Measurement Guide

Agilent Technologies

EMC Analyzers

This guide documents firmware revision A.06.xx

This guide provides documentation for the following instruments:

Agilent Technologies EMC Series

E7401A (9 kHz- 1.5 GHz)
E7402A (9 kHz - 3.0 GHz)
E7403A (9 kHz - 6.7 GHz)
E7404A (9 kHz - 13.2 GHz)
E7405A (9 kHz - 26.5 GHz)

Agilent Technologies

Manufacturing Part Number: E7401-90026
Supersedes: E7401-90012

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Safety Information

The following safety symbols are used throughout this manual. Familiarize yourself with the symbols and their meaning before operating this instrument.

WARNING

***Warning* denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a warning note until the indicated conditions are fully understood and met.**

CAUTION

Caution denotes a hazard. It calls attention to a procedure that, if not correctly performed or adhered to, could result in damage to or destruction of the instrument. Do not proceed beyond a caution sign until the indicated conditions are fully understood and met.

NOTE

Note calls out special information for the user's attention. It provides operational information or additional instructions of which the user should be aware.

The instruction documentation symbol. The product is marked with this symbol when it is necessary for the user to refer to the instructions in the documentation.

This symbol is used to mark the on position of the power line switch.

This symbol is used to mark the standby position of the power line switch.

This symbol indicates that the input power required is AC.

The CE mark is a registered trademark of the European Community.

N279 The C-Tick mark is a registered trademark of the Australian Spectrum Management Agency.

ISM1-A This is a symbol of an Industrial Scientific and Medical Group 1 Class A product. (CISPR 11, Clause 4)

The CSA mark is a registered trademark of the Canadian Standards Association.

WARNING **This is a Safety Class 1 Product (provided with a protective earth ground incorporated in the power cord). The mains plug shall be inserted only in a socket outlet provided with a protected earth contact. Any interruption of the protective conductor inside or outside of the product is likely to make the product dangerous. Intentional interruption is prohibited.**

WARNING **No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.**

WARNING **If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only.**

CAUTION Always use the three-prong AC power cord supplied with this product. Failure to ensure adequate grounding may cause product damage.

Before Applying Power

Verify that the product is configured to match the available main power source as described in the input power configuration instructions in this manual. If this product is to be powered by autotransformer, make sure the common terminal is connected to the neutral (grounded) side of the ac power supply.

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Where to Find the Latest Information

Documentation is updated periodically. For the latest information about Agilent Technologies **EMC** Analyzers, including firmware upgrades and application information, please visit the following Internet URL:

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

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1 Introduction

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

Please read "How to Use This Guide"on page 3. It will explain how to use this guide to maximize your effectiveness and minimize your learning curve.

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 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. It is also important to have 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 Guide

This guide contains flowcharts and associated procedures for making conducted or radiated precompliance measurements including:

Chapter 2, “Conducted Emissions Example”– Step-by-step procedures for testing for conducted emissions.

Chapter 3, “Radiated Emissions Example” – Step-by-step procedures for testing for radiated emissions in a shielded room environment.

Chapter 4, “Measurement Techniques” – Some background and instructions on key measurement functionality.

Chapter 5, “How Do I...” – Keypress sequences which you may find helpful in making precompliance measurements.

Appendix A, “Determining your Regulation Requirements”– Information on current compliance regulations.

Appendix B, “Disk Contents: Limit Lines and Transducer Factors”– Lists the contents of the floppy disk that contains the limit lines and transducer factors.

Documentation

The Agilent E7400A-Series Analyzer is shipped with the following hardcopy documentation:

- User's Guide
- Specifications Guide
- EMC Analyzers Measurement Guide
- Signal Analysis Measurement Guide
- Calibration Guide
- Programming Guide

Service and Support

Any adjustment, maintenance, or repair of this product must be performed by qualified personnel. Contact your customer engineer through your local Agilent Technologies Service Center. You can find a list of local service representatives on the web at:

`http://www.agilent.com/find/assist`

Click on “Contact Us” and select your country.

If you do not have access to the Internet, one of the following centers can direct you to your nearest Agilent Technologies representative:

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Japan	0120-32-0119
Latin America	(11) 7297-3700 (Brazil)
Australia/New Zealand	1-800-802-540 (Australia) 0800-738-378 (New Zealand)
Asia-Pacific	080-047-669

2 Conducted Emissions Example

In This Chapter...

Introduction

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

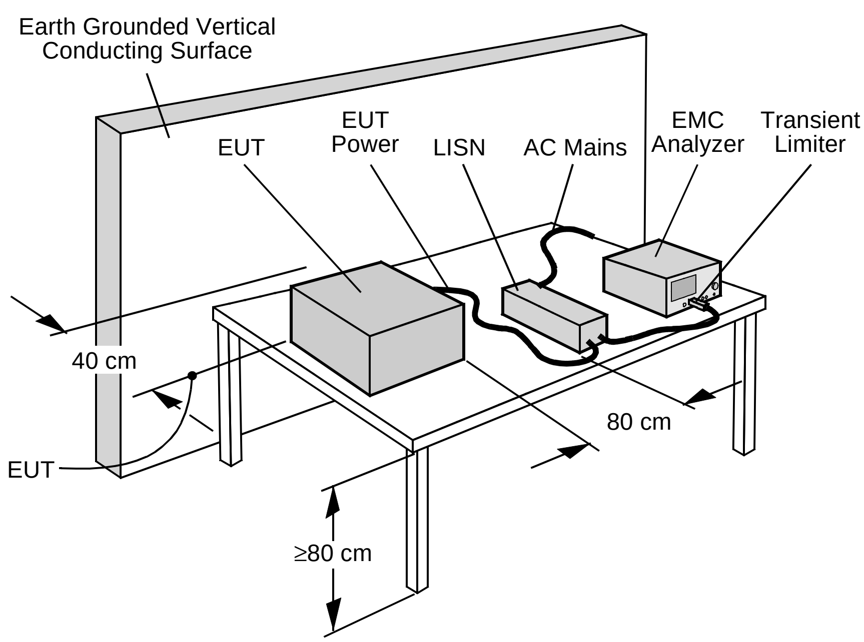
Conducted emissions testing focuses on signals present on the power mains that are generated by the EUT (equipment under test). The conducted energy is measured with a regulatory-defined item known as a LISN (line impedance stabilization network).

The regulatory limits specify the maximum EUT emission energy, usually in dBμV, detected by the LISN. Two types of detectors are defined: Quasi-Peak and Average, meaning that there are two limit lines. Conducted emissions measured by each detector must be below the corresponding limit. The test range for these measurements is typically 150 kHz to 30 MHz, though some limits may start as low as 9 kHz, depending on the regulation.

Since metallic surfaces near the EUT will produce variable coupling mechanisms, 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***



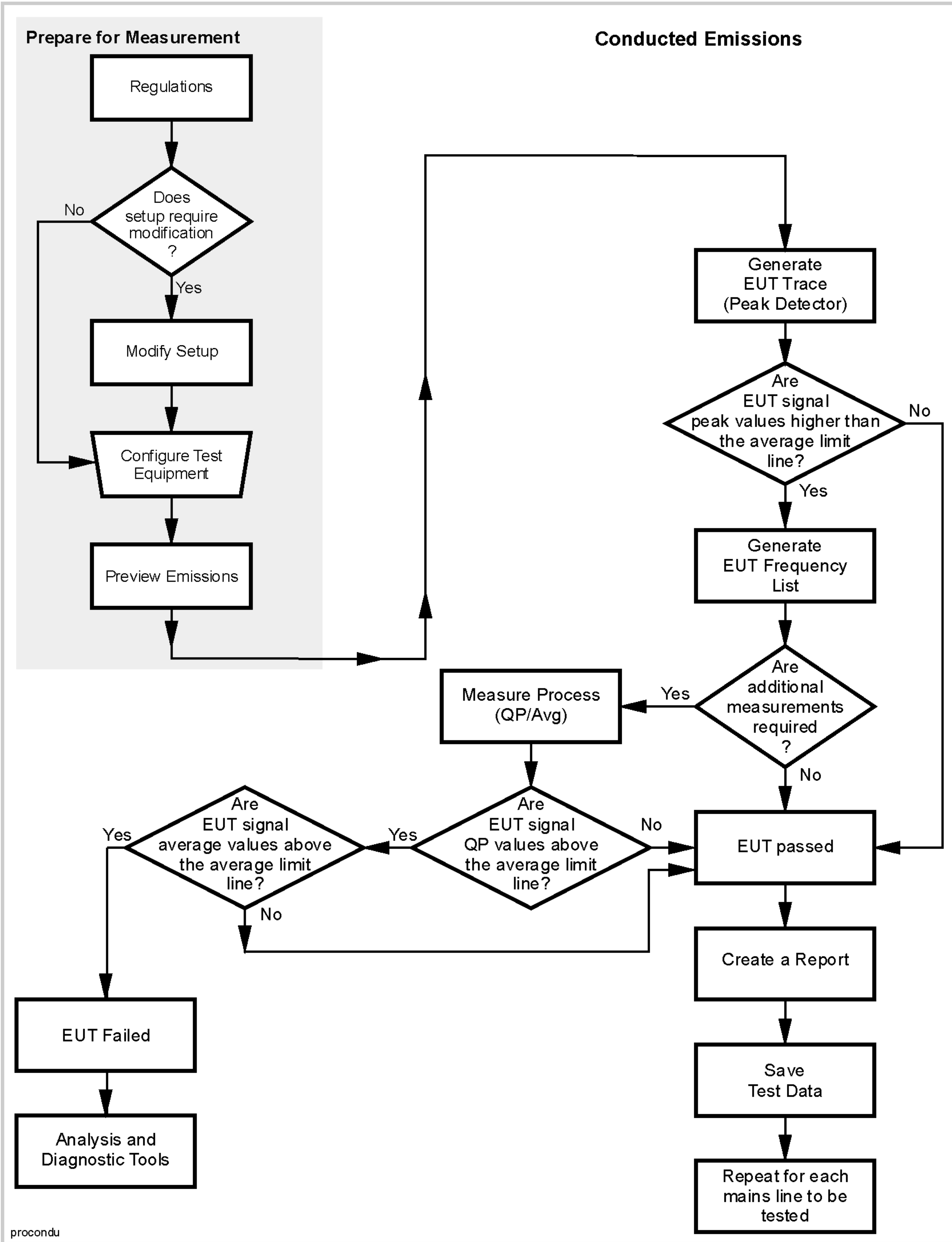
In this example the following steps will be carried out:

- Interconnect the equipment.
- Load in the appropriate limit line from the supplied limit line disk.
- Correct the analyzer display for the LISN and transient limiter.
- Perform the test.
- Save the data.

Flow Chart

Figure 2-2 on page 10 is a flow chart that shows the process for making a precompliance measurement of conducted emissions.

Figure 2-2 ***Precompliance Measurement of Conducted Emissions***



Configure Test Equipment

The equipment used in the test is arranged according to regulatory requirements, such as EN55022 Class B, to which the test is performed. You should refer to the regulation to which you are testing for specific configuration information. If you do not know to which regulation your product must comply, Appendix A , "Determining your Regulation Requirements," may help you get started.

The basic setup for a commercial conducted emissions measurement consists of a Line Impedance Stabilization Network (LISN), a transient limiter, and an EMC analyzer. The EUT receives its power through the LISN and any conducted emissions from the EUT are routed to the receiver by the LISN.

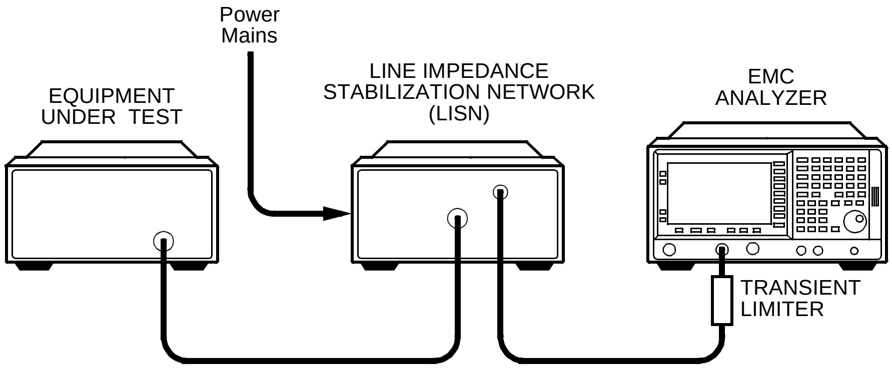
Typical Equipment

Equipment		Model/Part Number
EMC Analyzer:	9 kHz - 1.5 GHz	E7401A
	9 kHz - 3.0 GHz	E7402A
	9 kHz - 6.7 GHz	E7403A
	9 kHz - 13.2 GHz	E7404A
	9 kHz - 26.5 GHz	E7405A
EMC Setup, Limit Lines, Correction Factors Disk		E7401-10004
Transient Limiter		11947A
Line Impedance Stabilization Network (LISN)		11967D 11967E
10 Meter Coax Cable		11966L

This configuration can, of course, be modified to meet your own requirements.

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

Figure 2-3 ***Basic Conducted Emissions Test Setup***



Equipment Setup

CAUTION To prevent damage to the EMC analyzer 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.
- Disconnect the receiver input from the LISN (or current clamp) output prior to turning the EUT on or off.
- If you are using a switchable LISN, disconnect the receiver input from the LISN output prior to switching the LISN between lines.
- Disconnect the receiver input from the current clamp output prior to attaching or detaching it to a powered EUT main.

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. Follow all precautions provided by the manufacturer of the LISN.**

Procedure

1. Connect the power cord of the EUT to the LISN. The LISN provides a known RF impedance (50 Ω) 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 “50 Ω”.
4. Connect the EMC analyzer 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 ohm impedance to the receiver, allowing calibrated measurements.

About the Limiter

During conducted emissions testing, a transient limiter can protect the EMC analyzer input from damage caused by high-level transients from line impedance stabilization networks (LISNs) or current clamps. The E7400A-Series EMC Analyzers have limiter diodes placed before the first converter and the preamp to help protect both elements.

To provide additional protection to the EMC analyzer’s input when performing conducted emissions, the use of an external (11947A 9 kHz – 200 MHz) transient limiter is strongly recommended.

Prepare the Analyzer for Measurement

For this example you will create a setup for testing the conducted emissions range, 150 kHz – 30 MHz to the limits of EN55022 Class B. The setup will display the Quasi-peak and Average limit lines and correct the display for the LISN and transient limiter over the applicable frequency range. This example uses an 11967D LISN, an 11947A transient limiter, and an 11966L 10 m coaxial cable.

You must set up the EMC analyzer according to the type of precompliance measurement you are making. If you have done precompliance testing before with this EMC analyzer, you may have a saved setup file (.SET). If so, you can skip this section and start with "Load Conducted Emissions Demo Setup File" on page 19.

NOTE The keypresses in the following procedures all start from front panel function keys. As you become familiar with the receiver, you will discover ways to reduce the number of keystrokes required.

Delete Pre-existing Setup Data

Before creating a new setup, it is a good idea to delete any pre-existing setup data.

Procedure 2-1 How to Delete Pre-existing Setup Data

Step	Comments
1 Preset EMC analyzer.	• Press **Preset**.
2 Delete Limit Lines.	• Press **Meas Setup, More 1 of 2, Limits, Delete Limits, Delete Limits.**
3 Delete Antenna Corrections.	• Press **Meas Setup, More 1 of 2, Corrections, Modify, Select, Antenna, Delete, Delete.**
4 Delete Cable Corrections.	• Press **Meas Setup, More 1 of 2, Corrections, Modify, Select, Cable Delete, Delete.**
5 Delete Other Corrections.	• Press **Meas Setup, More 1 of 2, Corrections, Modify, Select, Other, Delete, Delete**.
6 Delete User Corrections.	• Press **Meas Setup, More 1 of 2, Corrections, Modify, Select, User, Delete, Delete**.
7 Delete Signal List.	• Press **MEASURE, More 1 of 2**, **Signal List, Delete Signals, Delete All, Yes.**

Create the Demonstration Setup

Procedure 2-2 How to Create the Demonstration Setup

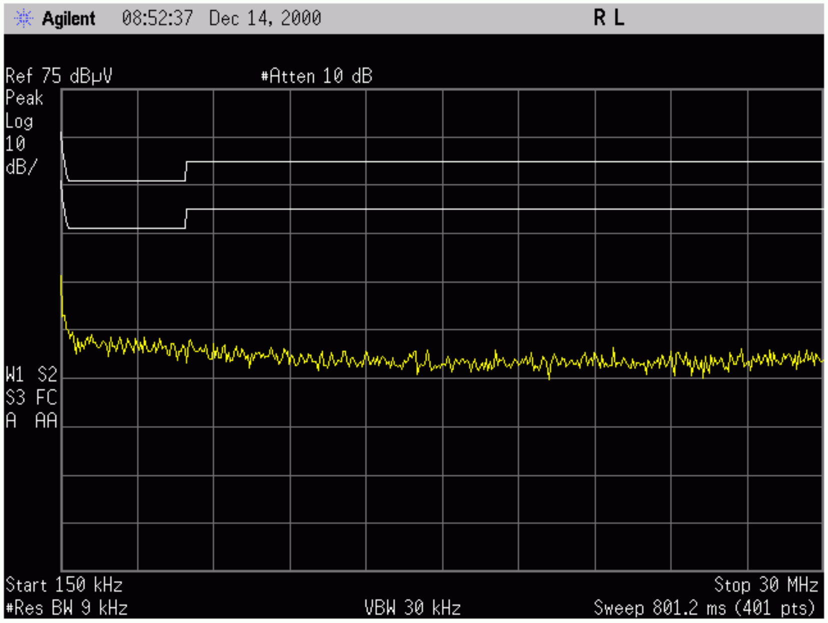
Step		Comments
1 Set the receiver to the band to be tested.	• Press **Meas Setup, 150 kHz – 30 MHz**.	• Note that when this band is selected, all the analyzer settings for a CISPR measurement in this frequency range are preset.
	• If prompted by the analyzer, select the appropriate coupling mode.	• Input coupling is set to AC by an instrument preset. For certain models and Option UKB, some amplitude specifications may apply only when coupling is set to DC. Refer to user's guide for further information on determining the appropriate input coupling mode.
2 Insert the diskette.	• Place the Limit Line and Transducer Factor floppy disk (E7401-10004) into the EMC analyzer disk drive (the label should face outward to the right).	• Refer to Appendix B , "Disk Contents: Limit Lines and Transducer Factors," for a listing of the contents of this disk.
3 Select the file type for limit lines.	• Press **File, Load, Type, Limits, Destination, Limit 1.**	
4 Select and load the EN55022 Class B Quasi-peak limit into limit 1.	a. Select the A: drive. b. Use the ↑↓ arrow keys or knob to select EN22BCQP.LIM. c. Press **Load Now**.	• If you are unsure as to how to select a drive please refer to "How Do I..." on page 105.
5 Select and load the EN55022 Class B Average limit into limit 2.	a. Press **File, Load, Type, Limits, Destination, Limit 2.** b. Use the ↑↓ arrow keys or knob to select EN22BCAV.LIM. c. Press **Load Now**.	

Procedure 2-2 How to Create the Demonstration Setup (Continued)

Step		Comments
6 Load the LISN correction factors.	a. Press **File, Load, Type, More 1 of 2, Corrections.** b. Use the ↑↓ arrow keys or knob to select HP11967D.ANT. c. Press **Load Now**.	• Loading the 11967D.ANT file automatically corrects the displayed trace using the LISN correction factors. • An ‘A’ appears in the lefthand annotation field indicating the amplitude correction is applied.
7 Load transient limiter corrections.	a. Press **File, Load, Type, More 1 of 2, Corrections.** b. Use the ↑↓ keys or knob to select HP11947A.OTH. c. Press **Load Now**.	• This corrects the display for the insertion loss of the transient limiter. • The insertion loss of the RF cable is negligible in the conducted band.
8 Set input attenuation.	• Press **AMPLITUDE, Attenuation** and use the numeric keypad to specify 10 **dB**.	

Procedure 2-2 How to Create the Demonstration Setup (Continued)

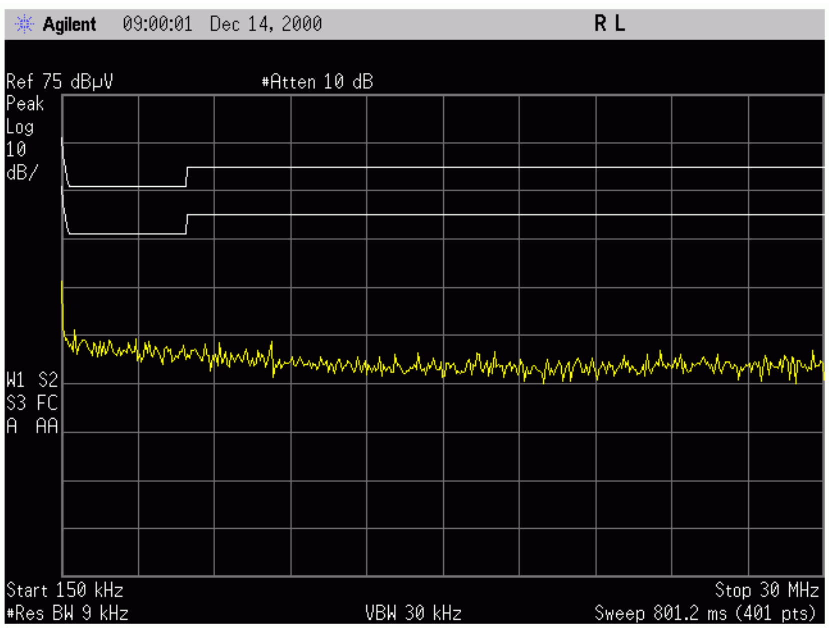
Step		Comments
9 Save this setup to a disk in A: as CONDEMO1.	a. Press **Meas Setup, Save Setup, Name** and use the Alpha Editor and the numeric keypad, or an external keyboard. Name the file **CONDEMO1** and press **Enter**. b. Press **Save Now**.	• Use a blank, formatted disk. • Note that saving a complete setup can take as long as 2 minutes.



Load Conducted Emissions Demo Setup File

Procedure 2-3 How to Load the Conducted Emissions Demo Setup File

Step		Comments
1 Insert the diskette on which you saved the setup you created in "Create the Demonstration Setup" on page 16.	• Place the floppy disk into the EMC analyzer disk drive (the label should face out).	
2 Select the setup file type.	• Press **Meas Setup, Load Setup**.	
3 Select and load the setup file CONDEMO1.SET.	a. Specify the A: drive. b. Use the ↑↓ keys or knob to select **CONDEMO1.SET** and press **Load Now**.	• If you are unsure as to how to select a drive please refer to "Specify a Drive" on page 134. • Note that you can also simply load the **CONDEMO.SET** file from the Limit Line and Transducer Factors Disk. This file will load the setup as it was specified above.



Preview Ambient Environment

It is recommended that you preview the ambient environment with the EUT off, prior to beginning an EMC test.

The ambient environment can impact measured results. The power cable between the LISN and the EUT can act as a antenna which can cause false EUT responses on the display.

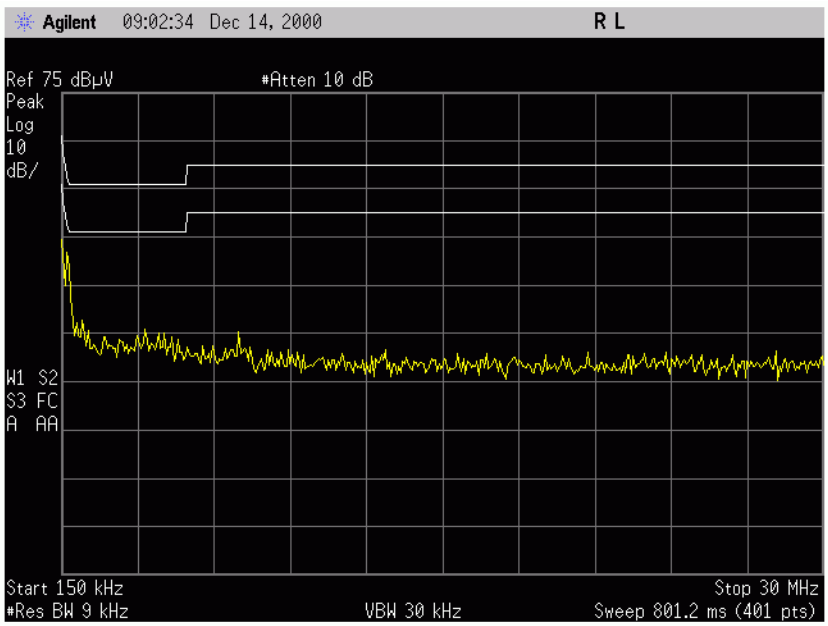
Preview Ambient Conditions

Procedure 2-4 How to Preview Ambient Conditions

Step		Comments
1 Disconnect Input.	• Disconnect the EMC analyzer INPUT from the transient limiter or LISN /current clamp.	• This procedure assumes that a conducted emissions setup has been loaded.
2 Turn OFF EUT.	• Power OFF the EUT.	
3 Reconnect Input.	• Connect EMC analyzer INPUT to the transient limiter or LISN.	• Input coupling is set to AC by an instrument preset. Some amplitude specifications apply only when coupling is set to DC. Refer to the user's guide for further information.

Procedure 2-4 How to Preview Ambient Conditions (Continued)

Step		Comments
4 Verify dynamic range.	• View the display. Verify that the noise floor and ambient signals are at least 6 dB below the limit line.	• If ambient signals appear above the limit line on the display, try using a shorter interconnecting power cord, or 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.

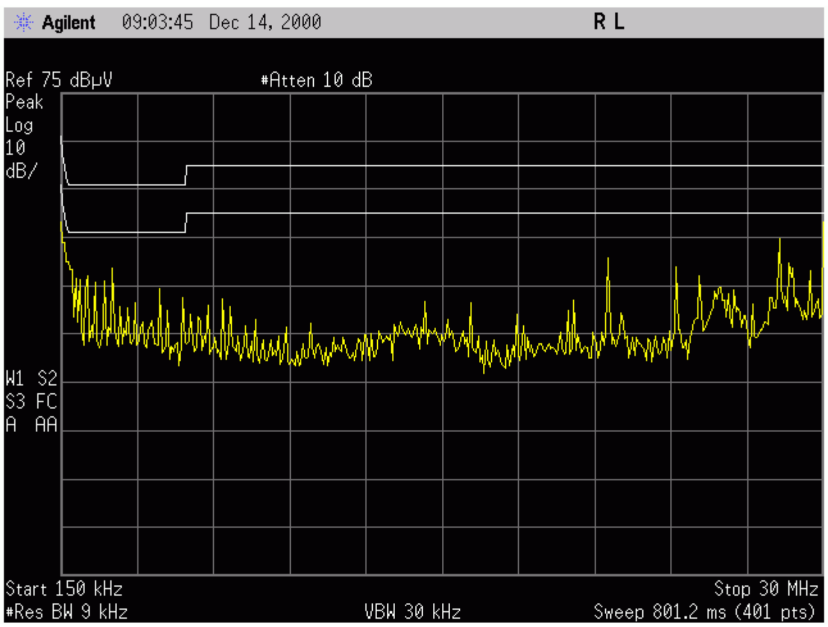


Preview EUT Emissions

It is recommended that you preview the EUT emissions prior to beginning an EMC test. This allows you to determine quickly whether or not there are obvious areas of failing emissions that may need to be addressed. It also provides a way for you to vary the operating state of the EUT to determine which states(s) may cause emission levels to increase.

