System Threshold`**. • The title of the property sheet changes to reflect the new limit line name on the graph. • Newly created limit lines are automatically checked.

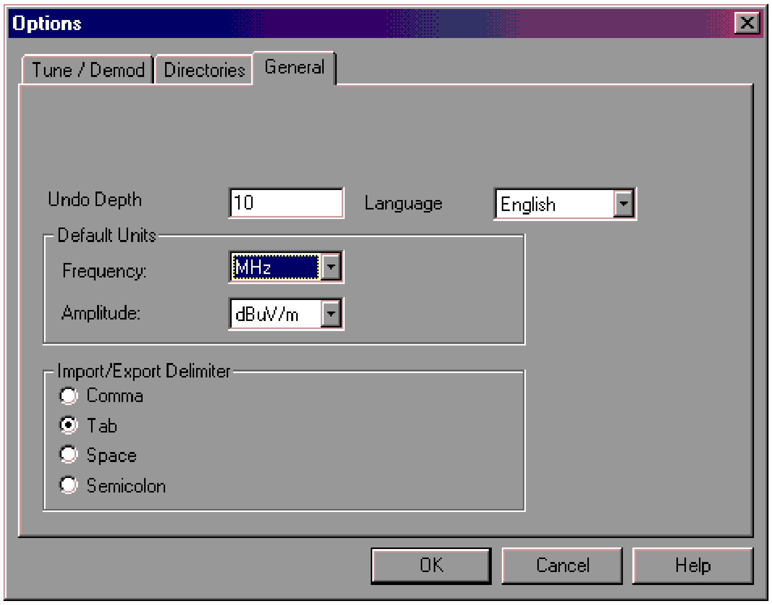
Procedure 5-6 How to Create a New Limit Line (Continued)

Step		Comments
Define the new limit line in the property sheet.	a. Under **Interpolation**, select the appropriate frequency and amplitude scale (**Linear** or **Log**) for your limit line (**Log** is the default). b. In the **Frequency Units** drop-down list, select the appropriate units (**MHz** is the default). c. In the **Amplitude Units** drop-down list, select the appropriate units (**dBmV** is the default).	• See glossary for interpolation information. • Enter a negative value to set the margin below the limit line. Enter a positive to set the margin above the limit line. • The margin displays on the graph with the limit line.
Enter start and stop frequency and amplitude for each limit line segment.	a. Click in the **Start Frequency** table cell in row 1 and enter the start frequency (for example 30). b. Use **[Tab]** to move the cursor to the **Start Amplitude** table cell and enter the start frequency amplitude (for example, 39). c. Tab to the **Stop Frequency** table cell and enter the stop frequency for this limit line segment (for example, 88). d. Tab to the **Stop Amplitude** table cell and enter the stop frequency amplitude (for example, 39). e. Press the **[Enter]** key after each limit line segment is added to save the limit line segment.	• Each point is defined by a frequency value and amplitude value (called the frequency/amplitude pair). • Two points define a line segment. *NOTE*: The **Start Frequency** value must be smaller than the **Stop Frequency** value. • One or more line segments placed in sequence define a limit line, therefore one or more start/stop frequency pairs define a limit line. • Editing the frequency and amplitude values of the displayed limit lines will update the graphs to reflect the limit line edits.

NOTE When creating limit lines it is recommended that two segments be added. The first segment should be slightly below the stop frequency and the value should be zero. The second segment should be slightly above the stop frequency and the value should be zero. This will prevent limit lines from extending beyond the intended frequency band.

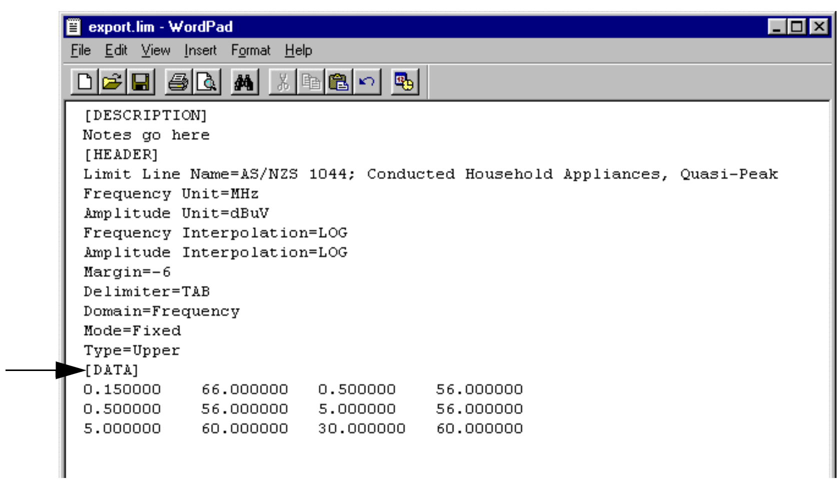
Procedure 5-7 How to Import a Limit Line

Step			Comments
1	Set the appropriate delimiter type for the import file.	a. From the menu, select **Tools** | **Options**. b. Press the **General** tab. c. Set the delimiter type.	• Correction factors must contain only ASCII data. • Correction factors must be entered as frequency and amplitude pairs. • Frequency and amplitude pairs must be separated by commas, tabs, spaces, or semicolons. • It is recommended that you first export an existing Limit Line, then edit the file as required. The file can then be saved with a different name and imported as needed. Use **WordPad** to edit the file. See "How to Export a Limit Line" on page 152.



Procedure 5-7 How to Import a Limit Line (Continued)

Step			**Comments**
2	Edit Limit Line file.	a. [DATA] must be included as a header immediately above the first frequency/amplitude pair. Other headings are optional. b. The file must be saved with a **lim** extension.	• To view the Limit Line file layout, export an existing Limit Line and open with WordPad. • Enter descriptive notes under [DESCRIPTION]. • Enter Header information such as units, interpolation, margin, and delimiter type under [HEADER]. • Enter data under [DATA] with the appropriate delimiter. Place each limit line segment per row. • Use **WordPad** rather than NotePad when editing limit lines. • The limit line file can include interpolation and units information; see figure. • It may be necessary to change the extension of the saved file from **txt** to **lim** using the system file manager (such as Windows Explorer).

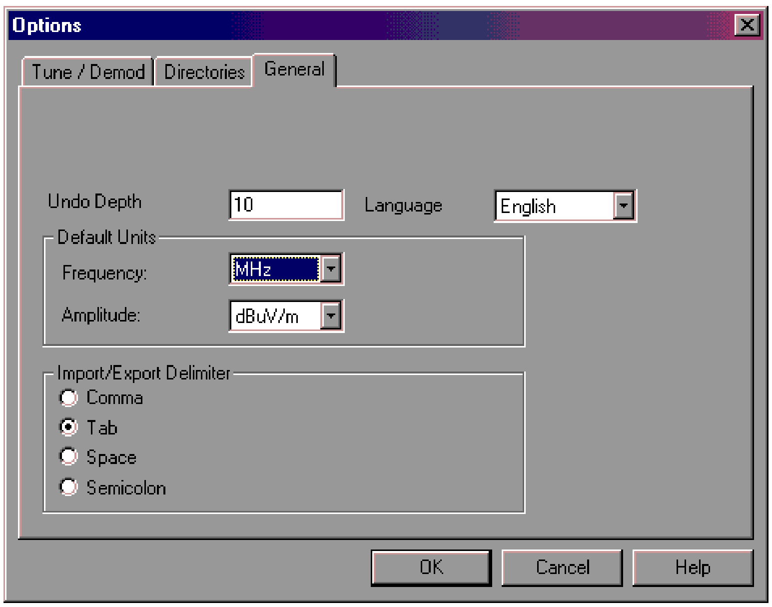


Procedure 5-7 How to Import a Limit Line (Continued)

	Step		Comments
3	Importing Limit Line data.	a. Select **Setup** | **Limit Line** from the Sidebar. b. Choose a Limit Line title (or create a new limit line name, see "How to Create a New Limit Line" on page 147). c. In the Interpolation area, specify either a **Linear** or **Log** frequency axis. d. In the Units area select the **Frequency** and **Amplitude** units. e. Click the **Import** button. Find and open the limit line file to import. f. Verify start/stop amplitude/frequency values in the new limit line property sheet.	• The Limit Line file can contain header information which includes Limit Line title, interpolation type, units, and delimiter type (see the figure in step 2). Use the property sheet to overwrite fields as desired.

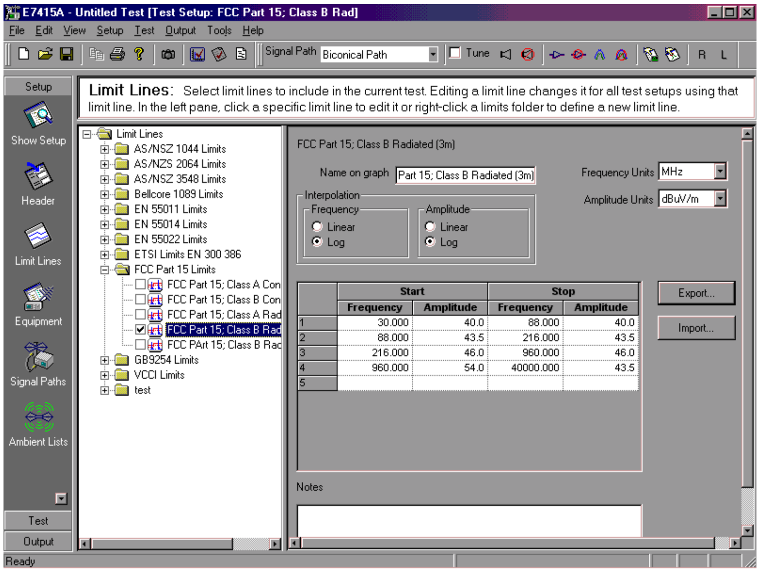
Procedure 5-8 How to Export a Limit Line

	Step		Comments
1	Set the appropriate delimiter type for the export file.	a. From the menu, select **Tools** | **Options**. b. Select the **General** tab. c. Set the delimiter type. d. Click **OK**.	• The export file will include three conditions: — Correction factors will contain only ASCII data. — Correction factors will be saved as frequency and amplitude pairs. — Frequency and amplitude pairs will be separated by the selected delimiter.



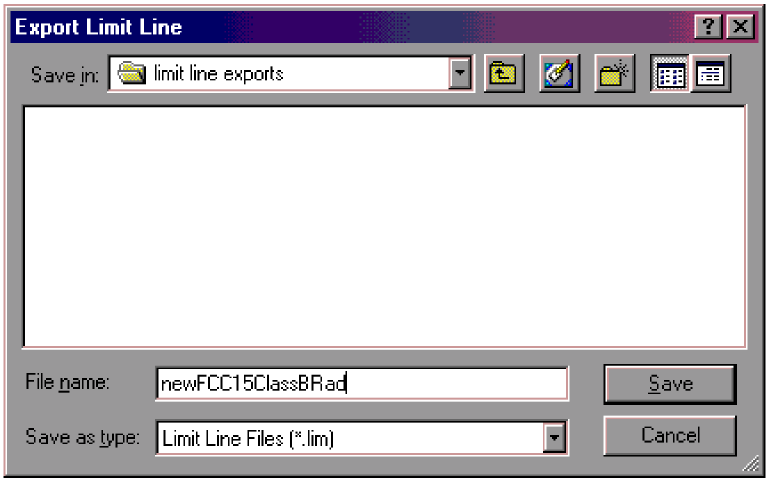
Procedure 5-8 How to Export a Limit Line (Continued)

	Step		Comments
2	Export Limit Line data.	a. Click on **Setup** folder. b. Click on the **Limit Line** icon. c. Choose a **Limit Line** title. d. Click on the **Export** button.	• The Limit Line data and header information (Limit Line title, interpolation type, units, and delimiter type) are saved to the file.

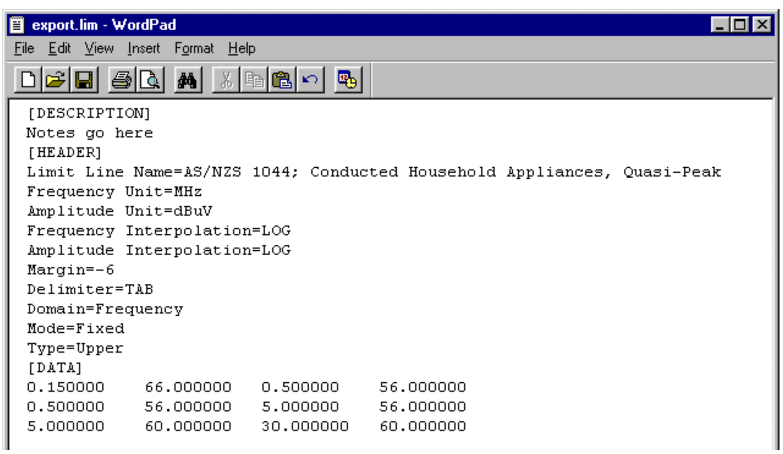


Procedure 5-8 How to Export a Limit Line (Continued)

Step		Comments
3	Name exported limit line.	• In the Export Limit Line window enter a descriptive file name in the File Name area then click Save.



Step		Comments
4	Verify the Limit Line data.	• Open the Limit Line file in WordPad and verify the data and header information.



Add and Setup Test Equipment

Test equipment is used to test EMI emissions. The equipment available for testing is listed under the Equipment folder. Additional equipment can be added and setup for use.

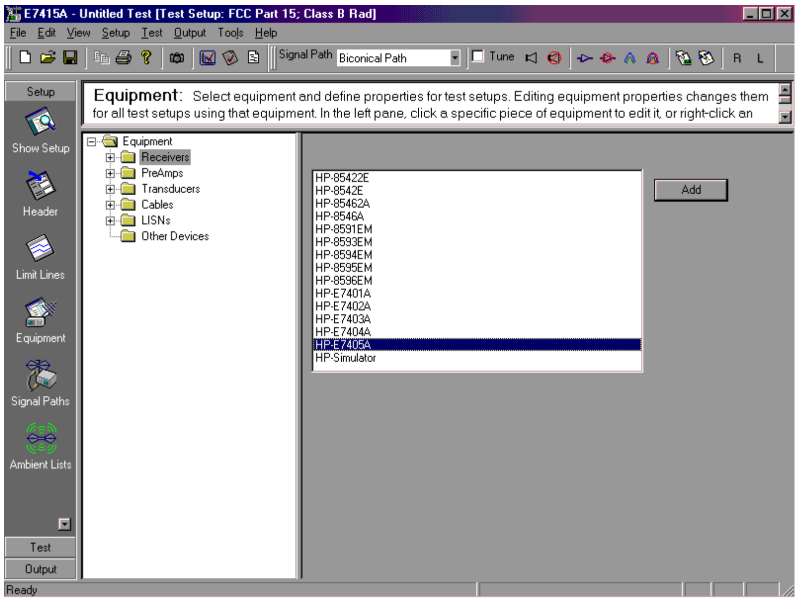
Each signal path uses a selection of available test equipment and calculates total path correction (see "Use Signal Paths" on page 166).

Test equipment setup data includes the following:

- Make
- Model
- Last calibration date
- Calibration due date
- Serial number
- Communication interface (receivers only)
- Bus address (receivers only)
- Communication library (receivers only)
- Corrections (except receivers)
- Notes

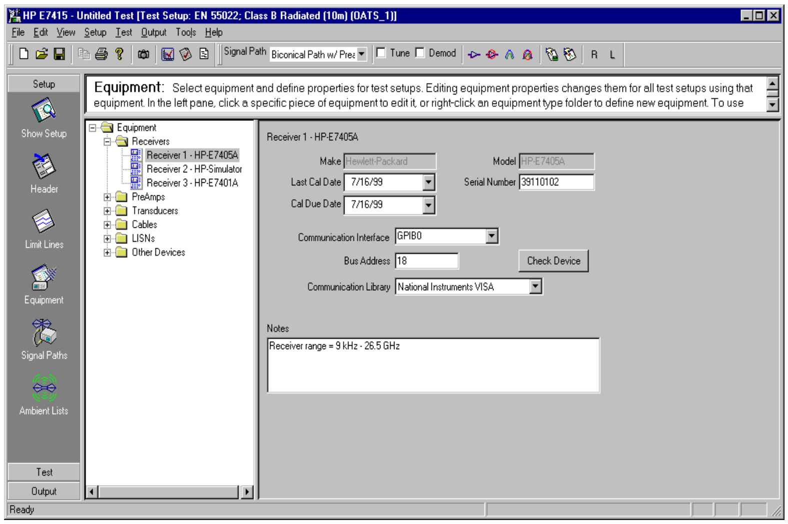
Procedure 5-9 How to Add and Setup a New Receiver

Step			Comments
1	Open the Equipment folder.	• Select **Setup** | **Equipment** from the Sidebar.	• The left pane displays a list of equipment subfolders.
2	Add a receiver.	a. Highlight the **Receiver** subfolder. b. In the right pane, click on the receiver to add. c. Click **Add**.	• The right pane displays the receiver drivers available for configuration and the left pane displays the receivers already configured for use in a test setup.



Procedure 5-9 How to Add and Setup a New Receiver (Continued)

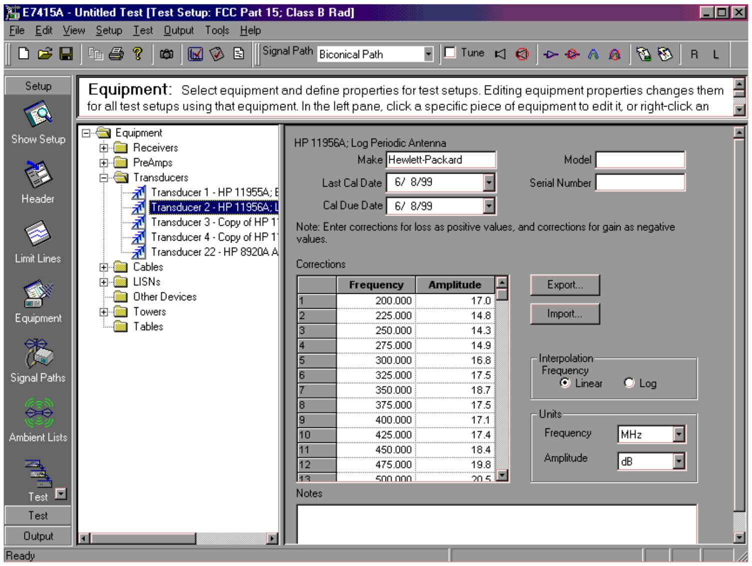
Step			Comments
3	Locate the receiver to configure.	a. Double-click the **Receiver** subfolder to open it. b. In the **Receiver** subfolder, click on the receiver you want to edit.	• The right pane contains the property sheet for the selected receiver.



Step			Comments
4	(Optional) Copy and rename the receiver.	a. Right-click on a receiver and choose **Duplicate**. b. Right click on the copy of the chosen receiver and choose **Rename**. c. Type in the name for your modified receiver.	• The duplicated receiver has the same properties as the copied receiver.
5	Configure the receiver.	• Make any changes necessary to the property sheet for your specific receiver.	• For example, calibration dates, bus address, and communication interface.
6	Connect the receiver.	a. Connect the receiver to your PC via an interface cable. b. Click the Check Device button to verify that the receiver is properly connected and configured.	• If the communication fields have been correctly entered and the interface cable properly installed between the PC and the receiver, the device communication should be successfully verified. • The **Serial Number** will be updated if the field is left blank.

Procedure 5-10 ***How to Add and Setup a Transducer (The procedure is similar for any other non-receiver test equipment)***

Step		Comments
1 Open the Equipment folder.	• Select **Setup** | **Equipment** from the Sidebar.	• The left pane displays list of equipment subfolders.
2 (Optional) Create a new transducer.	a. Double-click the **Transducers** subfolder. b. Highlight the **Transducer** subfolder, then right-click and select **New Transducer**. c. Right click the new transducer and select **Rename**. Enter a name for the new transducer (for example, SN 4564 Log Periodic). d. Press [**Enter**] to accept the changes.	• The transducers listed in the Transducer subfolder have been supplied with the application. They contain correction factors that are typical for that type of transducer. • If you have the same device as one supplied with the application, (for example, a log periodic antenna) you can modify the existing property sheet with the specific data for your device. Click on the applicable transducer name within the left pane to highlight it, then right-click and select Duplicate. A copy of the transducer is added to the bottom of the subfolder. Enter a new name for the device (by right clicking the new Transducer and selecting Rename), then edit the appropriate fields of the property sheet.



Procedure 5-10 How to Add and Setup a Transducer (The procedure is similar for any other non-receiver test equipment) (Continued)

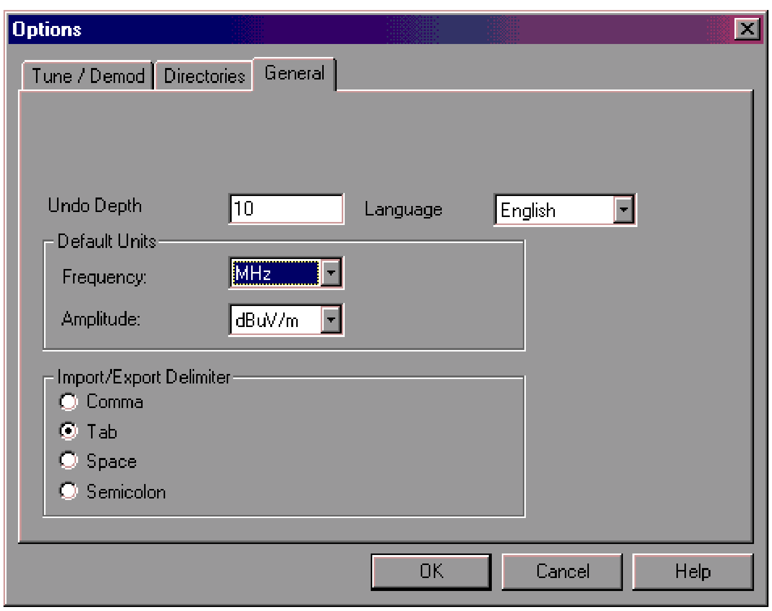
	Step		Comments
3	Edit the transducer parameters in the property sheet.	• Make any changes necessary to the property sheet for your specific transducer. (See next step for entering correction factors.)	• Use the data sheet supplied with your transducer to edit the appropriate fields (for example: make, model, serial number, calibration dates).
4	Enter the correction factors manually or import them from a file.	**Entering correction factors manually**: a. In the Interpolation area, specify either a **Linear** or **Log** frequency axis. b. In the Units area select the **Frequency** and **Amplitude** units. c. In the Corrections table, click on the first frequency column and enter the first frequency on the data sheet. (For example, 30 (MHz) would most likely be the first frequency entered for a Biconical antenna). d. Use the [**Tab**] key to move the cursor to the amplitude column and enter the corresponding amplitude. (For example, 14.65 (dB)). e. Press [**Enter**] to get to the next row (frequency/amplitude pair). f. Repeat steps 3 through 5 for each frequency amplitude pair.	• Make these selections based on the parameters used in the data sheet. See the Glossary entry, Interpolation on page 253, for more information. • Make these selections based on the parameters used in the data sheet. • Corrections for loss should be positive values and corrections for gain should be negative values. • Once you have entered all of the correction factors, you may want to save the data to a text file for external use. To do this, click the **Export** button. You can select the separator (comma, tab, space, or semicolon) used for the table data in the **Tools** | **Options** menu under the **General** tab. See "How to Import Correction Factors" on page 160.