Procedure 2-5 How to Preview Conducted EUT Emissions

Step		Comments
1 Disconnect INPUT.	• Disconnect the EMC analyzer INPUT from the transient limiter or LISN.	• This procedure assumes that a conducted emissions setup has been loaded.
2 Turn ON EUT.	• Power ON the EUT.	
3 Connect INPUT.	• Reconnect the transient limiter or LISN to the EMC analyzer INPUT.	
4 View EUT Emissions.	• Vary the operating state of the EUT, while monitoring the analyzer display, to determine which EUT state(s) result in the highest emissions. Use this state or states for your test.	



If no EUT signals appear above the lower (Average) limit line on the EMC analyzer display and you have verified that the EMC analyzer is not in IF or RF overload (see next section), then the product passes the conducted emissions limit.

IF Overload Detection and Correction

Signals must be set below the top of the screen to prevent IF overload. If one or more signals reach the top of the top graticule of the analyzer display, increase the reference level until all the signals lie below the top of the graticule.

NOTE See "IF Overload Detection and Correction" on page 80 for a more comprehensive discussion of IF overload.

NOTE If you are in the 200 Hz bandwidth (CISPR Band A) and the analyzer experiences an IF overload, an overload message will appear. In this case, increase the reference level until the overload message disappears.

RF Overload Test

Prior to making measurements, ensure that the analyzer is not in an RF overload state. RF overloads occur when the energy level at the input mixer of the analyzer is higher than the mixer’s linear operating range. This means that the mixer is in compression, which can cause errors in amplitude measurements.

NOTE Please refer to "RF Overload Detection and Correction" on page 77 for a more comprehensive discussion of RF Overload

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

Step		Comments
1 Prepare the analyzer for measurement.	• Check your setup parameters. If necessary, recall your setup.	• If you are unsure how to set up the analyzer see "Set up the Analyzer for a Measurement" on page 107.
2 Check for overload.	a. Press **AMPLITUDE, Attenuation Man.** b. Press ↑ to increment the attenuator while monitoring the output trace level on the display. c. Continue to step up the attenuator in 5 dB steps, until you no longer see a change in the peak value of the highest signals in the trace. d. If you did not experience an overload, reset the attenuation to your original value.	• If the amplitude level of the signals change as the attenuation is increased, then the analyzer is still in an RF overload condition.
3 Save any new attenuation value.	• Press **Meas Setup, Save Setup**.	• If an overload required that you changed either the reference level or the attenuation, you may want to resave your setup.

Generate the EUT Signal List

The most common source of conducted emissions are components such as switch-mode power supplies which can 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 following process describes one method of generating a signal list with the E7400A-Series EMC Analyzers. You may find other methods that better meet your specific application.

In this procedure, the conducted emissions will be observed and the failing or suspect emissions will be marked and measured using the Measure at Marker function.

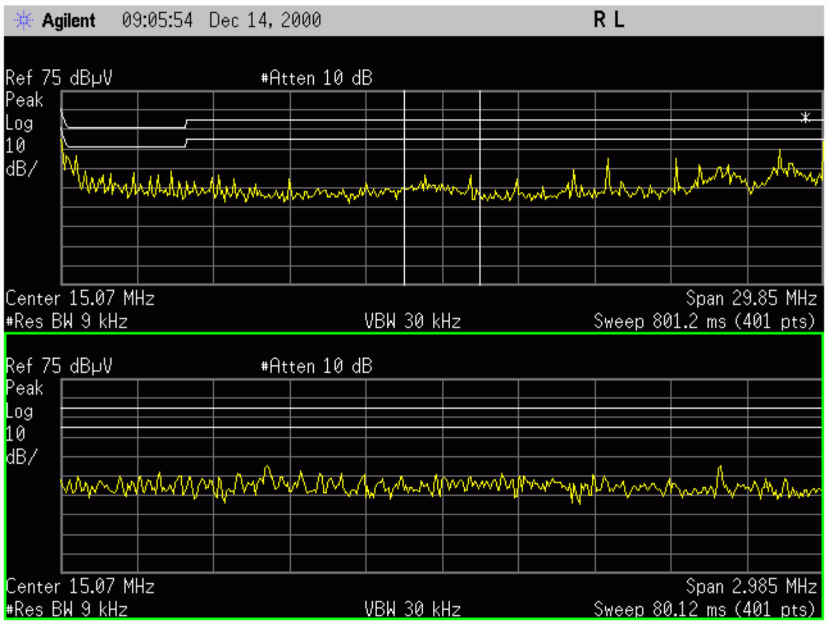
Finally, an emissions list will be generated for the selected suspect signals.

Procedure 2-7 How to Make a Conducted Emissions Measurement

Step		Comments
1 Insert the diskette on which you saved the setup you created in "Create the Demonstration Setup" on page 16.	• Place the floppy disk into the EMC analyzer disk drive (the label should face out).	
2 Select the setup file type.	• Press **Meas Setup, Load Setup**.	
3 Select and load the setup file CONDEMO1.SET.	• Select the A: drive. • Use the ↑↓ keys or knob to select **CONDEMO1.SET** and press **Load Now**.	• If you are unsure as to how to select a drive please refer to "Specify a Drive" on page 134. • Note that you can also simply load the **CONDEMO.SET** file from the Limit Line and Transducer Factors Disk. This file will load the setup as it was specified above.
4 Clear any existing signal lists.	• Press **MEASURE, More 1 of 2, Signal List, Delete Signals, Delete All, Yes**.	
5 Select the appropriate measurement detector.	• Press **Meas Setup, More 1 of 2, Meas Detector, Peak On, Quasi Peak On, Average On.**	• This is the default setting for the detectors.

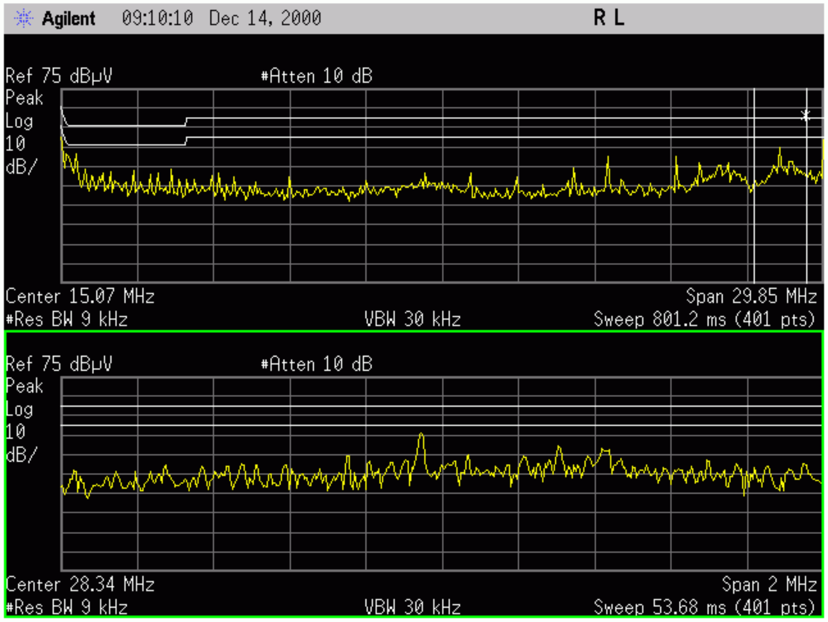
Procedure 2-7 How to Make a Conducted Emissions Measurement (Continued)

Step		Comments
6 Enable Zone Span.	• Press **Span, Zone, Zone On.**	• Tip: Pressing **Zoom** (located below the screen) will also enable the two-window display. • The Zone Span allows control of the two-window Zone function. In the upper window a broad frequency range is displayed with two “Zone Markers” (vertical bars) that define the span for the lower window.

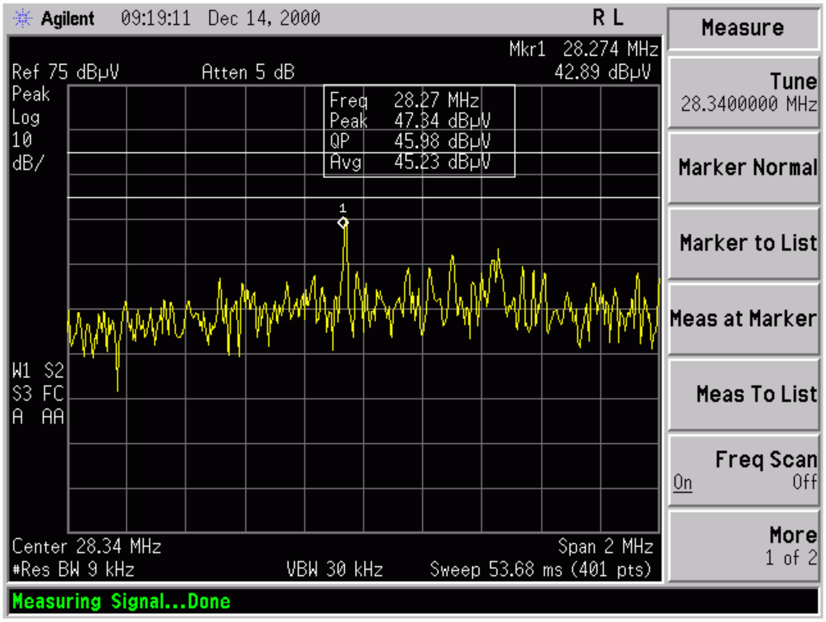


7 Zoom in to signals of interest.	a. Use **Zone Center**, and **Zone Span** to show the signals that are above or near the limit as well as any other signals of interest. b. Use the knob or ↑↓ arrow keys to change the zone center or adjust the zone span size to display the signal of interest with the desired resolution.	• Hint: Press **Zoom** (located below the screen) to display the selected zone in full screen mode. Press **Zoom** again to return to the dual-display.

Procedure 2-7 How to Make a Conducted Emissions Measurement (Continued)

Step	Comments
	
8 Measure the Peak, Quasi-peak and Average level of signals near or above the limit.	a. Press **MEASURE, Marker Normal**. b. Using the knob, scroll the marker to the peak of any signal of interest. c. Press **MEASURE, Meas at Marker**. • Hint: Press **Search** to place the marker on the highest peak in the active trace and use **Next Peak** to move the marker to other peaks in order of descending amplitude. • After the measurement, the signal frequency, peak, quasi-peak and average amplitudes of the measured signal appear in a box in the upper left of the display.

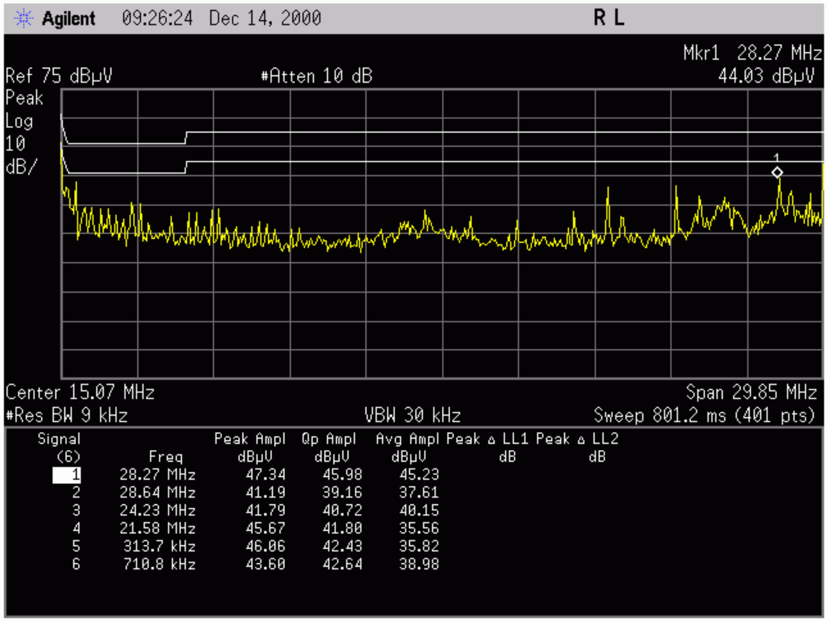
Procedure 2-7 How to Make a Conducted Emissions Measurement (Continued)



Step		Comments
9 Add the measured values to the signal list.	• Select **Meas to List.**	• Tip: When in split-screen display mode, use **Next Window** to select which trace will be active. Use **Zoom** to switch between split-screen and full-size display.
10 Repeat Steps 8 and 9 for all signals above the limit and other signals of interest in the span.		• Tip: During the measurement process, if it appears that the signal peak is off-screen to the left or right, decrease the zone span and remeasure the signal of interest.
11 Move Span to next area of interest.	a. Press **SPAN, Zone, Zone Center.** b. Use the knob or ↑↓ keys to move the zone to the next area of interest.	
12 Repeat Steps 8 – 11 until all the signals above the limit in the upper, or full range, view, have been measured.		

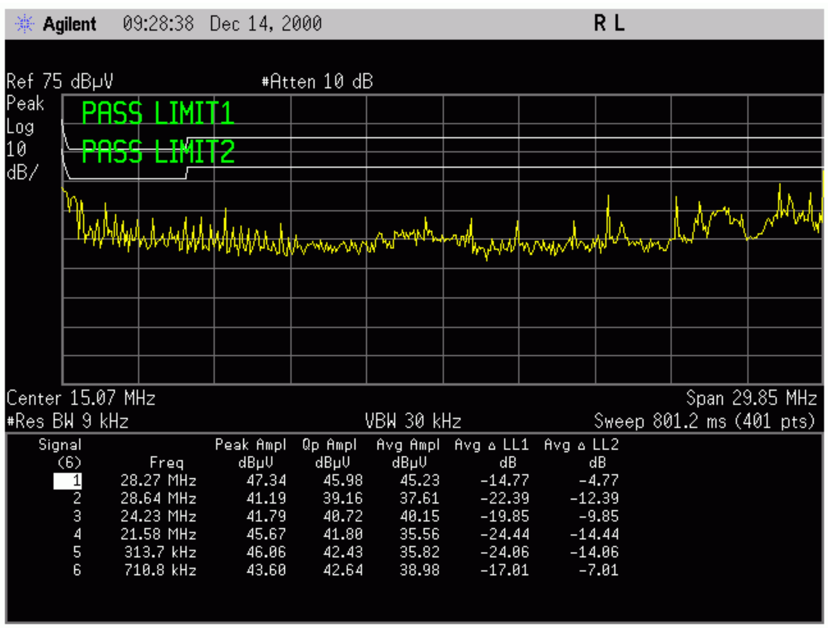
Procedure 2-7 How to Make a Conducted Emissions Measurement (Continued)

Step		**Comments**
13 Return focus to full-span view.	a. Press **Next Window** to switch the active window to full span view. b. Press **Span, Zone, Zone Off.**	• The active window is outlined in green.
14 Display the Signal List.	• Press **MEASURE, More 1 of 2, Signal List, Signal List On**.	



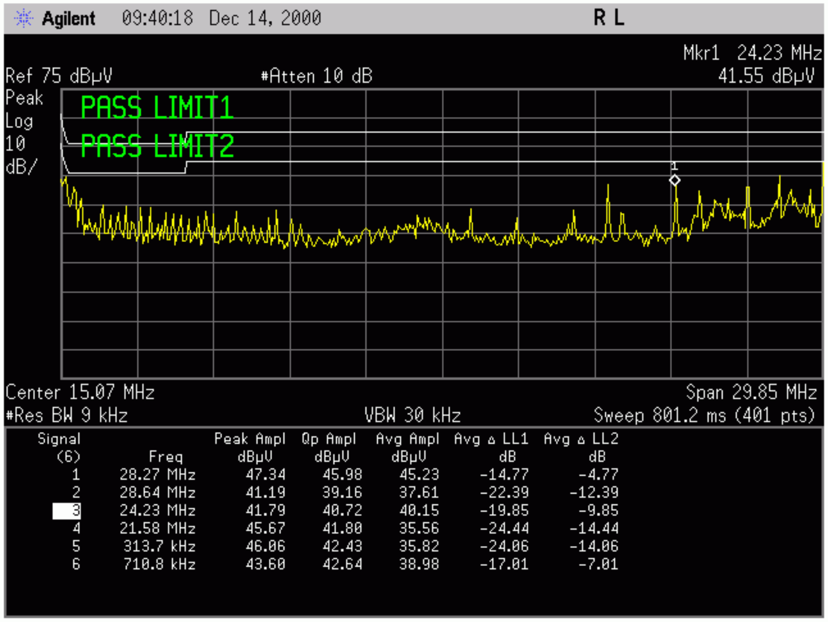
Procedure 2-7 How to Make a Conducted Emissions Measurement (Continued)

Step		Comments
15 Observe whether or not any measured quasi-peak values are above the quasi-peak or average limits.	a. Select **List Edit, QP Ampl On.** b. Press **Meas Setup, More 1 of 2, Limits, Modify, Limit 1, Test On, Limit 2, Test On**.	• If an emission is over the limit line (or margin, if selected), a FAIL LIMIT (or FAIL MARGIN) message will appear on the screen. • If there are no quasi-peak values above the average limit line, the product passes the conducted emissions test. • If there are no quasi-peak values above the quasi-peak limit, check the average values in the next step. • The amplitude difference between the selected value and the limit lines will appear in the 6th and 7th signal list columns.



Procedure 2-7 How to Make a Conducted Emissions Measurement (Continued)

Step		Comments
16 Observe whether or not any measured average values are above the average limit.	a. Press **MEASURE, More 1 of 2, Signal List, Signal List On**. b. Select **List Edit, AV Ampl On**.	• If there are no average values above the average limit, and there were no quasi peak values above the quasi-peak limit in the previous step, the product passes the conducted emissions test. • If your emissions fail the limit, you may want to perform further troubleshooting or diagnostics.
17 Tip: To remeasure signals in the list:	a. Press **MEASURE, More 1 of 2, Signal List, Signal List On.** b. Use ↑↓ keys to highlight a point in the list. The marker will follow on the trace and mark the point highlighted. c. Press **Remeasure, Remeasure** or **Remeasure All** to remeasure all the signals.	• The list will automatically be updated with new remeasured signals. • Use ↑ to move down the list and select other signal numbers.



Save the Signal List

Use the following procedure to save the signal list to a floppy disk.

Procedure 2-8 How to Save Signals

Step		Comments
1 Select the file type.	a. Press **MEASURE, More 1 of 2**, **Signal List, Save/Load, Save, Name**. b. Use the Alpha Editor and the numeric keypad, or an external keyboard, to enter `SigList1`. Press **Enter**.	• For other measurements you would, of course, supply your own file name.
2 Save the new file.	a. If you are unsure how to select a drive, please see "Specify a Drive" on page 134. b. Press **Save Now**.	

Generate Measurement Output

Use the following procedures to print out important measurement information.

Printing Screens

Procedure 2-9 How to print out the analyzer screen

Step		Comments
1 Print out screen contents.	• Press **Print Setup, Print Screen, Print**.	• This will print out what is displayed on the analyzer screen. • **Hint**: To improve the output appearance, press **Esc** to clear screen messages before printing. • **Hint:** If you don't want the softkey menu to appear on the output, expand the display to full screen by pressing **Display, Full Screen** prior to printing. • For information on saving screens to disk, please refer to "Save/Edit/Recall" on page 134.

Printing Reports

Procedure 2-10 How to print out report information

Step		Comments
1 Print out Report contents.	• Press **Print Setup, Print Report, Print.**	• This will print out a report which can include the current screen, signal list, corrections, limits and analyzer settings. • For information on how to generate report information, please refer to "Generate Reports" on page 138.

3 Radiated Emissions Example

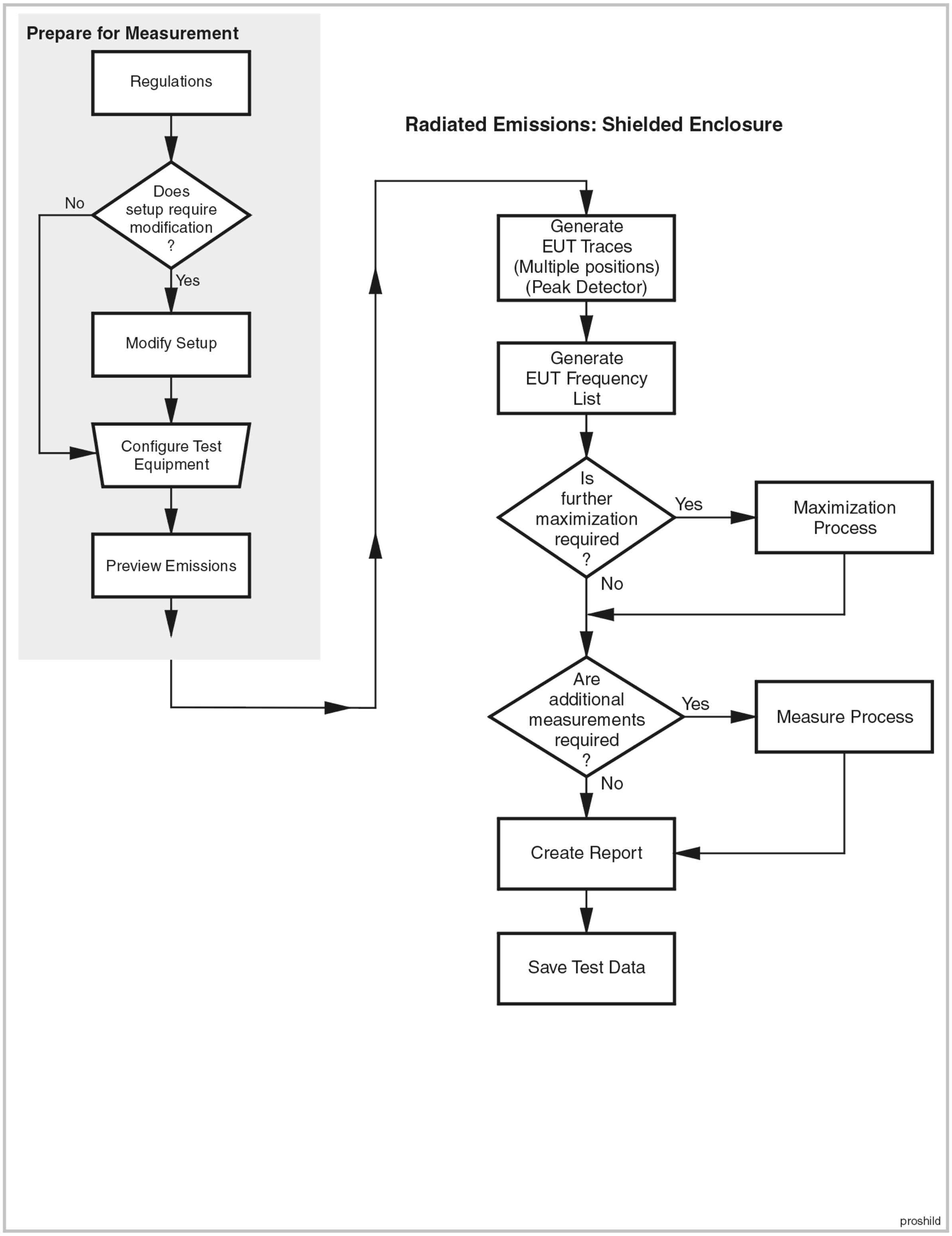
In This Chapter...

Introduction

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

Figure 3-1 on page 37 is a flow chart that shows the process for making a precompliance measurement of radiated emissions in a shielded enclosure.

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



Configure Test Equipment

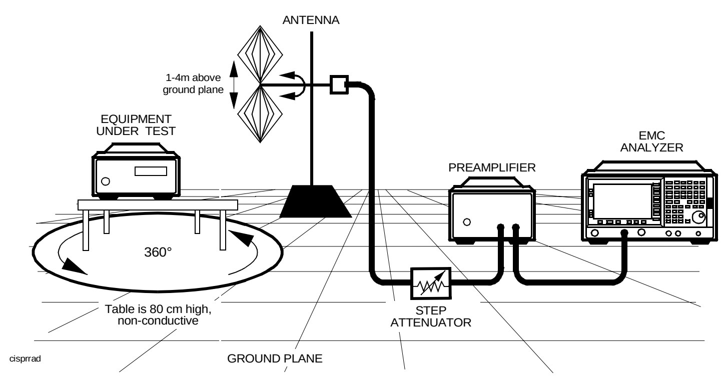
This section provides information about the typical configuration and equipment required for making radiated precompliance measurements. However, you should refer to the regulation to which you are testing for specific configuration information. The regulation usually specifies the test environment, receiver characteristics, and transducer characteristics for a compliance test. If you do not know which regulation your product design must comply with, Appendix A , “Determining your Regulation Requirements,” may help you get started.

In most radiated emissions tests antenna height and polarization is 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 the emissions. All these actions help insure that the worst-case emissions are found.

A typical radiated EMI measurement setup is shown in Figure 3-2. This configuration can be modified to meet your own requirements.

Figure 3-2 Basic Radiated Emissions Test Setup



Typical Equipment

Equipment		Model/Part Number
EMC Analyzer:	9 kHz - 1.5 GHz	E7401A
	9 kHz - 3.0 GHz	E7402A
	9 kHz - 6.7 GHz	E7403A
	9 kHz - 13.2 GHz	E7404A
	9 kHz - 26.5 GHz	E7405A
EMC Setup, Limit Lines, Correction Factors Disk		E7401-10004
Preamplifier		11909A
Biconical Antenna		11966C
Log Periodic Antenna		11966D
Bilog Antenna		11966P
Antenna Tripod		11968C

The Shielded Enclosure

A shielded enclosure 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 enclosure along with the antenna. The rest of the test equipment is typically located outside the chamber. Shielded rooms are also used quite often as a place to perform conducted emission measurements.

Shielded enclosures provide a quiet, ambient-free environment and protection from the weather at a moderate cost. A major drawback of shielded enclosures is, that since the surfaces are conductive, signals can experience multiple reflections within the chamber and set up standing waves. 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. Often anechoic material is applied to the walls and floors of a shielded enclosure to minimize the effects of these reflections.

Prepare the Analyzer for Measurement

You must set up the analyzer according to the type of precompliance measurement you are making.

In the following example, you will create a setup for testing the biconical range (30 – 300 MHz) of EN 55022 Class B Radiated Emissions.

The following equipment will be used:

- Internal Preamplifier
- 11966C Biconical Antenna
- 11966L Cable

NOTE The keypresses in the following procedures all start from front panel function keys. As you become familiar with the receiver, you will discover ways to reduce the number of keystrokes required.

Delete Pre-existing Setup Data

Before creating a new setup it is good practice to delete any pre-existing setup data.

Procedure 3-1 How to Delete Pre-existing Setup Data

Step	Comments
1 Preset Analyzer.	Press **Preset**.
2 Delete Limit Lines.	Press **Meas Setup**, **More 1 of 2**, **Limits**, **Delete Limits**, **Delete Limits**.
3 Delete Antenna Corrections.	Press **Meas Setup**, **More 1 of 2**, **Corrections**, **Modify**, **Select**, **Antenna**, **Delete**, **Delete**.
4 Delete Cable Corrections.	Press **Meas Setup**, **More 1 of 2**, **Corrections**, **Modify**, **Select**, **Cable**, **Delete**, **Delete**.
5 Delete Other Corrections.	Press **Meas Setup**, **More 1 of 2**, **Corrections**, **Modify**, **Select**, **Other**, **Delete**, **Delete**.
6 Delete User Corrections.	Press **Meas Setup**, **More 1 of 2**, **Corrections**, **Modify**, **Select**, **User**, **Delete**, **Delete**.
7 Delete Signal List.	Press **MEASURE**, **More 1 of 2**, **Signal List**, **Delete Signals**, **Delete All**, **Yes**.

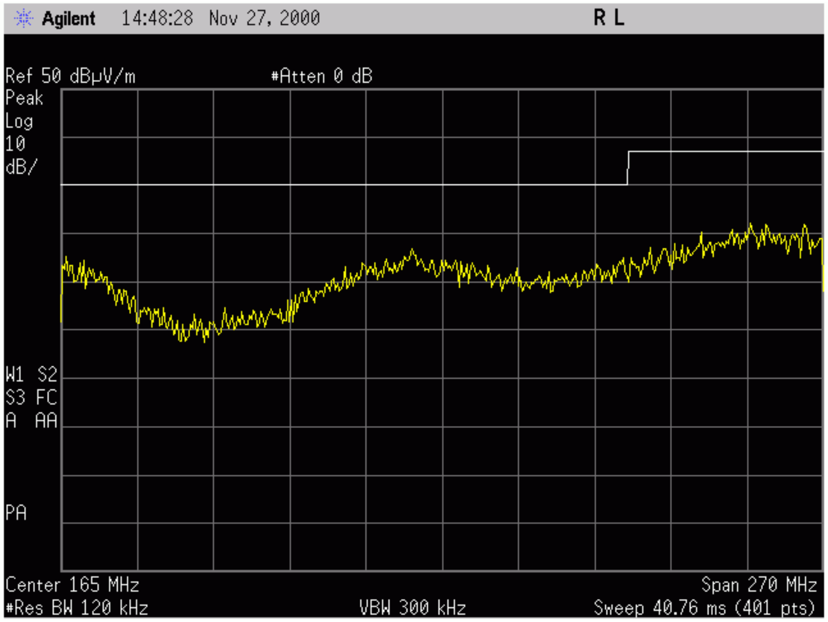
Create and Save the Demonstration Setup

Procedure 3-2 How to Create and Save the Demonstration Setup

Step		Comments
1 Set the receiver band to be tested.	• Press **Meas Setup**, **30 – 300 MHz**.	• Note that when this band is selected, all the analyzer settings for a CISPR measurement in this frequency range are preset. • See the User's Guide for information regarding which settings a preset affects and what their default values are.
2 Insert the diskette.	• Place the Limit Line and Transducer Factor floppy disk (E7401-10004) into the analyzer disk drive (the label should face outward to the right).	• Refer to Appendix B , "Disk Contents: Limit Lines and Transducer Factors," for a listing of the contents of this disk.
3 Set Marker Search parameters.	a. Press **Search**, **More 1 of 2**, **Search Param**, **Peak Search Param**. b. Press **Marker**, **Off**.	• This sets **Search** so that it always obeys peak search and peak threshold settings.
4 Select the limit (1 or 2) into which this limit should be loaded.	Press **File**, **Load**, **Type**, **Limits**, **Destination**, **Limit 1**.	
5 Select the A: drive and load the EN55022 Class B Limit into Limit Line 1.	a. Select the drive. b. Use the ↑↓ keys or knob to select **EN22BR10.LIM** and press **Load Now**.	• If you are unsure as to how to select a drive, please refer to "Specify a Drive" on page 134.
6 Select and load the biconical antenna corrections.	a. Press **File**, **Load**, **Type**, **More 1 of 2**,**Corrections**. b. Use the ↑↓ arrow keys or knob to select **HP11966C.ANT**. c. Press **Load Now**.	• Loading the 11966C.ANT file automatically corrects the displayed trace using the antenna factors. • An "A" appears in the left-hand annotation field, indicating amplitude correction is applied.

Procedure 3-2 How to Create and Save the Demonstration Setup (Continued)

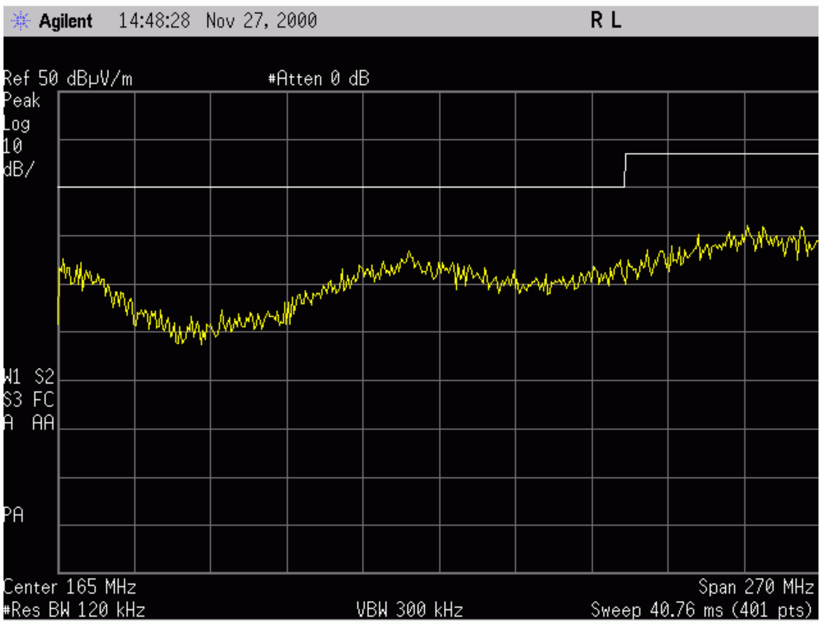
Step		Comments
7 Load the 10 m cable corrections.	a. Press **File**, **Load**, **Type**, **More 1 of 2**,**Corrections**. b. Use the ↑↓ arrow keys or knob to select **HP11966L.CBL**. c. Press **Load Now**.	
8 Activate the internal preamp.	Press **Meas Setup**, **More 1 of 2**, **Int Preamp On**.	• For further information refer to "When to Use Internal or External Preamplification" on page 74.
9 Set attenuation to 0 dB.	Press **AMPLITUDE**, **Attenuation** 0 dB.	
10 Set reference level to 50 dBμV/m	Press **AMPLITUDE**, **Ref Level** 50 dBμV/m.	
11 Save this setup to a disk in A: as RADDEMO1.	a. Press **Meas Setup**, **Save Setup**, **Name** and use the Alpha Editor and the numeric keypad, or an external keyboard, to name the file **RADDEMO1**. b. Press **Save Now**.	• Use a blank, formatted disk. • Note that saving a complete setup can take as long as 2 minutes.



Load Radiated Emissions Demo Setup File

Procedure 3-3 How to Load the Demonstration Setup

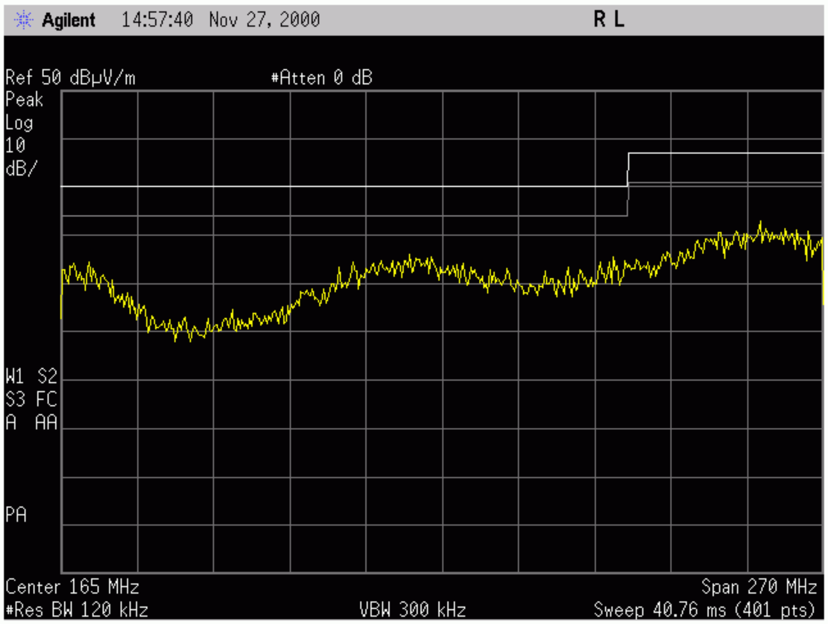
Step		Comments
1 Insert the diskette on which you saved the setup you created in "Create and Save the Demonstration Setup" on page 41.	• Place the floppy disk into the Analyzer disk drive (the label should face out).	
2 Select the setup file type.	• Press **Meas Setup**, **Load Setup**.	
3 Select and load the setup file RADDEMO1.SET.	a. Select the A: drive.	• If you are unsure as to how to select a drive please refer to "Specify a Drive" on page 134.
	b. Use the ↑↓ arrow keys or knob to select **RADDEMO1.SET** and press **Load Now**.	• Note that you can also simply load the **RADDEMO.SET** file from the Limit Line and Transducer Factors Disk. This file will load the setup as it was specified above.



Specify the Limit Line Margin (Optional)

Procedure 3-4 How to Specify the Limit Line Margin

Step		Comments
1 Go to the Limits menu screen.	• Press **Meas Setup**, **More 1 of 2**, **Limits**, **Modify**.	
2 Make sure you are specifying the margin for Limit Line 1.	• Select **Limit 1**.	
3 Set and activate the margin.	a. Select **Margin On**.	• This will set the margin value to 6 dB below the limit value.
	b. Using the numeric keypad, specify 6 **–dB**.	• When a limit line margin has been defined, the Auto-measure function can be used to gather all signals greater than the margin.



Preview EUT Emissions

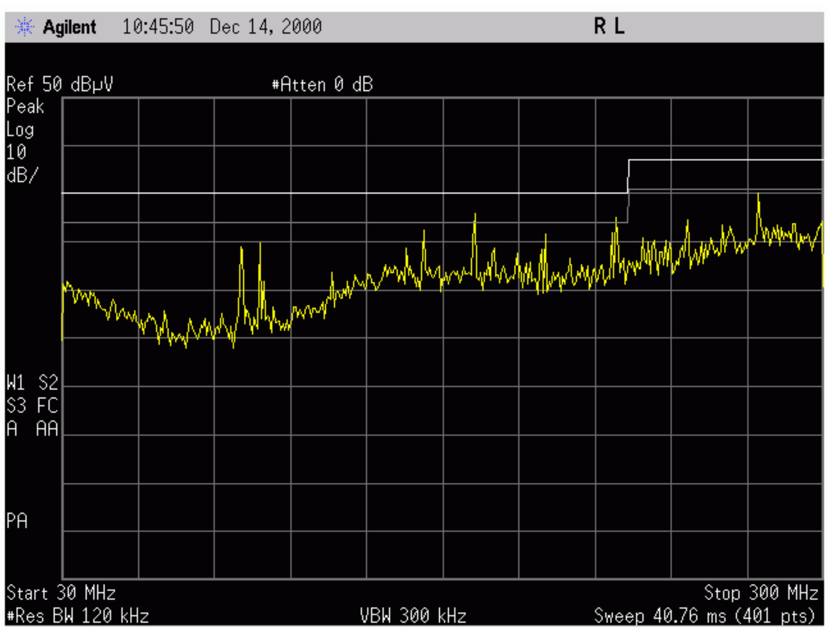
It is often useful to view the EUT emissions visually prior to beginning an EMI test. This allows you to determine right away whether or not there are obvious areas of failing emissions that may need to be addressed. Previewing emissions also provides a way for you to vary the operating state of the EUT and EUT cable orientations to determine which specific state(s) or orientations may cause emission levels to increase.

Viewing emissions over a wide span like this can also be useful when troubleshooting and attempting to reduce harmonically related emissions. Often reducing these harmonic emissions in one frequency area will cause them to increase in another.

Turn on the EUT and Preview Emissions over the full setup frequency range.

Procedure 3-5 How to Preview Radiated EUT Emissions

Step	Comments
1 Turn on the EUT and view EUT emissions.	• Vary the operating state of the EUT and the EUT orientations while monitoring the analyzer display, to determine which EUT state and/or orientations to use for your test.

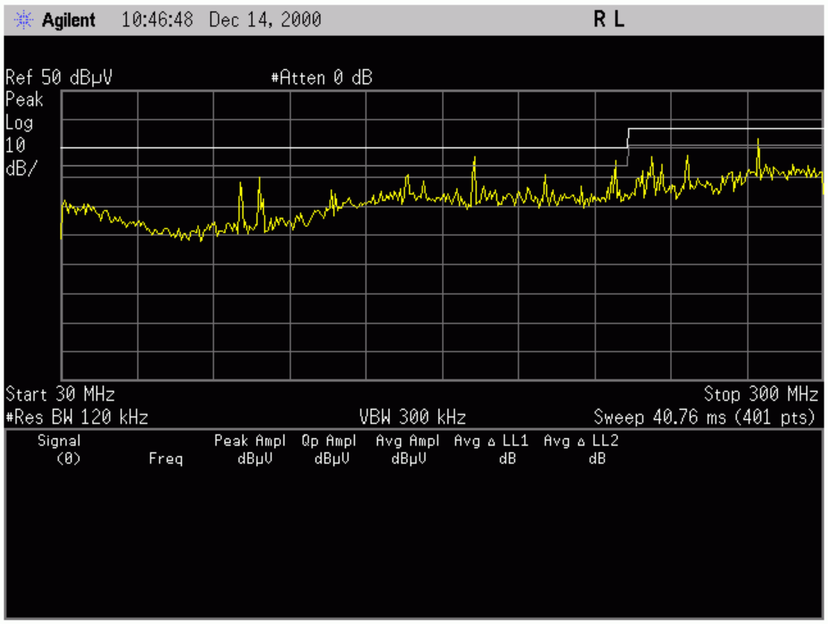


Generate EUT Signal List

Make Sure you are Starting with a New Signal List

Procedure3-6 ***How to Check the Contents of a Signal List***

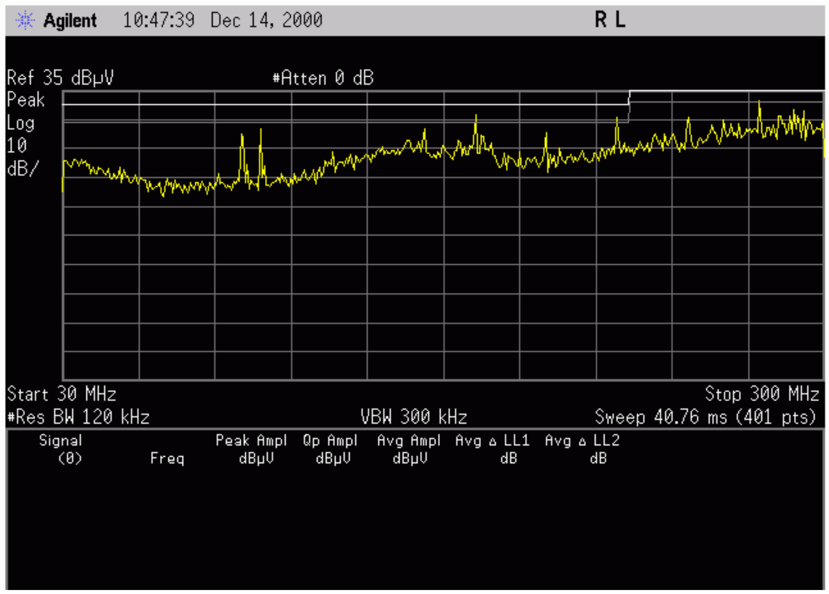
Step	Comments
1 Display the Signal List screen.	• Press **MEASURE**, **More 1 of 2**, **Signal List**, **Signal List On**.
2 If the list is not empty, delete its contents.	• Press **Delete Signals**, **Delete All**, **Yes**.



Optimize the Dynamic Range

Procedure 3-7 How to Optimize the Dynamic Range

Step		Comments
1 Move highest signal close to the top of the screen.	a. Press **AMPLITUDE**, **Ref Level**. b. Use the ↑↓ arrows to move the highest signals close to the top of the screen.	• Keeping the signals to be measured close to the top of the screen will optimize the analyzer's dynamic range.



IF Overload Detection and Correction

Signals must be set below the top of the screen to prevent IF overload. If one or more signals are above the top graticule of the analyzer display, increase the reference level until all the signals lie below the top of the graticule.

NOTE See "IF Overload Detection and Correction" on page 80 for a more comprehensive discussion of IF overload.

NOTE If you are in the 200 Hz bandwidth (CISPR Band A) and the analyzer experiences an IF overload, an overload message will appear. In this case, increase the reference level until the overload message disappears.

RF Overload Test

Prior to making measurements, ensure that the analyzer is not in an RF overload state. RF overloads occur when the energy level at the input mixer of the analyzer is higher than the mixer's linear operating range. This means that the mixer is in compression, which can cause errors in amplitude measurements.

NOTE See "RF Overload Detection and Correction" on page 77 for a more comprehensive discussion of RF Overload.

Procedure 3-8 How to Identify and Remove an RF Overload

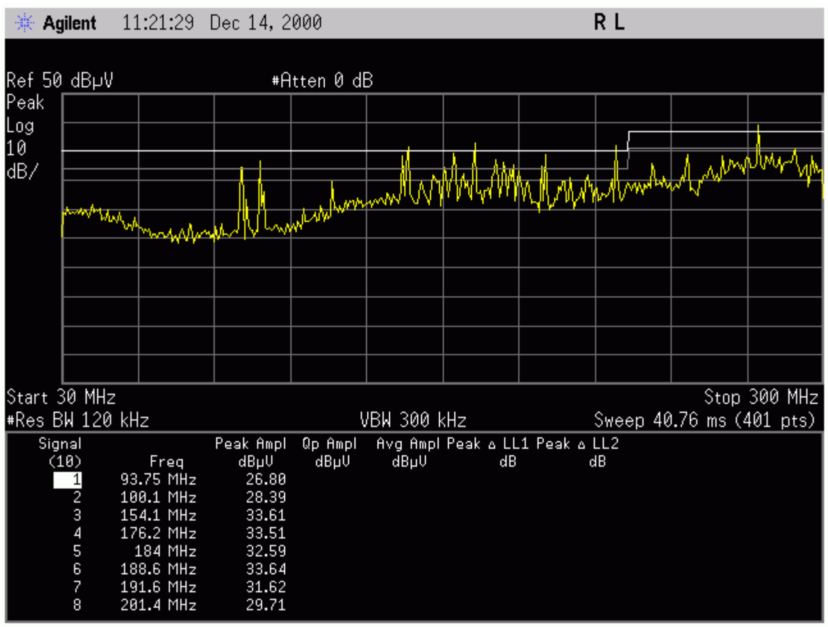
Step		Comments
1 Prepare the analyzer for measurement.	• Check your setup parameters. If necessary, recall your setup.	• If you are unsure how to set up the analyzer see "Set up the Analyzer for a Measurement" on page 107.
2 Check for overload.	a. Press **AMPLITUDE**, **Attenuation Man**. b. Press ↑ to step the attenuator while monitoring the output trace level on the display. c. Continue to step up the attenuator in 5 dB steps, until you no longer see a change in the level of the trace d. If you did *not* experience an overload, reset the attenuation to your original value.	• If the amplitude level of the signals change as the attenuation is increased, then the analyzer is still in an RF overload condition.
3 Save any new attenuation value.	• Press **Meas Setup**, **Save Setup**.	• If an overload required that you set the attenuation manually, you may want to resave your setup.

Use Automeasure to Generate a Signal List

NOTE You can select the detectors you need. Often for precompliance purposes, measuring with only the peak detector is adequate if the emissions fall below the limit line, but other detectors can be selected if desired.

Procedure 3-9 How to Use Auto-measure to Generate a Signal List

Step		Comments
1 Select Peak Detector only for this measurement.	• Press **Meas Setup**, **More 1 of 2**, **Meas Detector**, **Peak On**, **Quasi-Peak Off**, **Average Off**.	• Other detectors can be selected if desired.
2 Prepare for the measurement.	• Press **MEASURE**, **More 1 of 2**, **Auto-measure**, **Sigs > Margin On**.	
3 Start the measurement.	• Press **Start**.	



When the automeasure process in complete, the emissions above the limit line margin will be displayed in the signal list with the measured peak amplitude.

Moving the Marker to a Signal in the List

The ability to move the marker to an emission frequency allows you to readily remeasure that emission if desired. The following procedure describes how to move the marker to a signal in a list.

Procedure 3-10 How to Move the Marker to Signals in the Signal List

Step		Comments
1 Activate your signal list.	• Press **MEASURE**, **More 1 of 2**, **Signal List**, **Signal List On**.	• This highlights the signal list, activating it and making it convenient to remeasure signals in the list.
2 Move the cursor up and down the list.	• Use the ↑↓ arrows or the knob to select a signal.	• Note that the marker only moves to the signals in the list.

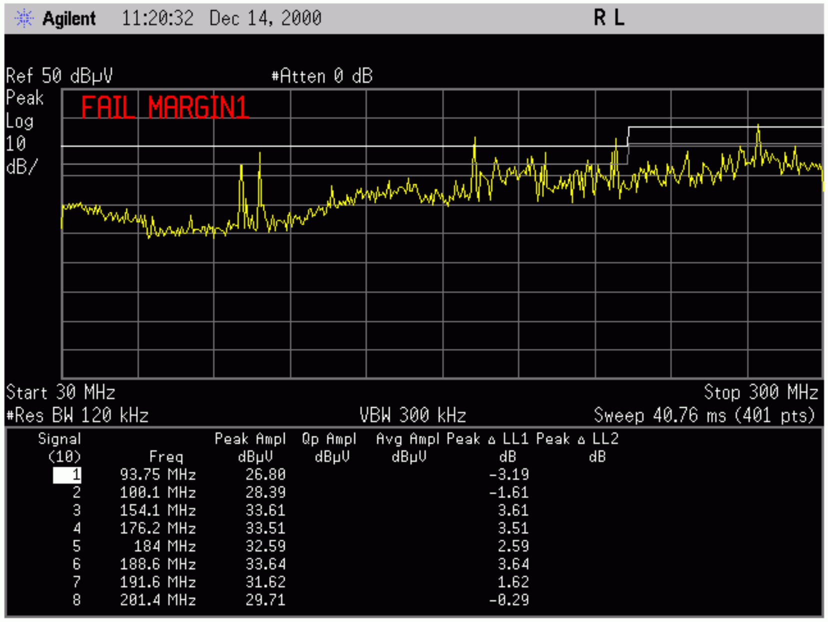
Comparing Emission Levels to a Limit Line

Comparing emission levels to the limit line allows you to quickly identify which emissions may need to be reduced in amplitude and by how much, in order to pass the limit.

Procedure 3-11 How to Compare Emission Levels to a Limit Line

Step		Comments
1 Turn testing on.	• Press **Meas Setup**, **More 1 of 2**, **Limits, Modify**, **Test On**.	• If an emission is over the limit line (or margin, if selected), a FAIL LIMIT (or FAIL MARGIN) message will appear on the screen.
2 View the emissions peak amplitude delta.	• Press **MEASURE**, **More 1 of 2**, **Signal List**, **List Edit**, **Peak Ampl On**.	• The amplitude difference between the highlighted signal measured, and the limit line will appear in the 6th signal list column.

Procedure 3-11 How to Compare Emission Levels to a Limit Line

Step	Comments
	
3 Turn testing off.	• Press **Meas Setup**, **More 1 of 2**, **Limits**, **Modify**, **Test Off**. • This turns limit line testing off.

Save your Signal List

During radiated emissions testing, the EUT emissions must be measured at several turntable angles, antenna heights and vertical/horizontal polarizations, in an attempt to maximize EUT emissions.

A good practice is to determine a file naming convention that will help you remember all of these equipment orientations for the EUT emissions frequencies gathered.

For example, if the turntable was at 45 degrees, antenna height 200 cm and the polarization was vertical when you gathered the signals on your list, you might choose to name the file: 045V200 (see "File Naming Rules" on page 136 for information on file naming conventions).

Use the following procedure to save the signal list to a floppy disk:

Procedure 3-12 How to Save Signals

Step		Comments
1 Select the file type.	a. Press **MEASURE**, **More 1 of 2**, **Signal List**, **Save/Load**, **Save**. b. Use the Alpha Editor and the numeric keypad, or an external keyboard, to enter **045V200**. Press **Enter**.	• For your own measurements you would, of course, supply your own file name.
2 Save the new file.	a. If you are unsure how to select a drive, please see "Specify a Drive" on page 134. b. Press **Save Now**.	

Delete the Old Signal List

Once your signals have been saved, you will want to delete your last signal list to prepare for measurement at subsequent EUT orientations (turntable angles), antenna heights and polarizations.

To delete your signal list:

Procedure 3-13 How to Delete a Signal List

Step		Comments
1 Delete Signal List.	• Press **MEASURE**, **More 1 of 2**, **Signal List**, **Delete Signals**, **Delete All**, **Yes**.	

Generate EUT List for Each Orientation

Repeat the process "Generate EUT Signal List" on page 46 for each EUT orientation (turntable angle), antenna height and polarization desired.

If emissions on the display are well below your limit line or margin you may choose not to gather signals in that orientation.

Load and Append Signal Lists

Once all the signal lists have been created and saved you may combine all the lists together to determine maximum emissions measured, as described in the procedure below.