Import and Export Corrections

Corrections (correction factors) are a set of frequency/amplitude pairs that characterize a device over frequency. The amplitudes are negative for gain (at an associated frequency) and positive for loss (at an associated frequency). Signal paths add the corrections of all equipment active in the path and provide the total correction to the receiver.

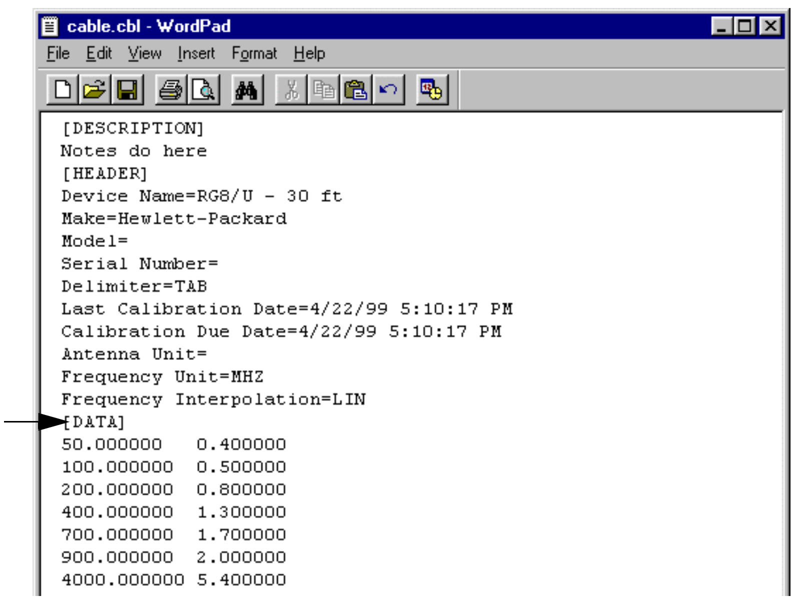
Procedure 5-11 How to Import Correction Factors

	Step		Comments
1	Set the appropriate delimiter type for the import file.	a. From the menu, select **Tools** | **Options**. b. Select the **General** tab. c. Set the delimiter type.	• Before you can import correction factors, the file must meet five conditions: — Correction factors must contain only ASCII data. — Correction factors must be entered as frequency and amplitude pairs. — Frequency and amplitude pairs must be separated by commas, tabs, spaces, or semicolons. — [DATA] must be included as a header (see step 2). — The file name extension must be “ant” for transducer correction factors and “cbl” for all other equipment. • It is recommended that you first export an existing correction factors file, then edit the file as required. The file can then be saved with a different name and imported as needed. Use **WordPad** to edit the file. See “How to Import Correction Factors” on page 160.



Procedure 5-11 How to Import Correction Factors (Continued)

Step		Comments
2 Edit correction factor file.	a. [DATA] must be included as a header immediately above the first frequency/amplitude pair. b. Save file with an **ant** or **cbl** extension.	• Enter notes under description. • Enter Header information such as device name, serial number, make, and model under [HEADER]. • Enter data under [DATA] with the appropriate delimiter. Place each correction factor per row. • Use **WordPad** rather than NotePad when editing limit lines. • The correction factor file can include interpolation and units information; see figure below. • It may be necessary to change the extension of the saved file from txt to ant or cbl using the system file manager (such as Explore).



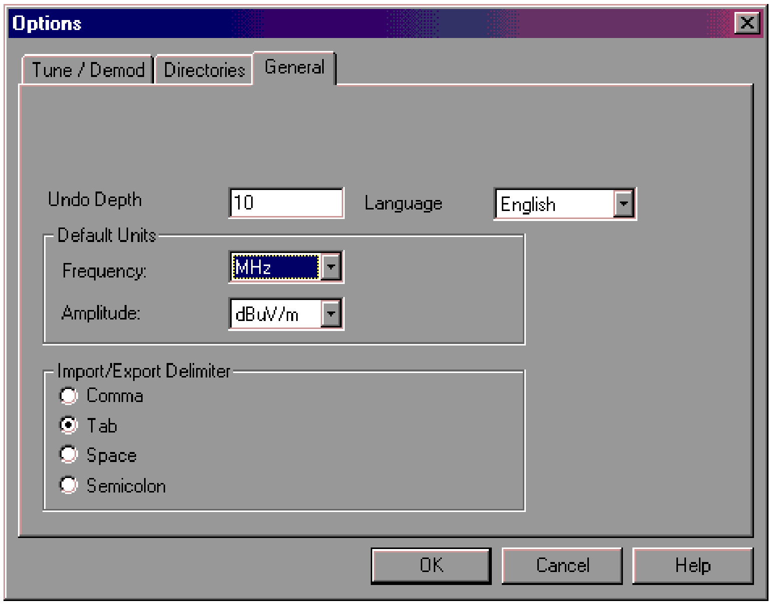

```
[DESCRIPTION]
Notes do here
[HEADER]
Device Name=RG8/U - 30 ft
Make=Hewlett-Packard
Model=
Serial Number=
Delimiter=TAB
Last Calibration Date=4/22/99 5:10:17 PM
Calibration Due Date=4/22/99 5:10:17 PM
Antenna Unit=
Frequency Unit=MHZ
Frequency Interpolation=LIN
[DATA]
50.000000    0.400000
100.000000   0.500000
200.000000   0.800000
400.000000   1.300000
700.000000   1.700000
900.000000   2.000000
4000.000000  5.400000
```

Procedure 5-11 How to Import Correction Factors (Continued)

	Step		Comments
3	Select the equipment and import corrections.	a. In the Sidebar, select **Setup | Equipment**. b. Choose the appropriate equipment subfolder and highlight the equipment for which you want to import correction factors. c. In the right panel, click **Import**. Find and open the appropriate corrections file to import.	• Receivers do not have any correction factors.

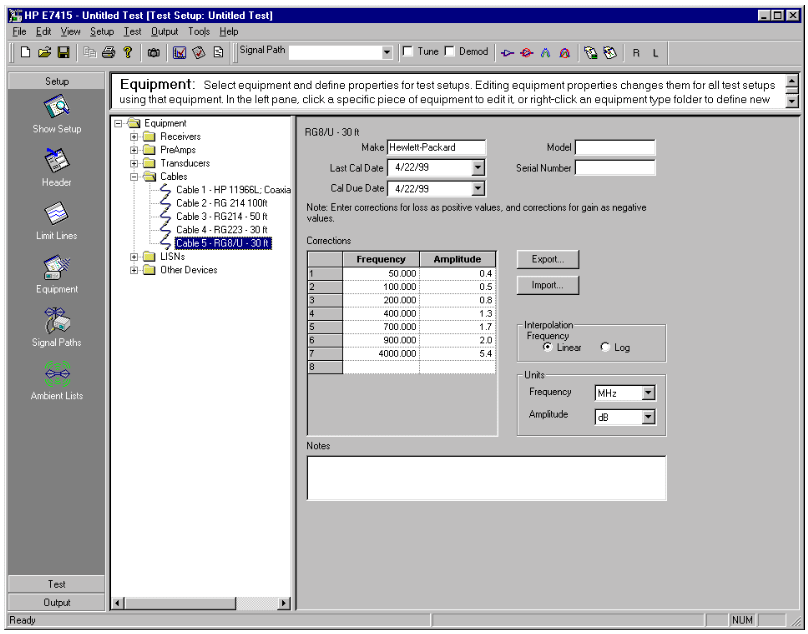
Procedure 5-12 How to Export Correction Factors

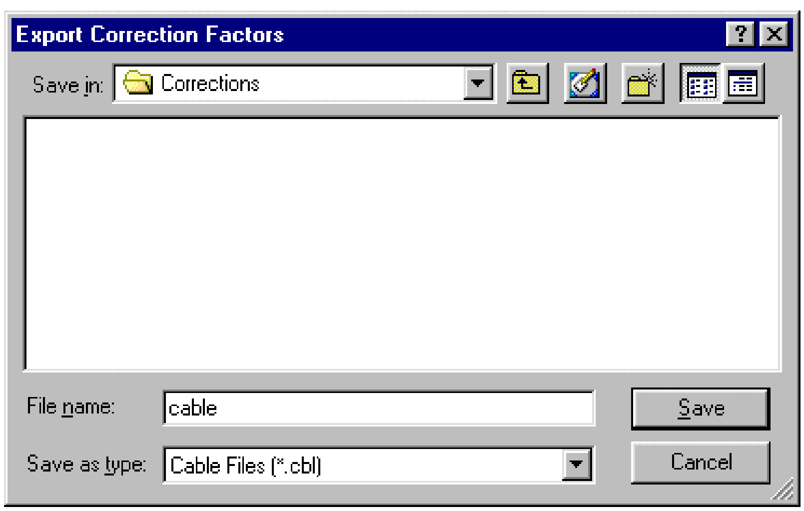
	Step		Comments
1	Set the delimiters.	a. From the menu select **Tools** | **Options**. b. Select the **General** tab. c. Choose the delimiter to use.	• Correction factors will contain only ASCII data. • Correction factors will be saved as frequency and amplitude pairs. • Frequency and amplitude pairs will be separated by commas, tabs, spaces, or semicolons.



Procedure 5-12 How to Export Correction Factors (Continued)

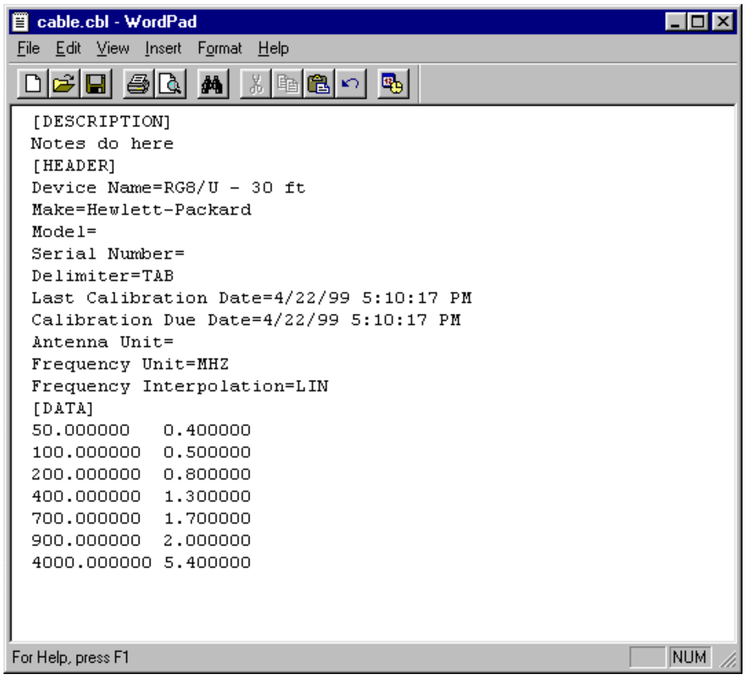
	Step		Comments
2	Export Corrections data.	a. Select **Setup** | **Equipment**. b. Click on the equipment to export. c. Click on the **Export** button. d. In the **Export Correction Factor** window enter a descriptive file name in the **File Name** area.	• The Corrections data and header information (title, interpolation type, units, and delimiter type) are saved to the file.





Procedure 5-12 How to Export Correction Factors (Continued)

	Step	Comments
3	Verify the correction factor data.	• Open the correction factor file in WordPad and verify the data and header information.

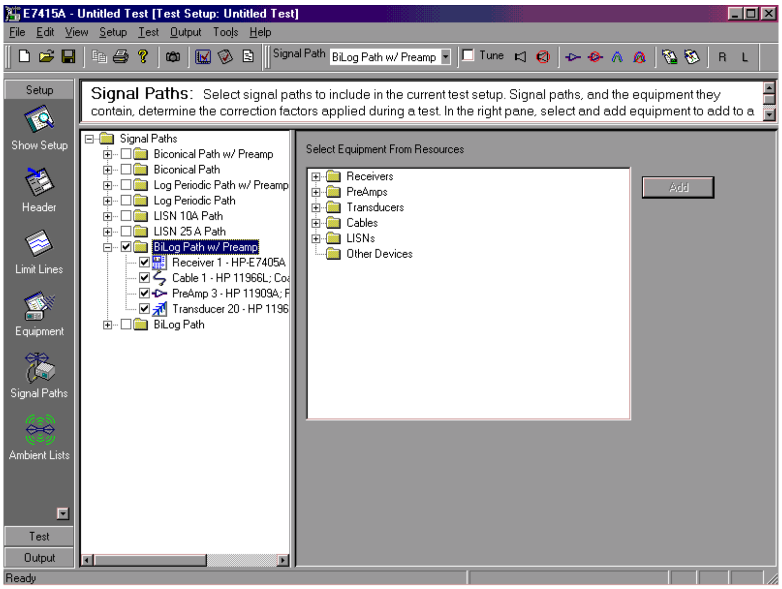


Use Signal Paths

Signal paths contain the equipment used in the test process. The signal path calculates the total path correction as the sum of the equipment corrections defined and active (checked) in the signal path. The total path correction is sent to the receiver.

Procedure 5-13 How to Select Signal Paths

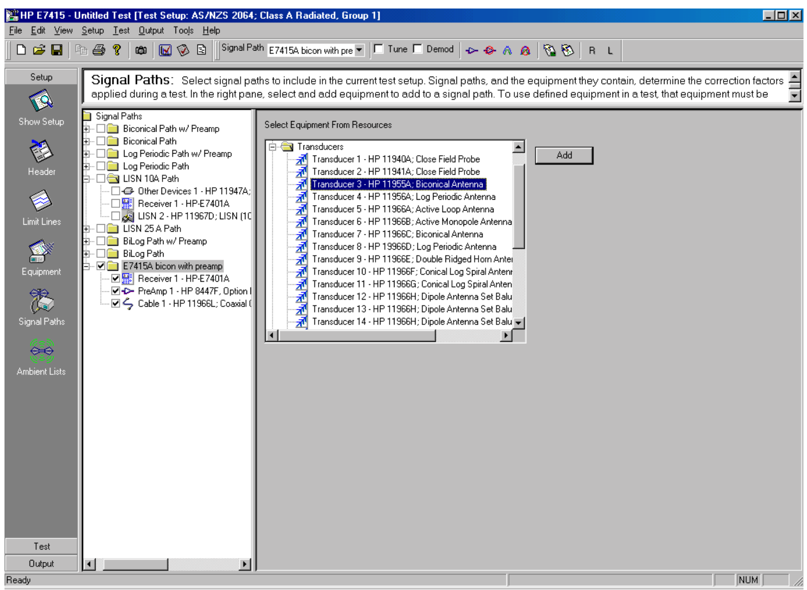
	Step		Comments
1	Open the Signal Path folder.	• Click the **Setup** bar then click the **Signal Paths** icon.	• The left pane is the resource list, which lists the signal paths that are defined and available for use. The right pane displays the property sheet of a selected signal path, and lists all of the defined equipment available. • The signal paths with **w/Preamp** in the name contain an external preamplifier in the signal path.



	Step		Comments
2	Select signal paths.	• Click the boxes preceding each signal path to check (include) or clear (do not include) the signal path.	• Checked signal paths are included in the receiver bar **Signal Path** pull-down list. • See "How to Create a New Signal Paths" on page 167 for information on adding or modifying signal paths.

Procedure 5-14 How to Create a New Signal Paths

Step			Comments
1	Open the Signal Path folder.	• In the Sidebar, select **Setup** | **Signal Paths**.	• The left pane is the resource list, which lists the signal paths that are defined and available for use. The right pane displays the property sheet of a selected signal path, and lists all of the defined equipment available.
2	Create a new signal path.	a. In the left pane, highlight the **Signal Paths** subfolder, then right-click it and select **New Signal Path**. b. Right click on Untitled Signal Path and select **Rename**. Enter a descriptive signal path name (for example, **`E7415 bicon with preamp`**). c. Press [Enter] to accept the changes.	• An Untitled Signal Path subfolder is added under the **Signal Paths** subfolder. • The new signal path is automatically checked for use within test setups.



Step			Comments
3	Add receivers and other components to the new signal path.	a. In the right pane, double click the **Receiver** folder to display the defined receivers. b. Highlight the desired receiver, then click **Add**. c. Highlight and add each component needed to create your signal path.	• The devices added to signal paths are automatically checked for use within the signal path.

Use Ambient Lists

When making conducted and radiated measurements, you may encounter ambient signals that mask the EUT emissions. This masking may yield erroneous test results, lengthen test time, and lead you to mistakenly record a high-level ambient signal as a worst-case emission.

During conducted emission tests, if ambient signals appear above the limit line on the display, try using a shorter interconnecting power cord, or try shielding the power cord. Do not use a ferrite core around the power cord as this may attenuate common mode signals coming from the EUT and thus give false readings.

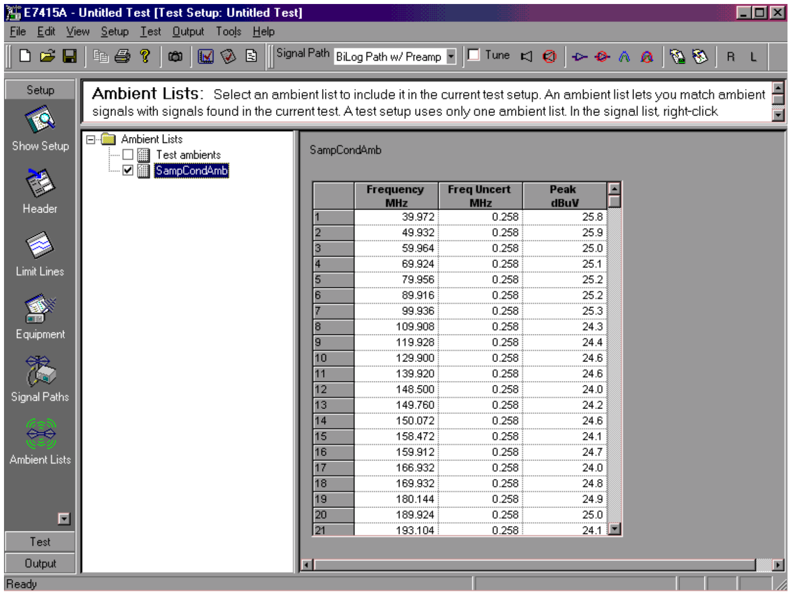
In most cases, you will not be able to eliminate all of the ambient signals by reconfiguring your test setup. You can create an ambient list that lets you compare ambient signals against the EUT emissions by sweeping the frequency range of interest with the EUT turned off. To correctly identify a signal as an ambient or as an emission, it is important to record ambient signals with good frequency accuracy. (The better the frequency accuracy, the less chance that two signals close together will be identified as one signal.)

Because the Sweep function provides better frequency accuracy (that is, reduced frequency uncertainty) than the Get Receiver Trace function, use the Sweep function to measure the ambient signals.

NOTE Many ambient signals are intermittent and can fluctuate greatly in amplitude. Therefore, an ambient signal list is only 100% accurate in the instance at which it is generated. Over time, as you encounter other ambient signals, you may add them to the ambient list.

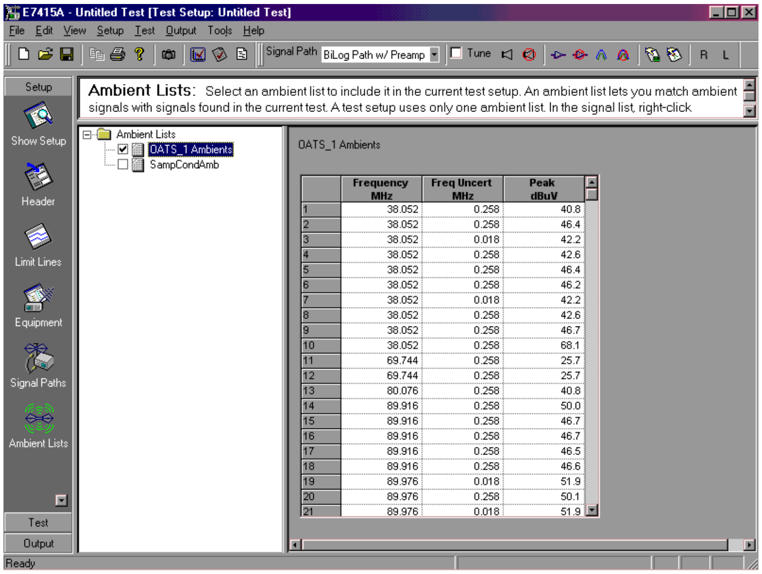
Procedure 5-15 How to Select an Ambient List

	Step	Comments	
1	Open the Ambients List folder.	• In the Sidebar, select **Setup** | **Ambient Lists**.	
2	Select ambient list.	• Click the box preceding the ambient list to check (to activate) or clear (to deactivate) the ambient list.	• When an ambient list is selected, it will be displayed in the signal list. • See “How to Create a New Ambient List” on page 170 for information on adding or modifying ambient lists.



Procedure 5-16 How to Create a New Ambient List

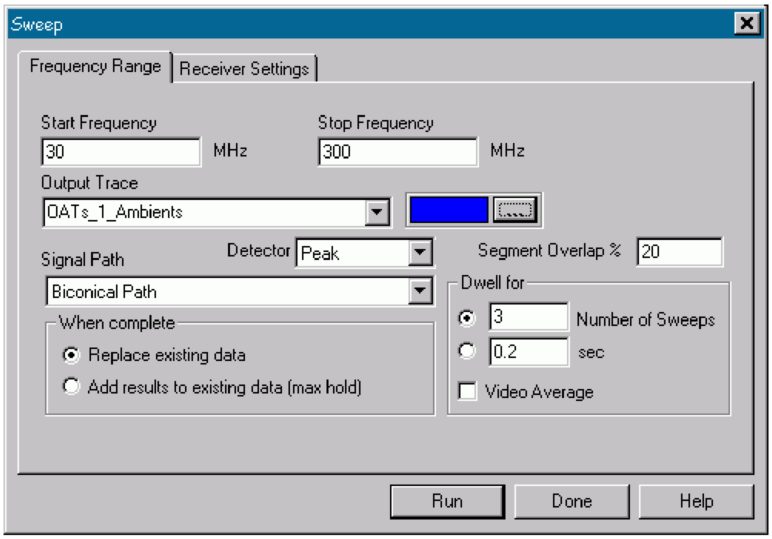
Step		Comments
1 Open the Ambients List folder.	• In the Sidebar, select **Setup** | **Ambient Lists**.	



Step		Comments
2 Create and name the new ambient list.	a. Highlight the **Ambients List** folder and right-click and select **New Ambient List**.	• An Untitled Ambients List is added under the Ambient Lists folder.
	b. Click on the new ambients list and enter a new list name (for example, **`OATS_1 Ambients`**).	• This ambient list is active.

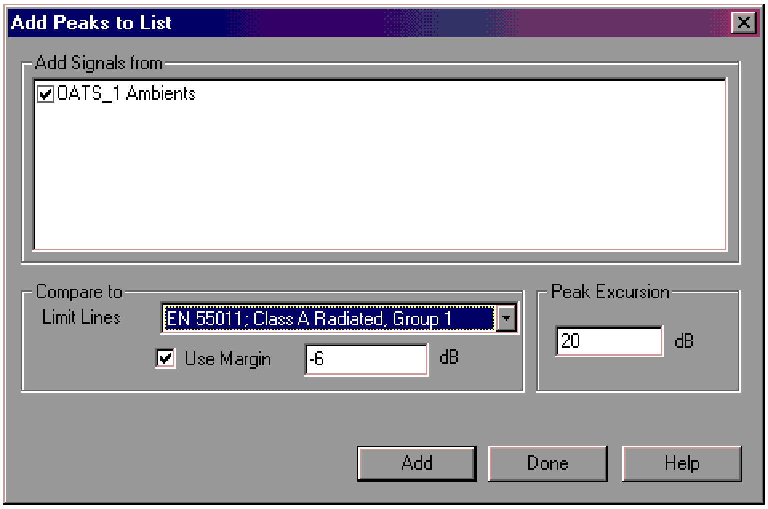
Procedure 5-16 How to Create a New Ambient List (Continued)

	Step		Comments
3	Sweep for Ambients.	a. In the Sidebar, select **Test** | **Sweep**. b. In the **Sweep** dialog box, set the start frequency and stop frequencies as outlined in the regulation to which you are testing and the transducer used. c. Enter **3** for number of sweeps to capture intermittent ambients. d. Enter a trace name in the **Output Trace** text box. e. Click **Run**.	• Make certain the receiver is not in an overload condition (see your receiver's user guide).



Procedure 5-16 How to Create a New Ambient List (Continued)

	Step		Comments
4	Define the peak parameters for ambients.	a. In the Sidebar, click **Add Peaks to List**. b. In the **Add Peaks to List** dialog box, increase the Peak Excursion criteria to 20 dB (default = 10). c. Clear (uncheck) **Use Margin**, then click **Add**.	• All signals that rise and fall 20 dB above the noise floor will be added to the signal list.



Procedure 5-16 How to Create a New Ambient List (Continued)

	Step		Comments
5	Add signals to active ambient list.	a. In the **Signal List** table, double-click the **Peak** column header to sort the signal list by highest peak amplitude. b. In the numbered column, click and drag on the first 20 signals to highlight them. c. Right-click in the **Signal List Table** and select **Save to Ambient List**.	• Double-clicking on a column header sorts the list table by toggling between ascending or descending order. • Choose how many signals to add to the ambient list. One method is to select signals that are within a certain amplitude of the limit line (for example, 10 dB). For this example we will add the first 20 signals with the highest amplitude. • The selected signals are saved to the active ambient list. • Ambient signals are displayed in blue print in the signal list. • To review the contents of the active ambient list, select **Setup** | **Ambient** List. Highlight the ambient list name to view the contents in the property sheet. • If there is not an ambient list enabled in the test setup, the application automatically creates an **Untitled Ambient List** and places the signals within this ambient list.

Procedure 5-17 How to Add/Remove a Signal to/from the Active Ambient List

	Step		Comments
1	Add signals to ambient list.	a. Highlight the signals to add in the signal list. b. Right-click in the **Signal List Table** and select **Save to Ambient List**.	• Multiple signals may be selected by using the Ctrl key. • Ambient signals are displayed in blue print in the signal list. • To review the contents of the active ambient list, select **Setup** | **Ambient List**. Click on the ambient list name. • If there is not an ambient list enabled in the test setup, the application automatically creates an **Untitled Ambient List** and places the signals within this ambient list.
2	Remove from ambient list.	a. Highlight the signals to remove in the signal list. b. Right-click in the Signal List Table and select **Remove from Ambient List**.	• The selected signals are removed from the active ambient list, leaving them in the signal list.

Use the Sweep, Add Peaks to List and Measure Functions

The Sweep, Add Peaks to List, and Measure functions can be used for all your testing needs. With the versatility of the E7415A measurement software, you can make an automated measurement beginning with the initial sweep to final measurement using the detector called out in your regulation.

The following procedures will show you how to customize and use these functions to best suit your testing needs.

Set Up and Perform Sweeps

The Sweep function sets up the receiver to sweep the frequency range set in the sweep dialog box. The sweep function is comprised of multiple receiver sweeps, that is, the frequency range is segmented, and each segment is swept in turn by the receiver. The composite of all receiver sweeps is displayed on the E7415A graph as a single trace.

Frequency range settings tab contains:

- The frequency range you choose depends on the receiver model you selected in Setup | Equipment, as well as the CISPR (or other regulation) to which you are measuring. Start and stop frequencies are set to the range of the antenna you are testing. More than one antenna may be needed to cover the radiated frequency range of the regulation to which you are testing. For example:
  - — Set the start frequency to 30 MHz and the stop frequency to 200 MHz for a biconical antenna.
  - — Set the start frequency to 200 MHz and the stop frequency to 1000 MHz for a log periodic antenna.
- A Detector; Peak, Quasi-Peak, or Average. Use the Peak detector for initial scans. Peak is the most constrictive of detectors so selecting Peak will ensure that signals that fail the limit line or limit line margin will be included in the data set
- The choice of whether to Replace existing data (overwrite the trace named in the Output Trace box), or Add results to existing data (max hold) (overwrite data for the selected trace only if data point is higher than existing data point).
- Segment overlap (% of uncertainty) between segments during the sweep process. Segment size dictates the frequency uncertainty. The percentage of the overlap defines the amount by which two segments may overlap for two (or more) signals to be considered duplicates.
- The signal path, selected from the drop-down box.

- The dwell settings, or the amount of time the receiver tunes to the zoomed signal peak in zero span before moving to the next peak.
- Video Average for measurements below 1 GHz the VBW is set to 300 kHz if selected. For measurements above 1 GHz the VBW is set to 3 MHz. See **Help | Contents...** for more information on Video Averaging.

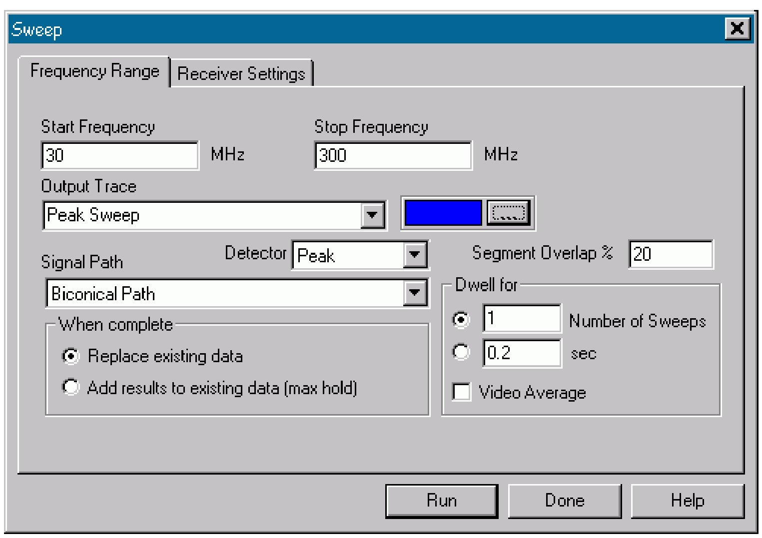
Receiver Settings tab contains:

- **Auto All**: When Auto All is selected, the software selects the appropriate values for RBW, VBW, Reference Level, Attenuation, Sweep Time and Segment Size. The RBW will be determined by the Frequency Range specified in the Frequency Range Tab and the regulations governing it. The selection of VBW, Sweep Time and Segment size are dependent on the selected RBW.
- **RBW** (Resolution BandWidth). The primary purpose for having a sequence of resolution bandwidth filters in a receiver is to be able to resolve adjacent signals of different frequency separations.
  — If Auto RBW is checked, the application sets the RBW value as follows:
  — For measurements below 1 GHz the RBW is set to 120 kHz. For measurements above 1 GHz the RBW is set to 1 MHz.
  — You can manually set the RBW as desired; decreasing the RBW will increase the resolution of signals close in frequency. (The sweep time will increase with decrease RBW.)
- **VBW** (Video BandWidth).
  — If set to Auto the application sets the VBW value as follows:
  — For measurements below 1 GHz the VBW is set to 300 kHz. For measurements above 1 GHz the VBW is set to 3 MHz.
  — Manually decreasing the VBW smooths the trace display by filtering the higher frequency components.
- **Ref Level** is the amplitude value (shown at the top graticule of the graph display area), from which remaining amplitude values derive. If the reference level value is different from the Auto setting, clear the Ref Level Auto check box and enter the correct reference level.
- **Attenuation**: The amount of attenuation applied to the input signal before reaching the mixer. If set to Auto, it is coupled with the Ref Level. Increasing the attenuation decreases the noise floor, but also decreases the dynamic range, see “Determine Receiver Settings” on page 33.
- **Sweep Time**: The time spent by the receiver to sweep over the specified segment while it is sampling values for a data point. Increase to capture intermittent signals. The minimum is a function of frequency range and bandwidth settings.

- **Segment Size**: The frequency span the receiver uses for each single sweep.

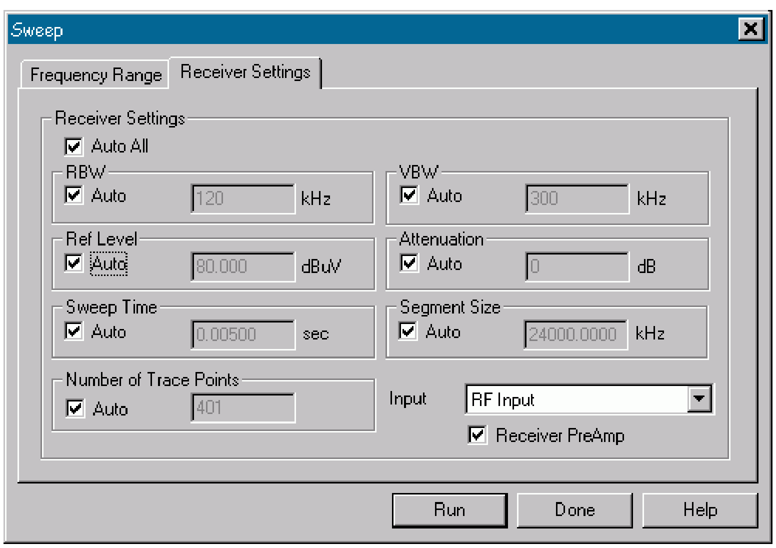
Procedure 5-18 How to Setup and Perform a Sweep

	Step		Comments
1	Set the Frequency Range parameters.	a. In the Sidebar, click the **Test** button, then click the **Sweep** icon. b. Set the start and stop frequencies to the range of the antenna which you are testing. c. Choose a detector for sweep d. Choose whether to **Replace existing data** or **Add results to existing data** (max hold). e. Set the segment overlap (% of uncertainty) between segments during the sweep process. f. Select the signal path to use from the active signal paths. g. Set the dwell settings. h. Select Video Average if you want to average the trace by the **Number of Sweeps**.	• If necessary, double-click the graph to set the graph settings to the correct start and stop frequencies. • Increase dwell to capture intermediate signals. — **Number of Sweeps**: The application will sweep each segment the number of times set in the box before sweeping the next segment. — **sec**: The application will continue to sweep each segment for the number of seconds set in the box before sweeping the next segment. • *Tip:* Increase “Dwell for” values to capture intermittent signals or signals with slow cycle times. For example, if the EUT’s operating state has a 10 second cycle time, set Dwell for to 15 or 20 seconds.



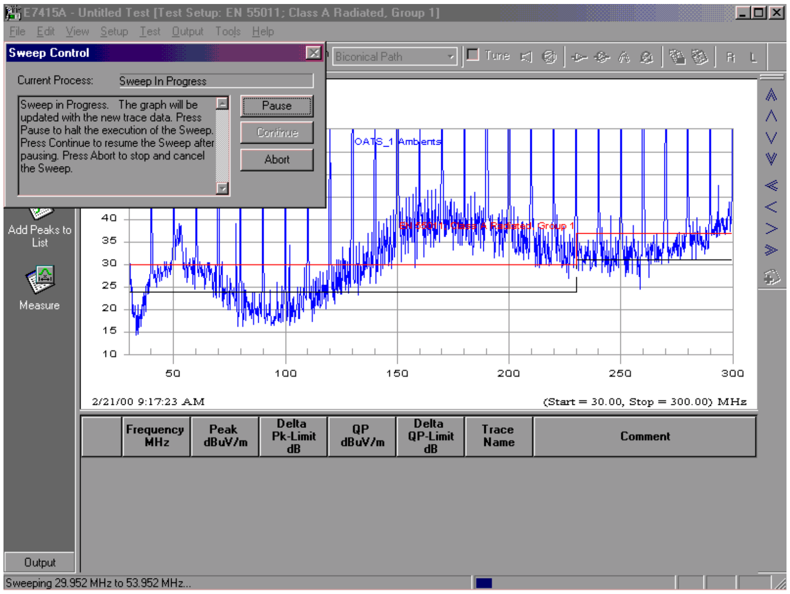
Procedure 5-18 How to Setup and Perform a Sweep (Continued)

Step		Comments
2 Name and define the trace.	a. In the **Output Trace** drop-down box, enter a trace name. b. Click on the color bar and select a color for the trace. c. Click **OK** to close the color palette.	
3 Set up the receiver.	a. Open the **Receiver Settings** tab within the **Sweep** dialog box. b. Adjust receiver settings if Auto All does not apply. c. Select the **Receiver PreAmp** box if you want to use your receiver's internal preamp. d. Check your receiver's manual regarding Number of Trace Points.	• See the Receiver Settings tab section in "Set Up and Perform Sweeps" on page 175. • Some receivers have more than one input (for example, Input 1 and Input 2 on the 854x series receivers). If there is more than one receiver input, select the Input to use from the drop-down box. Selected input is used for the particular set of measurements. *NOTE*: The inputs on the receiver support very specific frequency ranges. All the signals to be measured are compared to the frequency range of the receiver input. If the signals that do not fall within the supported frequency range they are removed from the measure list. A prompt lists the signals that will not be measured with the selected input.



Procedure 5-18 How to Setup and Perform a Sweep (Continued)

	Step		Comments
4	Perform sweep.	• Click **Run** in the **Sweep** dialog box to start the sweep.	• You can monitor the status of the sweep in the status bar of the application window; you also can view the trace as it is updated on the graph. Press **Abort** to stop the sweep.

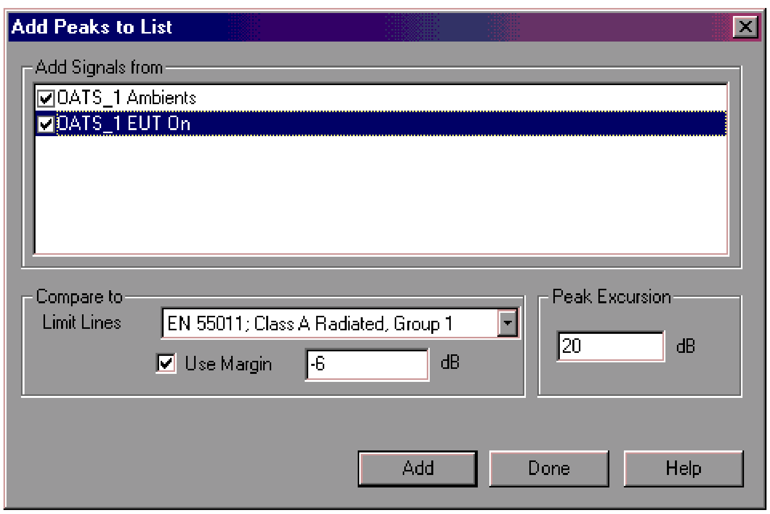


Add Signals to the Signal List

You can extract the signals from the trace data and place them in the signal list table. The signal list data can then be used as a basis for future measurements.

Procedure 5-19 How to Add Peak Signals from the Graph to the Signal List

	Step		Comments
1	Open the Add Peaks to List dialog box.	• In the Sidebar, select **Add Peaks to List**.	• OR, right-click the graph area and select **Add Peaks to List**. • Peak signals are added from the trace data; therefore, trace data must exist before adding peaks to list.
2	Select and add signals.	a. In the **Add Signals from** area, select the **OATS_1 Ambients and OATS_1 EUT On** traces. b. In the **Compare to** area, choose the limit line to which you are testing. c. Check the **Use Margin** box; set the margin as desired (–6 dB is the default setting). d. Set **Peak Excursion Criteria** as desired. e. Click **Add**.	• The signals above the limit line margin (except duplicate signals) are added to the list. The Trace Name column in the Signal List table shows the trace from which each signal is generated. • The larger the excursion value, the fewer signal will be captured. The smaller the excursion value, the more signals will be captured with decreased chance of masked emissions and an increase in the number of duplicate signals.



Procedure 5-20 How to Add a Data Point from the Graph to the Signal List

	Step		Comments
1	Add a graph data point to the Signal List Table.	a. Position the mouse pointer over the desired trace data point on the graph area. The mouse pointer turns into a hand symbol when it is placed on a data point of the graph. b. With a hand symbol displayed, click to move the trace selection marker (that is, little black box) to the current trace position. c. Right click on the mouse and select **Add Data Point to List**, or use the **Add Data Point to List** button on the bottom of the Marker bar.	• The Marker bar buttons can also be used to move the marker to the desired signal. See "How to Use Graph Markers" on page 211 for more information. • If it is difficult to place the marker on a trace data point, click and drag the desired portion of the graph (either above or below the trace) to zoom in. This will improve the resolution of the graph data and make it easier to pick the desired data point. • The amplitude and frequency location of the trace selection marker is added to the end of the Signal List Table. • The mouse pointer can also be positioned on the limit line or limit line margin. The **Add Data Point to List** function cannot be selected when the marker is on the limit lines. This keeps limit line data from being added to the frequency list.

Make Measurements

The measure process uses the selected receiver detectors to measure signals from the signal list. The measure process can use one or more detectors to measure each signal. The results of the measurement are displayed in the signal list.

Signal and Detector options:

- **Signal Path**: This drop-down box displays all the paths that are enabled in the **Test** setup. The default path selected is the path active on the **Receiver Bar**. Changing to another path updates the signal path on the **Receiver Bar**. Measurements cannot be performed without any entries in this box.

NOTE If there are no paths listed, at least one signal path needs to be defined in the **Test Setup** before measurements can be performed.

- **Measure from List**:
  - **Measure from List**: **Measure All Displayed Signals** measures the complete list of signals within the signal list.
  - **Measure Selected Signals** measures only the selected (highlighted) signals from the signal list. The signals need to be selected before the Measure dialog box is opened.
  - **From** measures the signals from the signal list that fall between the set frequency range.
- **Detectors**: **Peak**, **Quasi-peak**, **Average**. Peak detection is the default detection mode and the most common detection method used to quickly evaluate electromagnetic emissions. For commercial compliance measurements Quasi-peak detection is specified. However, peak detection can be used instead because it will always give the worst case (highest) emission level when compared to quasi-peak. If emissions levels meet requirements using peak detection, then a quasi-peak measurement is not necessary.Dwell Time for each of the selected detector can be specified in the adjacent box.

Before Measurement options:

- **Frequency Search**: Uses the frequency uncertainty of the signal to set the receiver span. The receiver span is set from (frequency of signal being measured) - (frequency uncertainty) to (frequency of signal being measured) +(frequency uncertainty). After setting the span, the receiver finds the highest peak in that span. The frequency at the highest peak is used to perform the measurement on the signal.

— If this check box is not enabled, the frequency of the listed signal is used to set the center frequency of the receiver. This frequency is used to perform the measurement on the signal

- **Tune and Listen**: Tunes the receiver to the selected signal frequency to enable you to perform an acoustic identification to distinguish ambient transmissions, such as radio signals, and from noise generated by the EUT.
- **Prompt Before Measure**: Before measuring each signal the application prompts you with a message box.
- **Enter Text Message**: Enter text to display before measuring each signal.

After Measurement options:

- **Always Update Signal**: Enables updating of the appropriate signal amplitude values, depending on the detectors selected.

  — If peak detector is used, the peak amplitude value of the signal is updated, and likewise with the QP and Avg detectors.