Procedure 3-14 How to Load and Append Signal Lists

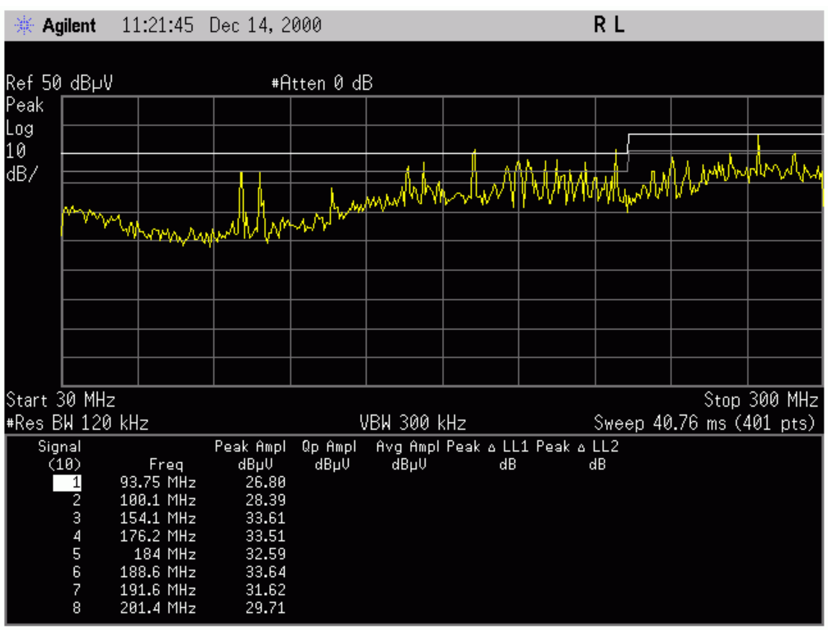
Step		Comments
1 Go into the list file manager.	• Press **MEASURE**, **More 1 of 2**, **Signal List**, **Save/Load**, **Load**	
2 Select the drive where the file is located.	• If you are unsure how to select a drive, please see "Specify a Drive" on page 134.	
3 Select the file.	• Use the knob or ↑↓ arrows to select the correct file name.	
4 Load the file.	• Press **Load Now**.	• The selected signal list will get appended to any other signal list currently in the analyzer memory. • The total number of signals in the list cannot exceed 2000.
5 Repeat 1-4 for each file to be appended.		• If you wish to view the signals below the bottom of the screen, press **Signal List On** to make the list active and scrollable.

Mark and Delete Lower Duplicates

Duplicates are multiple signals recorded at the same frequency. The lower amplitude duplicate signals in the combined list can be marked and deleted, leaving only those with the maximum amplitude.

Procedure 3-15 How to Mark and Delete Lower Signal Maximums

Step		Comments
1 Mark lower duplicate signals.	• Press **MEASURE**, **More 1 of 2**, **Signal List**, **Signal Marking**, **Select Marks**, **Mark Lwr Dups**.	
2 Delete lower duplicate signals.	• Press **Return**, **Return**, **Delete Signals**, **Delete Mrkd**, **Yes**.	• This may take a few seconds.
3 Sort the signals.	• Press **Return**, **Sort Signals**, **By Freq Asc**.	• This will sort the remaining signals in the list by ascending frequency.
4 Save the list of signal maximums.	a. Press **Return**, **Save/Load**, **Save**. Use the alpha softkeys and/or numeric keypad to specify a file name. b. Specify the drive. c. Press **Save Now**.	• If you are unsure how to select a drive please refer to "Specify a Drive" on page 134.



Compare Emission Levels in the List to Limit Values

Procedure 3-16 How to Compare Emission Levels in the List to Limit Values

Step		Comments
1 Turn testing on.	• Press **Meas Setup**, **More 1 of 2**, **Limits**, **Modify**, **Test On**.	
2 Activate the signal list.	• Press **MEASURE**, **More 1 of 2**, **Signal List**, **Signal List On**.	
3 View the emissions peak amplitude delta from the limit line.	• Press **List Edit**, **Peak Ampl On**.	• The amplitude difference between the selected list item and the limit line will appear in the 6th signal list column. • Ignore the trace information. It does not display list information.
4 Turn testing off.	• Press **Meas Setup**, **More 1 of 2**, **Limits**, **Modify**, **Test Off**.	• This turns limit line testing off. • If your emissions fail the limit, you may want to perform further Troubleshooting or Diagnostics.

Using your Signal List to Perform Further Testing

After you have gathered a signal list, you may use this list in different ways, for example:

- You may want to tune to the signals in the list that are greater than a predetermined level in order to perform additional troubleshooting.
- You may want to take the signal list to an Open Area Test Site (OATS) for further maximization and testing.

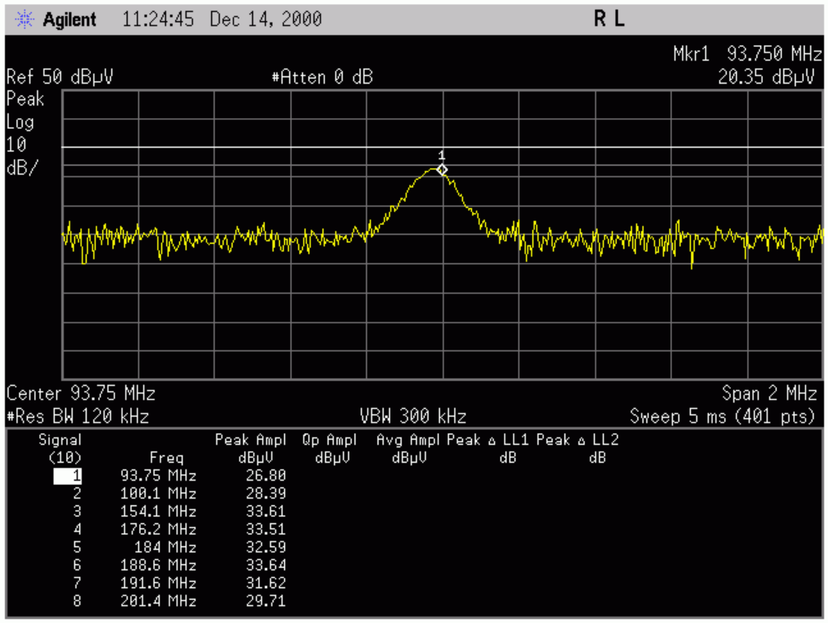
The following example shows how this list might be used when remeasuring signals on an OATS.

Work from the list of maximized emissions gathered in the previous steps.

Procedure 3-17 How to tune the EMC Analyzer to the signals in the list, remaximize and remeasure

Step		Comments
1 Narrow the span setting of the EMC Analyzer.	• Press **SPAN**, **Span**, 2 **MHz**	• This allows you to view the frequency spectrum only around the list signal frequency.
2 Tune the receiver to the first signal in the list.	• Press **MEASURE**, **More 1 of 2**, **Signal List**, **Signal List On** • Press the ↑ arrow then the ↓ arrow.	• The EMC Analyzer will tune to the first frequency in the list. The marker should be positioned on the emission.
3 Orient the EUT, the antenna height and the polarization for the highest signal amplitude.	• Maximize the signal of interest.	• In this step, you may want to take additional steps to make sure the emission is due to the EUT and is not an ambient. • Tip: Refer to "Manual Maximization (using Max Hold)" on page 91.

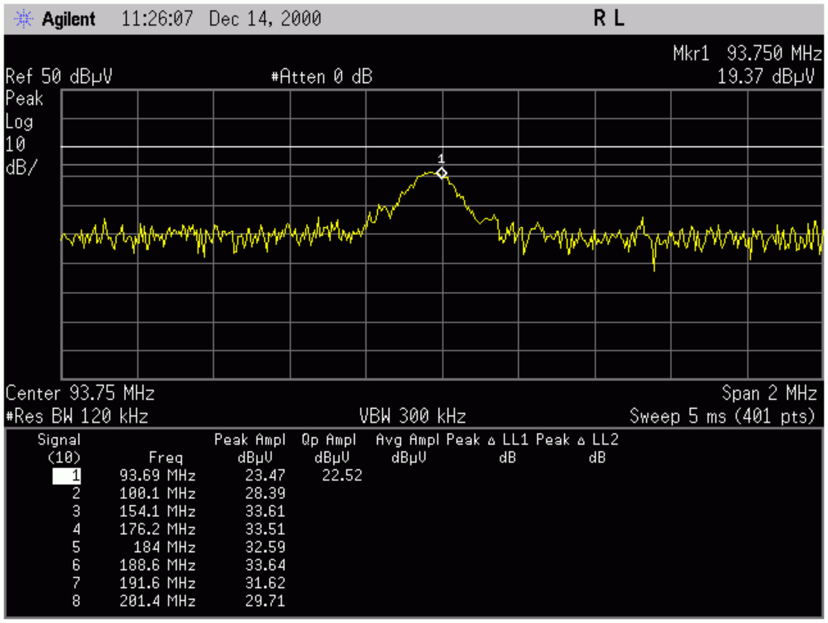
Procedure 3-17 How to tune the EMC Analyzer to the signals in the list, remaximize and remeasure (Continued)



Step		Comments
4 Select the Peak and Quasi-Peak detectors for measurement.	• Press **Meas Setup**, **More 1 of 2**, **MeasDetector**, **Peak On**, **QuasiPeak On**	• Other detectors can be selected if desired.
5 Remeasure the list signal that you are tuned to.	• Press **MEASURE**, **More 1 of 2**, **Signal List**, **Remeasure**, **Remeasure**	• Notice that the peak and the quasi-peak amplitudes will both be remeasured and displayed in the signal list.

Procedure 3-17 How to tune the EMC Analyzer to the signals in the list, remaximize and remeasure (Continued)

Step	Comments
6 Repeat this process for each signal you wish to remeasure.	



Generate Measurement Output

Use the following procedures to print out important measurement information.

Printing Screens

Procedure 3-18 How to print out the analyzer screen

Step		Comments
1 Print out screen contents.	• Press **Print Setup**, **Print Screen**, **Print**.	• This will print out what is displayed on the analyzer screen. • **Hint:** To improve the output appearance, press Esc to clear screen messages before printing. • **Hint:** If you don't want the softkey menu to appear on the output, expand the display to full screen by pressing **Display**, **Full Screen** prior to printing. • For information on saving screens to disk, please refer to "Save/Edit/Recall" on page 134.

Printing Reports

Procedure 3-19 How to print out report information

Step		Comments
1 Print out Report contents.	• Press **Print Setup**, **Print Report**, **Print**.	• This will print out a report which can include the current screen, signal list, corrections, limits and analyzer settings. • For information on how to generate report information, please refer to "Generate Reports" on page 138.

4 Measurement Techniques

In this Chapter. . .

Making Automatic Measurements

Automatic measurements can be performed in two ways: either by using the **Meas at Marker** function or by using the **Auto-measure** function.

- The **Meas at Marker** function makes an automatic measurement using any detectors that have been specified during measurement setup. If a marker has been turned on, the measurement will be performed at the marker position. If no marker is present on the screen, then one is turned on and placed on the highest peak on the screen.

  During measurement, the span is reduced to 2 times the resolution bandwidth and the signal peak is located on the screen. In the background, the analyzer tunes to this zoomed signal peak in zero span and dwells at this state for the dwell time specified by the value of the **Range Dwell** function ("Dwell Time Settings" on page 63).

  The signal is then ranged to the top of the screen and a measurement using the dwell time associated with each of the selected detectors (peak, quasi-peak or average) is performed.

- The **Auto-measure** function gathers a list of signals that meet or exceed a user-specified marker peak or limit line margin criteria. After the list of signals is gathered, this function performs a **Meas at Marker** on the signals gathered.

When performing measurements with **Meas at Marker** or **Auto-measure** it is important to understand how some of the analyzer settings can affect the measured results. It is also important to understand the nature of the EUT emission(s) that your are attempting to measure. For example:

- Is the emission CW in nature?
- Is the emission broadband or narrowband relative to the analyzer's measurement bandwidth?
- Is the emission periodic or time varying?

These factors can effect what analyzer settings you will choose you attempt to optimize the measurement of EMI emissions.

There are several settings that affect how the {Meas at Marker} performs measurements:

- The dwell time settings, **Peak**, **Quasi Peak**, **Average** and **Range Dwell** are the primary settings affecting how **Meas at Marker** is carried out.
- The marker search keys, **Peak Threshold**, **Peak Excursn**, **Peak Search** keys allow you to position the marker on the peaks of the signals you want to measure.

These settings will be discussed in the sections that follow.

Dwell Time Settings

When performing a **Meas at Marker**, the dwell time settings that you select will depend on the characteristics of the emission you are measuring. The default dwell time (200 ms) should work well for typical EUT emissions, but sometimes you will encounter emissions for which the defaults are not optimal. This is especially the case for emissions that vary slowly over time or have a slow repetition rate. By lengthening the dwell times you can increase the likelihood of accurately measuring these low repetition rate signals.

Within the **Meas at Marker** function, the analyzer dwells for a specified period of time before adjusting the signal peak to the top of the screen for further measurements.

This dwell time may be adjusted using the **Range Dwell** setting. If a signal’s repetition period is greater than 200 ms (the default setting), the **Range Dwell** time should be increased to capture at least two and preferably more repetitions of the signal (or signal peak). The range dwell setting should also be set greater than or equal to the longest dwell time of any detector that is turned on. This will assure that the reference level is properly adjusted prior to performing the measurement with the detectors that are turned on.

After the appropriate reference level has been selected, the receiver dwells in zero span before performing a measurement with each detector. The **Peak**, **Quasi Peak** and **Average** detectors each have their own independent dwell time settings. If the signal's repetition period is greater than 200 ms (the default setting), the dwell time should be increased to capture at least two and preferably more repetitions of the signal. Additionally, if you do not need or wish to use a detector to make a measurement, that specific detector may be turned off.

Procedure 4-1 How to specify range and detector dwell times

Step		Comments
1 Select the appropriate detector(s) and dwell time settings.	a. Press **Meas Setup**, **More 1 of 2**, **MeasDetector**.	
	b. If a range dwell time is desired other than the default (200 ms) press **Range Dwell** and use the knob or numeric keypad to select a dwell time.	• Increasing the Range Dwell and detector dwell times is recommended if the signal has a repetition rate slower than 10 Hz.
	c. If a detector dwell time is desired other than the default for one or all of the detectors (Peak, Quasi Peak or Average) press the appropriate softkey (for example **Peak** and use the knob or numeric keypad to select a detector dwell time.	

Setting Search Criteria

The **Peak Search**, **Peak Excursn** and **Peak Threshold** settings determine how the marker will find signal peaks.

The **Peak Search** setting determines how a signal peak will be found when the **Search** key is pressed. The **Peak Search** key has two modes Param and Max. When the Max mode is selected, pressing **Search** will place the marker on the highest peak on the screen (it automatically ignores the LO if it is displayed). In the Param mode, the **Search** function will obey search rules set by the **Pk Threshold** and **Pk Excursn** settings. For EMC measurements it is often best to set the **Peak Search** to the Param mode.

The **Pk Threshold** sets a boundary above which trace excursions can be identified as signal peaks. For a trace excursion to be identified as a signal peak when the peak threshold is lower than the noise floor, it must rise and fall above the noise floor by the peak excursion value. For a trace excursion to be identified as a signal peak when the peak threshold is set higher than the noise floor, it must rise and fall above the threshold by the peak excursion value. The peak threshold boundary is defined in amplitude units that correspond to its vertical position compared to the reference level. For example, if the reference level is 70 dBμV and the peak threshold is set to 20 dBμV, the peak threshold will remain 50 dB below the reference level as the reference level is changed. The threshold is always active even when it is not displayed. In the **Meas Setup** bands, the default threshold value is 16.99 dBμV (–90 dBm). For typical EMC measurements, it is best to set the **Pk Threshold** to the bottom of the screen so that it does not affect the peak excursion above the noise floor. For example, if the reference level is 107 dBμV, set the **Pk Threshold** to 7dBμV.

The **Peak Excursn** setting sets the minimum amplitude variation of a trace rise and fall that can be identified as a signal peak. For example, if you want to measure only signals that extend 10 dB or more out of the noise floor (or peak threshold value if it is set higher), you would set this value to 10 dB. The marker next left or right peak would only move to signals that rise and fall more than 10 dB out of the noise floor (or peak threshold value if it is set higher). It is good practice for EMC measurements to optimize the peak excursion value so that noise is not selected as a peak by the marker but desired signals are. The default setting for the peak excursion is 6 dB.

Procedure 4-2 How to set peak search parameters

Step		Comments
1 Set up the peak search criteria.	a. Press **Search**, **More 1 of 2**, **Search Param**.	
	b. To specify the Peak Excursion: Press **Peak Excursn** and use the knob or numeric keypad to specify a peak excursion value.	• A typical value for peak excursion is 6 dB (this is also the default).
	c. To specify the Peak Threshold: Press **Peak Threshold** and use the knob or numeric keypad to specify a value for the peak threshold.	
	d. Press **Peak Search Param**.	• Setting the Peak Search function to Param, ensures that the marker is placed on peaks that obey the peak criteria set using the Peak Excursion and Peak Threshold functions.

Using the Search Function

When performing measurements with **Meas at Marker**, it is often convenient to move the marker to new signal peaks using the marker **Search** function such as **Search**, **Next Pk Right**, **Next Pk Left** and the ↑ and ↓ arrows.

Procedure 4-3 How to use Search

Step		Comments
1 Select the appropriate frequency span for the measurement.		
2 Select a peak for measurement.	• Press **Search** and **Next Pk Right** or **Next Pk Left** to position the marker on a signal of interest.	• The marker will be placed at peaks which satisfies the specified peak search parameters.

Measure using Measure at Marker

Once the measurement and peak criteria have been specified and a peak has been selected, the measurement of the signal can proceed.

Procedure 4-4 How to use {Meas at Marker}

Step		Comments
1 Make the measurement.	Press **MEASURE**, **Meas at Marker**.	

Using Auto-measure

Since the **Auto-measure** function automatically searches for signal peaks and then calls the **Meas at Marker** function to measure those peaks, all of the settings described that affect the operation of **Meas at Marker** will also affect **Auto-measure**. Additional settings that affects the operation of **Auto-measure** are described below.

If a limit line margin is defined and on, when the **Sigs>Margin** is Off, Auto-measure will capture any signal that meets the peak criteria set by **Pk Threshold** and **Peak Excursion** settings. When the **Sigs>Margin** is enabled, Auto-measure will capture any signal that meets the peak criteria set by **Pk Threshold** and **Peak Excursion** and is greater than the limit line margin.

The frequency range over which **Auto-measure** will capture signals may be adjusted by setting the **Start Freq** and the **Stop Freq**.

Procedure 4-5 How to use {Auto Measure}

Step		Comments
1 Prepare the analyzer for measurement.		
2 Select the appropriate detector(s) and dwell time settings.	a. Press **Meas Setup**, **More 1 of 2**, **MeasDetector**. b. If a range dwell time is desired other than the default (200 ms) press **Range Dwell** and use the knob or numeric keypad to select a dwell time. c. If a detector dwell time is desired other than the default for one or all of the detectors (Peak, Quasi Peak or Average) press the appropriate softkey (for example **Peak** and use the knob or numeric keypad to select a detector dwell time.	
3 Set up the peak search criteria.	a. Press **Search**, **More 1 of 2**, **Search Param**. b. To specify the Peak Excursion: Press **Peak Excursn** and use the knob or numeric keypad to specify a peak excursion value. c. To specify the Peak Threshold: Press **Peak Threshold** and use the knob or numeric keypad to specify a value for the peak threshold. d. Press **Peak Search Param**.	• A typical value for peak excursion is 6 dB (this is also the default). • Setting the Peak Search function to Param, ensures that the measurement is made on peaks that obey the peak criteria that were set using the Peak Excursion and Peak Threshold functions.

Procedure 4-5 How to use {Auto Measure}

Step		Comments
4 Make the measurement.	a. Press **MEASURE**, **More 1 of 2**, **Auto-measure**.	
	b. To measure all the peaks that pass the specified peak search criteria press **Start**.	
	c. To measure only those peaks that pass the limit line margin, press **Sigs > Margin**, **Start**.	• Note that you must have specified a limit line and a limit line margin in order to activate the **Sigs > Margin** function.

Making Quasi-peak and Average Measurements

Besides the options available for making automatic measurements (as described in "Making Automatic Measurements" on page 62), it is possible to measure signals manually (that is, without using the Measure at Marker or Auto-measure functions), by activating the Peak, Quasi Peak or Average detectors in manual mode.

Manual measurements are necessary when your signal is unstable, drifting, or broadband in nature. In these cases, a measurement at a fixed frequency (that is, zero span) may not capture the maximum signal amplitude or may miss the signal entirely. This results in erroneous test data since the emissions amplitude is not captured completely.

Manual measurements are often made over a frequency span, ensuring that the signal is captured correctly.

Peak detection can be used to quickly scan over the frequency range of interest. Since peak detected amplitudes are always greater or equal to quasi-peak and average amplitudes, this type of measurement yields the worst-case results. After a peak measurement is made, those segments of the spectrum which require further analysis can easily be identified. Such analysis and investigation can be carried out using quasi-peak and average detection.

The Quasi-peak Detector

The implementation of the quasi-peak detector, as called out in CISPR 16 Part 1 (1998), consists of a circuit with a specific charge and discharge constant, depending on the measurement frequency range. This detector weights broadband signals as a function of repetition rate. Lower repetition rate emissions cause a lower annoyance factor and thus gets less emphasis. Higher repetition rate signals cause more annoyance in broadcast systems and are emphasized more by the quasi-peak detector. As the repetition rate approaches that of a CW signal, (that is, 100% duty cycle), it reaches the maximum interference potential and therefore no weighting is applied at all. This results in the maximum level at the detector output.

The quasi-peak detector circuit also includes a network that simulates an analog meter movement. This time constant provides a smoothing function to the signal at the output of the previous detector stages so that a single value reading can be obtained. The quasi-peak value will always be less than or equal to the peak value of the emission.

The Average Detector

The average detector is used in measurements of narrowband signals for overcoming problems associated with either modulation content or the presence of broadband noise. Using the average detector it is possible to recover the amplitude of any narrowband signal that might be buried beneath broadband signals, such as pulses or a modulation envelope.

This detector does this by stripping the modulation content from narrowband signals and suppressing the broadband signal content in the spectrum of interest. This makes it possible to measure the amplitude of the remaining carriers.

The use of average detection, when measuring narrowband signals, is based on the observation that combined narrowband and broadband signals may cause more annoying interference than is indicated by a quasi-peak measurement alone. Since a quasi-peak detector responds predominantly to the peaks of a broadband impulsive signal, the pulses may mask a lower amplitude continuous sine wave signal. The characteristics of the average detector, on the other hand, very effectively suppress broadband impulsive signals and recover the amplitude of the underlying sine wave or narrowband signal.

Making a Quasi-peak or Average Measurement

Manual quasi-peak and average measurements over *frequency spans* can be made using the procedure described here.

Procedure 4-6 How to make a quasi-peak measurement

Step		Comments
1 Specify a frequency span of interest.	a. Press **Meas Setup** and select the band of interest. b. Observe the trace to determine locations of suspect signals.	
2 Adjust the sweep time if necessary.	• Press **Sweep**, **Sweep Time** and use the numeric keypad or knob to specify a value that produces a stable signal on the screen.	• To capture broadband signals adequately, a longer sweep time may be required. This allows more spectral components of the broadband signals to be displayed in the selected frequency span, making the identification of critical segments of the spectrum easier.

Procedure 4-6 How to make a quasi-peak measurement (Continued)

Step		Comments
3 Identify the critical frequency segment.	a. Press **Marker**, **Normal**. b. Use the knob to scroll the marker to the start or stop frequency of the critical frequency segment. c. Press **Marker**, **Delta** and use the knob to scroll to the other frequency boundary, defining the critical frequency segment. d. Press **Marker ->**, **Mkr Δ-> Span** to enter the frequency range defined by the normal and Δ markers.	• You are using the marker functionality to identify a critical segment in the peak detected spectrum of interest. • The frequency range defined by the normal and Δ markers will be the span within which the new measurement sweep will take place.
4 Make the quasi-peak measurement.	• Press **Det/Demod**, **EMI Detector**, **Quasi Peak**.	• When you press **Quasi Peak**: a. The autorange function is invoked to adjust the peak of the trace close to the reference level. b. The display mode will be changed to Lin, because the Quasi Peak detector requires a linear amplification for undistorted display and accurate measurement. c. The sweep time is calculated and applied to the span to be measured. d. The sweep begins. • Note: If, after pressing **Quasi Peak** your measurement lies at the bottom graticule of the screen, use the x10 function to change the reference level (see Procedure 4-6 below).

When to use QP/AVG X10 Gain

When using the quasi-peak or average detector, the EMC analyzer is in linear display mode. Because the digital display has 10,000 display points to represent the measured amplitude values, a signal at the reference level has a digital value of 10,000 display units. A midscreen signal is 6 dB down and has a value of 5000 display units. The smallest display unit is 1/10000 or 80 dB down. This is enough dynamic range to make a quasi-peak or average measurement, but the screen resolution decreases with lower amplitudes. To address the need for improved resolution, a post detection gain (x10Gain) can be switched into the signal path to raise the signal amplitude on the display by 20 dB and thus improve the screen resolution.

NOTE This function is only available if either Quasi Peak or Average functions have been selected in the EMI Detector menu as described in "Making a Quasi-peak or Average Measurement" above.

Procedure 4-7 How to add gain to improve screen resolution

Step		Comments
1 Add gain to improve screen resolution.	• Press **Det/Demod**, **EMI Detector**, **QP/Avg Gain x10**.	• The trace will rise by 20 dB. • The reference level setting is adjusted to account for the extra gain. • Even if signals exceed the reference level after the extra gain is applied, on-screen signals are still measured accurately.

Changing Detector Views

Changing detector views makes it possible to quickly switch back and forth between peak and quasi-peak/average measurements. Sweep times which have previously been used, are restored for each measurement type (peak or quasi-peak/average). By comparing peak, and average or quasi-peak, the data that describes signal characteristics (for example, narrowband or broadband type, modulation content, and so forth) can be obtained.

NOTE This function is only available if either Quasi Peak or Average functions have been selected in the EMI Detector menu as described in "Making a Quasi-peak or Average Measurement" above.

Procedure 4-8 How the change detector views

Step		Comments
1 Select the view of interest.	• Press **Det/Demod**, **EMI Detector**, **View Pk QP/Avg**. • Select either **Pk** or **QP/Avg** depending on which view is of interest.	• Note: the **View Pk QP/Avg** function invokes the measurement again, using the selected detector.

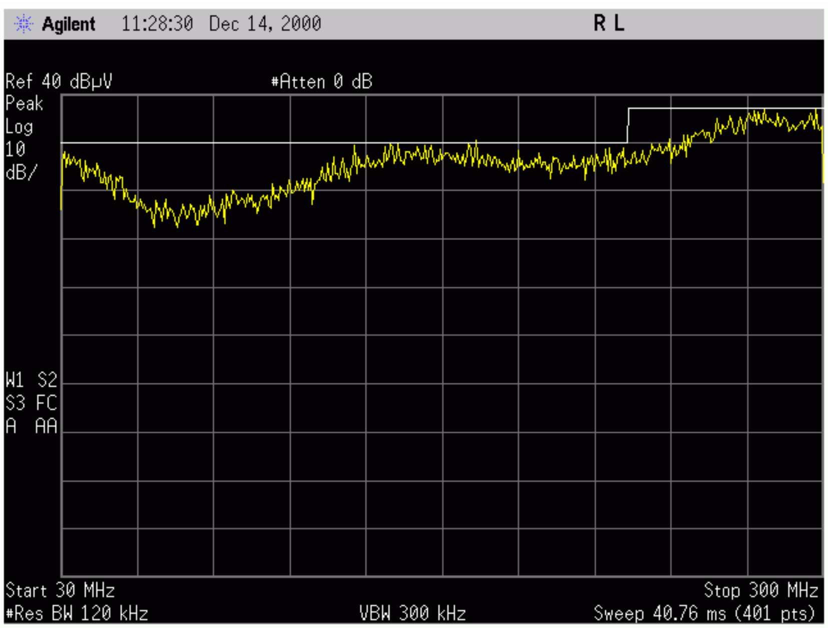
When to Use Internal or External Preamplification

In some instances, you may find it necessary to use a preamplifier in order to improve the noise figure of the emission measurement, and to compensate for transducer factors and losses in the measurement system.

The following describes the steps required to determine if you need to use internal or external preamplification.

1. Remove any inputs to the E7400A series EMC Analyzer.
2. Select the frequency band in which you wish to perform measurements.
3. Load the limit line of the regulation to which you wish to test.
4. Load the correction factors for the transducer and cable losses. (Note: Do not load corrections for an external preamp or turn the internal preamp on at this time).
5. Set the input attenuation to 0 dB, then adjust the reference level to position the lowest point on the limit line to within 10 dB or so from the top of the screen. The analyzer will be displaying the approximate best limit line to noise floor separation possible without utilizing a preamplifier.

Figure 4-1 ***Limit to Noise Floor Separation without a Preamplifier***

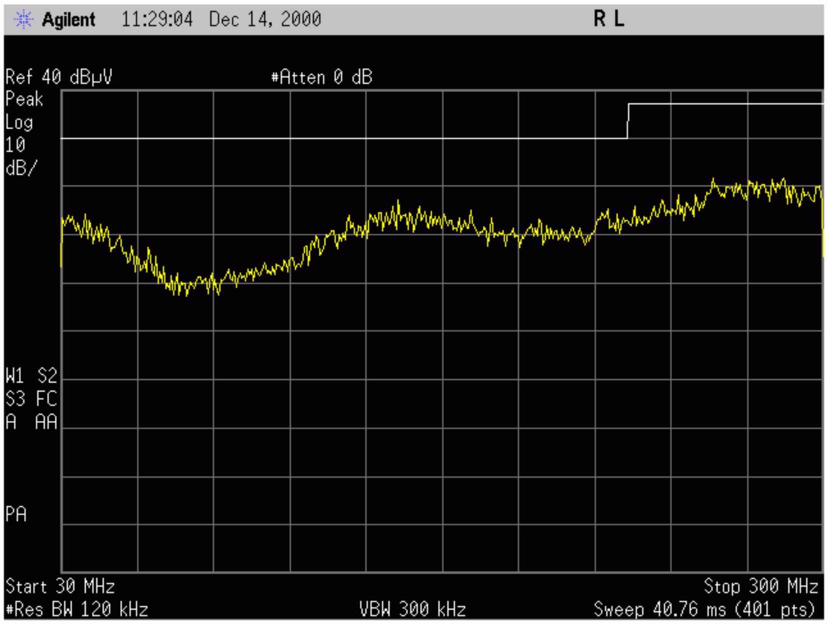


6. If you have adequate limit line to noise floor separation without using preamplification, and do not wish to use a preamp, you may

skip the rest of these steps. If the noise floor to limit line separation is not adequate for measuring your emissions, you may need to add internal or external preamplification.

7. The E7400A Series EMC Analyzers have a built in preamplifier that should provide adequate preamplification for most applications. Turn the internal preamp on. The limit line to noise floor separation should improve. The annotation “PA” will be displayed in the lower left corner of the display, indicating that the internal preamp is on.

Figure 4-2 ***Limit to Noise Floor Separation with the Preamplifier On***



8. Vary the attenuator setting, moving to higher values, and observe what happens to the limit line to noise floor separation. You may notice that as the attenuation is increased, the limit line to noise floor separation decreases. When performing measurements on signals that are close to the limit line you will need to avoid attenuation settings that result in inadequate limit line to noise floor separation. Otherwise the noise floor could hide emissions you wish to measure. It is good practice to set the RF attenuation as low as possible, being careful to avoid ensuing RF overload that could result if you are measuring low amplitude signals.

9. Return the attenuation to 0 dB.

10. Vary the reference level, as you increase its value, and observe what happens to the limit line to noise floor separation. You may observe that the limit line to noise floor separation will decrease as you increase the reference level past a certain point. When performing measurements on signals that are close to the limit line you will need to avoid reference level settings that result in an inadequate limit line to noise floor separation, otherwise the noise floor could

hide emissions you want to measure. It is a good practice to set the reference level so that the signal peak is close to the top of the screen, especially when measuring low amplitude signals.

11. If you have adequate limit line to noise floor separation using the internal preamp, you may not need to use an external preamp and you may choose to skip the rest of these steps. If you do not have enough limit line to noise floor separation to perform your measurement using the internal preamp, you may need to use an external preamp.

12. Turn off the internal preamp.

13. Load the correction files for the external preamp that you are using. Make sure that the preamp corrections are turned on. Connect the preamp output to the EMC Analyzers input. Terminate the input to the preamp.

14. Vary the attenuator setting, increasing its value, and observe what happens to the limit line to noise floor separation. You may notice that as the attenuation is increased, the limit line to noise floor separation decreases. When performing measurements on signals that are close to the limit line you will need to avoid attenuation settings that result in inadequate limit line to noise floor separation. Otherwise the noise floor could hide emissions you might want to measure. It is good practice to set the RF attenuation as low as possible, taking care not to generate an ensuing RF overload in cases where the signals have a low amplitude.

15. Return the attenuation to 0 dB.

NOTE When an external preamp is used, an external attenuator may be required in between the preamp and the transducer to check the external preamp for RF overload.

16. Vary the reference level increasing its value and observe what happens to the limit line to noise floor separation. You may observe that the limit line to noise floor separation decreases as you increase the reference level past a certain point. When performing measurements on signals that are close to the limit line you will need to avoid reference level settings that result in an inadequate limit line to noise floor separation. Otherwise the noise floor could hide emissions you might want to measure. It is a good practice to set reference level so that the peak of the signal peak of the signal is close to the top of the screen, especially when measuring low amplitude signals.

RF Overload Detection and Correction

Test for RF overload conditions before making EMI measurements. Overload is caused by high level RF energy compressing the input stage of the preamplifier or input mixer. As a device becomes compressed, it no longer operates in the linear portion of its dynamic range. As a result, the relationship between the input and output is no longer predictable.

E7401A

The E7401A has a switched preamplifier at the input followed by a step attenuator and input mixer. There is a possibility of overload conditions occurring in the preamplifier, the input mixer or both.

The following procedure will identify and remove overload conditions. First test the input mixer, then the preamplifier.

Procedure 4-9 How to remove RF overload in E7401A EMC Analyzers

Step		Comments
1 Prepare the analyzer for measurements.		• For RF overload testing this includes the following band settings: desired reference level, attenuation, and internal preamp state.
2 Check for overload of the input mixer	a. Press **AMPLITUDE**, **Attenuation Man** b. Increase the attenuation using the ↑ arrow while monitoring the displayed signals. If the amplitude changes, then the input mixer is overloaded. c. Return the attenuator to its original attenuation. If the signal increases, then a mixer overload condition exists. d. Continue to increase the step attenuator until no further change is noted.	• Note: When checking for RF overload, it may be useful to span down on a signal that is fairly CW in nature and extends above the noise floor by 30 dB or more. • Note: If the signal that you are measuring is close to the noise floor, that noise power can add to the signal level when the input attenuation is increased or if the preamp is turned off, causing an apparent amplitude shift that is not related to overload. • Make sure when you zoom down that the RF attenuation and preamp states are set to levels at which you would like to perform the measurements for that band. When you have determined the settings that prevent RF and preamp overload, you can return to a full band and set these settings appropriately.

Procedure 4-9 How to remove RF overload in E7401A EMC Analyzers

Step		Comments
3 Check for overload of the input amplifier.	a. Press **AMPLITUDE**, **More 1 of 2**, **Internal Preamp Off** while observing the displayed signals. b. If the signal level increases, then the amplifier is overloaded. Turn the internal preamplifier back on, reduce the input signal and perform step (a) again. c. Carry out steps (a) and (b) until no change in the signal level occurs when the preamplifier is turned off and on.	• If the signals remain at the same amplitude when the preamp is turned off, then the amplifier is not overloaded. • If the amplifier is overloaded, you must either reduce the input signal or keep the amplifier off for your measurements. • When the amplifier is off, the signal level at the input mixer is reduced, and the attenuation level you specified previously may now be to high. You can increase the signal level at the input mixer by decreasing the attenuation, using caution not to introduce an overload condition in the input mixer.

E7402, E7403, E7404, E7405

Procedure 4-10 How to Identify and Remove an RF Overload in E7402, E7403, E7404, E7405 EMC Analyzers

Step		Comments
1 Prepare the analyzer for measurements.		• For RF overload testing this includes the following band settings: desired reference level, attenuation, and internal preamp state.
2 Check for overload.	a. Press **Attenuation Man** b. Press ↑ to step the attenuator while monitoring the output trace level on the display. c. Continue to step up the attenuator in 5 dB steps, until you no longer see a change in the level of the trace. d. If you did *not* experience an overload, reset the attenuation to your original value.	• If the amplitude level of the signals change as the attenuation is increased, then the analyzer is still in an RF overload condition.

Procedure 4-10 How to Identify and Remove an RF Overload in E7402, E7403, E7404, E7405 EMC Analyzers (Continued)

Step		Comments
3 Save any new attenuation value.	• Press **Meas Setup**, **Save Setup**.	• If an overload required that you set the attenuation manually, you may want to resave your setup.

IF Overload Detection and Correction

Resolution Bandwidths < 1 kHz

The E7400A series of EMC analyzers utilize digital bandwidths when resolution bandwidth settings are < 1 kHz. This includes measurements performed with the 200 Hz filter utilized for CISPR band A. The E7400A series automatically detect an IF overload condition when using these digital bandwidths. If an IF overload condition exists, an **IF OVERLOAD** message will appear in the upper right of the graticuled display when the sweep reaches the portion of the trace that causes the overload. This message will remain displayed on the screen until the end of the sweep. If the **IF OVERLOAD** message appears, this means that the IF section is operating in a range that can result in inaccurate amplitude measurements.

To clear the **IF OVERLOAD** message, increase the reference level until the message no longer appears during the entire sweep. If you are measuring a signal in a wide span, the IF overload indication may be due to higher level signals that you are not interested in measuring (for example, ambients). To clear an **IF OVERLOAD** that is not caused by the signal you are trying to measure, reduce the frequency span (around the signal of interest) until the signal that is causing the **IF OVERLOAD** no longer appears during an entire sweep.

Resolution Bandwidths ≥1 kHz

When performing measurements with resolution bandwidths ≥1 kHz there is *no* **IF OVERLOAD** indication. To prevent amplitude inaccuracies due to an IF overload condition, make sure that the signal you are measuring is below the top of the screen.

NOTE Measurements will be accurate even if stronger adjacent signals are above the top of the screen as long as the RF overload conditions have been previously cleared (see "RF Overload Detection and Correction" on page 77).

How to Identify Broadband and Narrowband Signals

Classification of a signal as either Narrowband (NB) or Broadband (BB) is dependent on the signal's occupied frequency spectrum relative to the bandwidth (resolution bandwidth) of the measuring instrument.

Emissions occupying a narrow frequency spectrum relative to the resolution bandwidth are defined as Narrowband. Examples of NB signals are:

- Continuous Wave (CW) signal
- Digital circuit clocks and their harmonics

Emissions occupying a broad frequency spectrum relative to the resolution bandwidth are characterized as Broadband. Sources of BB signals can be:

- Impulsive emissions from automobile ignition systems
- Brush noise from electric motors
- Power line rectifier impulses
- TV broadcasts
- Random noise

Common measurement units for NB signals are dBμV (dB above 1 μV) and dBμV/m (field strength). BB emissions measurements require normalization to a reference bandwidth (for example, 1 MHz). Common BB measurement units are dBμV/MHz and dBμV/m/MHz (field strength).

CISPR Recommendations

Commercial regulatory agencies (for example, FCC, VDE) use an emission measurement method which is based on CISPR (Special International Committee on Radio Interference) recommendations. The CISPR method specifies the measuring receiver bandwidth and detector characteristics.

One detector, called the Quasi-Peak detector (or CISPR detector) has specific charge, discharge and meter movement time constants (for example t_{charge} = 1 ms, $t_{discharge}$= 160 ms, t_{meter} = 160 ms). The response of the Quasi-Peak detector is dependent on the pulse repetition frequency (PRF) of the input signal. Signals with a low PRF are considered less annoying and therefore have a lower Quasi-Peak detector response. Quasi-Peak detection and peak detection will have the same response for a CW signal.

Another detector, called the Average detector, has a corresponding set of specifications.

However, specifying the exact receiver characteristics as done in commercial emissions measurements and setting one limit does not guarantee a minimum interference potential. Take the case of a low level CW signal (NB) in the presence of a relatively high impulsive signal (BB). Even when the Quasi-peak level meets emissions requirements, the lower level CW signal may still cause considerable interference. For this reason, an additional average detection limit must be met, since average detection emphasizes NB signals.

Because of this potential interference problem, agencies regulating emissions on commercial products have set both QP and Avg limits to measure the interference potential of NB and BB signals.

Measured Signal Amplitude Depends on Receiver Bandwidth

A signal of repetitive RF impulses will give greatly different amplitude readings depending on the receiver resolution bandwidth used.

At narrow bandwidth settings, individual spectral lines are measured. As the receiver bandwidth increases, more of the signal spectrum is captured with a resulting increase in amplitude reading. Finally, all the signal spectrum is contained within the receiver passband and no further increase in measured amplitude occurs.

When the measurements are normalized to a 1 MHz bandwidth, the resulting spectral intensities in dBμV/MHz also change with bandwidth. Therefore, it is important that regulatory agencies specify which bandwidth to choose for comparing the measured signal to the BB limit level.

Resolution Bandwidth

The primary purpose for having a sequence of resolution bandwidth filters in an EMC analyzer is to be able to resolve adjacent signals of different frequency separations.

Signals are classified as NB (for example, CW) if they show no change in maximum displayed amplitude with changes in EMC analyzer bandwidth. Broadband signals (for example, Noise) however, do exhibit amplitude changes in maximum displayed amplitude as the bandwidth is changed. The resolution bandwidth test is one technique used to distinguish between NB and BB signals.

Broadband signals fall into two categories: Impulsive BB and random BB.

- Impulsive BB signals have frequency components which are time coherent (that is, fixed phase relationships between spectral lines).

- Random BB signals are not time coherent. They are incoherent because they originate at random time intervals.

Time coherent impulsive signals have stationary spectral lines with slowly changing phase shift between them. A x10 change in resolution BW results in a x10 change in the number of spectral lines that are captured within the bandwidth. Since the amplitudes of the individual spectral lines add nearly in-phase, the impulse response changes by a factor of 10, or 20 dB. Random signals, such as noise, do not have voltage vectors in-phase. Because of their random amplitude and phase they add on a power basis. Thus, a x10 change in resolution BW results in a 10 log (ΔBW), or a 10 dB change in amplitude. The peak amplitude of a CW signal does not change with resolution BW.

NB Signal Test

Signals are characterized as NB with respect to the EMC analyzer resolution bandwidth when there is only one spectral component of the signal contained within the filter bandpass. Thus each spectral component, or line, is individually resolved. The signal is then being viewed on the EMC analyzer in what is described as the Spectral Line Mode. Three independent tests to determine that a signal is being viewed in the Spectral Line Mode are:

- Change the SA span. The displayed line spacing will change
- Change the SA resolution bandwidth. The peak amplitude will remain the same.
- Change the SA sweep time. The line spacing will remain the same.

If the observed spectrum was caused by coherent pulses, then the PRF is simply the spacing in frequency between two spectral lines.

Signals with low PRFs can have many spectral lines within the resolution bandwidth. The analyzer therefore will not resolve individual spectral lines.

BB Signal Test

Broadband signals with more than one spectral line within the bandwidth of the analyzer are displayed as time domain pulses.

The analyzer display appears as a sequence of pulses with amplitudes which are proportional to the envelope of the BB spectrum. With the analyzer tuned to a particular frequency, the spectral lines contained within the impulse bandwidth around that tuning frequency will add periodically at a rate corresponding to the signals PRF. As the analyzer is tuned to a different frequency, the maximum pulse amplitude will change in relation to the change in the envelope of the pulse spectrum.

A scanning analyzer will therefore display a pulse every 1/PRF seconds with an amplitude proportional to the spectrum envelope amplitude at the frequency to which the analyzer is tuned.

To determine if the signal is displayed in the Pulse Mode, the same tests that were used for the spectral line mode can be applied:

- The displayed pulse spacing is independent of the frequency span because it is a time phenomenon. A response occurs for every pulse at the input to the analyzer.
- The displayed amplitude changes with the resolution bandwidth. In the pulse mode, the number of spectral components in the passband changes with bandwidth. Therefore, the pulse amplitude is proportional to the number of spectral components in the pass band.
- Pulse spacing changes with sweep time. Since the responses occur at the PRF, the time between each response is the period (T) and the PRF may be calculated as 1/T. If the sweep of the analyzer is not synchronized with the PRF, the responses will move on the display.

While the responses on the CRT result from a time phenomenon, the spectrum envelope nevertheless remains a frequency phenomenon. Therefore, the pulse width can be determined from the shape of the displayed envelope by observing the frequency difference between adjacent nulls or minima in the envelope.

The absolute amplitude measurement of BB signals requires knowledge of the effective analyzer bandwidth in order to normalize the measured amplitude to that of a reference bandwidth. In case of coherent impulses, this is the impulse bandwidth BW_i, and for noise it is the noise bandwidth BW_n.

For coherent BB signals which change 20 dB in amplitude for a factor of 10 change in bandwidth, the measured values are normalized by adding 20 log (BW_i/BW_{ref}) dB. The corrected levels in dBµV/MHz are then compared to the appropriate BB limit.

Random BB signals, such as noise, which exhibit 10 dB amplitude changes for factor 10 changes in bandwidth require correction by adding $10\log(BW_n/BW_{ref})$ dB. The reference bandwidth chosen is typically 1 Hz and signals are recorded in units of dBm/Hz or $dB\mu V/\sqrt{Hz}$.

NOTE For measurements of the peak amplitude of coherent BB signals the video bandwidth should be set to $VBW \geq 10BW_{3dB}$ to accurately obtain the peak pulse amplitude.

NOTE For random BB signals, the video bandwidth is set sufficiently smaller than the resolution bandwidth to smooth out signal fluctuations.

Video Filtering

Video (post detection) filtering provides averaging of the higher frequency components (such as noise) at the output of the envelope detector. When the video filter bandwidth is narrower than the resolution bandwidth filter, averaging occurs. Narrowband (for example, CW) signal amplitudes are not affected by video filtering.

With the analyzer in linear amplitude mode, video filtering provides the average value of a signal.

To obtain this value, the video BW must be less than the lowest PRF, and the frequency sweep must be slow enough to let the video filter charge completely. Preferably, these measurements are taken at a single frequency (zero span).

With the analyzer in the log amplitude mode, video filtering greatly reduces the amplitude of the impulsive and random broadband signals. The amplitude of narrowband signals is unaffected.

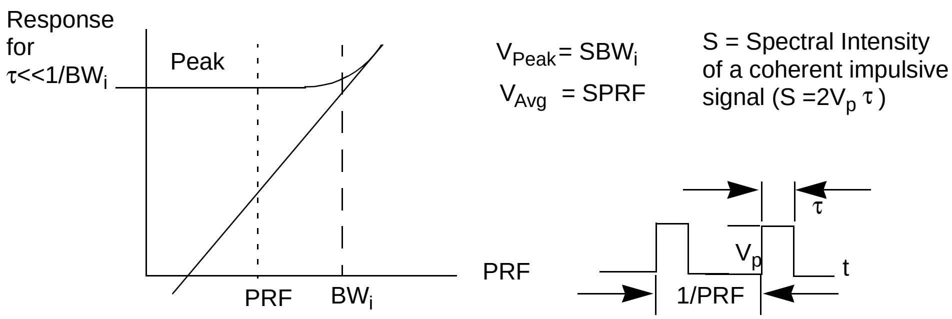
In the log amplitude mode the analyzer's video filter smoothes the logarithmically distorted detector output signal

For BB impulsive signals the smoothed indication is considerably lower than the average value of the impulses. This smoothing effect allows more accurate measurement of the NB component in a mixed NB/BB spectrum. Furthermore, the measurement dynamic range is larger in log mode so that even low level NB signals in the presence of larger amplitude BB signals, can be measured.

The video bandwidth needs to be reduced only to the point where the rapid fluctuations of the signal are smoothed. Further reduction will not change the measured value but will increase the required settling, analysis and measurement times.

NOTE The ratio of peak to average voltage for a BB impulsive signal with known PRF is the same as the ratio of the receiver impulse bandwidth to the PRF: $V_{peak}/V_{avg}=BW_i/PRF$. This allows for easy determination of BW_i (see Figure 4-3).

Figure 4-3 ***The ratio of peak to average voltage for a BB impulsive signal with known PRF is the same as the ratio of the receiver impulse bandwidth to the PRF.***



Summary

The methods shown in Figure 4-3 can easily and quickly be used with a EMC analyzer to determine if a signal is NB or BB relative to the EMC analyzer bandwidth.

- Tuning Test – Tune (look) away ± ΔBW_i and observe changes in the signal's displayed amplitude. A BB signal's amplitude stays constant.
- PRF Test – Use the sweep time control (or Span or RBW) to determine if the signal is being displayed in the Line Mode or Pulse Mode. A change in the number of displayed responses indicates BB pulse mode.
- Peak vs Avg – Select a Video BW 3 to 10 times narrower than the resolution BW selected and observe amplitude reduction and smoothing of BB signals.
- Bandwidth Test – Increase or decrease the Resolution BW and observe amplitude changes of the signals. A constant amplitude indicates that the signal is NB relative to the EMC analyzer bandwidth.

EMI Measurement Difficulties

As discussed previously, performing commercial emissions tests can result in unique measurement difficulties.

For commercial EMI measurements, low level NB (CW) signals with serious interference potential can be masked by impulsive signals when quasi-peak detection is used. Peak detection allows both NB and BB signals to be observed. NB signals can be further enhanced on the analyzer display by using video filtering, especially in log amplitude display mode. Average measurements against regulatory average limits are performed in linear amplitude display mode.

The normalized BB measurement results are constant only over a specific BW range. The EMC analyzer’s range of BW’s and the CRT display aid in the selection of the proper BW’s for the measurement of BB signals. Also, the NB/BB analysis methods of Tuning Test, PRF test, Peak vs Average Detection and Bandwidth Test can be quickly performed.

Making EMC Measurements above 3.0 GHz

Many of today's EMC Analyzers employ harmonic mixers and YIG-tuned preselectors for making measurements in the microwave frequency bands. Typically, high-band signals are routed to a broadband, YIG-tuned filter before they are applied to a harmonic mixer where they are mixed with the fundamental output or harmonics of a YIG-tuned local oscillator. The presence of the preselector is used to attenuate unwanted mixing products such as image and multiple responses.

To ensure overall amplitude accuracy, the preselector filter must be centered for measurements above 3 GHz. The E7400A Series EMC Analyzers have the capability to automatically center the preselection filter. Particularly, the Preselector Center function will automatically adjust the input filter tracking above 3.0 GHz to center the filter about the signal at the active marker. Pressing **Presel Center** just prior to making a measurement will yield the most amplitude accurate measurement within stated specifications.

NOTE When using **Auto-measure** and **Meas at Marker**, the E7400A Series EMC Analyzers will automatically center the preselector filter before each measurement is made. The Preselector Center function may be disabled for **Auto-measure** and **Meas at Marker** by turning **Center Presel** Off. **Center Presel** may be found by pressing **Meas Setup**, **More 1 of 2**, **Meas Detector**.

Example

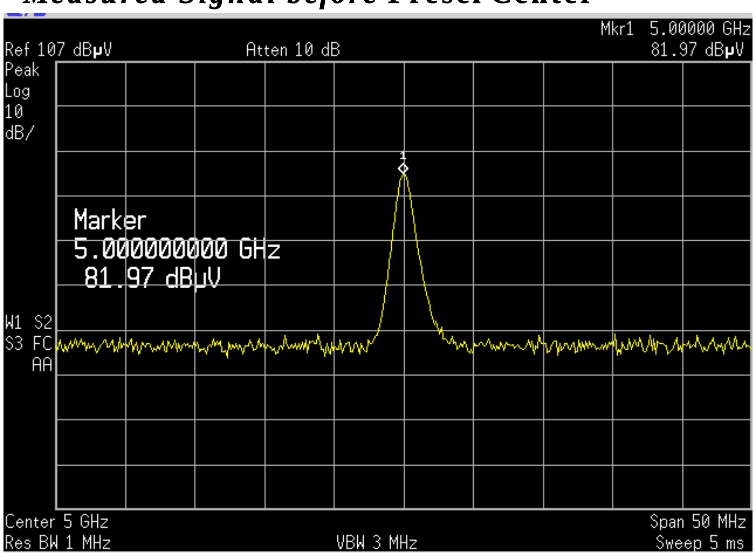
Use **Presel Center** to measure a known input signal at 5.0 GHz. In this example procedure, the input signal is 86.99 dBµV at 5.0 GHz.