- **Only if Larger**: Enables comparison of the resulting measured amplitudes with the listed signal amplitudes (depending on the detectors used). The application updates the signal amplitudes only if the measurement result is higher than the previously listed amplitudes of the signal.

  — If peak detector is used, the application compares measured peak amplitude of the signal with the listed peak amplitude, and likewise with QP and Avg values.

- **Prompt for OK or Skip**: After the measurement is completed, this option prompts you with a dialog box asking to update the signal or skip the update. If the choice is **Skip** update, the amplitudes of the signal are not modified. If the choice is **OK**, the amplitudes of the signal are updated from the results of the measurements.

Receiver Settings tab options:

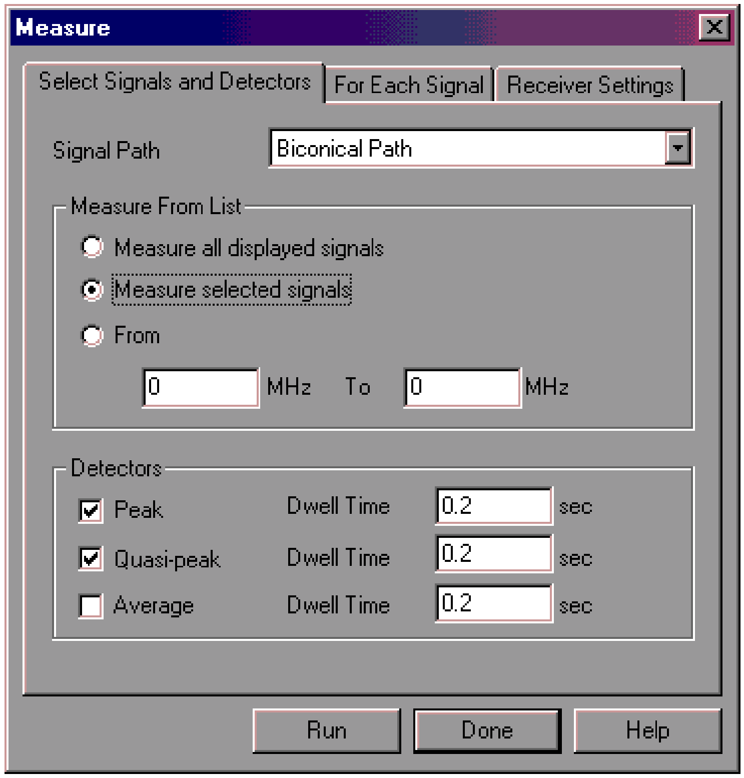
- **Receiver PreAmp**: This check box is displayed only if the receiver has a built-in PreAmp (or there are no defined signal paths). Check the box to enable the receiver PreAmp.
- **Input**: Some receivers have more than one input (for example, Input 1 and Input 2 on the 854x series receivers). If there is more than one receiver input, the input to use can be selected. Selected input is used for the particular set of measurements.

NOTE The inputs on the receiver support very specific frequency ranges. After the selection of input, all the signals to be measured are compared to the frequency range of the receiver input. The signals that do not fall within the supported frequency range of the input are removed from the measure list. The user is then prompted with the list of signals that will not be measured with the selected input.

- **Auto-range Sweep Time**: Sets the sweep time for the measurement.
- **RBW**: Resolution Bandwidth. When Auto is cleared, coupling between sweep time and resolution bandwidth is disabled. A resolution bandwidth can be chosen for the measurement depending on the bandwidth range implemented in the hardware receiver. Check Auto to reestablish coupling. The sweep time will increase with decrease RBW.
- **VBW**: Video Bandwidth. When Auto is cleared, the VBW uncouples video bandwidth fro resolution bandwidth. Check Auto to reestablish coupling. You can manually set the VBW as desired; decreasing the VBW smooths the trace display by filtering the higher frequency components.
- **Attenuation**: Specifies the input attenuation. Increasing the attenuation decreases the noise floor, but also decreases the dynamic range, see “Determine Receiver Settings” on page 33.

Procedure 5-21 How to Setup and Perform a Measurement

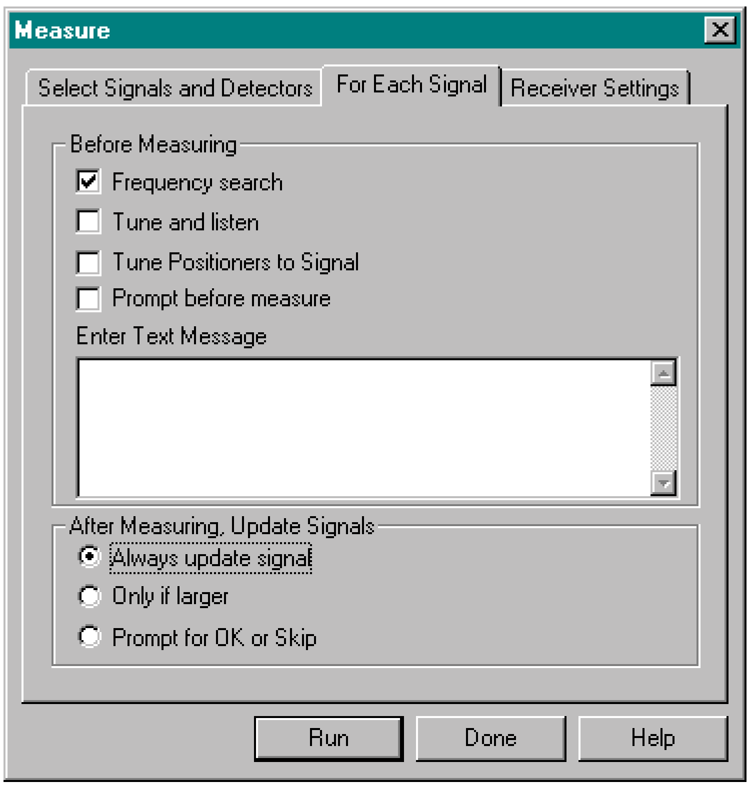
	Step		Comments
1	Open the Measure dialog box.	• Select the **Test** | **Measure** from the Sidebar or menu.	



2	Set signal and detector options.	a. Choose a **Signal Path**. b. Select the **Measure From List** option. c. Select the **Detectors** to use.	• Detailed option descriptions are in “Make Measurements” on page 182. • *Tip*: Intermittent signals may require a longer dwell time.

Procedure 5-21 How to Setup and Perform a Measurement (Continued)

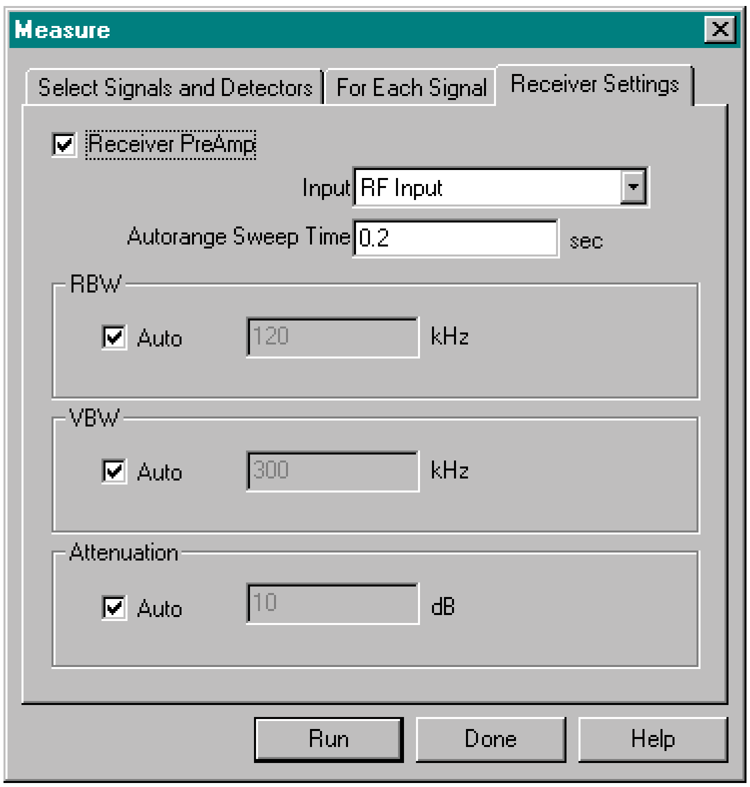
	Step	Comments
3	Set before measurement options.	a. Select the **For Each Signal** tab. b. Select or deselect **Frequency Search:** c. Select or deselect **Tune and Listen**. d. Select or deselect **Prompt Before Measure**. e. **Enter Text Message** if you would like a prompt before measuring each signal.



	Step	Comments
4	Set after measurement options.	a. Select or deselect **Always Update Signal**. b. Select or deselect **Only if Larger**. c. Select or deselect **Prompt for OK or Skip**.

Procedure 5-21 How to Setup and Perform a Measurement (Continued)

Step			Comments
5	Set receiver settings for measurement.	a. Select **Receiver Settings tab** b. Select **Receiver PreAmp** to enable a built-in preamp. c. Select **Input**. d. Set the **Auto-range Sweep Time**. e. Use Auto or manually set the **RBW**. f. Use Auto or manually set the **VBW** (Video Bandwidth). g. Use Auto or manually set the Attenuation.	• For more information, see "Receiver Settings tab options" on page 183.



Procedure 5-21 How to Setup and Perform a Measurement (Continued)

	Step		Comments
6	Run the measurement	• Click **Run** to begin the measurement.	• Each signal is remeasured using the peak and quasi-peak detectors. The Peak column is updated with new values acquired with greater frequency accuracy (lower frequency uncertainty). The QP (Quasi-Peak) column and data are added to the signal list table. • The Delta Pk-Limit and Delta QP-Limit columns are updated with data.

Generate Reports

You can generate two types of reports:

- Snapshot report

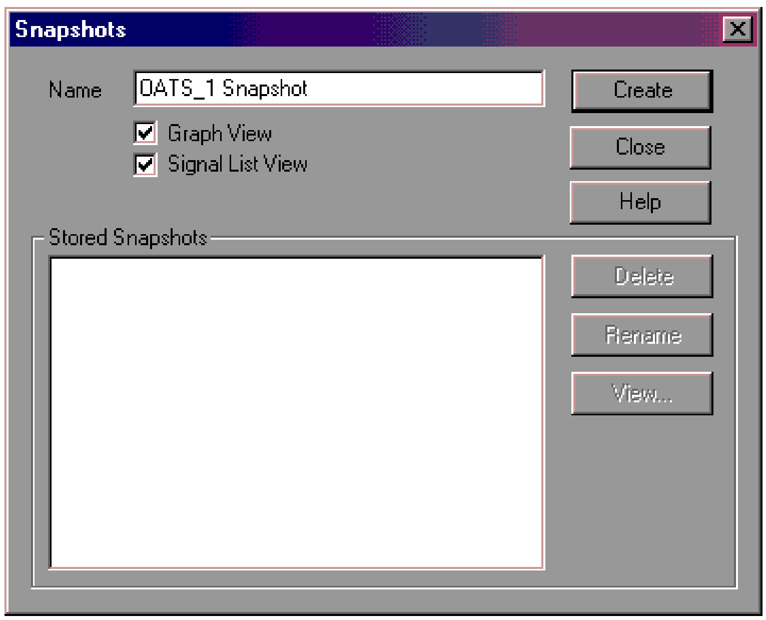
  A quick report comprised of the graph and/or signal list.

- Custom report

  A comprehensive report that can contain varied and extensive information about the test.

Procedure 5-22 How to Create a Snapshot Report

Step	Comments
1 Open the Snapshots dialog box.	• Select **Output** | **Snapshot** from the Sidebar or menu.

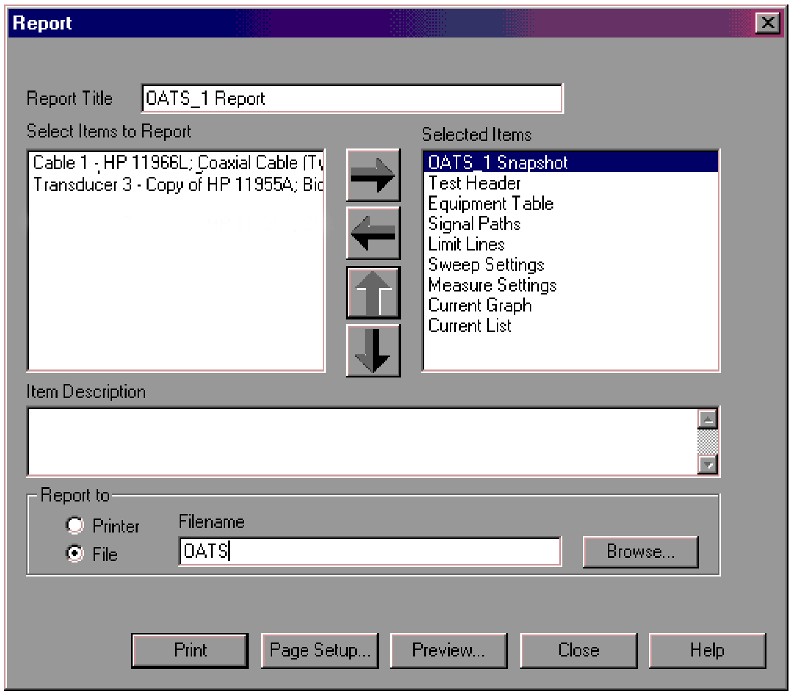


Procedure 5-22 How to Create a Snapshot Report (Continued)

	Step		Comments
2	Take the snapshot.	a. In the Snapshots dialog box, enter a name to identify the current graph and signal list state.	• Use “Snapshot” in the snapshot name. This will make it easier to identify if you wish to include snapshots later in a report.
		b. To capture both the graph and list data, make sure both the Graph View and List View boxes are checked, then click **Create**.	• The new snapshot is listed in the Stored Snapshots area.
3	View the snapshot.	• Highlight the new snapshot title in the Stored Snapshots area, then click **View...**.	• This is ideal for comparing before and after fix data when a potential EMI improvement has been made to the EUT. • The Snapshot will be added to the Report items. See “How to Create a Custom Report” on page 191.

Procedure 5-23 How to Create a Custom Report

Step		Comments
1 Open the Report window.	• Select **Output** | **Report** from the Sidebar or menu.	
2 Enter a title for the report.	• In the Report dialog box, enter a **Report Title**.	



Step		Comments
3 Select report options.	a. In **Select Items To Report**, hold down the [Ctrl] key while clicking on report items to include. b. Click on the right arrow button to move the highlighted items into the **Selected Items** box.	• These items will now be included in your report. Select a report item, then use the up and down arrow buttons to move the report item up or down in the list. • To deselect a report item, click on the item in the **Selected Items** list and use the left arrow button.
4 Add comments.	• Highlight a selected report item, then enter comments into the **Item Description** area.	• Comments will be included with the report.

Procedure 5-23 How to Create a Custom Report (Continued)

	Step		**Comments**
5	View and print the report.	a. Click on the **Preview** button to view the report. b. Use the scroll bar on the right side of the window to scroll through the contents of the report. c. **Print** the report d. Click **Close** to exit the **Preview** window.	• A print preview of the report will appear in the window. • Use the buttons at the bottom of the Report Preview to print and manipulate the page setup.
6	Save the report.	• Select **Report To File** to save the report as an *.rtf file, then enter a file name.	• RTF files can be open in many applications that recognize rich text format, such as word processors.
7	Close the report.	• Select **Close** to exit the **Report** dialog box.	

Customize Signal Lists

The signal list contains the signals from the trace data that meet user-defined criteria. The signal list can be sorted and filtered to facilitate data reduction and reporting.

Signal List Columns

Signal Attributes Available for Listing:

- **Frequency** of the signal.
- **Frequency Uncertainty** of the signal (obtained from the receiver trace).
- **Peak**
- **Peak Uncorrected**
- **QP**
- **QP Uncorrected**
- **Avg**
- **Avg Uncorrected**

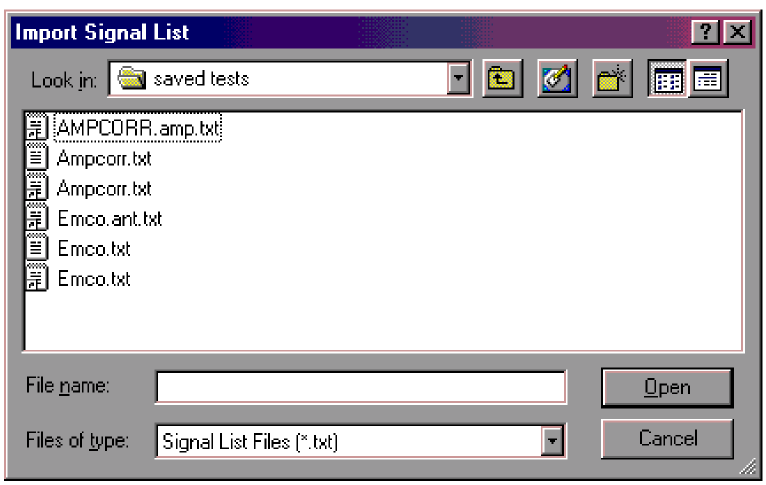
NOTE

Peak through **Avg Uncorrected** signal attributes refer to the amplitudes corresponding to each frequency point in the signal list.

- The amplitude in dB from an **A-B** trace corresponding to each frequency point in the signal list. The A-B trace must be previously defined.
- The **RBW** (Resolution Bandwidth) used to obtain trace data at the corresponding frequency.
- The **VBW** (Video Bandwidth) used to obtain trace data at the corresponding frequency.
- **Correction**, which is the sum of Transducer Correction + Cable Correction.
- The sum of all the **Transducer Corrections** that are used in the signal path.
- The sum of the **Cable Corrections** + preamp corrections + corrections for other devices in the signal path.
- The **Trace Name** from which the signal (frequency and amplitude pair) was generated.
- **Comment** holds descriptive text previously entered regarding signal attributes.
- The **Date/Time** stamp from the trace data. Each trace that is obtained from the receiver is date and time stamped by the application.
- **Ambient** displays a **Yes** if the listed signal is an ambient signal and a No if not. See “Use Ambient Lists” on page 168 for information on selecting Ambient signal lists.

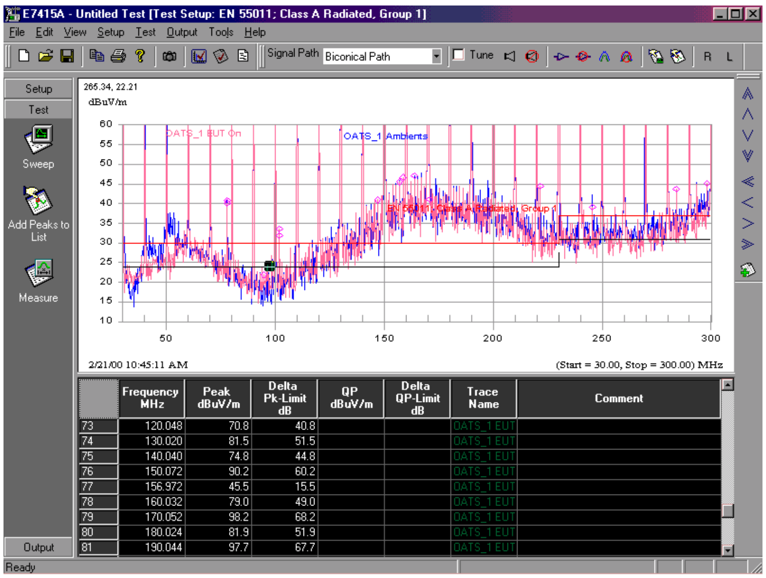
- Potential Ambient displays a Yes if the listed signal is obtained from the receiver trace and is a duplicate of a signal found within an ambient signal list. Displays No if not a potential ambient. In **Potential Ambient**, the user can choose to override the application comparison by selecting **User set Yes** or **User set No**. Signals that are marked with **User set Yes** or a **User set No** do not participate in ambient matching. Set the cell value to **Auto** to allow the application to perform the comparison. Cell values are edited by using the left mouse button.
- **Duplicate** flags signals that are duplicates of each other in the list, based on the % of frequency uncertainty.
- Duplicate options are:
  — **Auto**: Duplicate matching is applied. After duplicate matching, program determines if signal is duplicate, and sets value accordingly.
  — **User set YES**: Signal is not subject to automatic duplicate matching; duplicate status is defined by user as YES.
  — **User set NO**: Signal is not subject to automatic duplicate matching; duplicate status is defined by user as NO.

Procedure 5-24 How to Import a Signal List

Step		Comments
1 Open Signal List.	• From the menu choose **File** | **Import** | **Signal List...** 	
2 Choose file and import.	• Highlight the signal list to import. Click **Open**.	• As with exporting, set appropriate delimiter type.

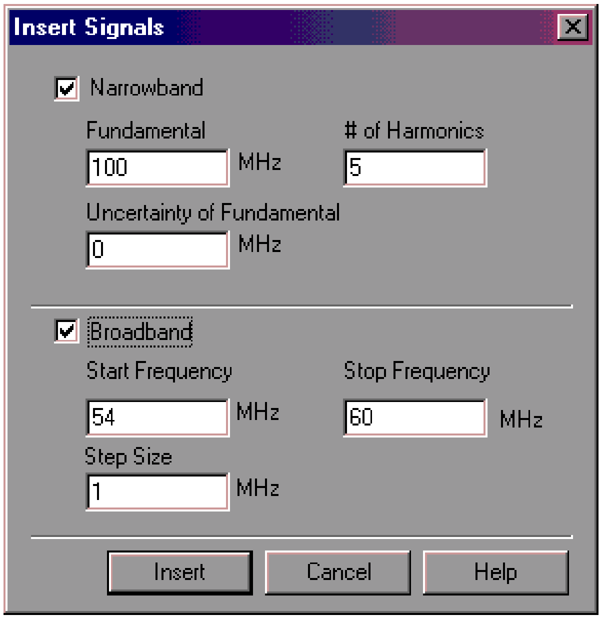
Procedure 5-25 How to Export a Signal List

Step		Comments
1	Select the signals to export.	• Highlight entire **Signal List** (click upper left box) or select signals from the signal list.



Step		Comments
2	Copy to clipboard.	• Select **Edit** | **Copy** from menu.
3	Paste into application	• Paste into a spreadsheet program (for example, Excel) or into a text editor (for example, Word or WordPad).