Procedure 4-11 ***How to use {Presel Center} to measure a known input signal***

Step		Comments
1 Connect the known input signal to the E7400A Series EMC Analyzer.		
2 Center the preselector about the signal marker at 5.0 GHz.	a. Press **Preset**. b. Press **Frequency**, **Center Freq** 5 GHz. c. Press **Span** 50 MHz. d. Press **Search**. e. Press **AMPLITUDE**, **Presel Center**.	• **Presel Adjust** should now indicate the offset that was used to center the filter on the active marker.
3 Make the measurement.	• Press **MEASURE**, **Meas at Marker**.	• The measured value is the most amplitude accurate measurement the analyzer will make in this band. The actual measured value will meet published specifications.

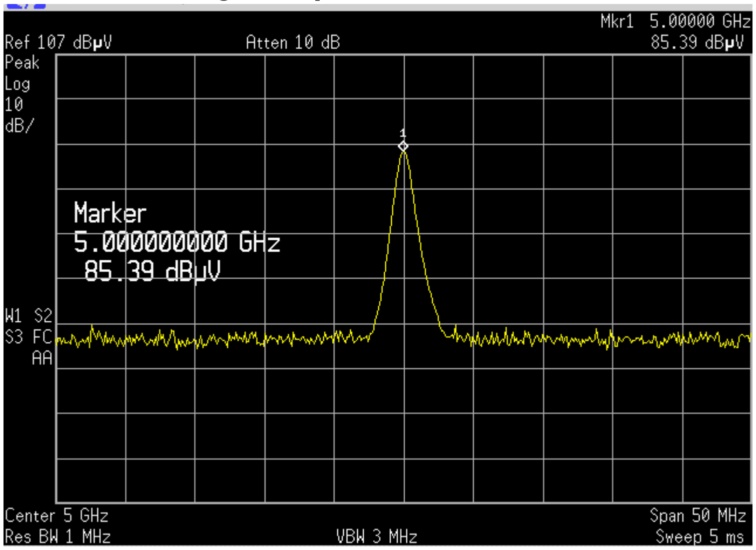
The following two figures illustrate how the Preselector Center function will improve the accuracy of a measured signal. (Note: The input signal is 86.99 dBµV at 5.0 GHz)

Figure 4-4 ***Measured Signal before*** **Presel Center**



In Figure 4-4, the analyzer reads a value of 81.97 dBμV which is below the actual input signal level. In this case, the Preselector filter has not been centered for best amplitude accuracy.

Figure 4-5 ***Measured Signal after* Presel Center**



In Figure 4-5 the analyzer reads a value of 85.39 dBμV which is within the stated specifications (±0.54 dB absolute amplitude accuracy + ±1.5 dB absolute frequency response).

Manual Maximization (using Max Hold)

The **Max Hold** function can be used as an aid for maximization or to capture intermittent signal peaks by capturing and holding the peak amplitude of a given emission. This ability is useful when you are changing the orientation of the EUT or attached cables to determine which position or EUT state yields the maximum emission response. This feature can also be used to capture the peak value of an emission that is intermittently present.

NOTE This technique is not recommended when viewing the signal with Quasi Peak or Average detection due to long sweep and trace update times. Also, using this technique may not be useful if you are working in an environment with a significant amount of impulsive (for example, ignition) noise.

Turn on the Max Hold Trace

Procedure 4-12 How to turn on a Max Hold Trace

Step		Comments
1 Center the signal of interest on the screen with Trace 1 in Clear Write.		
2 To turn on a Max Hold trace:	• Press **View/Trace**, **Trace 2**, **Clear Write**, **Max Hold.**	• Pressing **Clear Write** before **Max Hold** clears the trace buffer.
3 If desired, turn on both Max Hold and Min Hold traces.	• Press **View/Trace**, **More 1 of 2**, **Max/Min On**	• **Max/Min** is useful for distinguishing broadband signals from CW signals.

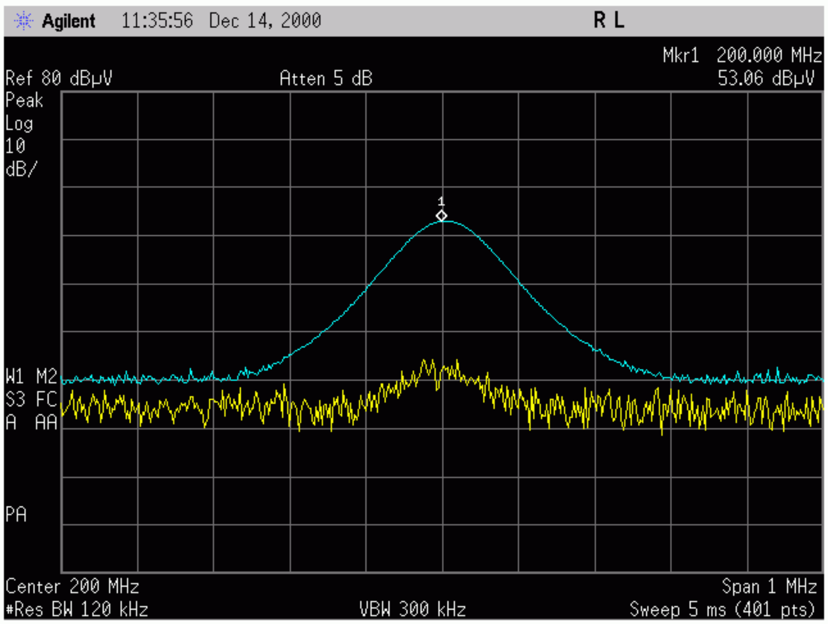
The EUT may now be oriented to search for a maximum response. If you are searching for an intermittent signal, wait until the signal is captured by the Max Hold trace.

Position the Marker on the Max Hold Trace

The marker may be positioned on the Max Hold trace so that the peak value may be read.

Procedure 4-13 How to Position the Marker on a Max Hold Trace

Step		Comments
1 Position the marker.	• Press **Marker**, **More 1 of 2**, **Marker Trace 2**.	• The marker is now positioned on trace 2.



Demodulation Example

This example illustrates the use of demodulation for EMI measurements. For a general explanation of Demodulation please refer to the “Signal Analysis Measurement Guide”.

NOTE For the purposes of this example, the following known input signal was used: 99.5 MHz at –65 dBm (signal coupled in with the FM Band).

The goal of this example will be to find the signal emanating from the EUT using the demodulation capabilities of the EMC Analyzer.

Procedure 4-14 How to Identify a modulated signal

Step	Comments
1 Set the Analyzer up for making a measurement in a portion of the FM Band.	a. Press **Preset**. b. Select the **30-300MHz** band. c. Press **Span**, **Zone**, **Zone On**. d. Press **Zone Center**, **98 MHz**. e. Press **Zone Span**, **10 MHz**.
2 Set up the analyzer to demodulate signals.	a. Press **Det/Demod**, **Demod**, **FM**. b. Press **Speaker On**. c. Press **Demod Time** and use the knob or numeric keypad to specify **3 s**.

Procedure 4-14 How to Identify a modulated signal

Step		Comments
3 Search for the signal emanating from EUT.	a. Press **Search**. b. Adjust the Volume level for acceptable level. c. Press **Next Pk Right** or **Next Pk Left** to step through signal peaks.	• Depending on the frequencies of local FM radio stations, signal peaks may exist at different points. • **Next Pk Right** and **Next Pk Left** will use the Peak Excursion and Threshold Level when locating the next signal. The default values for Peak Excursion and Threshold Level are 6 dB and 16 dBmV, respectively. **Next Pk Right** and **Next Pk Left** will move to the next signal which meets these parameters. The message “No Peak Found” will be displayed if no signal can be found which meets both parameters. See "Setting Search Criteria" on page 64 for information on how these values affect your measurement.
4 Determine if the signal is an FM radio station.	• Listen to the signal. Observe its signature, if possible.	• If the signal does not produce an audio response, it is more than likely emanating from the EUT and should be measured.
5 Measure the signal.	• Press **MEASURE**, **Meas at Marker**.	

NOTE It is recommended that, when you exit the Demodulation Mode, you first deactivate the Speaker before turning demodulation Off.

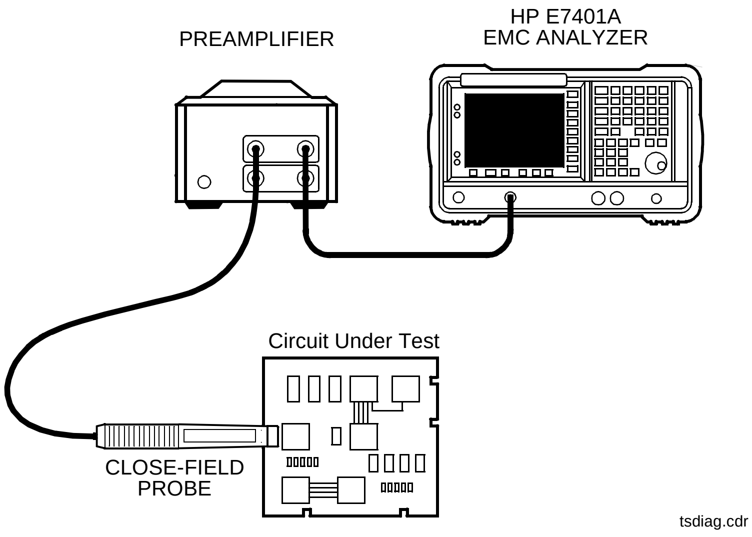
Making Diagnostic Measurements with Close-field Probes

Typically, close-field probes are used for diagnosing product designs which have initially failed precompliance emissions testing. The steps to performing a diagnostic measurement of this type are as follows:

- Configure the setup by selecting the desired frequency band and load in the probe correction factors.
- Probe the device to find the largest emissions.
- Store the trace on a diskette for future reference.
- Make desired changes to the device to reduce emissions.
- Use the probes to retest the device.
- Recall the previous measurement from the diskette for comparison.

Figure 4-6 shows a typical diagnostics test setup including an EMC analyzer, close field probes, and amplifier. The typical probe correction factors are included on a ROM card supplied with the EMC analyzer. In this example, the probes are used to identify “hot spots” in different areas of the PC board.

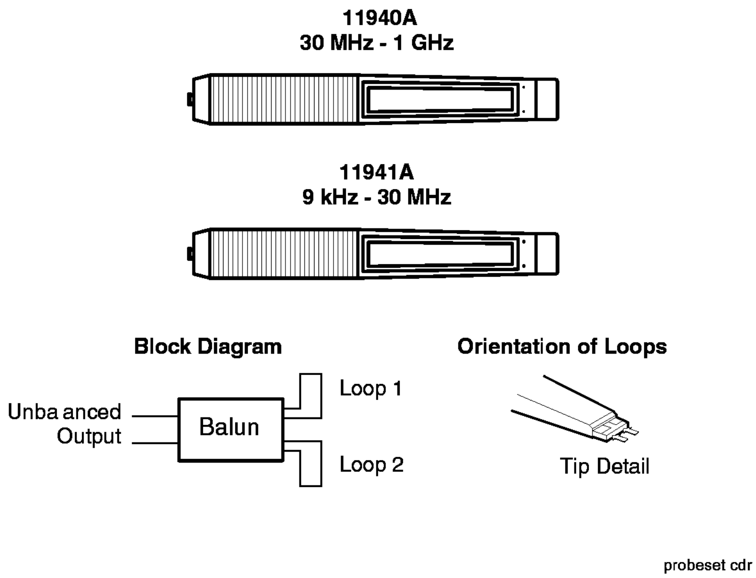
Figure 4-6 ***EMC Diagnostic Measurement Setup***



NOTE Changes that you make to solve problems at one frequency can cause problems at other frequencies, so be sure to scan the entire frequency of interest.

Agilent Technologies has a number of close field probe sets designed to assist in this kind of close field testing. Figure 4-7 shows one available set.

Figure 4-7 ***The HP/Agilent 11945A Close Field Probe Set***

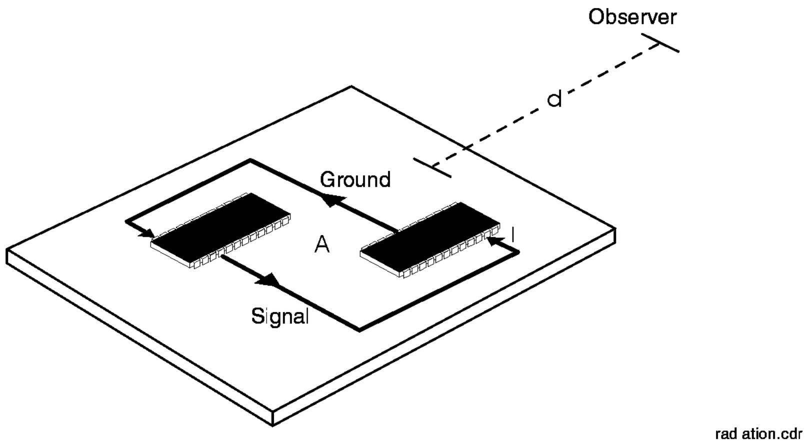


The 11940 series close-field probes incorporate a double-loop design. The outputs of the loops are combined in a *balun* in such a way that the electric field voltage components are 180 out of phase, canceling each other out. Thus, only the voltage components caused by the magnetic field remain. This characteristic results in excellent measurement repeatability compared to the other probe designs. The 11940A close field probe has a frequency range of 30 MHz to 1 GHz, and the 11941A has a frequency range of 9 kHz to 30 MHz. The detail in Figure 4-7 shows the orientation loops. The probes are most sensitive to fields pointing into the tip of the probes.

Each probe is individually calibrated and has its own transducer factor which is in dB(μA/m)/μV, measured at five points across the frequency band. With the addition of these transducer factors, the EMC analyzer measures in magnetic field strength units (μA/m). Typical transducer factors are included with the EMC analyzer on the Limit Line and Transducer Factor floppy disk (E7401-10004).

Radiation from a Current Loop

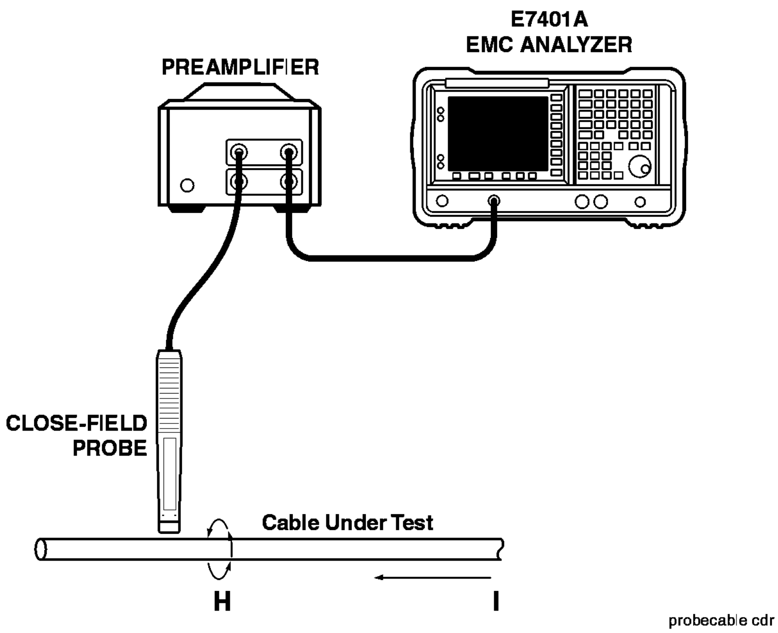
Figure 4-8 ***Radiation from a Current Loop***



The magnetic field induced by current flowing in the signal and power-distribution traces is a principal cause of radiation on PC boards. The most practical strategy for reducing printed circuit board emissions is to make the radiators as inefficient as possible. Although the radiation is primarily magnetic near the loop, an accompanying electric field is induced as energy propagates away from the loop as a wave. EMC regulations are measured in terms of electric field, which is in V/m, and is dependent on the square of the frequency, area of the loop, and observation distance. To reduce E field emissions, reduce the area of the loop, the current level in the loop, or reduce the high frequency component of the signals in the loop. Correcting emissions problems at the PC board level can be fixed at very little additional cost. Waiting to solve emissions problems later in the development cycle could result in costly shielding or filtering.

Probing a Cable

Figure 4-9 ***Probing a Cable***

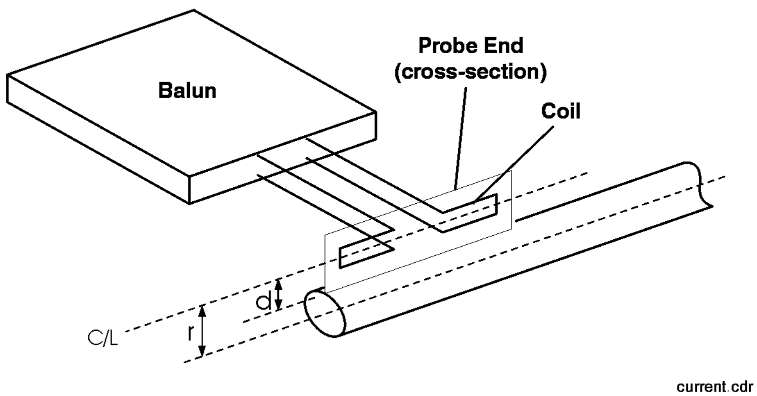


Use the close field magnetic probe to determine the magnetic field intensity around a cable. The current density can then be calculated if the distance from the center of the cable to the center of the probe loops is known.

For example: I = H x 2pr or I (dBmA) = H (dBmA/m) + 20 log(2pr)

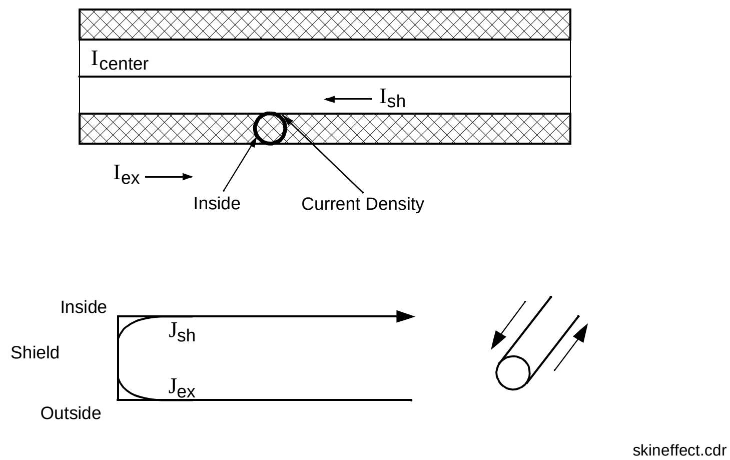
Determining Conductor Current

Figure 4-10 ***Determining Conductor Current***



Separation of Currents by Skin Effect

Figure 4-11 ***Separation of Currents by Skin Effect***



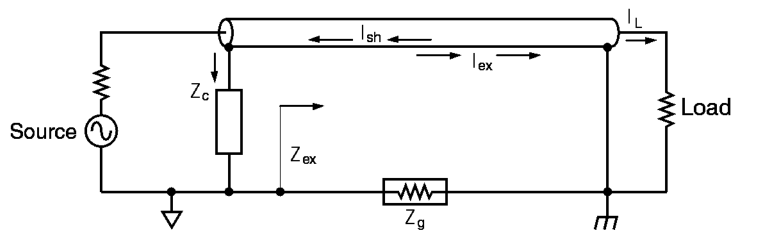
At low frequencies the current is evenly distributed throughout the conductor. But at higher frequencies, the skin effect enables the cable shield to provide additional protection. Here, most of the return current flows on the inside of the shield because it is the surface closest to the center conductor in which the signal current flows.

When the current flows only on the inside of the shield, high values of shielding effectiveness can be obtained from a cable. The limiting factor is usually the presence of a hole in the woven shield.

Skin effect also holds true for currents flowing on the outside of the shield. These can occur when the outer conductor is not well grounded and stray electric fields capacitively couple onto the outside of the shield.

External Shield Current due to Poor Grounding

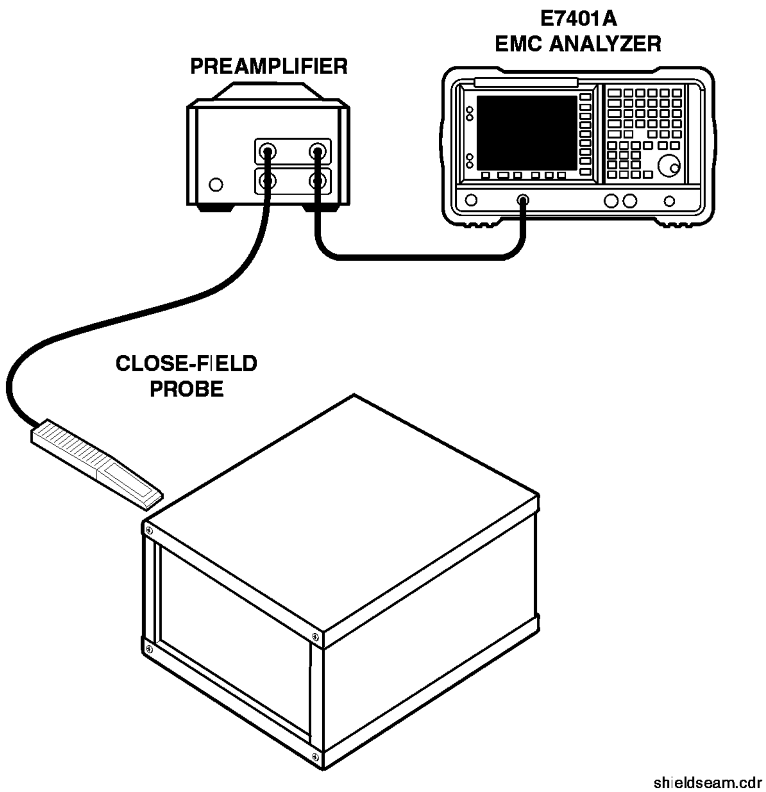
Figure 4-12 ***External Shield Current due to Poor Grounding***



Poor grounding will cause current to flow on the outside of the shield no matter how impenetrable it has been made. Ground leads must be kept very short. Pigtails should be avoided. Coaxial cables should be terminated in connectors that offer a 360 degree ground for the shield.

Probing a Shield Seam

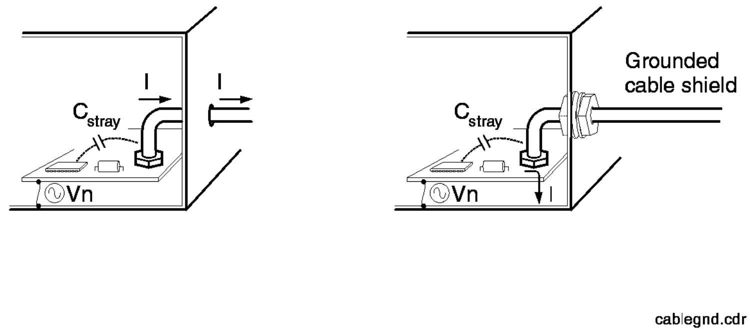
Figure 4-13 ***Probing a Shield Seam***



Use the close field probes to isolate gaps in shield and electrical gaskets. Even loose screws can cause a problem. A quick evaluation procedure involves placing the display of the analyzer in **Max Hold** mode to collect the strongest emissions found among repeated sweeps. Scanning the close-field probe along the seam records the worst-case values. This result is then saved, and the analyzer display is returned to **Clear Write** mode so that the strongest source of emissions can be located.

Shielded Cable Grounding

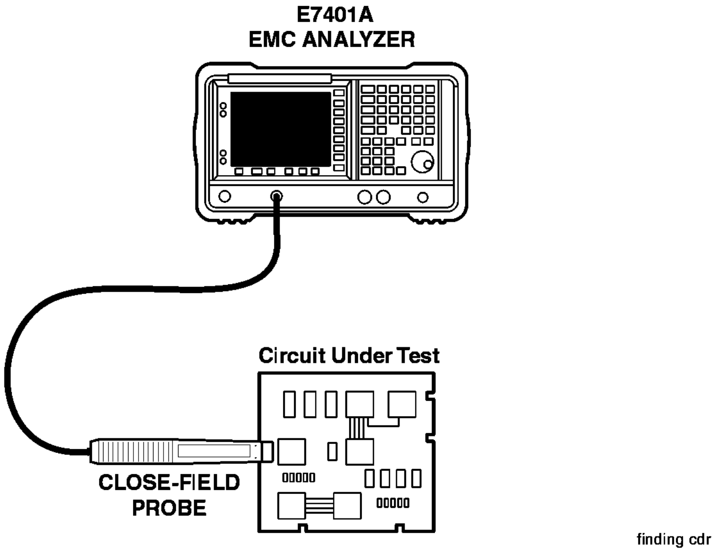
Figure 4-14 ***Shielded Cable Grounding***



Bringing a coaxial or other shielded cable out through a hole in an enclosure can seriously compromise the integrity of the shield. Common-mode current (I) is induced on the outside of the cable shield by ground noise Vn and by electrical field coupling, indicated by the stray capacitance. The cable shield conducts the common mode current outside the enclosure where it radiates. Low impedance grounding of the cable shield where it leaves the enclosure effectively shunts the common mode current to ground.

Finding Susceptible Currents

Figure 4-15 ***Finding Susceptible Currents***



A close field probe like the HP/Agilent 11940A or 11941A is a useful tool for locating susceptible circuits. The probe is driven from a signal generator tuned to a problem frequency, and then is moved along the circuitry until a problem is located. The relatively small size of a probe enables the isolation of the problem. If the frequency of the problem is not known, use a swept source like the tracking generator of a EMC analyzer.

5 How Do I...

In This Chapter...

Specify Measure Detectors and Set Dwell Times

Select a Detector

You can select one or more of the following signal detection methods:

- Peak
- Quasi-peak
- Average

Procedure 5-1 How to Select a Detector

Step		Comments
1 Access the Meas Detector Menu.	• Press **Meas Setup, More 1 of 2, Meas Detector**.	
2 Activate or deactivate detectors.	a. Select **Peak On** to activate Peak detection (**Peak Off** to deactivate). b. Select **Quasi Peak On** for Quasi-peak detection (**Quasi Peak Off** to deactivate). c. Select **Average On** for Average detection (**Average Off** to deactivate).	• Select and activate those detector(s) you want to use for the measurement • In Preset state, all detectors are ON. • The numeric keypad or knob may be used to set the detector dwell time.

Set the Range Dwell Time

Procedure 5-2 How to set the range dwell

Step		Comments
1 Set the range dwell time.	a. Press **Meas Setup, More 1 of 2 Meas Detector Range Dwell.** b. Use the numeric keypad or the knob to select a dwell value.	

Set up the Analyzer for a Measurement

You must set up the analyzer according to the type of precompliance measurement you are making.

Make a list of the equipment you will be using with your test in order to load the proper corrections.

Delete Pre-existing Setup Data

Before creating a new setup it is a good idea to delete any pre-existing setup data.