Procedure 5-26 How to Insert (Broadband or Narrowband) Signals into the Signal List

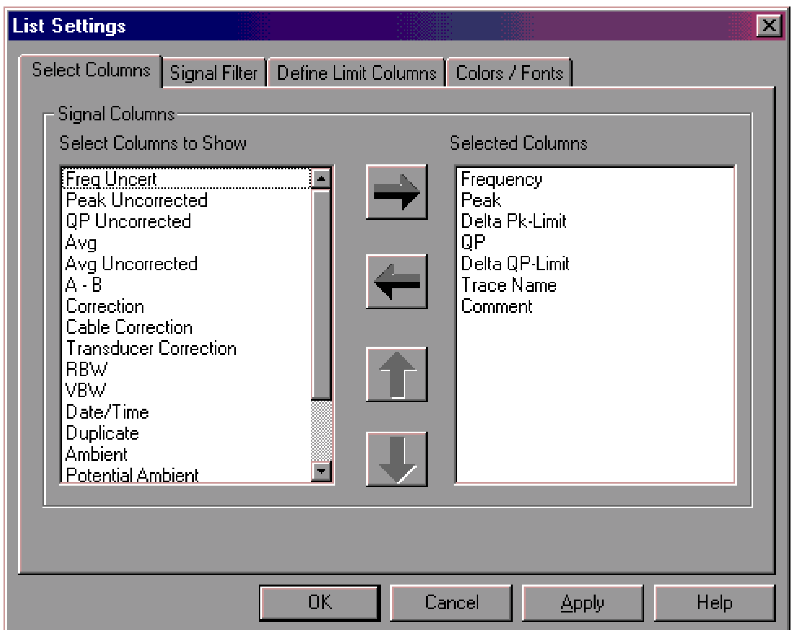
	Step	Comments
1	Open the Insert Signals dialog box.	• From the menu select **Test** | **Insert Signals....** 
2	Enter the narrowband signal parameters.	a. Enter the **Fundamental** frequency of the signal to be inserted. b. Enter the **# of Harmonics**. c. Enter the **Uncertainty of Fundamental** frequency. • **# of Harmonics**: The harmonic number of the fundamental frequency to insert. The fundamental signal plus the harmonic signals up to and including the harmonic number entered as # of Harmonics will be inserted into the signal list. For example, if 30 MHz is the **Fundamental** frequency and the ***# of Harmonics*** = 5, then the signals that will be inserted into the signal list have the frequencies as follows: 30 MHz (fundamental) 30 MHz X 2 = 60 MHz (2nd harmonic) • **Uncertainty of Fundamental**: The uncertainty of each harmonic is a factor of the fundamental uncertainty. For example, the uncertainty of the second harmonic is the uncertainty of the fundamental frequency times 2.

Procedure 5-26 How to Insert (Broadband or Narrowband) Signals into the Signal List (Continued)

	Step		Comments
3	Enter the broadband signal parameters.	a. Enter the **Start Frequency** for the broadband signal. b. Enter the **Stop Frequency** for the broadband signal. c. Enter the **Step Size**.	• **Step Size** is the value between frequency points for the frequencies between start and stop. The frequency uncertainty defaults to 2 times the **Step Size**. The **Step Size** value determines the number of signals that are inserted in the signal table and the frequency uncertainty. For example, if the **Start Frequency** = 30 MHz, the **Stop Frequency** = 90 MHz, and the **Step Size** = 5 MHz, then the signals are inserted from 30 to 90 MHz at intervals of 5 MHz. The frequency uncertainty of these signals defaults to 10 MHz.
4	Insert signals into the signal list.	• Click **Insert**.	• The signals will be inserted into the signal list with the Trace Name “User Created”. • The amplitude values will be blank.

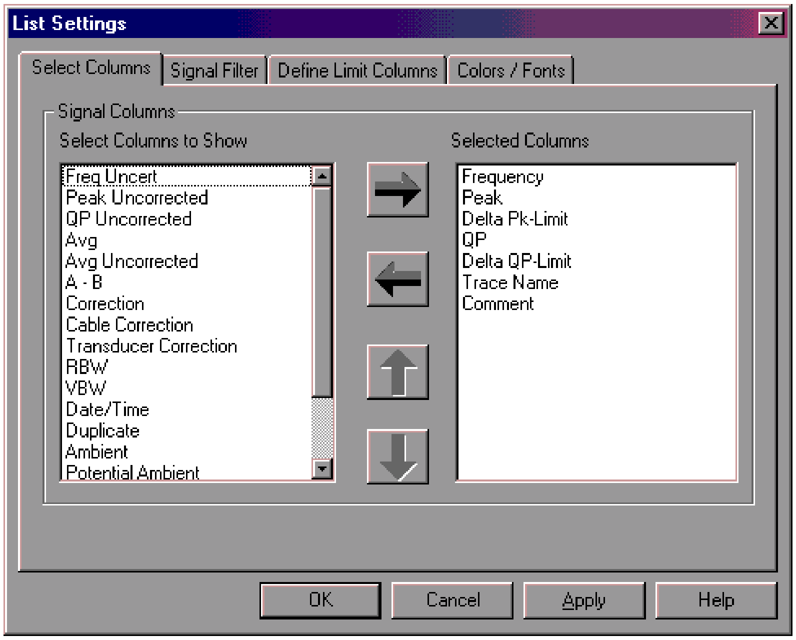
Procedure 5-27 How to Rearrange List Columns

Step	Comments
1 Arrange Signal List columns.	**Method 1**: a. Select **Setup** | **List Settings...** from the menu or Sidebar. b. In the **Signal Columns** page you will see a left pane (**Select Columns to Show**) and a right pane (**Selected Columns**). Highlight a signal item in the right pane to be moved and then click on the up or down arrow buttons to reposition the item. c. When you have arranged the columns, click **OK**. **Method 2**: a. Place the mouse curser over the column header to be moved (notice that the curser becomes a arrow pointing down). b. Left click to highlight the column and release. c. Left click and the mouse curser now has a rectangle box. Drag the box (and associated red line) to the desired new location of the column.



Procedure 5-28 How to Add Signal Attributes (List Columns) to the Signal List

Step		Comments
1 Open the Signal Attributes dialog box.	a. From the menu select **Setup** | **List Settings** or select the red checked icon in the tool bar. b. Choose the **Select Columns** tab.	



Step		Comments
2 Select the attributes to list.	a. Highlight the attribute in the left-hand list b. Use the right and left arrow buttons (or double-click) to move highlighted attributes from one side to the other.	• The left-hand list (**Select Columns to Show**) holds attributes that are available for listing, but will not be included in the list • The right-hand list (**Selected Columns**) hold attributes that will be listed.
3 Create the list.	• Click **OK** or **Apply**.	• New column headers will be generated using the modified signal list attributes.

Procedure 5-29 How to Sort Signal List Data

	Step		Comments
1	Sort signal list data.	• Place mouse arrow curser on the column header of the data to be sorted and right click the mouse. Double-click the column header to toggle the data in ascending or descending order.	

Procedure 5-30 How to Edit Signal List Entries

	Step		Comments
1	Edit signal list entry.	a. Click mouse in the cell to edit. b. Backspace over the value and type in the new entry value.	• To undo your edit, press the **Esc** key before pressing **Enter** or leaving the cell. Your original signal list entry will be restored.

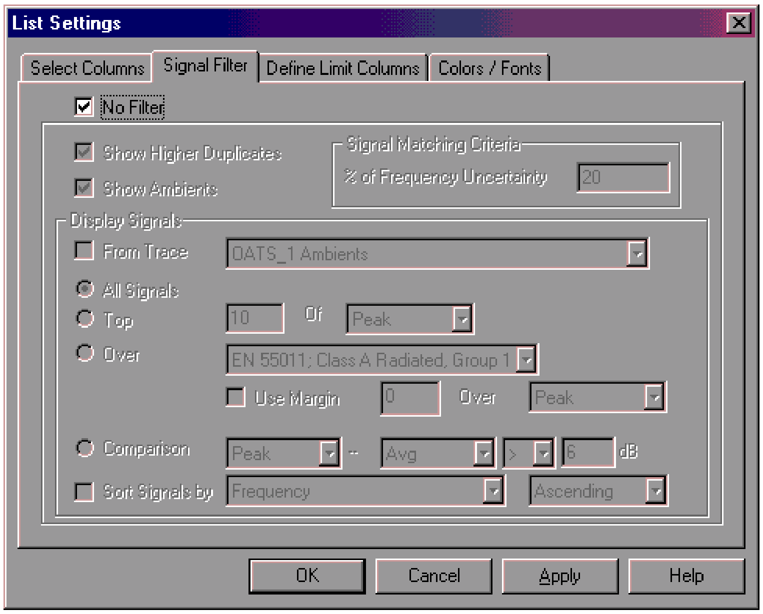
Signal List Filters

Filter fields include:

- Select **Show Higher Duplicates** to display all duplicate signals within the signal list.
- **Signal Matching Criteria (% of Frequency Uncertainty)**
- Select **Show Ambients** to display all ambient signals. Uncheck the box to not display ambient signals.
- Select **From Trace** and use the drop-down to display only the signals with the selected trace name. Uncheck the box to not filter based on trace name.
- Select the **All Signals** to apply the filter criteria to all signals within the signal list.
- Select the **Top** button to apply the filter criteria to the top (largest) n signals only. Click the button, enter a number for n in the first field. Select the detector to use
- Select the **Over** button to apply the filter criteria to the signals with an amplitude higher than the selected limit line or limit line with margin.
- Check **Sort Signals by** to select a column by which the signals within the list will be sorted. Click the box, select a column heading, select ascending or descending.

Procedure 5-31 How to Filter Signal List Data

	Step	Comments
1	Choose whether or not to filter signal list data.	a. From the menu or Sidebar, select **Setup** | **List Setting**. b. Select the **Signal Filter** tab. c. Click to select the **No Filter** box if you do not want to filter your signal list. If you do wish to use filters, proceed to Step 2.

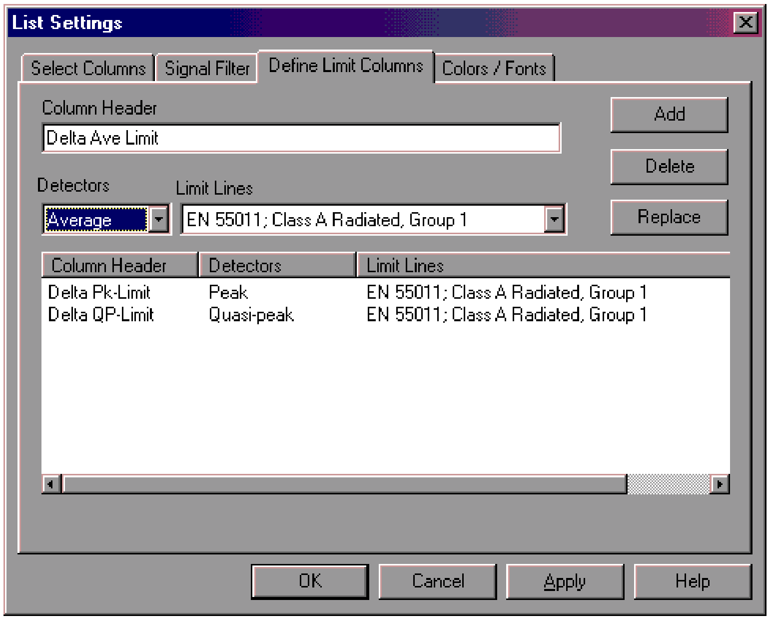


Procedure 5-31 How to Filter Signal List Data (Continued)

Step		Comments
2 Filter signal list data.	a. From the menu select **Setup** | **List Setting**. b. Select the **Signal Filter** tab. c. Click to clear the **No Filter** box. d. Select the filtering criteria for the signal listing from the options presented in the filtering criteria.	• See "Signal List Filters" on page 200 for more information on filters. • If **Show Higher Duplicates** is not checked, all duplicate signals are compared with each other and only the signal that has the highest peak amplitude is displayed. The remaining duplicate signals are not deleted, but they are removed from the view. As a signal is added to the signal list, it is compared to each existing signal within the signal list. If the new signal falls within the duplicate comparison boundaries, it is considered a duplicate signal of an existing signal. The equations for the comparison boundaries are as follows: — Upper Boundary: (Existing Signal Frequency) + (Frequency Uncertainty * Percentage) — Lower Boundary: (Existing Signal Frequency) - (Frequency Uncertainty * Percentage) *NOTE*: Increasing the setting within the **% of Frequency Uncertainty** field will increase the number of duplicates in the signal list. • If a margin is necessary, check **Use Margin**, enter the margin in the **Over** field, and select the detector to use.

Procedure 5-32 How to Define and Add Limit Columns

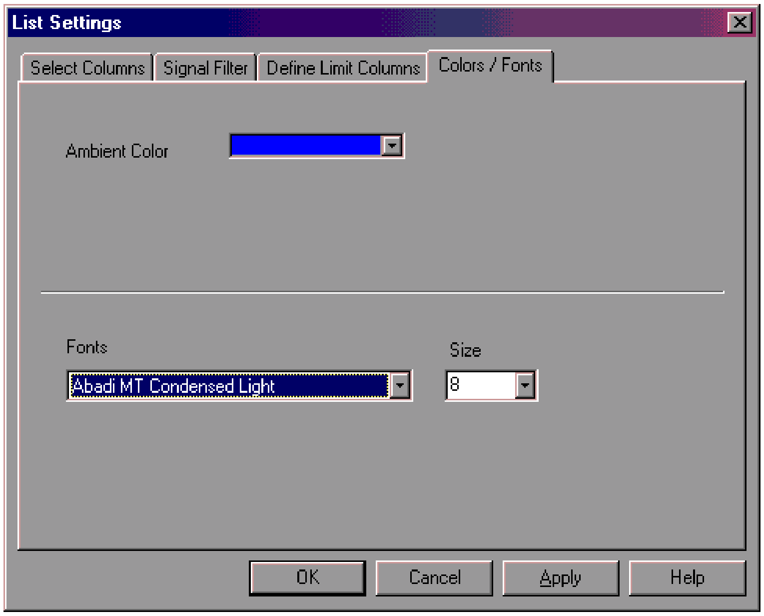
	Step	Comments
1	Open List Settings.	a. From the menu select **Setup** | **List Settings**. b. Select **Define Limit Columns** tab.



Procedure 5-32 How to Define and Add Limit Columns (Continued)

	Step		Comments
2	Define Limit Column.	a. Enter a name for the column header into the **Column Header** text box. b. Select the detector to use from the **Detectors** drop-down list. c. Select the limit line to use for comparison from the **Limit Line** drop down list. d. Click **Add** to add the new column to the signal list. e. Click **OK**.	• Enter the name or title of the column displayed in the signal list. There is not a predefined name for this column, it is user-specified. • The signal comparison will use the values measured with the selected detector with the selected limit at the frequency point. The comparison values entered in to the signal list columns are the difference between the measured value with the signal detector and the limit value at the measured signal's frequency. The following selections are available: — **<none>** No comparison is performed. The values within the column are the amplitude of the selected limit at the signal frequency. — **Peak**: The values within the column are the difference between the Peak amplitude of each signal and the limit value at the signal frequency. — **Quasi-Peak**: The values within the column are the difference between the Quasi-Peak amplitude of each signal and the limit value at the signal frequency. — **Average**: The values within the column are the difference between the Average amplitude of each signal and the limit value at the signal frequency. • Use Replace to edit an existing limit column. • The limit columns will be added to the list.

Procedure 5-33 How to Change the Color of the Ambient Signals and the Font of the Signal List

	Step	Comments
1	Open List Settings.	a. From the menu select **Setup** | **List Settings**. b. Select **Colors/Font** tab. 
2	Select Color and Font.	a. Select the signal list color for the **Ambient Signal** from the **Ambient Color** drop-down list. b. Select a font from the **Fonts** drop-down list. c. Select a font size from the **Size** drop-down list.
3	Apply the changes.	• Click **OK** or **Apply**.

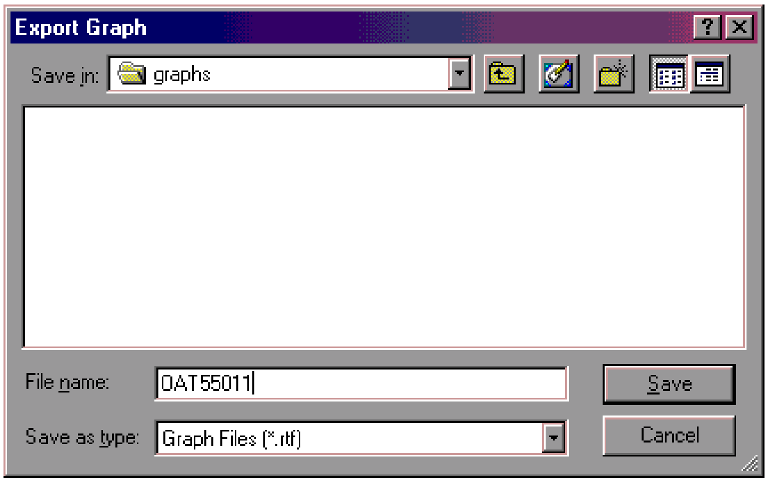
Customize Graph and Trace Data

The E7415A graph maybe comprised of multiple traces. Each trace may be comprised of multiple receiver sweeps.

The E7415A application includes useful tools to manipulate trace data, such as Max Hold and A-B comparison. In addition, the graph can be set to facilitate trace identification and readability.

Procedure 5-34 How to Export Graph Data

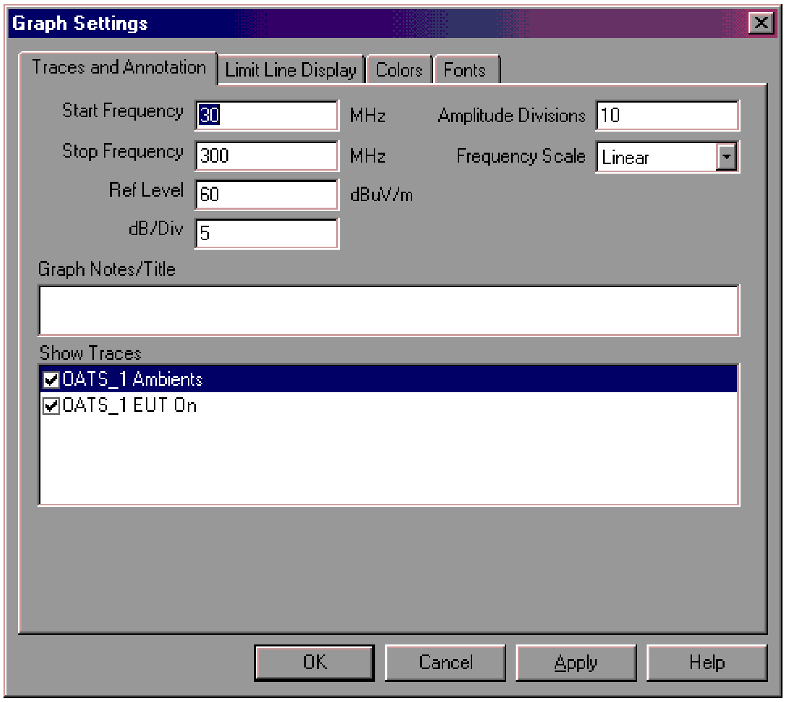
Step			Comments
1	Open Export Graph dialog box.	• Select **File** | **Export** | **Graph...**	• Both the graph and zoom graph (if open) are exported.



2	Name and Save file.	a. Select folder. b. Enter name of graph file. c. Click **Save**.	• Saves as an RTF file.

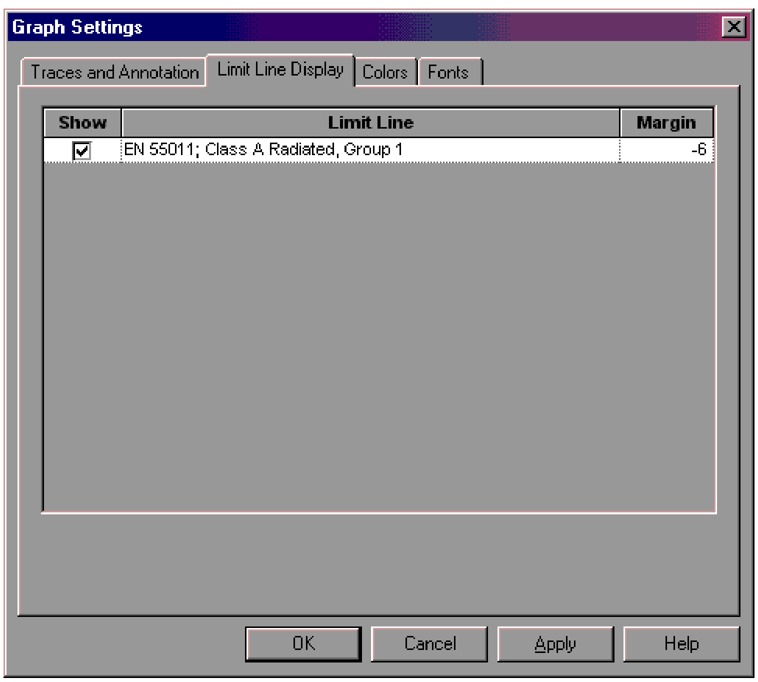
Procedure 5-35 How to Modify the Graph Settings

Step		Comments
1	Open the Graph Settings dialog box.	a. Select the **Test** bar to display the graph and signal list table. b. Double-click in the graph area to open the **Graph Settings** dialog box.



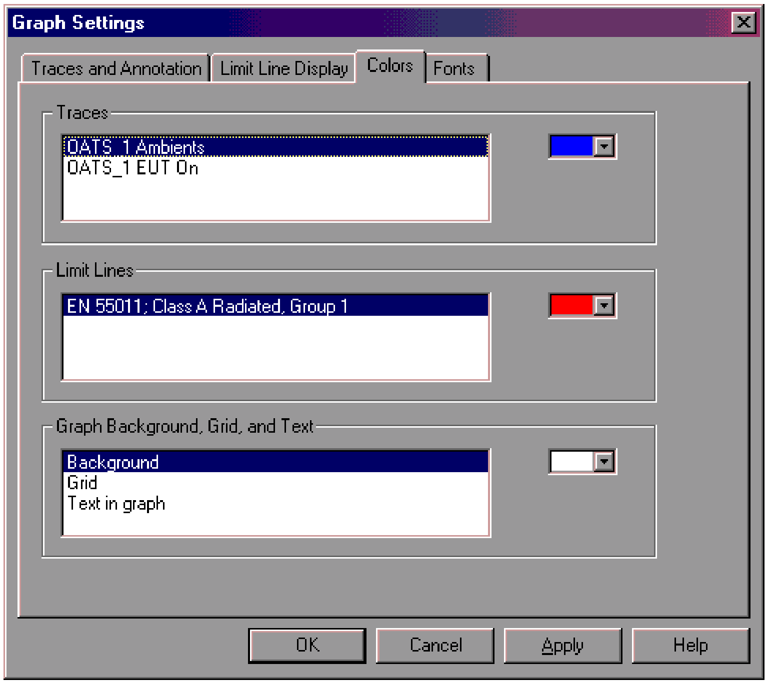
Procedure 5-35 How to Modify the Graph Settings (Continued)

Step			Comments
2	Define Trace and Annotation Settings.	a. Set the **Start Frequency**. b. Set the **Stop Frequency**. c. Set the **Reference Level**. d. Set the **dB/Div** spacing between each grid line. e. Set the **Amplitude Divisions**. f. Set the **Frequency Scale** to either Linear or Log scale. g. Enter **Graph Notes/Title**. h. Select the **Show Traces** you want to display.	• **Reference Level** is defined as the uppermost grid line on the graph. Editing affects both the composite and zoom graphs. • Editing the **dB/Div** spacing or **Frequency Scale** affects both the composite and zoom graphs. • **Amplitude Divisions** are the total number of divisions on the vertical axis. Editing affects both the composite and zoom graphs. • **Frequency Scale** is either Linear or Log scale. Editing affects both the composite and zoom graphs. • **Graph Notes/Title** will display at the top left of the composite graph, not on the zoom graph. • **Show Traces** displays the complete list of traces generated during the measurements or captured from receiver traces.
3	Select Limit Lines to display.	a. Select the **Limit Line Display** tab in the **Graph Settings** dialog. b. Select the Limit Line to display.	• The Limit Lines Display page lists the limit lines selected under Setup.



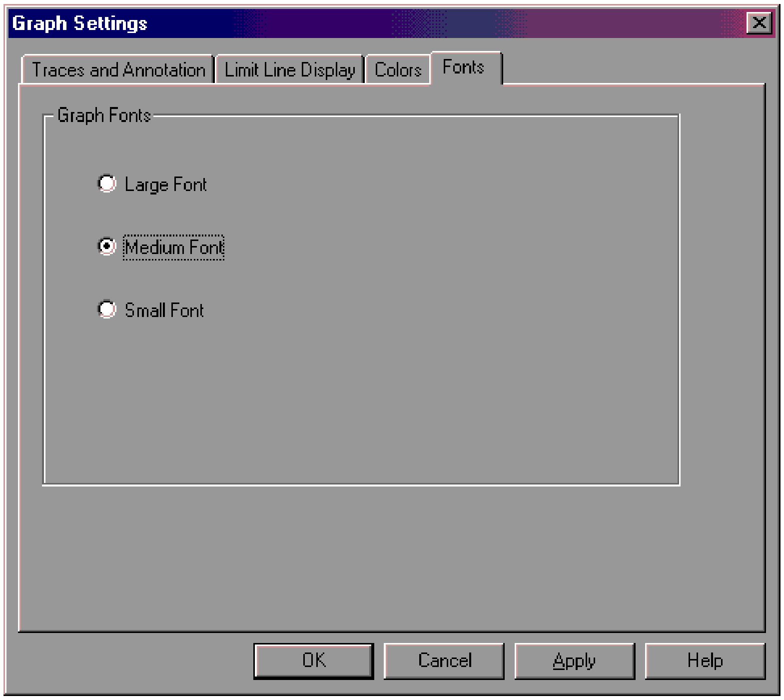
Procedure 5-35 How to Modify the Graph Settings (Continued)

Step		Comments
4 Select trace, limit line, and other colors.	a. Select the **Color** tab in the Graph Settings dialog. b. Select a color for each trace on graph. c. Select a color for each limit line on graph. d. Select colors for the graph background, grid, and text.	• Each trace can have a different color. • Each limit line can have a different color.



Procedure 5-35 How to Modify the Graph Settings (Continued)

Step		Comments
5	Select the graph font size.	a. Select the **Font** tab in the **Graph Settings** dialog. b. Select **Large Font**, **Medium Font**, or **Small Font**.

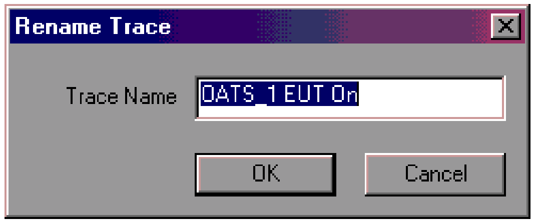


Step		Comments
6	Apply the graph settings.	• Click **OK** or **Apply**.

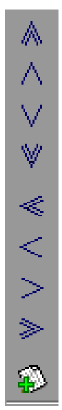
Procedure 5-36 How to Delete a Trace

Step		Comments
1	Activate the trace to be deleted.	• Click on the trace to place a marker and activate the trace.
2	Delete trace.	• Right click and select **Delete Trace**.

Procedure 5-37 How to Change a Trace Name

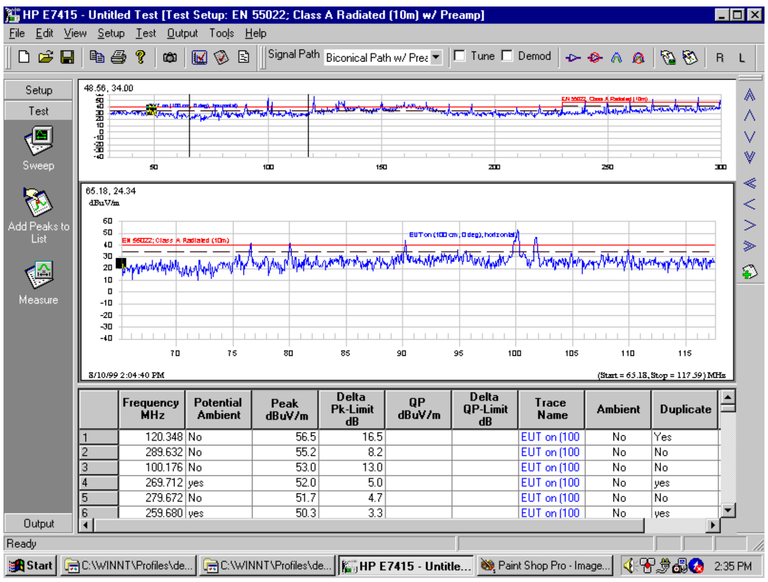
Step		Comments
1 Activate trace to rename.	• Click on the trace to place a marker and activate the trace.	
2 Rename trace.	a. Right click and select **Rename Trace**.  b. Enter new name. c. Click **OK**.	

Procedure 5-38 How to Use Graph Markers

Step		Comments
1 Display the Marker Bar.	• If the Marker Bar is not already displayed along the right side of the window, select **View** | **Toolbar** | **Marker Bar**.	• The frequency and amplitude (shown in the upper left corner of the screen) of the marker is displayed when the mouse icon is placed on the marker.
2 Use the Marker Bar to move the marker on the graph.	 Highest Peak Next Highest Peak Next Lowest Peak Lowest Peak Next Peak Left Next Data Point Left Next Data Point Right Next Peak Right Add Data Point to List	

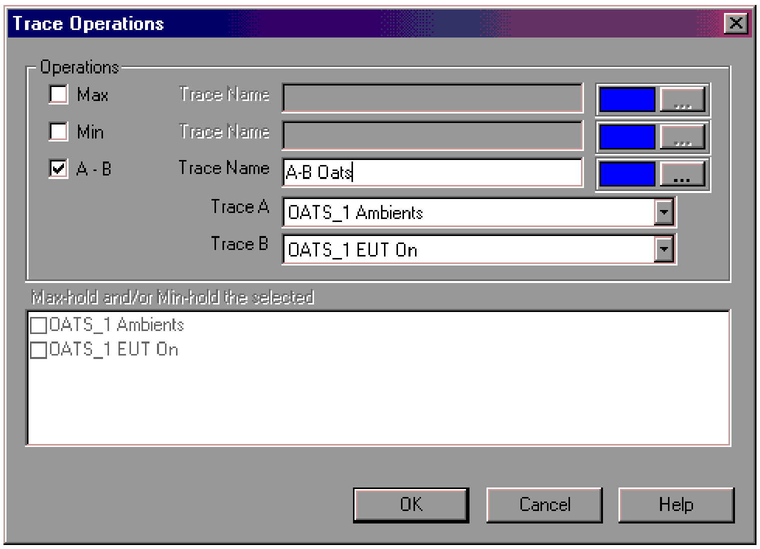
Procedure 5-39 How to Zoom in on a Region of the Graph

Step			Comments
1	Select the portion of the graph desired for zoom.	a. Place the mouse pointer on a starting frequency of the composite graph.	• The data displayed on the zoom graph is the same as the data on the graph, only at a higher resolution.
		b. Click the left mouse button and drag the mouse pointer to the desired stop frequency on the composite graph.	• The mouse icon changes to a magnifying glass when zoom is large enough.
		c. Release the mouse button at the stop frequency.	• The zoom graph is displayed below the graph.



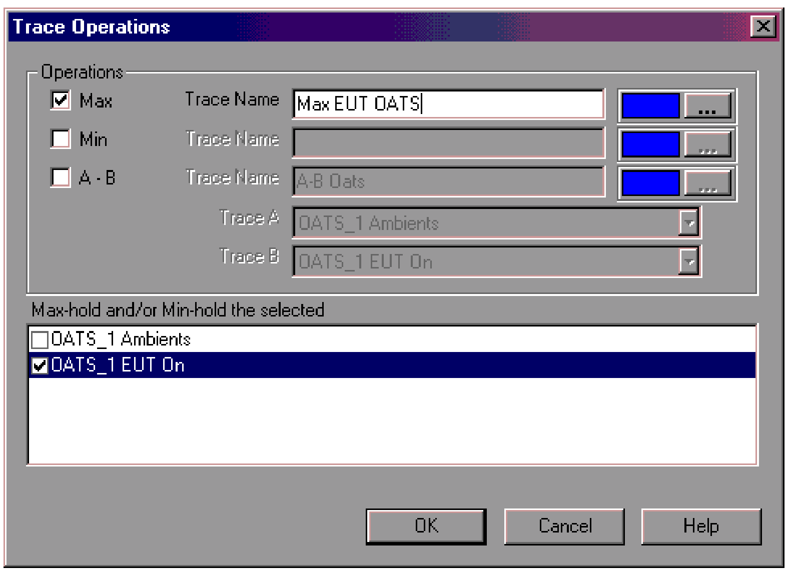
Procedure 5-40 How to Perform A–B Operations

Step			Comments
1	Open the Trace Properties dialog box.	a. Select **Test** | **Trace Operations...** from the menu.	
		b. Check the **A – B** check box.	
		c. Enter a name in the **Trace Name** text box.	• For example, **EUT 34588 RevA-RevB**.
		d. Select a color for the **A-B** trace.	• In this example the A-B trace will show positive values for decreases in emission for rev B compared to rev A.
		e. Select the trace for **Trace A** and the trace for **Trace B**.	
		f. Click **OK**.	



Procedure 5-41 How to Perform Max. Hold and Min. Hold Operations

Step		Comments
1 Max hold trace math.	a. Open the **Trace Operations** dialog box from the menu by selecting **Test** | **Trace Operations**. b. Check the **Max** check box. c. Enter a name for the **Max** trace within the name edit box. d. Select a color. e. Select the trace to Max hold. f. Click **OK**	• **Max** holds the maximum value while performing sweeps. • A **Max** trace is created and displayed on the graph and zoom graph. • The trace points from each sweep are compared with each other and the maximum value is saved and displayed (The **Max** trace is the resulting trace comprised of the maximum values at each frequency point from one or more sweep traces.) Therefore, the **Max** trace graphically indicates the maximum value measured at each frequency point.



Procedure 5-41 How to Perform Max. Hold and Min. Hold Operations

	Step		Comments
2	Min hold trace math.	a. Open the **Trace Operations** dialog box from the menu by selecting **Test** | **Trace Operations**. b. Check the **Min** check box. c. Enter a name for the **Min** trace within the name edit box. d. Select a color. e. Select the trace to Min hold. f. Click **OK**.	• **Min** holds the minimum value while performing sweeps. • A **Min** trace is created and displayed on the graph and zoom graph. • The trace points from each sweep are compared with each other and the minimum value is saved and displayed (The **Min** trace is the resulting trace comprised of the minimum values at each frequency point from one or more sweep traces.) Therefore, the **Min** trace graphically indicates the minimum value measured at each frequency point.

Use Receiver Functions

The receiver can accept information from and send information to the E7415A application.

In addition, the receiver can be set in local mode allowing you to directly control the receiver.

Send Information to the Receiver

Procedure 5-42 How to Set Receiver in Local or Remote Mode

	Step		Comments
1	Select local mode.	• On the **Receiver Bar**, click on the **L**.	• The receiver will accept commands from the receiver front panel and not from the application. • The selected limit lines and signal path corrections will be sent to the receiver.
2	Select remote mode.	• On the **Receiver Bar**, click on the **R**.	• The receiver will accept commands from the application and not directly from the receiver front panel.

Procedure 5-43 How to Display the Selected Limit Lines on the Receiver

	Step		Comments
1	Set to local mode.	• On the **Receiver Bar**, click on the **L**.	• Limit lines are sent automatically to the receiver.

Procedure 5-44 How to Send Signal Path Corrections to the Receiver

	Step		Comments
1	Set to local mode.	• On the **Receiver Bar**, click on the **L**.	• Signal path corrections are set automatically to the receiver.

Retrieve Information from the Receiver

Procedure 5-45 How to Insert the Signal at the Receiver Marker into the Signal List

	Step		Comments
1	Set receiver to Local Mode.	• On the **Receiver Bar**, click on the **L**.	
2	Select signal to insert	• Place the receiver marker on the signal you want to insert into the signal list.	
3	Get Receiver Marker.	• On the **Receiver Bar**, click on the **Get Receiver Marker** icon.	• The signal at the receiver marker position is inserted into the signal list.

Procedure 5-46 How to Tune the Receiver to a Select Signal

	Step		Comments
1	Tune on a signal.	a. On the **Receiver Bar**, check the **Tune** box. b. Highlight the desired signal on the signal list.	• The receiver is tuned to the active signal (the receiver center frequency is set to selected signal frequency) whenever you move the cursor around on the signal list. The receiver is set to zero span.
2	Tune on a signal span.	a. On the **Receiver Bar**, check the **Tune** box. b. Zoom the desired portion of the graph.	• When the graph is zoomed, the receiver is tuned to the span of the zoom graph. Span is defined under **Tools** | **Options** | **Tune/Demod**.

Procedure 5-47 How to Demodulate a Select Signal (FM Demodulation)

	Step		Comments
1	Select demodulate.	a. On the **Receiver Bar**, check the **Tune** box. b. Select the **Turn Demod On** icon on the **Receiver Bar**.	• **Demod** only works if the Tune box is checked. • FM demodulation is turned on for the chosen receiver by default. For AM demodulation, see your receiver manual. • To listen to signals with reduced interruption, increase the sweep time on the receiver.

Procedure 5-48 How to Enable Receiver Preamp

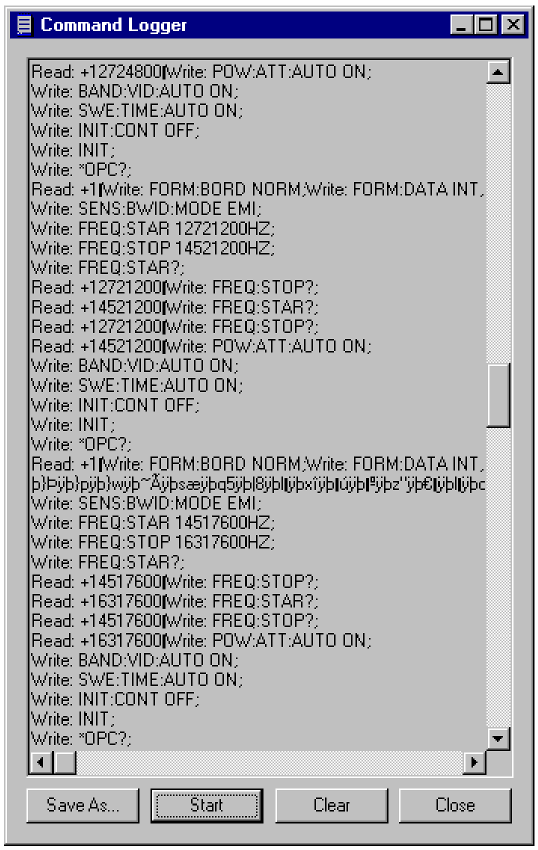
	Step	Comments
1	For Sweeps.	a. **Sweep** | **Receiver Settings** tab. b. Check **Receiver PreAmp** check box.
2	For Measurements.	a. **Measure** | **Receiver Settings** tab. b. Check **Receiver PreAmp** check box.

Use Command Logger

The command logger function allows you to monitor the receiver commands sent to the receiver by the E7415A application. The command logger is particularly useful when troubleshooting test problems and when validating test steps.

Procedure 5-49 How to Use the Command Logger Feature

	Step		Comments
1	Open the command logger.	a. From the menu choose **Tools** | **Command Logger**.	• Commands sent to and received from the receiver are logged here. The logger starts logging commands after the command logger window is open.



2	(optional) Save the log.	a. Click on **Stop**. b. Choose **Save As...**	• To restart the logger click on **Start**. • Saved log files may be opened in WordPad.

Characterize Cables

Cable correction factors can be generated with the E7415A application. As with other devices, the correction factors are a set of frequency/amplitude pairs. The following process measures cable loss and generates the frequency/amplitude pair list.

The cable characterization process contains four main steps:

Calibrate the EMI receiver

Setup the E7415A application to capture cable loss data

Measure cable loss

Setup receiver for measurements

Measure with through cable only

Measure with through cable plus cable to characterize

Create a list with amplitude differences verses frequency (correction factors)

Import cable correction factors into E7415A application (see “How to Import Correction Factors” on page 160)

For this example, since the spectrum analyzer has 401 trace points and the frequency span will be set from 30 MHz to 2.03 GHz, a cable loss factor will be generated every 5 MHz.

This example uses an 8546A receiver in local mode. For other receivers the steps are similar.

NOTE A tracking generator is necessary to perform these steps.

Procedure 5-50 How to Calibrate the EMI Receiver (for the 8546A/42E)

	Step		Comments
1	Calibrate the receiver (spectrum analyzer).	a. On the spectrum analyzer, select **[CALIBRATE] {CAL ALL}**. b. After the routine is done, press **{CAL STORE}**. After a few seconds, you should see ‘CAL: Stored’ on the display.	• Hardkeys are within [**brackets**], softkeys within {**braces**}. • CAL ALL does not calibrate the tracking generator, which must be calibrated separately.
2	Calibrate the tracking generator.	a. Connect a short low-loss 50 ohm RF cable from the receiver's TRACKING GENERATOR OUTPUT on the RF Filter Section to INPUT 2. b. Calibrate the tracking generator; select **[CALIBRATE] {More} {More} {CAL TRK GEN}**. c. After the routine is done, press **{CAL STORE}**. After a few seconds, you should see ‘CAL: Stored’ on the display.	• You will observe the receiver mode changes to Signal Analysis, and several messages will briefly be displayed including 'SRC POWER –10 dBm', 'peaking', and 'SPAN 2.8 GHz'. • Calibrating the tracking generator takes about 40-60 seconds.

Procedure 5-51 How to Capture Cable Loss Data

	Step		Comments
1	Check the equipment list for your receiver.	a. In the sidebar, select the **Equipment** icon under the **Setup** folder. b. Expand the **Receivers** subfolder by clicking the plus sign next to it. c. Check to ensure that the receiver that will be used to perform the cable calibration is present in the **Receiver** subfolder. (Verify receiver model number and serial number.) d. If the receiver used is not within the list, add the appropriate receiver.	• Click and highlight on a receiver to view its property sheet in the left pane. • Refer to "How to Add and Setup a New Receiver" on page 156 for more information on adding receivers.
2	Create a signal path for the cable measurement.	a. In the sidebar, select the **Signal Paths** icon under the **Setup** folder. b. Right-click the **Signal Paths** folder and select **New Signal Path**. c. Right-click on 'Untitled Signal Path', select **Rename**. Enter a descriptive name for the signal path and press [Enter]. d. From the **Select Equipment From Resources** list in the right pane, click the plus sign next to the Receivers folder to expand the list of available receivers. e. Select the receiver to be used for the cable loss measurement and click **Add** to add it to the new signal path.	• The new signal path will contain the receiver only. • '"Untitled Signal Path" should appear at the bottom of the defined Signal Paths. • For example, **`8546A closed loop`**. • Click the plus sign to the left of the new signal path to expand it and verify the receiver has been added to the signal path. • The new signal path will be automatically checked, making it available for testing. • Refer to "How to Create a New Signal Paths" on page 167 for more information on creating signal paths.
3	Display the receiver toolbar.	• If the receiver bar is not displayed, from the menu, select **View** | **Toolbar** | **Receiver Bar**.	• The receiver toolbar appears to the right of the main toolbar.