Procedure 5-3 How to Delete Pre-existing Setup Data

Step		Comments
1 Preset Analyzer.	• Press **Preset** Press **Meas Setup, More 1 of 2, Corrections, Modify.**	• After Preset, antenna corrections are automatically selected.
2 Delete Antenna Corrections.	• Press **Delete, Delete**.	
3 Delete Cable Corrections.	• Press **Select, Cable, Delete, Delete**.	
4 Delete Other Corrections.	• Press **Select, Other, Delete, Delete**.	
5 Delete User Corrections.	• Press **Select, User, Delete, Delete.**	
6 Delete Signal List.	• Press **MEASURE, More 1 of 2, Signal List, Delete Signals, Delete All, Yes.**	

Create a Setup

Procedure 5-4 How to Create a Measurement Setup

Step		Comments
1 Set the analyzer band.	a. Press **Meas Setup**. b. Select the appropriate span for the measurement type (conducted or radiated).	• Note that when a band is selected, all the analyzer settings for the CISPR measurement in this frequency range are preset. • See the Reference Guide for information regarding which settings are affected and what their default values are.
2 Insert the diskette.	• Place the Limit Line and Transducer Factor floppy disk (E7401-10004) into the analyzer disk drive (the label should face outward to the right).	• Refer to Appendix B , “Disk Contents: Limit Lines and Transducer Factors,” for a list of the contents of this disk.
3 Set the attenuation.	• Press **AMPLITUDE, Attenuation,** 0 **dB**.	
4 Activate the internal preamp.	• Press **Meas Setup, More 1 of 2, Int Preamp On**.	
5 Select limit 1 or 2.	• Press **File, Load, Type, Limits, Destination, Limit 1 or 2**.	• This will determine into which limit your limit line values are loaded.
6 Load the appropriate compliance limit.	a. Select drive A: b. Use the ↑↓ arrow keys or knob to select the correct file name and press **Load Now** (for example, EN22BCAV.lim).	• The appropriate compliance limit will be loaded (for example, EN55022 Class B, Conducted, Average). • If you are in doubt about how to select a drive, please see "Specify a Drive" on page 134. • See the document “Limit Line and Transducer Factors” for information on file names for EMC compliant limit lines provided.

Procedure 5-4 How to Create a Measurement Setup (Continued)

Step		Comments
7 Load the appropriate antenna corrections.	a. Press **File, Load, Type, More 1 of 2, Corrections**. b. Use the ↑↓ arrow keys or knob to select the file name that correctly represents the type of antenna you are using for your measurement. For example, 11966HB.ANT. c. Press **Load Now**.	
8 Load cable corrections.	a. Press **File, Load, Type, More 1 of 2, Corrections** b. Use the ↑↓ arrow keys or knob to select the appropriate correction file. For example, HP11966L.CBL. c. Press **Load Now.**	
9 Activate the antenna corrections.	• Press **Meas Setup, More 1 of 2 Corrections, Modify, Selec**t, **Antenna, Correction On.**	
10 Set the antenna units.	• Press **Antenna Units, µV/m.**	
11 Turn on the cable corrections.	• Press **Select, Cable, Corrections On.**	
12 Save this setup.	a. Press **Meas Setup, Save Setup, Name**. b. Use the Alpha Editor and the numeric keypad, or an external keyboard to name the file. c. Select the appropriate drive (A: or C:) d. Press **Save Now**.	• If you are not sure how to specify a drive please refer to "Specify a Drive" on page 134.

Load a Setup File

Procedure 5-5 How to Load a Measurement Setup

Step		Comments
1 Insert the diskette.	• Place the Limit Line and Transducer Factor floppy disk into the Analyzer disk drive (the label should face out).	
2 Select the setup file type.	• Press **Meas Setup, Load Setup**.	• For example, **RADDEMO.SET**.
3 Load a setup file.	a. Select the A: drive. b. Use the ↑↓ arrow keys or knob to select the correct file name, and press **Load Now**. (For example, **RADDEMO.SET**).	• If you are in doubt about how to specify a drive, please see "Specify a Drive" on page 134.

Create and Specify a Limit Line and Margin

Limit lines provide the capability to compare measured signal data to a specified limit and determine if the signals pass or fail. A library of the most common limit lines is provided on diskette; however, you can create your own custom limit lines that best suit your needs. For example, you can create limit lines as thresholds to eliminate unwanted noise or signals that are below a particular amplitude.

You can either copy, and then edit an existing limit line, or create a new limit line.

An upper and/or lower limit line can be displayed. Limit lines are constructed from a table of frequency and amplitude coordinate pairs. Limit line segments are created by connecting these points. Limit lines can be entered as coordinates of frequency and amplitude (or in terms of time and amplitude for zero span measurements).

Delete points on Existing Limit Lines

Procedure 5-6 How delete points on an existing limit line

Step		Comments
1 Access the limit line table.	a. Press **Meas Setup, More 1 of 2, Limits**. b. Press **Modify, More 1of 2**, **Edit**.	• If a limit line is currently loaded then the existing limit line table will appear.
2 Delete a specific point.	• Press **Delete Point, Delete Poin**t for each point in the limit line table.	• Sometimes it is desirable to retain a portion of the limit line.
3 Purge an entire limit line.	a. Press **Return**. b. Select **Limit 1** or **Limit 2** depending on which list you plan to eliminate. c. Press **Delete, Delete**.	• Most often, it is easiest just to purge the entire limit line and start over.

Select the Type of Limit Line

Procedure 5-7 How to specify the type of limit line

Step		Comments
1 Access the limit line properties screen.	• Press **Meas Setup, More 1 of 2, Limits, Properties.**	
2 Specify the x-axis units.	• Press **X Axis Units Freq Time**.	• When **Freq** is underlined, the x-axis coordinate will be in frequency. When **Time** is underlined, the x-axis coordinate will be time. • Limit lines for EMI measurements will always be specified in terms of frequency.
3 Specify the type of limit line.	• Press **Limits Fixed Rel**.	• **Limits Fixed Rel** selects the type of limit line. There are two types of limit lines: fixed and relative. Fixed limit lines are comprised of absolute amplitude and frequency (or time) values. EMI measurements are always made in terms of absolute values. • Relative limit lines are comprised of frequency values that are referenced to the analyzer center frequency and amplitude values that are relative to the analyzer reference level. The relative setting does not affect time values. Time values are always displayed from the start of the measurement.

Consider the following examples of fixed versus relative limit lines:

If a limit line is specified as *fixed* and you enter a limit line segment with a frequency coordinate of 300 MHz, a limit line segment will be displayed at 300 MHz.

If the same limit line table is specified as *relative*, it is displayed relative to the analyzer center frequency and reference level. If the analyzer center frequency is at 900 MHz, a relative limit line segment with a frequency coordinate of 300 MHz will display a limit line segment at 1.2 GHz.

If the amplitude component of a relative limit line segment is –10 dB and the analyzer reference level is –15 dBm, then –10 dB is added to the reference level value and the amplitude component of the limit line will be shown at –25 dBm.

`Limits=RELATIVE` is displayed in the limit line table when the limit line type is relative; `Limits=FIXED` is displayed when the limit line type is fixed. A limit line entered as fixed may be changed to relative, and one entered as relative may be changed to fixed. When the limit line type is changed, the frequency and amplitude values in the limit line table are modified by the current center frequency and reference level settings to keep the limit line in the same position on the analyzer.

Select the Limit Line Table Format

Procedure 5-8 How to specify the limit line table format.

Step		Comments
1 Specify the limit line table format.	• Press **Meas Setup, More 1 of 2**, **Limits, Modify, Type Lower Uppe**r to underline either Upper or Lower.	• You can use an upper limit line only, or a lower limit line only, or both an upper and a lower limit line.

Specify Segments and Enter Coordinates

A limit line segment is a portion of a limit line having at least two points that are connected. You can specify one or more segments for any given limit line. For example, you might have a limit line with an amplitude of 42 dBµV from 30 to 230 MHz and 47 dBµV from 230 MHz to 1 GHz.

Segments are created by entering the appropriate frequency (or time) values and amplitude values into a limit line table. The frequency (or time) and amplitude values specify a coordinate point from which a limit line segment is drawn. The segment is defined by its beginning point, that is the coordinate point that is the lowest frequency (or time) point of the line segment. The frequency at which the amplitude changes is specified twice: once as the last point characterized by the first amplitude and once for the new amplitude.

Procedure 5-9 How to specify segments and enter coordinates.

Step		Comments
1 Access the limit line edit menu.	• Press **Meas Setup, More 1 of 2, Limits, Modify, More 1 of 2, Edit.**	
2 Specify the first point in the first segment.	a. Press **Frequency** (or **Time**) and use the numeric keypad to enter the starting frequency of the segment (for example, 30 MHz). b. Press **AMPLITUDE** and use the numeric keypad to enter the amplitude of this segment (for example, 42 dBμV). c. Press **Connected No**.	• As a general rule of thumb, select **Connected No** for the first point in a limit line segment.
3 Specify the final point for this segment.	a. Press **Point** and use the UP arrow to move to the next point in the list. b. Press **Frequency** (or **Time**) and use the numeric keypad or the knob to enter frequency value for the *end* of the segment (for example, 230 MHz). c. Press **AMPLITUDE** and use the numeric keypad to enter the *same* amplitude that you specified in (2) above (that is, 42 dBμV). d. Make sure **Connected Yes** is true.	• As a general rule of thumb, select **Connected Yes** for the final point in a limit line segment.

Procedure 5-9 How to specify segments and enter coordinates.

Step		Comments
4 Specify the first point for the next segment.	a. Press **Point** and use the ↑ arrow to move to the next point in the list. b. Press **Frequency** (or **Time**) and use the numeric keypad or the knob to enter a frequency value for the *start* of the segment (that is, 230 MHz). c. Press **AMPLITUDE** and use the numeric keypad to enter an amplitude for this segment (for example, 47 dBµV). d. Press **Connected No**.	• **Note:** The starting frequency for this segment should be the *same* as the ending frequency for the last segment. For more information on connecting segment points, please see "Connect Segment Points" on page 116.
5 Select and specify the final point for this segment.	a. Press **Point** and use the UP arrow to move to the next point in the list. b. Press **Frequency** (or **Time**) and use the numeric keypad or the knob to enter a frequency value for the end of the segment (for example, 1 GHz). c. Press **AMPLITUDE** and use the numeric keypad to enter the same amplitude that you specified in step 1 above (that is, 47 dBµV). d. Check that **Connected Yes** is true.	
6 Repeat steps 4 and 5 until all segments have been specified.		

NOTE Then entering a limit line segment, the frequency (or time) and amplitude values will be listed as asterisks (***) until new values are entered. The new segment will be listed last until the frequency (time) of line segment have been entered. Once the value is entered, the segment will be sorted into the limit line table according to frequency or time.

Connect Segment Points

Segments are defined by the frequencies (or times), and amplitudes of a set of points and how they are connected. The following are some examples of valid limit line segments:

- A single point, unconnected to any other points. For an upper limit line, a point segment is indicated by a line drawn from the coordinate point, vertically off the top of screen. For a lower limit line, a point segment is indicated by a line drawn from the coordinate point, vertically off the bottom of screen. The line may continue to the right edge of the display, but testing stops at the defined point.
- Two points with the same amplitude and different frequencies (or times) with the first point defined as *unconnected* (**Connected No**) and the second point defined as *connected* (**Connected Yes**). This draws a zero slope line between the coordinate points, producing limit line values equal in amplitude for all frequencies (or times) between the two points (a horizontal line appears on the analyzer screen when the limit line is activated).
- Two or more points, in which the amplitude (as well as the frequency or time) values of the two segments differ, with the first point defined as *unconnected* (**Connected No**) and the remaining points defined as *connected* (**Connected Yes**). In this case the limit line will either slope (if the Limit line is defined on a linear scale) or curve (if the Limit line is defined on a logarithmic scale), where the amplitude varies. This case can also occur if you end a horizontal segment (as described in the previous paragraph) and then start another horizontal segment at a higher frequency.

Regardless of how your limit line segments are specified, all signals which fall between the limit start and stop frequencies, will be tested against the defined limit values when measurement and/or testing proceeds.

Complete Table Entry and Activate Limit Line Testing

Procedure 5-10 How to complete table entry and activate limit line testing.

Step		Comments
1 Activate the limit line.	• Press **Meas Setup, More 1 of 2**, **Limits, Modify, Limit On**.	• **Tip:** Make sure you use **Limit 1 2** and underline the correct number for the limit line you want to view.
2 Turn on testing.	• Press **Test On**.	• If an emission is over the limit line (or margin, if selected), a FAIL LIMIT (or FAIL MARGIN) message will appear on the screen.

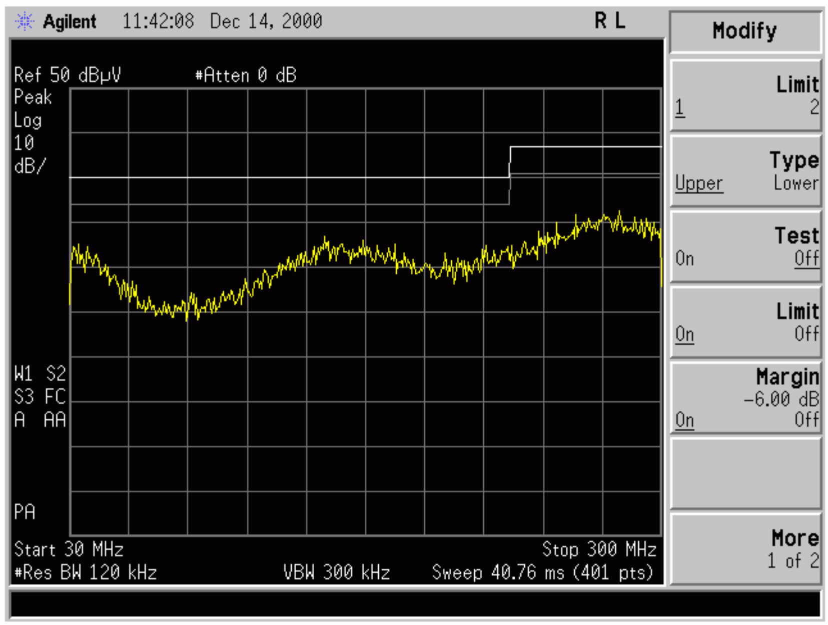
Specify the Limit Line Margin (Optional)

Procedure 5-11 How to Specify the Limit Line Margin

Step		Comments
1 Access the Limits menu screen.	• Press **Meas Setup, More 1 of 2, Limits, Modify**.	
2 Select the Limit.	• Select **Limit 1** or **Limit 2**.	

Procedure 5-11 How to Specify the Limit Line Margin

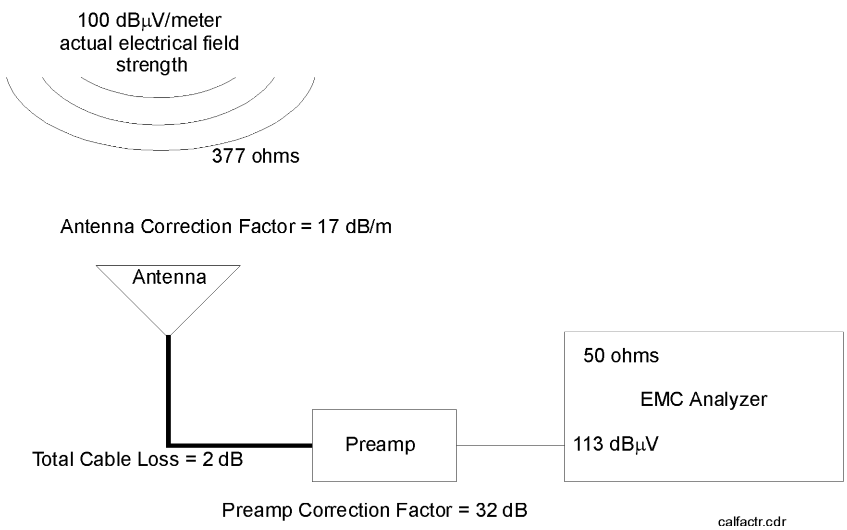
Step		Comments
3 Activate and set the margin.	a. Select **Margin On**. b. Using the numeric keypad, specify 6 **–dB**.	• This will set the margin value to 6 dB *below* the limit value. • **Note:** The value in this case is negative because the example assumes an *upper* limit line. However, for a *lower* limit line, you would want to specify the margin in positive dBs.



Create Correction Factors

Corrections factors are used to compensate for the gains and losses associated with the addition of external devices such as antennas and amplifiers. By applying Corrections, you can read the true signal level (such as electric field strength) directly from the analyzer. The unit conversions are automatically handled by the analyzer when the appropriate correction factors are applied.

Example: Suppose that at a particular frequency, the analyzer measures 113 dBμV. Use Corrections to account for the conversion loss of the antenna (transferring a 377 Ω system to 50 Ω system), the loss of the cable, and the gain of the amplifier.



In order to transfer the measured signal amplitude to the true signal level it is necessary to correct for the following:

- The gain of the amplifier. Subtracting the amplitude gain correction factor (32 dB) from 113 dBμV, will yield a level of 81 dBμV.
- The overall cable loss. Since the cable loss results in a measured value lower then the actual value you must add the cable correction factor (2 dB) to the 81 dBμV. This will yield a value of 83 dBμV.
- The conversion loss between the intrinsic impedance of free space (377 Ω) and the 50 Ω system the analyzer operates in. By adding the correction factor of 17 dBμV to 83 dBμV the true signal level of 100 dBμV is determined.

Because of the way in which corrections are applied, the following convention is used for indicating correction factors as positive or negative values:

Table5-1 Correction Factor Conventions

Correction Factor	Sign
Antenna Factors	Positive
Cable Factors	Positive
Other Factors	Positive
User Factors	Negative

NOTE The correction factor signs are only a convention. Although all correction factors are handled the same algebraically, losses are typically entered as positive corrections and gains are typically entered as negative corrections.

Antenna, Cable, and Other correction factors are generally entered as positive values. This indicates a loss in the external device. User correction factors are typically entered as negative values which indicate a gain in the external device.

NOTE For amplitude-correction factors, only the first and last points of a series with the same frequency values are used; any middle points are ignored.

Amplitude-correction data is sorted in the table by frequency. The sorting occurs immediately after you have entered the frequency value via the front-panel.

Procedure 5-12 How to create correction factors

Step	Comments
1 Specify the correction type.	a. Press **Meas Setup, More 1 of 2, Corrections, Modify, Select.** b. Press the softkey of the type of correction.
2 Specify the display axis units.	• Specify **Freq Interp Log** to show the corrections on a logarithmic axis. Specify **Freq Interp Lin** to show the corrections on a linear axis.
3 Specify antenna correction, units (if type = antenna).	• Press **Antenna Units** and select the softkey that represents the units type.

Procedure 5-12 How to create correction factors

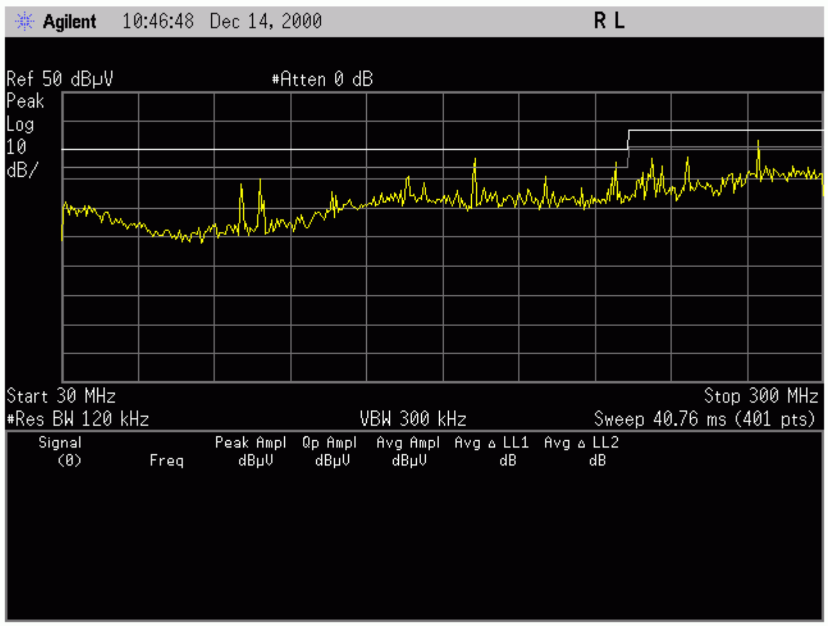
Step		Comments
4 Access the correction Edit screen.	• Press **Edit.**	
5 Specify the first point in the table.	a. Press **Frequency** and use the numeric keypad to enter a value. b. Press **AMPLITUDE** and specify 0 **dB**.	• **Note:** The first and last point of any given set of corrections factor points must always have a value of 0 dB for the amplitude.
6 Specify the next point in the table.	a. Press **Point** and use the up arrow to move down to the next point in the list. b. Press **Frequency** and use the numeric keypad or knob to enter a value. c. Press **AMPLITUDE** and use the numeric keypad or knob to enter a value.	
7 Repeat step 6 until all points have been specified.		
8 Finish the Segment.	a. Press **Frequency** and use the numeric keypad to enter a value (higher than your last frequency value). b. Press **AMPLITUDE** and specify 0 **dB**.	• **Note:** The last point in a correction factors list must have a value of 0 dB for the amplitude.
9 Save the list.		• For details and help on how to save or load a file see "Save/Edit/Recall" on page 134.
10 Activate the corrections.	a. Press **Meas Setup, More 1 of 2, Corrections, Modify,** Select **Cable, Correction On**. b. Select **Return, Corrections On**.	• Note that **Correction On** only activates the specific correction (in this case cable loss), whereas, **Corrections On** turns on all correction factors that have been individually activated using **Correction On**.

Create and Manipulate Signal Lists

Clear the Signal List

Procedure 5-13 How to clear the Signal List

‘Step	Comments
1 Display the signal list.	• Press **MEASURE, More 1 of 2, Signal List, Signal List On**.
2 Delete it, if desired.	• Press **Delete Signals, Delete All, Yes**.



Generate a Signal List

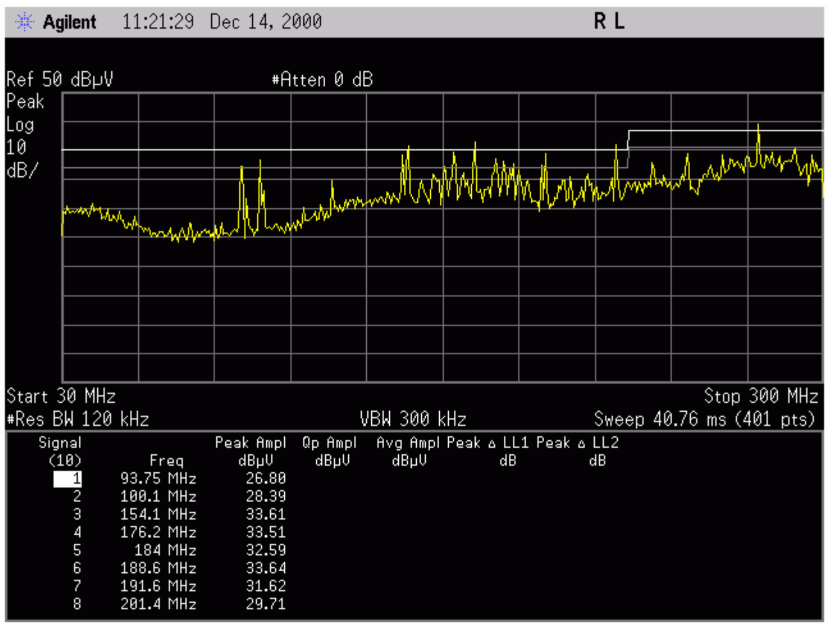
A signal list can be created in one of the following ways:

- Automatically – as part of a measurement that spans a specified frequency range and measures signal peaks that meet your peak excursion criteria (auto-measure).
- Manually – point by point. This is usually an option you would use after the basic signal list is created and you want to scan the trace, adding points one at a time.

NOTE You can select the detectors you need. Often for precompliance purposes, measuring with only the peak detector is adequate if the emissions fall below the limit line, but other detectors can be selected as needed.

Procedure 5-14 How to use Auto-measure to Generate a Signal List

Step		Comments
1 Prepare for the measurement.	• Press **MEASURE, More 1 of 2, Auto-measure**.	• **Tip:** If you have specified a limit line and margin, you can select **Sigs > Margin On** to measure only those peaks which lie above the limit line margin.
2 Start the measurement.	• Press **Start**.	• When the automeasure process is complete, all measured peaks will be added to the signal list.



Move the Marker to a Signal in the List

Procedure 5-15 How to Move the Marker to Signals in the Signal List

Step		Comments
1 Activate the signal list.	• Press **MEASURE, More 1 of 2, Signal List, Signal List On**.	• This highlights the signal list and makes it active.
2 Move the cursor up and down the list.	• Use the ↑↓ arrows or the knob or the numeric keypad to select a signal number.	• Note that the trace marker follows the cursor to the selected signal in the list.

Save a Signal List

During radiated emissions testing, the EUT emissions must be measured at several turntable angles, antenna heights and vertical/horizontal polarizations, in an attempt to maximize EUT emissions.

It is best to determine a file naming convention that will help you remember all of these equipment orientations for the EUT emissions frequencies gathered.

For example, if the turntable was at 45 degrees, antenna height 200 cm and the polarization was vertical when you gathered the signals in your list, you might choose to name the file: 045V200.

Use the following procedure to save the signal list.

Procedure 5-16 How to save a Signal List

Step		Comments
1 Access the list file manager.	• Press **MEASURE, More 1 of 2**, **Signal List, Save/Load, Save, Name**.	
2 Save the file.	a. Use the Alpha Editor and the numeric keypad, or an external keyboard, to enter the name. (For this example D45V20D.) Press **Enter**. b. Select the drive (A: or C:). c. Press **Save Now**.	• If you are unsure how to select drives, please refer to "Specify a Drive" on page 134.

Load and Append to Signal Lists

Procedure 5-17 How to Load and Append Signal Lists

Step		Comments
1 Access the list file manager.	• Press **MEASURE, More 1 of 2**, **Signal List**, **Save/Load**, **Load**.	• If you do not want to append to an existing list, you must first delete any signals that have previously been added to the analyzer signal list data. See "Clear the Signal List" on page 122.
2 Load the file.	a. If you are unsure how to select the drive see "Specify a Drive" on page 134. b. Use the knob or ↑↓arrows to select the correct file name. c. Press **Load Now**.	• The selected signal list will be appended to any other signal list currently in the analyzer memory. • The total number of signals in the list cannot exceed 2000.

Sort List Data

You can sort the data in a signal list in the following ways:

- By Frequency
- By Peak Amplitude
- By Quasi-peak Amplitude
- By Average Amplitude
- By the distance from your limit line(s) (below: (–) or above: (+)).