Procedure 5-51 How to Capture Cable Loss Data (Continued)

	Step		Comments
4	Set the amplitude units.	a. Open the Options dialog box by selecting **Tools** | **Options...** from the menu. b. Open the **General** page by clicking the **General** tab. c. Within the **Default Units** area, select **dBm** from the **Amplitude** pull-down list. d. Click **OK**.	• Verify that **Frequency: Default Units** is set to MHz.
5	Define the graph settings.	a. Display the graph and signal list window by selecting the **Test** folder from the sidebar. b. Double-click in the graph area to open the **Graph Settings** dialog box. c. Set the graph setting fields as follows: • Start Frequency = 30 MHz • Stop Frequency = 2030 MHz • Ref Level = –10 dBm • dB/Div = 2 d. Click **OK**.	
6	Define the signal list settings.	a. Open the **List Settings** dialog box by selecting **Setup** | **List Settings...** from the menu. b. Highlight **Frequency** and **A - B** within the **Signal Columns** list and click the right arrow button.	• This moves the Frequency and A-B signal attributes to the Selected Columns list, to be displayed on the signal list. (One or both of these attributes may already reside within the Selected columns list.)

A Determining your Regulation Requirements

In This Chapter...

Introduction

In this chapter the regulations that govern EMC emissions, and therefore your product design, will be discussed.

Regulations are one of the primary (though not the only) reasons why products are tested for EMC emissions. In many cases, it is simply a requirement imposed by a government law or contract. Compliance to local EMC regulations often are required by other nations to whom you may wish to export your products. Failing to comply with these requirements can result in forced removal of a product from the marketplace, confiscation of non-compliant equipment, monetary fines, and, in extreme cases, imprisonment.

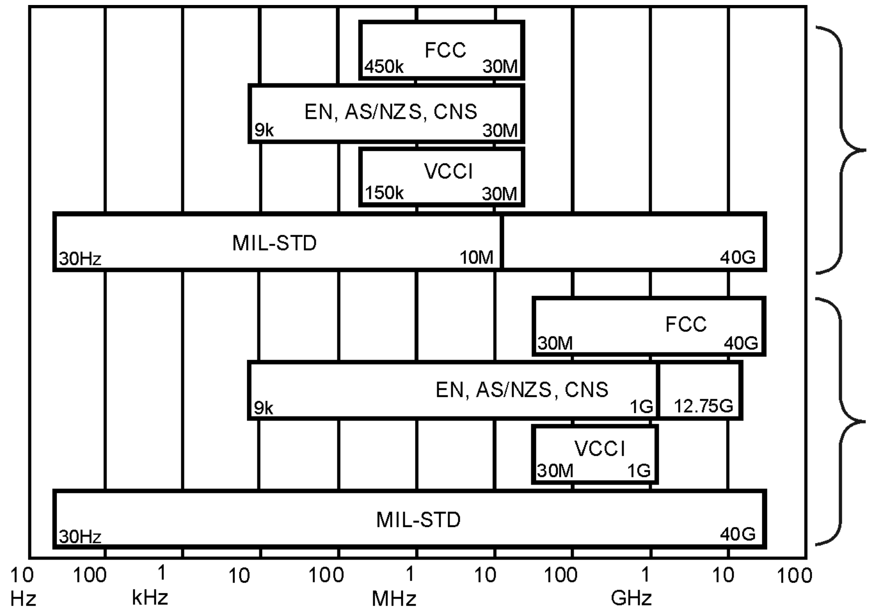
Even at the precompliance level of testing, you need to be aware of the types of regulations to which your product must conform so that your design reflects the appropriate EMC emissions levels when you are ready to have the final compliance testing performed.

You can find a list of many current EMC regulatory standards at:

http://europa.eu.int/comm/dg03/directs/dg3b/newapproa/eurstd/harmstds/reflist/emc.html

What Products are Covered?

EMC regulations cover the entire spectrum of electrical products, from computing equipment to microwave ovens to aircraft. As shown in the following figure, the frequency ranges of interest for EMC testing extend from dc to over 40 GHz, depending on the agency and the type of measurement.



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While individual EMC requirements vary widely from one another, one common aspect is the goal of achieving valid, repeatable results. Therefore, most regulations specify the test environment, receiver characteristics, and transducer characteristics. In the case of radiated emissions, antenna height and polarization are usually varied, and the equipment under test (EUT) is rotated to find the maximum response from the device. The EUT is normally exercised in a way that represents its typical usage, and interconnect cables, if they are present, are oriented to maximize emissions. All these actions help insure that the worst-case emissions are found.

Table A-1 provides an overview of some common emission regulations and what products they cover.

Table A-1 Industrial emissions regulations summary and comparison

CISPR	FCC	EN's	Description
11	Part 18	EN 55011	Industrial, scientific, and medical
12	(SAE)	------	Automotives
13	Part 15	EN 55013	Broadcast, receivers
14	------	EN 55014	Household appliances/tools
15	------	EN 55015	Fluorescent lights/luminaries
16	------	------	Measurement apparatus/methods
22	Part 15	EN 55022	Information technology equipment
------	------	EN 500081-1,2	Generic, emissions standards

Table A-2 provides the commensurate European standards.

Table A-2 Industrial emissions regulations summary and comparison

Equipment Type	Regulation
Generic Equipment • Residential • Light Industrial	EN 50081-1
Industrial	EN 50081-2
Information Technology Equipment (ITE)·	EN 55022
Industrial, Scientific Medical Products (ISM)	EN 55011

To assist you in keeping current with the changing regulations, below are some regulatory agency and EMC information web sites:

FCC:	**http://www.fcc.gov/**
IEC:	**http://www.iec.ch/**
ANSI:	**http://www.ansi.org/**
IEEE EMC Society:	**http://www.ewh.ieee.org/soc/emcs/**
ITU:	**http://www.itu.int/**
ETSI:	**http://www.etsi.org/**
VCCI:	**http://www.vcci.or.jp/**

What to Consider when Choosing a Standard

Before measurements can be performed on a product, some preliminary questions must be answered.

- Where will the product be sold (that is, United States, Japan, Europe, and so on)?
- What is the classification of the product (that is, information technology equipment (ITE) devices; industrial, scientific, medical (ISM) devices; automotive or communications)?
- What is the use environment for the product (that is, home, commercial, light industry or heavy industry)?

With the answers to the above questions, you can determine which testing requirements apply to your product. For example, if you have determined that your product is an information technology (ITE) device and you will sell it in the U.S. then you need to test the product to FCC part 15 regulations. The tables below may be useful to help you choose the appropriate requirement(s) for your product. Contact the appropriate agency for final confirmation of the applicable requirements.

European Norms Detailed Description

EN55011 (CISPR 11)

Industrial, Scientific, and Medical Products

- Class A: Used in establishments other than domestic areas.
- Class B: Suitable for use in domestic establishments.

Group 1, Laboratory, medical, and scientific equipment. (For Example, signal generators, measuring receivers, frequency counters, spectrum analyzers, switching mode power supplies, weighing machines, and electronic microscopes.)

Group 2, Industrial induction heating equipment, dielectric heating equipment, industrial microwave heating equipment, domestic microwave ovens, medical apparatus, spark erosion equipment and spot welders. (For example, metal melting, billet heating, component heating, soldering and brazing, wood gluing, plastic welding, food processing, food thawing, paper drying, and microwave therapy equipment.)

EN55014 (CISPR 14)

Electric motor-operated and thermal appliances for household and similar purposes, electric tools, and electric apparatus. Depending on the power rating of the item being tested, use one of the following limits.

Household and similar appliances (conducted)	EN014-HL
Household and similar appliances (radiated)	EN014-HH
Motors <700Watts (conducted)	EN14-P1
Motors <700Watts (radiated)	EN14-P4
Motors <1000Watts (conducted)	EN14-P2
Motors <1000Watts (radiated)	EN14-P5
Motors >1000Watts (conducted)	EN14-P3
Motors >1000Watts (radiated)	EN14-P6

NOTE The conducted range is 150 kHz to 30 MHz and the radiated range is 30 MHz to 1 GHz.

EN55022 (CISPR 22)

Information Technology Equipment

Equipment with the primary function of data entry, storage, displaying, retrieval, transmission, processing, switching, or controlling. (For example, data processing equipment, office machines electronic business equipment, and telecommunications equipment.)

Class A ITE: Not intended for domestic use.
Class B ITE: Intended for domestic use.

US (FCC) Norms Detailed Description

FCC Part 15

Radio frequency devices - unintentional radiators (For example, TV broadcast receivers, FM broadcast receivers, CB receivers, scanning receivers, TV interface device, cable system terminal device, Class B personal computers and peripherals, Class B digital devices, Class A digital devices and peripherals, external switching power supplies.)

Class A digital devices are marketed for use in a commercial industrial, or business environment.

Class B digital devices are marketed for use in a residential environment.

Table A-3 **FCC (Federal Communications Commission)**

Equipment Type	Regulation
Broadcast receivers	Part 15
Household appliances/tools	
Fluorescent lights/luminaries	
Information Technology Equipment (ITE)	
Industrial, Scientific, Medical Products (ISM)	Part 18
Conducted measurements: 450 kHz to 30 MHz	
Radiated measurements: 30 MHz -1000 MHz, 40 GHz	

One of the most important standards setting organizations for commercial EMC standards is CISPR. It is an international group with members from many different countries which develops recommended EMC test limits and test procedures. CISPR has no regulatory authority of its own. It is up to the regulatory agencies of each country to adopt their own EMC requirements. However, most countries use the CISPR standards, perhaps with some modifications, as the basis for their own national regulations.

Because most countries use CISPR standards as the basis for their own regulations, you can often find correlation between the myriad of regulations. The list below shows the various Federal Communications Commission (FCC) in the US and European EuroNorms (EN's) and their relation to the CISPR standards.

- CEN - European Committee for Standardization
- CENELEC - European Committee for Electrotechnical Standardization
- ISO - International Standards Organization
- IEC - International Electrotechnical Commission
- CISPR - International Special Committee on Radio Interference
- EU - European Union (formerly European Community)
- EFTA - European Free Trade Association
- EEA - European Economic Association (from 1 Jan. 94)

Some History and Background

Role of European Norms

One of the results of the formation of the European Union (EU) has been to develop a common set of EMC requirements. These are collectively known as the EuroNorms (EN's). By having one common set of standards, goods can flow freely from one country to another. Countries of the European Free Trade Association (EFTA) will likely adopt these same EMC standards.

Therefore, products which pass the EN requirements will have access to a huge, unified market.

Starting January 1, 1996, the older country specific EMC requirements were dropped completely and all products must fulfill the EMC Directive requirements. The easiest and most common way to show fulfillment of this directive is compliance with the new EMC EuroNorms.

The European Norms are quite encompassing, and apply to nearly all types of electronic equipment. You must first determine if there is a product specific category for the product. If there is not a product specific category, the product must be tested to the generic requirement for the environment it is to be used in.

FCC Regulations

The FCC part 15 and part 18 regulations cover a variety of products. Part 15 classifies products in three general categories - intentional, incidental, and unintentional radiators. Information technology equipment, which includes computers, is an example of an unintentional radiator. Unintentional radiators fall in two further subcategories - Class A devices intended for commercial, industrial, or business use, and Class B devices intended for residential environments.

For intentional radiators, such as wireless communications devices or field disturbance sensors, the FCC requires you to test to the 10th harmonic or 40 GHz, whichever is lower.

As advances in digital technology push clock frequencies higher and higher, the potential for undesirable emissions at higher frequencies increases. For this reason, the FCC now requires testing to 2 GHz if the highest frequency generated or used in an EUT is in the 108 to 500 MHz range and up to 5 GHz if the device generates or uses signals in the 500 to 1000 MHz range.

A product must pass the applicable FCC EMI requirements to be legally sold in the United States. To achieve this certification, EMI test data must be submitted to the FCC. Upon approval of the application, the manufacturer must place an identification label on the equipment and a notice in the operating manual stating that the product meets the FCC requirements.

On August 31, 1993 the FCC issued a report number DC-2484 which represents a significant step toward the harmonization of EMC Standards. This document allows manufacturers to use the limits contained in CISPR Publications 22 as an alternative to those in Part 15 of the FCC rules when testing digital devices for compliance.

The FCC has deregulated the filing requirement for personal computers and their peripherals in order to allow manufacturers to meet market requirements. Testing must still be performed but the certification, filing, and review process is omitted. The person placing the product on the market can self-declare. This was docket No. 95, FCC 96-208, 14 May 1996.

EMC testing must still be performed and the testing should be performed at an accredited test lab as defined by the FCC. At this time, the authorized organizations for accrediting labs are the National Voluntary Accreditation Program (NVLAP) or the American Association for Laboratory Accreditation (A2LA).

Note that testing of the CPU boards and power supplies is now required. A statement verifying compliance must be in literature provided with the product.

Personal computers constructed using modular components (separately authorized) must be authorized under the D of C process.

Some classes of products are specifically exempted from FCC part 15 rules. However, it is important to remember that even though these products may not need to pass a government requirement, they usually need good EMC performance to operate properly in their intended environment. An EMC malfunction in a car, a medical device, or an industrial process control device could be dangerous or even life-threatening. For this reason, many products are tested for EMC whether a regulation exists for it or not.

The first EMI requirements were effective for new products placed on the AS/NZ market 1 Jan 1997. The requirements will be mandatory for all products (old and new) starting 1 Jan 1999.

Glossary of EMC Acronyms and Terms

A–B

An A - B trace is the resultant trace calculated by subtracting the amplitude values of one trace from another at each frequency point. The difference is stated in dB. A dB scale is added to the right side of the graph when the
A - B resultant trace is displayed.

For example, if the amplitude of trace A at 30 MHz = 10 dBmV and trace B at 30 MHz = 25 dBmV; A-B at 30 MHz = -15 dB.

Add Peaks to List

The Add Peaks to List function adds all signals from the selected trace(s) to the signal list that meet the signal criteria. Criteria are set in the Add Peaks to List dialog box and include comparison to limit lines with or without margin and peak excursion (See Peak Excursion).

Ambient (signal)

An ambient signal is a radiated or conducted signal existing at a specific test location and time when the test sample is not activated. Each signal is defined as an amplitude/frequency pair.

Ambient level

1. The values of radiated and conducted signal and noise existing at a specified test location and time when the test sample is not activated. Each signal is defined as an amplitude/frequency pair.

2. Those levels of radiated and conducted signal and noise existing at a specified test location and time when the test sample is inoperative. Atmospherics, interference from other sources, and circuit noise, or other interference generated within the measuring set compose the ambient level.

Ambient List

An ambient list is a list of ambient signals (amplitude/frequency pairs) that exist for a specific test location. The ambient list usually includes known man-made source such as radio, television stations, cellular phones, and so on.

AMN (Artificial Mains Network)

See "LISN" on page 253.

Amplitude Frequency Pair

See "Frequency/Amplitude Pair" on page 249.

Amplitude modulation

1. In a signal transmission system, the process, or the result of the process, whereby the amplitude of one electrical quantity is varied in accordance with some selected characteristic of a second quantity, which need not be electrical in nature.

2. The process by which the amplitude of a carrier wave is varied following a specified law.

Anechoic chamber

1. An anechoic chamber is an enclosure for making electro-magnetic measurements. The interior surfaces of the enclosure absorb electromagnetic radiation which reduces reflection and room resonance. Fully lined anechoic chambers (FLAC) have such material on all internal surfaces to absorb incident waves on walls, ceiling, and floor. It is also called a fully anechoic chamber. A semi-anechoic chamber is a shielded room which has absorbing material on all surfaces except the floor.

2. An enclosure especially designed with boundaries that absorb sufficiently well the sound incident thereon to create an essentially free-field condition in the frequency range of interest.

Antenna (aerial)

1. A means for radiating or receiving radio waves.

2. A transducer which either emits radio frequency power into space from a signal source or intercepts an arriving electromagnetic field, converting it into an electrical signal.

Antenna effective length

1. The ratio of the antenna open-circuit (induced) voltage to the strength of the field component being measured. See "Antenna induced voltage" on page 242.

2. The ratio of the antenna induced voltage to the intensity of the field component being measured.

Antenna factor

The factor which, when properly applied to the voltage at the input terminals of the measuring instrument, yields the electric field strength in volts per meter (volts/meter) and the magnetic field strength in amperes per meter (amperes/meter). This factor includes the effects of antenna effective length, and mismatch and transmission losses.

Antenna induced voltage

The voltage which is measured or calculated to exist across the open-circuited antenna terminals.

Antenna terminal conducted interference

Any undesired voltage or current generated within a receiver, transmitter, or their associated equipment appearing at the antenna terminals.

Auxiliary Equipment (AE)

Equipment not under test that is nevertheless indispensable for setting up all the functions and assessing the correct performance (operation) of the EUT during its exposure to the disturbance.

Average (Detector) The peak-detected signal is passed through a filter (with bandwidth much less than the RBW). The filter integrates (averages) the higher frequency components such as noise. Average detection is used for measurement of narrowband signals to overcome problems associated with either modulation content or the presence of broadband noise.

Balun

A balun is an antenna balancing device, which facilitates use of coaxial feeds with symmetrical antennas such as a dipole.

Broadband emission

1. A broadband emission is that which has a spectral energy distribution sufficiently broad, uniform, and continuous so that the response of the measuring receiver in use does not vary significantly when tuned over a specified number of receiver impulse bandwidths. Also see broadband interference (measurement) below

2. Broadband is the definition for an interference amplitude when several spectral lines are within the RFI receiver's specified bandwidth.

Broadband interference (measurement)

A disturbance that has a spectral energy distribution sufficiently broad, so that the response of the measuring receiver in use does not vary significantly when tuned over a specified number of receiver bandwidths.

Broadband Response

Broadband response is displayed on the receiver when its bandwidth is wider than the discrete frequency components of the received impulsive signal. In this mode, each displayed response represents more than one frequency component. This occurs, for example, when the receiver bandwidth is wider than the repetition frequency (PRF) of a pulsed transmission.

To check for broadband response, vary the receiver bandwidth, sweep time, or span width. Broadband response has three characteristics. First, amplitude varies directly with the receiver bandwidth; doubling the bandwidth increases the displayed amplitude 6 dB. Second, line spacing depends on sweep time; increasing the sweep time decreases the line spacing. Third, span width does not affect line spacing. See Narrowband Response.

BSI

British Standards Institute.

Bus Address

The bus address is the GPIB (or HPIB) interface address. The receiver bus address and the bus address within the receiver property sheet must match.

Cable Loss

Cable loss is the insertion loss in the signal path which is attributed to the RF cable(ing). Cable loss is frequency dependent, therefore, cable loss correction factors are typically defined as a set of frequency/amplitude pairs (see Correction Factors).

CEN

Comité Europeen de Normalisation.

CENELEC

Comité Europeen de Normalisation Electronique

CISPR

Comité International Spécial des Perturbations Radioélectriques

Close Field Probes

1. Close field probes are small, hand-held, electromagnetic field sensors that provide repeatable, absolute, magnetic field measurements over a wide frequency range.

2. When attached to a source, the probes generate a localized magnetic field for electromagnetic susceptibility (EMS) testing.

Communication Interface

Communication interface is the type of communication port used for communication between the E7415A application and the receiver. The interface may be GPIB or HPIB. The communication interface type must match between the I/O card and driver and the receiver property sheet.

Communication Library

The communication interface library of commands. The library may be HP VISA or National Instruments VISA. The communication library type must match between the I/O card and driver and the receiver property sheet.

Conducted emission

Desired or undesired electromagnetic energy which is propagated along a conductor. Such an emission is called “conducted interference” if it is undesired.

Conducted interference

Interference resulting from conducted radio noise or unwanted signals entering a transducer (receiver) by direct coupling.

Continuous wave(s) (CW)

Electromagnetic waves, the successive oscillations of which are identical under steady-state conditions, which can be interrupted or modulated to convey information.

Correction Factors

Correction factors are a set of frequency/amplitude pairs that characterize a device over frequency. The amplitudes are negative for gain (at an associated frequency) and positive for loss (at an associated frequency). Correction factors are added to the measured data to produce corrected results.

Corrections

See “Correction Factors”.

Counterpoise

1. The reference-plane portion (grounded or ungrounded) or an unbalanced antenna.

2. A system of conductors of an antenna.

NOTE The purpose of a counterpoise is to provide a relatively high capacitance and thus a relatively low impedance path to earth. The counterpoise is sometimes used in low frequency and medium frequency applications where it would be more difficult to provide an effective ground connection.

Cross-coupling

The coupling of a signal from one channel, circuit, or conductor to another, where it becomes an undesired signal.

Cross-modulation

1. Modulation of a desired signal by an undesired signal. This is a special case of intermodulation.

2. A type of intermodulation due to modulation of the carrier of the desired signal by an undesired signal wave.

Crosstalk

1. An electromagnetic disturbance introduced by cross-coupling.

2. Undesired energy appearing in one signal path as a result of coupling from other signal paths.

NOTE Path implies wires, waveguides, or other localized or constrained transmission systems.

Current Probe

A current probe is the transducer used for most military-conducted emissions tests. It measures the magnetic field produced by current in wire when clamped around the wire. Output voltage of a current probe is proportional to the current level, frequency, and probe characteristics. Transfer impedance of a probe must be known to calculate the current level in a wire.

$$I(dB\mu A) = V(dB\mu V) - Z(dBohm)$$

Decibel (dB)

A decibel is a unit used as a measure of the ration of two power levels:

$$dB = 10 \cdot \log\frac{W_1}{W_2}$$

or, assuming that measured values of electric potential or current have the same impedance:

$$dB = 20 \cdot \log\frac{V_1}{V_2} = 20 \cdot \log\frac{A_1}{A_2}$$

Decoupling Network

A decoupling network is an electrical circuit for preventing test-signals which are applied to the EUT from affecting other devices, equipment, or systems that are not under test. IEC 801-6 states that the coupling and decoupling network systems can be integrated in on box (commonly direct injection) or they can be in separate networks (commonly clamp injection).

Degradation

Degradation is an unwanted change in the operational performance of a test specimen. This does not necessarily mean malfunction or catastrophic failure. The EMC test specification generally requires stating the criteria for degradation of performance.

Demod

The Demod function is used to demodulate signals to assist in acoustically identify signals such as ambient or EUT-generated (the demodulated signal may be heard through the receiver's speaker).

DIN

Deutsches Institut fur Normuny (German Institute for Standardizaton)

Dipole

1. An antenna consisting of a straight conductor (usually not more than a half-wavelength long), divided at its electrical center for connection to a transmission line.

2. Any one of a class of antennas producing a radiation pattern approximating that of an elementary electric dipole.

NOTE Common usage considers the dipole antenna to be a metal radiating structure which supports a line current distribution similar to that of a thin straight wire so energized that the current has a node only at each end.

Dwell Time

The dwell time setting is the amount of time the receiver will spend either sweeping each segment or measuring each list signal. Dwell time can be increased to capture intermittent or slow cycle signals (minimum dwell time is a function of frequency span and RBW).

Dynamic Range

Dynamic range is the maximum power ratio of two signals simultaneously present at the input that may be measured within the limits of specified accuracy, sensitivity, and distortion: >70 dB.

Electromagnetic compatibility (EMC)

1. The capability of electronic equipment or systems to be operated with a defined margin of safety in the intended operational environment at designed levels of efficiency without degradation due to interference.

2. EMC is the ability of equipment to function satisfactorily in its electromagnetic environment without introducing intolerable disturbances into that environment or into other equipment.

3. The capability of electronic equipment or systems be operated in the intended operational electromagnetic environment at designed levels of efficiency.

Electromagnetic interference

Electromagnetic interference is the impairment of a wanted electromagnetic signal by an electromagnetic disturbance. Also see electromagnetic compatibility.

Electromagnetic wave

The radiant energy produced by the oscillation of an electric charge characterized by oscillation of the electric and magnetic fields.

EMC

See “Electromagnetic compatibility (EMC)”.

Emission

Electromagnetic energy propagated from a source by radiation or conduction.

Equipment

Any electrical, electronic, or electromechanical device, or collection of items, intended to operate as an individual unit and perform a singular function. As used herein, equipment included, but are not limited to the following: receivers, transmitters, transceivers, transponders, power supplies, power amplifiers, electrical office machines, general amplifiers, hand tools, processor, test apparatus and instruments, and material handling equipment.

ETSI

European Telecommunications Standards Institute.

EUT

Equipment Under Test. The device, equipment, subsystem, or system to be tested for EMI compliance. For example, a computer system including monitor.

External Attenuation

External attenuation is an attenuator that is located outside of the receiver, before the receiver's input.

External installation

An equipment location on a platform which is exposed to the external electromagnetic environment, such as an aircraft cockpit which does not use electrically conductive treatments on the canopy or windscreen.

Far field

1. The region where the power flux density from an antenna approximately obeys an inverse square law of the distance. For a dipole this corresponds to distances greater than lambda/2 where lambda is the wavelength of the radiation.

2. That region of the field of an antenna where the angular field distribution is essentially independent of the distance from a specified point in the antenna region.

Field strength

The term "field strength" shall be applied only to measurements made in the "far field." The measurement may be of either the electric or the magnetic component of the field, and may be expressed as V/m, A/m, or W/m: any one of these may be converted to the others.

NOTE For measurements made in the "near field", the term "electric field strength" or "magnetic field strength" shall be used according to whether the resultant electric or magnetic field, respectively, is measured. In this field region the relationship between the electric and magnetic field strength and distance is complex and difficult to predict, being dependent on the specific configuration involved. In as much as it is not generally feasible to determine the time and space phase relationship of the various components of the complex field, the power flux density of the field is similarly indeterminate.

Flight-line equipment

Any support equipment that is attached to or used next to an aircraft during pre-flight or post-flight operations, such as uploading or downloading data, maintenance diagnostics, or equipment functional testing.

Frequency/Amplitude Pair

Frequency and amplitude pairs are typically formatted as tabular or list data. The amplitude and associated frequency comprise the amplitude/frequency pair. For example, 10 dmV/m 30 MHz = an amplitude of 10 dmV/m at the
30 MHz frequency point.

Frequency band

A continuous range of frequencies extending between two limits.

GPIB

General Purpose Interface Bus is a general name for the communications interface system defined in the ANSI/IEEE Standard 488.1-1987 and ANSI/IEEE Standard 488.2-1987. See "HP-IB" on page 250.

Ground plane

1. A conducting surface or plate used as a common reference point for circuit returns and electric or signal potentials.

2. A metal sheet or plate used as a common reference point for circuit returns and electrical or signal potentials.

Harmonic Distortion

Harmonic distortion occurs when the input signal is of sufficient amplitude to drive the mixer into non-linear operation. When this occurs, harmonics of the input signals may be generated in the mixer. These harmonics are called harmonic distortion.

Harmonic Mixing

Harmonic mixing is a technique that extends the frequency range of the receiver. A response is displayed when the input signal satisfies the following equation:

$$F_{in} = nF_{LO} \pm F_{IF}$$

where

Fin is frequency of input signal,

FLO is frequency of the receiver local oscillator

n is the harmonic number of the receiver local oscillator

HP-IB

HP-IB is an acronym for the Hewlett-Packard Interface Bus (Hewlett-Packard's implementation of GPIB). It supports IEEE-488 and IEC-645, which are worldwide standards for instrument interfaces. The HP-IB is accessed at the rear panel of the computer and all HP-IB controlled peripherals (printer, plotter, receiver, and so on). See GPIB.

IF Feedthrough

Since the spectrum analyzer is a heterodyne receiver, a signal equal in frequency to the first IF lifts the entire display baseline, regardless of the frequency control settings. This phenomenon is known as IF feedthrough. Lifting the baseline obscures the display and may completely submerge other signals present. Thus, to eliminate any gap in the spectrum analyzer frequency coverage, an alternate IF must be available and the two IFs must not be harmonically related. A preselector also eliminates IF feedthrough.

Image Responses

An image responses is a false response which appears at 2 * Fif above or below the applied signal. This can occur for any IF within the receiver.

Immunity

1. The property of a receiver or any other equipment or system enabling it to reject a radio disturbance.

2. The ability of electronic equipment to withstand radiated electromagnetic fields without producing undesirable responses.

Impedance

Impedance is the nominal input impedance of the spectrum analyzer. 50 ohm and 75 ohm are most widely used.

Impulse

1. An electromagnetic pulse of short duration relative to a cycle at the highest frequency being considered.

2. Mathematically, it is a pulse of infinite amplitude, infinitesimal duration, and finite area. Its spectral energy density is proportional to its volt time area, and is uniformly and continuously distributed through the spectrum up to the highest frequency at which it may be considered an impulse. Regularly repeated impulses of uniform level will generate a uniform spectrum of discrete frequencies (Fourier components) separated in frequency by an amount equal to the repetition frequency.

Impulse Bandwidth

1. The peak value of the response envelope divided by the spectrum amplitude of an applied impulse.

2. The peak value divided by the area of the impulse response envelope.

Impulse Bandwidth (BWi)

The impulse bandwidth (BWi) of a filter is the bandwidth of a rectangular filter having the same peak-voltage response as the filter in question. Impulse bandwidth (BWi) = 1.6 times resolution bandwidth (BW3dB).

Impulse emission

1. That produced by impulses having a repetition frequency not exceeding the impulse bandwidth of the receiver in use.

2. The rms unmodulated sine-wave voltage required to produce in a circuit a peak response equal to that produced by the impulse in question, divided by the impulse bandwidth of the circuit. For the purpose of this standard, it is expressed in terms of uV/MHz or dBuV/MHz. The area under the amplitude-time relation for the impulse.

Insertion Loss

Insertion loss is the reduction in power which occurs at the load on insertion of a network between the source and load. It is generally expressed as a ratio in dB.

Interconnecting leads

Control and signal lines which interface with equipment or subsystems not being supplied under the same contract. Control leads use AC or DC power for control of such devices as relays, solenoids, valves, machinery control sensors, and synchros; whereas signal leads send or receive such signals as clock, IF, RF, audio, and digital.

Interference emission

Any undesirable electromagnetic emission

Intermodulation

1. Mixing of two or more signals in a nonlinear element, producing signals at frequencies equal to the sums and differences of integral multiples of the original signals.

2. The modulation of the components of a complex wave by each others, as a result of which waves are produced that have frequencies equal to the sums and differences of integral multiples of those of the components of the original complex wave.

Intermodulation (IM) Distortion

Intermodulation (IM) distortion occurs when two strong and closely-spaced signals are fed into the receiver input mixer. The two signals drive the mixer into non-linear operation. This causes the two signals to interact and produce several mixing products. For example, if two signals, f1 and f2 are fed into the input mixer, then 2f1 ± f2, 2f2 ± f1, 2(f1 ± f2), 3(f1 ± f2), and so on, are some of the intermodulation distortion products that may be seen on the display. 2f1 – f2 and 2f2– f1 are called third order IM products and are the most critical distortion products. They are the most critical because they are located close to f1 and f2; the rest of the IM products are farther from the spectrum of interest.

Internal Attenuation

Internal attenuation is the attenuator inside the receiver. See External Attenuation.

Internal Installation

An equipment location on a platform which is totally inside an electrically conductive structure, such as a typical avionics bay in an aluminum skin aircraft.

Interpolation

Interpolation is the method by which values for frequency and amplitude are approximated between frequency/amplitude pairs. Interpolation may be done on a log or linear scale.

Isotropic

Isotropic means having properties of equal values in all directions.

ITU

International Telecomm Union

Limit Line

A limit line is the line on the E7415A graph or the receiver display that represents the associated regulation limits.

Limit (Line) Margin

Limit line margin is the confidence interval for EUT emissions measurements relative to the applicable limit (denoted as negative dB).

LISN

Line Impedence Stabilization Network

Local

Local is the receiver state in which commands can be entered directly on the receiver panel.

Magnetic Field Strength

Magnetic field strength is the magnitude of the magnetic field, commonly expressed in amperes per meter and notated as |H|.

Margin

See “Limit (Line) Margin”.

Monopole

An antenna consisting of a straight conductor (usually not more than one-quarter wavelength long) mounted immediately above, and normal to, an imaging (ground) plane. It is connected to a transmission line at its base and behaves, with its image, like a dipole.

Narrowband emission

1. That which has its principal spectral energy lying within the bandpass of the measuring receiver in use.

2. Narrowband is the definition for an interference amplitude when only one spectral line (and possibly the modulation sidebands) are within the RFI receiver's specified bandwidth.

Narrowband Response

A narrowband response is displayed on an EMC receiver when the receiver bandwidth is narrow enough to resolve the discrete frequency components of the received signal. For example, since the individual spectral components of a pulsed RF transmission are spaced at the pulse repetition frequency (PRF), the receiver displays a narrowband response when its bandwidth is narrower than the PRF. (To be sure that all components are resolved, regardless of their relative amplitudes, receiver bandwidth should be less than 0.3 times the PRF.)

To check for narrowband response, vary the receiver bandwidth, span width, or sweep time. The amplitude of a narrowband response should not change as the bandwidth is varied. Widening the span width decreases spacing between spectral lines; sweep time changes do not affect spectral line spacing. See Broadband Response.

Near Field

Near field is the region of the field of a source between the source and the far field region where the angular field distribution is dependent upon distance from the source.

Non-critical area

A location in a ground installation where EMI will not result in failure or abortion of a mission or degradation of the overall system performance. Examples of areas which may be considered non-critical are office buildings, recreational areas, laundry areas, food servicing areas, drafting rooms, and woodworking shops.

Non-developmental item

A non-developmental item is a broad, generic term that covers material available from a wide variety of sources with little or no development effort required by the Government.

Normalized Site Attenuation

Site Attenuation divided by the antenna factors of the radiating and receiving antenna.

Open Area Test Site (OATS)

A site (test site) for radiated electromagnetic interference measurements which is open flat terrain at a distance far enough away from buildings, electric lines, fences, trees, underground cables, and pipe lines so that effects due to such are negligible. This site should have a sufficiently low level of ambient interference to permit testing to the required limits. In IEEE documentation, this is referred to simply as the “test site”.

Peak (Detector)

A peak detector detects the peak value of the signal (worst-case). The receiver has an envelope detector in the IF chain that has a time constant such that the voltage at the detector output follows the peak value of the IF signal at all times.

Peak Excursion

Peak excursion is the criteria by which a trace peak is considered to be a signal. The signal must rise and then fall by the peak excursion value to be considered a peak signal. Higher values lead to fewer signals being discerned. Lower values lead to more signals being discerned. For example, if the peak excursion is set too low, the peaks in the noise floor may be discerned as signals and stored in the signal list. In contrast, if the peak excursion is set too high, many legitimate peaks will not be discerned as signals.

Polarization

A term used to describe the orientation of the field vector of a radiated field.

Preamp

A preamplifier either internal or external to the receiver. A high gain, low noise preamp will usually improve the receiver's noise figure and increase the dynamic range, especially when placed close to the antenna.

QPD

See "Quasi-Peak Detector".

Quasi-Peak Detector

1. Quasi-peak detection is a weighted form of peak detection. During quasi-peak detection, the displayed response drops as the repetition rate of the measured signal decreases This signal weighting is accomplished by circuitry with specific charge (1 millisecond) and discharge (600 milliseconds) time constants.

2. The QPD is a way of measuring the "annoyance factor" of a signal.

NOTE For continuous wave signals, the peak and quasi-peak values are the same.

Radiated emission

Radiation and induction field components in space.

Radiated interference

Radio interference resulting from radiated noise or unwanted signals. Compare radio frequency interference below.

Radiation

1. The propagation of a signal or interference from a source other than by conduction.

2. The emission of energy in the form of electromagnetic waves. The term is also used to describe the radiated energy.

Radio frequency interference (RFI)

RFI is the high frequency interference with radio reception. This occurs when undesired electromagnetic oscillations find entrance to the high frequency input channel of a receiver or antenna system. These oscillations may be received (along with the desired signal) by the antenna, and will degrade the reception of the desired signal. Compare radiated interference above.

Radio interference power

Radio interference power is the power measured on the conductor with an absorbing clamp and a radio interference measuring receiver. As in the case of radio interference voltage, it can be measured as a quasi-peak or non-weighted quantity.

Receiver

A receiver is a measurement device, such as an EMC receiver, that detects and measures electromagnetic energy levels.

Receiver Settings

Measurement settings within the receiver (can be set with the E7415A application) that determine the frequency span, RBW, VBW, Ref Level, Sweep Time, Attenuation, and so on. CISPR defines receiver settings to use while performing emission measurements.

NOTE The E7415A application default receiver settings are as defined by CISPR.

Remote

Remote is the receiver state in which commands can be entered through the application user interface. When in remote mode, the receiver is controlled by an external controller, such as a PC.

Repetition rate

Repetition rate is the number of periodic switching and discharge processes per time unit. The repetition rate can be measured, for example, at the intermediate frequency (IF) output of the radio interference measuring receiver by means of an oscilloscope.

Resolution Bandwidth (RBW)

Resolution bandwidth is the 3 dB bandwidth of the receiver IF stage. (CISPR specified bandwidths, that is, 200 Hz, 9 kHz, 120 kHz, and 1 MHz use a 6 dB bandwidth.) It is called the resolution bandwidth because two closely-spaced equal amplitude signals are just resolved if they are separated by an amount equal to the receiver 3 dB bandwidth. For example, a final IF bandwidth of 100 Hz just resolves two equal amplitude signals 100 Hz apart. However, if the two signals are less than 100 Hz apart, they are within the IF bandwidth at the same time and, therefore, appear as one signal

RFI - click, continuous and discontinuous

Click RFI (or disturbance) is short duration interference with a duration that does not exceed a specified period. Click RFI is counted, measured, and judged only if its amplitude is above the limits applicable for continuous RFI. Continuous RFI is interference with a duration that exceeds a specified period. In VDE 0875, continuous RFI is identified as an indicated value (for example, meter reading) as observed on the RFI meter which does not immediately decrease after reaching a maximum. Discontinuous RFI is interference which is not continuous RFI. The meter reading decrease after reaching a maximum.

RFI field strength

RFI field strength is the field strength measured with an antenna and a radio interference measuring receiver. As in the case of radio interference voltage, it can be measured as a quasi-peak or non-weighted quantity.

RFI sources

RFI sources are equipment and systems as well as their components which can cause RFI.

RFI Suppression

RFI suppression is the technique to reduce high frequency electromagnetic oscillations of electrical equipment and systems which can cause RFI.

RFI Voltage

1. RFI voltage is the voltage measured across defined reference resistances (equivalent resistances) with a radio interference measuring receiver. It can be measured as a weighted (quasi-peak) or non-weighted quantity. The reference resistances (equivalent resistances) can be part of a power mains network or a probe.

2. Weighted RFI voltage (quasi-peak) is the measured radio interference voltage corresponding to the physiological impression of interference (acoustic or visual).

Segment

The frequency range scanned during a Sweep operation is divided into multiple segments when necessary. These segments are swept to ensure proper frequency accuracy. See Segment Size.

Segment Overlap

The segment overlap is the percent overlap (% of frequency uncertainty) between segments during the sweep process. This value specifies the segment overlap as a % (percentage) of the receiver's specified frequency uncertainty. For example, segment overlap = 100% will provide segment (span) overlap equal to 100% of the receiver's specified frequency uncertainty, or actually 1 to 3% frequency overlap of adjacent segments, depending on the actual receiver. See Segment.

Segment Size

The segment size is the frequency span setting used by the receiver. Typically, unless the sweep frequency range is narrow, the receiver will scan multiple segments during a Sweep operation. The trace displayed on the graph is a composite of all the segments scanned during a Sweep.

If Auto Segment is selected, (under the Sweep, Frequency Range tab) the number of segments is dependent on the receiver (number of points and RBW) and the actual measurement frequency range. If Auto Segment is disabled, the user can enter a segment size, which defines the maximum frequency span used by the receiver during a sweep.

Shielded Room/Enclosure

A screened or solid metal housing designed expressly for the purpose of isolating the internal from the external electromagnetic environment. The purpose is to prevent outside ambient electromagnetic fields from causing performance degradation and to prevent emissions from causing interference to outside activities.

Signal

A signal is a frequency point (with corresponding amplitude) that represents a peak on the E7415A trace. For a peak to be considered a signal, the peak excursion criteria must be met. See Peak Excursion.

Signal List

A signal list is a table of signals. Signals are generated from the Add Peaks to List process, or from the Add Data Point to List process, or from inserting signals through the Insert Signals dialog box. Signal lists can be filtered, sorted, and otherwise customized to display various signal attributes to meet specific requirements.

Signal Path

The signal path is the interconnected equipment that defines the signal path from transducer to receiver. It may include transducers, limiters, preamps, cables, LISNs, receivers, and other devices. Corrections are included for each device in the signal path to account for signal amplification and attenuation with respect to frequency. Correction factors from the devices comprising the Signal Path are added to measured data to generate corrected measurement results during the Sweep and Measure processes.

Snapshot

A Snapshot is a method for generating a quick report showing the graph traces and/or the signal list.

Source Electromotive Force (EMF)

1. Twice the voltage of the matched output value (IEEE).

2. The voltage of the terminals of the ideal voltage source in the representation of an active element (IEV).

Stripline

Parallel plate transmission line to generate an electromagnetic field for testing purposes.

Subsystem

For the purpose of EMC equipment and techniques, the definition in one of the two subsections below shall be considered as a subsystem. In either case, the devices or equipment may be physically separated when in operation and will be installed in fixed or mobile stations, vehicles, or systems.

a. A collection of equipment designed and integrated to function as a single entry, but wherein any device or equipment is not required to function as an individual equipment, as defined herein.

b. A collection of equipment and subsystems, as defined above, designed and integrated to function as major subdivision of a system and to perform an operational function, or functions, therein.

Susceptibility

Susceptibility is the characteristic of electronic equipment that permits undesirable responses when subjected to electromagnetic energy.

Sweep

1. The sweep function sets up the receiver to sweep the frequency range set in the sweep dialog box. The sweep function creates a single (composite) trace on the E7415A graph comprised of multiple receiver spans, that is, the frequency range is segmented, and each segment is swept in turn by the receiver.

2. A sweep performed by the receiver over the frequency span set on the receiver.

System

A system is a composite of equipment, subsystems, skills, and techniques capable of performing or supporting an operational role. A complete system includes related facilities, equipment, subsystems, materials, services, and personnel required for its operation to the degree that it can be considered self-sufficient within its operational or support environment. EMC requirements for “systems” are normally included in such documents.

Test Generator

A generator (RF-generator, modulation source. attenuators, broadband power amplifier and filters) capable of generating the required signal.

Trace

1. A trace is the graphical representation of one or more receiver sweeps on the E7415A. Also see Sweep.

2. The sweep trace displayed on the receiver created from a single receiver sweep or continuous sweeps.

Transducer

A transducer is a device used to emit radio frequency energy into space from a signal source or intercept an arriving electromagnetic field, converting it into an electrical signal. In EMC applications, a transducer is typically an antenna or field probe for radiated measurements, or a current probe or a LISN for conducted measurements.

Transfer Impedance

Transfer impedance is the magnitude of the current sensed by a current probe divided by the voltage across the output terminals of the probe (when properly terminated). Commonly express in decibels referenced to one ohm (dbohm):

Zt = V – I

where

Zt is transfer impedance (dBohm)

V is magnitude of voltage across probe (dBmV)

I is magnitude of current measured (dBmA)

Transient Limiter

A transient limiter can protect the receiver input from damage caused by high-level transients from LISNs or current clamps.

Tune

With the Tune box checked (within the Receiver bar):

The receiver is set to center frequency equal to the selected list signal. The frequency span sets to the frequency uncertainty unless otherwise set in the options dialog box (Tools > Options; select Fixed Span:).

The receiver is set to the span of the zoom graph as the zoom region is selected.

Tune and Listen

Tune and Listen is the process of tuning to a signal, demodulating the signal, then listening to the demodulated signal to acoustically determine if the signal is an ambient, such as a radio station, or noise generated by the EUT.

VCCI

Japanese Voluntary Control Council for Interference by Information Technology Equipment.

Video Bandwidth (VBW)

The video bandwidth determines the amount of video filtering. See Video Filter.

Video Filter

A video filter is a post-detection averaging device which averages the noise present in the receiver. A noise averaging filter is a low-pass filter whose bandwidth should be much narrower than the resolution bandwidth of the receiver. However, since the video filter is located after the IF bandwidth, it does not affect frequency resolution.

In some measurements, like AM, FM, and pulse RF demodulation, the video filter bandwidth should be equal to or greater than the IF bandwidth to pass the demodulated waveform without distortion.

Zoom Graph

The zoom graph is a region of the graph that, when created, is displayed below the graph. The zoom graph displays the zoom region with greater resolution. The start/stop frequencies of the zoom graph are selected with the mouse (click and drag within the graph area), and are denoted in the graph with vertical lines.

The zoom graph displays the actual uncompressed data as taken with the receiver. The original frequency resolution is retained.

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