Procedure 5-18 How to sort signal list data.

Step		Comments
1 Sort the list.	• Press **MEASURE, More 1 of 2, Signal List, Signal List On, Sort Signals.** • Select the sort option of interest. For example, to sort the signals by descending frequency, press **By Freq Dsc**.	

Tune the Analyzer

The Tune function allows you to tune the analyzer to a center frequency.

Procedure 5-19 How to tune to a signal

Step		Comments
1 Tune the analyzer center frequency.	• Press **MEASURE, Tune.**	• Using the knob you can move up and down the frequency range, tuning the analyzer center frequency.

Invoke the Auto-measure Function

Procedure 5-20 How to use the Auto-measure function

Step		Comments
1 Activate the limit line.	• Press **Meas Setup, More 1 of 2, Limits, Modify, Limit On.**	• If you have not loaded (or created) a limit line, see "Create and Specify a Limit Line and Margin" on page 111 for information on how to do so.
2 Activate the limit line margin (optional).	• Press **Meas Setup**, **More 1 of 2, Limits, Modify, Margin On**.	• If you have not specified a limit line margin, see"Specify the Limit Line Margin (Optional)" on page 117 for information on how to do so.
3 Prepare for the measurement.	• Press **MEASURE, More 1 of 2, Auto-measure.**	• If you have activated a limit line margin, select **Sigs > Margin On**}to measure only those signals with amplitudes higher than the specified limit line margin.
4 Start the measurement.	• Press **Start**.	

Invoke the Measure at Marker Function

Measurements can be made by placing the marker on the signal of interest and then selecting the Meas at Marker function.

The algorithm:

- Measures the selected signal using the detectors currently selected.
- Displays the results in the on-screen marker box.

The marker box remains on the screen until the marker position or analyzer tuning is changed. The measure-at-marker results can be saved to the signal list.

Procedure 5-21 How to use the Meas at Marker function

Step	Comments
1 Move the marker to a signal of interest.	• Use available marker functions to position the marker on a signal peak you wish to measure.
2 Measure the peak.	• Press **MEASURE, Meas at Marker.**
3 If desired, add the measured signal to the signal list.	• Select **Meas to List**.

Make Cable Loss Measurements

The following process measures cable loss and generates the insertion loss factors as a frequency/amplitude pair list which can be exported.

NOTE This procedure requires that you manually reformat a generated signal list so that it conforms to the file format specifications of a corrections file. Currently this conversion process is not supported. You may want to consider this before you start the procedure.

NOTE The following procedure can only be followed if you have the Tracking Generator Option, 1DN. To view the analyzer's installed options, press **System, More 1 of 3, Show System**.

Procedure 5-22 How to measure cable loss

Step		Comments
1 Calibrate the tracking generator. **(E7402A, E7403A, E7404A, and E7405A only)**	a. Connect a short low-loss 50 W RF cable from the analyzer RF OUT to the analyzer INPUT. b. Press **Preset, System, Alignments, Align Now, TG (Ext Cable).**	• The message "Aligning TG" appears on the display. The tracking generator alignment is finished when the message disappears. • Aligning the tracking generator takes about 30 – 45 seconds.
2 Set the frequency range.	a. Press **Frequency, Start Freq**. b. Use the knob or numeric keypad to specify a starting frequency (for example, start 30 MHz). c. Select **Stop Freq** and use the knob or numeric keypad to specify a starting frequency (for example, stop 1.03 GHz).	
3 Delete any previous signal list data.	• Press **MEASURE, More 1 of 2, Signal List, Delete Signals, Delete All, Yes**.	
4 Change amplitude units.	• Press **AMPLITUDE, More 1 of 3, Y-axis Units, dBm**.	

Procedure 5-22 How to measure cable loss (Continued)

Step		Comments
5 Adjust reference level.	• Press **Return, Ref Level,** –7 dBm.	• **Note:** If antenna corrections are On and the antenna correction units have been changed to a unit other than dBmV, then dBm (and other) units are not available.
6 Set the attenuation.	• Press **AMPLITUDE, Attenuation Man** and use the numeric keypad or knob to select 10 dB.	
7 Couple the sweep time.	• Press **Sweep, Swp Coupling SR**.	• SR autocouples the sweep time for stimulus-response mode, and is usually much faster for swept response measurements.
8 Reduce the RBW.	a. Press **BW/Avg, Resolution BW Man**. b. Use the numeric keypad or the knob to enter 10 kHz.	• Reducing the RBW increases the sensitivity; narrowing the VBW smoothes the trace noise.
9 Narrow the Video BW.	• Select **Video BW Man** 1 kHz.	
10 Turn on the tracking generator.	• Press **Source, AMPLITUDE On**.	• The trace should appear relatively flat near the top of the display.
11 Change the Amplitude Scale.	• Press **AMPLITUDE, Scale/Div** and enter 2 dB.	
12 Increase the sweep time.	a. Press **Sweep, Sweep Time**. b. Use the numeric keypad or the knob to increase the sweep time until there is no observed change in the trace.	• In the stimulus-response mode, the Q (reactance vs resistance of the EUT) determines the fastest rate at which the receiver can be swept. This step allows you to correct for cases in which the receiver is sweeping too fast. • Sweep times of 1 to 2 seconds are not unusual. • Longer cables will require longer sweep times to ensure the cable-under-test is not being overswept.

Procedure 5-22 How to measure cable loss (Continued)

Step		Comments
13 Normalize the signal.	• Press **View/Trace, More 1 of 2, Normalize, Store Ref (1→ 3), Normalize On.**	• Normalization removes the test system's frequency response error before capturing data for the cable. • The normalized trace should appear at the top of the display (that is, along the 0 dB reference). • The reference trace may appear below the normalized trace.
14 Connect the cable.	• Connect the cable you want to characterize to the short low-loss 50 Ω RF cable and then to the analyzer INPUT.	
15 Increase the sweep time.	a. Press **Sweep, Sweep Time.** b. Use the numeric keypad or the knob to increase the sweep time until there is no observed change in the trace.	• In the stimulus-response mode, the Q (reactance vs resistance of the EUT) determines the fastest rate at which the receiver can be swept. This step allows you to correct for cases in which the receiver is sweeping too fast. • Sweep times of 1 to 2 seconds are not unusual. • Longer cables will require longer sweep times to ensure the cable-under-test is not being overswept.
16 Add cable characterization points to the list.	a. Press **MEASURE, Marker Normal.** b. Use the knob or numeric keypad to specify a frequency of interest. c. Press **Marker to List.** d. Repeat step (a), (b) and (c) until you have captured all the points you want to use to characterize the cable. e. To view the signal list, press **MEASURE, More 1 of 2, Signal List, Signal List On**	

Procedure 5-22 How to measure cable loss (Continued)

Step		Comments
17 Save the signal list.	a. Insert a floppy disk into the analyzer disk drive. b. Press **MEASURE, More 1 of 2**, **Signal List, Save/Load, Save, Name**. c. Use the Alpha Editor or an external keyboard to specify a file name that makes sense (for example, **CabTypN**) and press **Enter**. d. Select the A: drive. e. Press **Save Now**.	• If you are unsure how to specify the A: drive, please refer to "Specify a Drive" on page 134.
18 Modify the file format.	a. On a PC, Open the file in a text editor such as Wordpad and reformat the columns to conform with correction file formatting. b. Save As **CabTypN.CBL**.	• The file extension must appear to the analyzer like a corrections file. • You may need to delete the .txt extension. Verify the name and extension after you have closed the file.
19 Load the file as a corrections file.	a. Insert the floppy disk into the analyzer disk drive. b. Press **File, Load, Type, More 1 of 2, Corrections**. c. Select the A: drive. d. Use the ↑↓ arrows to place the cursor on the filename (which, for the example in step 17 should now appear as: **CabTypN.CBL** in the file list. e. Press **Load Now**.	• If you are unsure how to specify the A: drive, please refer to "Specify a Drive" on page 134.
20 Activate the corrections.	a. Press **Meas Setup, More 1 of 2**, **Corrections, Modify, Select Cable, Correction On.** b. Select **Return, Corrections On**.	• Note that **Correction On** only activates the specific correction (in this case cable loss), whereas, **Corrections On** turns on all correction factors that have been individual activated using **Correction On**.

Select between 1 MHz 3 dB, 6 dB, and Impulse Bandwidths

In the Agilent E7400A Series EMC Analyzers, the default 1 MHz bandwidth is set to Impulse.

Depending on your application and the regulatory agency to which you must comply, you may have to specify another bandwidth for measurements above 1 GHz.

Above 1 GHz, regulations governing EMC compliance specify the measurement bandwidth as follows:

- FCC regulations specify a 6 dB, 1 MHz bandwidth
- CISPR regulations specify an impulse, 1 MHz bandwidth

Procedure 5-23 How to switch between 1 MHz 3 dB, 6 dB and Impulse Bandwidths

Step		Comments
1 Select the 1 MHz bandwidth type.	a. Press **BW/Avg, More 1 of 2, 1MHz BW Type**. b. Select **Impulse** for CISPR compliance. c. Select **6 dB** for FCC compliance. d. Select **3 dB** for signal analysis.	

Save/Edit/Recall

This section explains how to save and load data files to and from analyzer memory or floppy disk using the functions in the **File** menu.

A number of file types can be saved and loaded:

- **Setups:** The current analyzer measurement settings.
- **States:** The current analyzer settings and the current trace.
- **Traces:** The selected trace(s). You can specify which trace to save by selecting 1, 2 or 3 or you can save them all by selecting All.
- **Limits:** The selected (1 or 2) limit line table. See "Create and Specify a Limit Line and Margin" on page 111.
- **Corrections:** The selected table of correction data. See "Create and Specify a Limit Line and Margin" on page 111 for more information on correction factors.
- **Screens:** The currently displayed analyzer screen.
- **Signal Lists:** The signal list currently in the analyzer memory.
- **Reports:** Any report that has been defined.

Saving state data saves the analyzer settings, but not the trace data. Saving trace data saves the trace data and the state data. States, traces, limit line tables, and amplitude correction factors are retained in analyzer memory even if the instrument is turned off or **Preset** is pressed.

See "File Naming Rules" on page 136 for the rules for naming a file.

Specify a Drive

You can save (or load) to (or from) one of two drive locations:

- The floppy drive. This appears as drive A:
- The analyzer internal flash memory. This appears as drive C:

There are three possible states your analyzer may be in when you are selecting a drive:

State 1: In any drive, saving to that drive. For example, the analyzer is pointing to drive C: and you want to save to (or load from) a file in that drive.

State 2: In drive C: going to drive A:

State 3: In drive A: going to drive C:

In the procedures which follow, the specific keypresses required to save or load a file from each of these states, are flagged and discussed separately.

Save a File

Procedure 5-24 How to save files

Step		Comments
1 Find and select the file type you want to save.	a. Press **File, Save, Type**. b. Select the file type you want to save, using **More 1 of 2** if necessary, to find the file type of interest.	• The correct file extension for this file type is automatically appended to the file name you specify (for example, **mysetup.SET**.
2 If you are saving a Setup, State, Signal List or Report, continue to Step 7.		
3 If you are saving a Trace:	a. Press **Source** and select **Trace 1**, **Trace 2**, **Trace 3**, or **All Traces**. b. Press **Format** and select **Trace + State** or {CSV}.	
4 If you are saving a Limit:	a. Press **Source** and select **Limit 1** or **Limit 2**	
5 If you are saving Corrections:	a. Press **Source** and select one of the following: **Antenna, Cable, Other** or **User**.	
6 If you are saving a Screen:	a. Press **Format** and select **Bitmap**, **Metafile**, **Reverse Bitmap**, or **Reverse Metafile**.	
7 Specify a file name.	a. Press **Name** and use the Alpha Editor and the numeric keypad, or an external keyboard, to enter the file name. b. Press **Enter**.	
8 Save the new file.	a. From **State 1:** Press **Save Now**. b. From **State 2:** or **State 3:**, Press **Dir Select** and select the desired drive using the ↑↓ arrows or the knob. Then press **Dir Select** again. Press **Save Now**.	• The definitions of these states can be found "Specify a Drive" on page 134.

Load a File

Procedure 5-25 How to load files

Step		Comments
1 Find and select the file you are interested in.	a. Press **File, Load, Type** and select the file type you want to load. b. Select the file you wish to load by using the ↑↓ arrows or the knob.	• If you don't see it, try pressing **More 1 of 2**. • If you select Limits, you will also have to select **Limit 1** or **Limit 2**.
2 Load the selected file.	a. From **State 1:** Press **Load Now**. b. From **State 2:** or **State 3:**, Press **Dir Select** and select the desired drive using the ↑↓ arrows or the knob. Then press **Dir Select** again. Press **Load Now**.	

File Naming Rules

File names for storing states, traces, limit lines or amplitude correction data files in the analyzer should follow the conventions as indicated below:

1. They can be up to eight characters long. In addition, they can have a file extension up to three characters long. The analyzer assigns the extension.
2. They are not case sensitive. It does not matter whether you use upper case or lower case letters when you type them.
3. They can contain only the letters A through Z, the numbers 0 through 9, and the following special characters:
    - underscore _
    - carat ˆ
    - dollar sign $
    - tilde ˜
    - exclamation point !
    - number sign #
    - percent sign %
    - ampersand &
    - hyphen -
    - braces {}
    - at sign @
    - single quotation mark ‘
    - apostrophe ’
    - parenthesis ()

    No other characters are valid.

4. They cannot contain spaces, commas, backslashes, or periods. (except the period that separates the name from the extension.)
5. They cannot be identical to the name of another file in the same directory. That is, if you want to resave a setup or other file type, and you want to use the same file name as you used before, you must first delete the existing file and save to that name again.

Generate Reports

Generate a Quick Report

The fastest way to generate a report is simply to save the entire contents of the report cache to the analyzer's C: or A: drive. This will result in an HTML file that contains *all* the information regarding your current state (screen + setup). This procedure is described here.

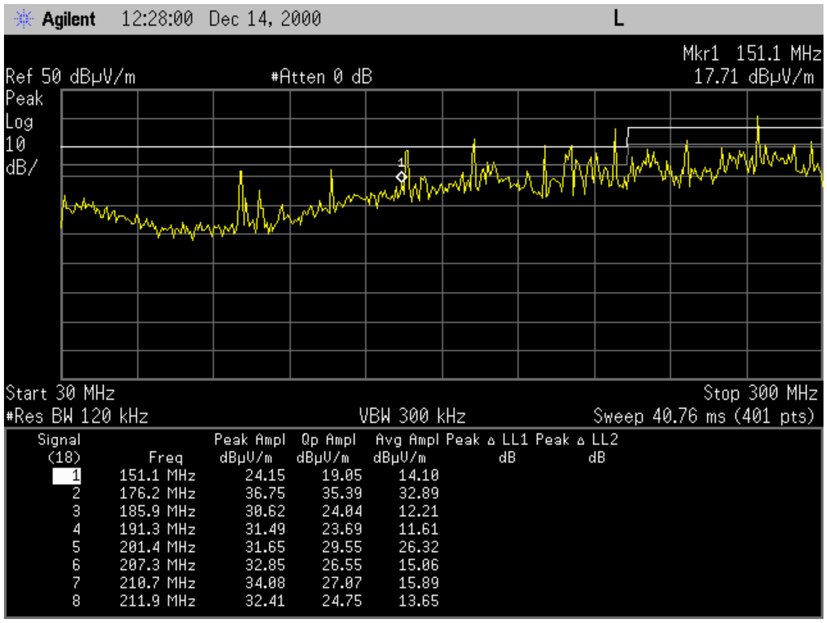
Later on when you want a more sophisticated reporting mechanism, you can follow the instructions in "Generate a Custom Report" on page 142, to define a report that contains a set of parameters which emphasize only those elements you are particularly interested in.

Procedure 5-26 How to generate a quick report

Step		Comments
1 Save the report data.	a. Press **File, Save, Type, More 1of 2, Report.** b. Press **Name** and use the Alpha Editor, or an external keyboard, to specify a name. Press **Enter**. c. Specify a drive (A: or C:) d. Press **Save Now**.	• If you are unsure how to specify a drive please refer to "Specify a Drive" on page 134.
2 Recall the report and review it on you computer.	a. Insert the diskette that has your report data into your computer disk drive. b. Start a browser (Netscape or Internet Explorer, for example) c. Open or double click on the file to open it.	• HTML files are easily cut and pasted into other word processor files, if you require another format.

Output from this quick report appears as shown in the following table:

Typical Report Output



Current Ampcor Settings	Ampcor is	ON
	Antenna Corrections are	ON
	Antenna Freq Corrections are	LIN
	Cable Corrections are	OFF
	Other Corrections are	OFF
	User Corrections are	OFF
	Current Limit Settings	
	Limit Line 1 Display is	ON
	Limit Line 1 Margin is	ON
	Limit Line 1 Margin Value is	-6 dB
	Limit Line 1 Limit Testing is	OFF
	Limit Line 2 Display is	ON
	Limit Line 2 Margin is	ON
	Limit Line 2 Margin Value is	-6 dB
	Limit Line 2 Limit Testing is	OFF

	Current Frequency Settings	
	Center Frequency is	515 MHz
	Frequency Span is	970 MHz
	Start Frequency is	30 MHz
	Stop Frequency is	1 GHz
	CF Step Size is	97 MHz
	Frequency Offset	0 Hz
Current Sweep Settings		
	Sweeptime is	146.4 ms
Current Bandwidth Settings		
	The RBW is	120 kHz
	The Video Bandwidth is	300 kHz
	The VBW/RBW ratio is	3.00
	Averaging is	OFF
	Average Count is	100
Current Amplitude Settings		
	Reference Level is	96.99 dBuV/m
	Reference Level Offset is	0.0 dB
	Reference Position is	10
	The scale is	LOG
	The Attenuation Level is	0 dB
	Amplitude Units are	dBuV/m
	Log Amplitude Units are	dBuV/m
	Lin Amplitude Units are	uV/m
Current Display Line Settings		
	Display Line is	OFF
	Display Line Value is	82 dBuV/m
	Display Threshold is	OFF

	Display Threshold Value is	17 dBuV/m
Current Trace Settings		
	Trace 1 is in	ClearWrite mode
	Trace 2 is in	Blank mode
	Trace 3 is in	Blank mode
Current Detector/Demod Settings		
	Detector is in	PEAK mode
	The Dwell time is	OFF
	The Dwell time is	500 ms
	The QP/Avg gain is	OFF
	The QP/Avg Gain Value is	0
	The QPD Offset is	20
	Demodulation is	OFF
	Demodulation is	AM
	FM Gain	100 kHz
	The SQUELCH Value is	0
Current Source Settings		
	The Source is	OFF
	The Source Amplitude Value is	-10 dB
	The Source Attenuation Value is	8 dB
	The Source Power Offset is	0 dB
	The Source Power Step is	10 dB
	The Source Power Sweep is	0 dB
Current Gate Settings		
	Gate Delay	1 us
	Gate Length is	1 us
	Gate is	OFF

	Zone is	OFF
	Zone Center is	300 MHz
	Zone Span is	300 MHz
Other Current Settings		
	Peak Excursion is	6 dB
	Mixer Level is	-10 dB
Current System Settings		
	GPIB Address is	18
	Remote Port is	GPIB port

Generate a Custom Report

There are three main options for generating a report:

- Screen On or Off – This allows you to decide whether or not it is important for this report to show a screen shot. A good snapshot of a saved trace may be useful for later comparison purposes.
- List – This allows you to specify a set of options for reviewing the lists that you have generated during a given measurement. These options determine the columns that will show up in your report signal list.
- Settings On or Off – This allows you specify whether or not all the CURRENT SETTINGS are to be included in the report or not.

Procedure 5-27 How to generate a custom report

Step		Comments
1 Define your report.	• Press **Meas Setup**, **More 1of 2, Define Report**.	• This will take you to the top set of options for defining a report.
2 Specify inclusion of analyzer screen.	• Press **Screen On Off** and underline On or Off.	• The default is to include a screen shot (On).

Procedure 5-27 How to generate a custom report (Continued)

Step		Comments
3 Specify List options.	a. Press **List**. b. Press **List Detectors** to specify which of the detector data you want to include. c. Press **Return**, **List Limits**. d. Press **Limit 1 On Off** or **Limit 2 On Off** to specify which limit line to use for the list data. e. Press **Limit 1** ∆ or **Limit 2** ∆ and choose whether or not to show the detector data to compare to the specified limit line. If one of these is selected activate the appropriate detector(s). f. Press **Return, Return, List Comments On** to include any comments applied to the list. g. Press **List Corr On** to include any corrections applied to the list. h. Press **List Marked** to show the marked points on the list.	• The default is to include them all. • The limit line default is the limit line currently selected in the measurement settings. • The default for the limit delta options is Off for the unselected limit line and On for the selected limit line.
4 Show or hide analyzer settings.	a. Press **Return, Settings On Off**. b. Underline **On** to show all EMC analyzer settings. c. Underline **Off** to hide the settings.	• The default is to include the settings.

A Determining your Regulation Requirements

In This Chapter...

Introduction

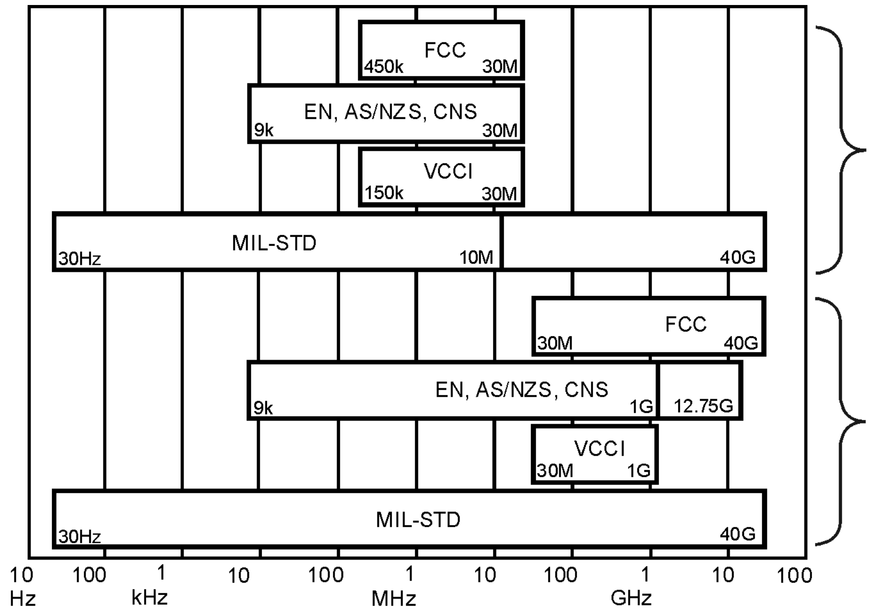
In this chapter the regulations that govern EMC emissions, and therefore your product design, will be discussed.

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.

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.



bb91a

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 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. However, mandatory compliance and labeling has been delayed to 19 June 1997. 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.

B Disk Contents: Limit Lines and Transducer Factors

Table B-1 Limit Lines

Description	Frequency Range	DOS Filename
AS/NZS 1044; Conducted Household Appliances, Quasi-Peak	150 kHz to 30 MHz	1044CHAQ.lim
AS/NZS 1044; Conducted Household Appliances, Average	50 kHz to 30 MHz	1044CHAA.lim
AS/NZS 1044; Conducted < 700 W, Motors, Quasi-Peak	150 kHz to 30 MHz	1044Cx7Q.lim
AS/NZS 1044; Conducted < 700 W, Motors, Average	150 kHz to 30 MHz	1044Cx7A.lim
AS/NZS 1044; Conducted > 700 W < 1000 W, Motors, Quasi-Peak	150 kHz to 30 MHz	1044Cx1Q.lim
AS/NZS 1044; Conducted > 700 W < 1000 W, Motors, Average	150 kHz to 30 MHz	1044Cx1A.lim
AS/NZS 1044; Conducted > 1000 W, Motors, Quasi-Peak	150 kHz to 30 MHz	1044C1xQ.lim
AS/NZS 1044; Conducted > 1000 W, Motors, Average	150 kHz to 30 MHz	1044C1xA.lim
AS/NZS 1044; Radiated Household Appliances, Quasi-Peak	30 MHz to 300 MHz	1044RHAQ.lim
AS/NZS 1044; Radiated Household Appliances, Average	30 MHz to 300 MHz	1044RHAA.lim
AS/NZS 1044; Radiated < 700 W, Motors, Quasi-Peak	30 MHz to 300 MHz	1044Rx7Q.lim
AS/NZS 1044; Radiated < 700 W, Motors, Average	30 MHz to 300 MHz	1044Rx7A.lim
AS/NZS 1044; Radiated > 700 W < 1000 W, Motors, Quasi-Peak	30 MHz to 300 MHz	1044Rx1Q.lim
AS/NZS 1044; Radiated > 700 W < 1000 W, Motors, Average	30 MHz to 300 MHz	1044Rx1A.lim
AS/NZS 1044; Radiated > 1000 W, Motors, Quasi-Peak	30 MHz to 300 MHz	1044R1xQ.lim
AS/NZS 1044; Radiated > 1000 W, Motors, Average	30 MHz to 300 MHz	1044R1xA.lim
AS/NZS 2064; Class A Conducted, Group 1, Average	150 kHz to 30 MHz	2064AC1A.lim
AS/NZS 2064; Class A Conducted, Group 1, Quasi-Peak	150 kHz to 30 MHz	2064AC1Q.lim

Table B-1 Limit Lines

Description	Frequency Range	DOS Filename
AS/NZS 2064; Class A Conducted, Group 2, Average	150 kHz to 30 MHz	2064AC2A.lim
AS/NZS 2064; Class A Conducted, Group 2, Quasi-Peak	150 kHz to 30 MHz	2064AC2Q.lim
AS/NZS 2064; Class B Conducted, Group 1 and 2, Quasi-Peak	150 kHz to 30 MHz	2064BCQ.lim
AS/NZS 2064; Class B Conducted, Group 1 and 2, Average	150 kHz to 30 MHz	2064BCA.lim
AS/NZS 2064; Class A Radiated, Group 1	30 MHz to 1 GHz	2064AR1.lim
AS/NZS 2064; Class A Radiated, Group 2	50 kHz to 30 MHz	2064AR2.lim
AS/NZS 2064; Class B Radiated, Group 1	30 MHz to 1 GHz	2064BR1.lim
AS/NZS 2064; Class B Radiated, Group 2	30 MHz to 1 GHz	2064BR2.lim
AS/NZS 3548; Class A Conducted, Quasi-Peak	150 kHz to 30 MHz	548ACQP.lim
AS/NZS 3548; Class A Conducted, Average	150 kHz to 30 MHz	3548ACAV.lim
AS/NZS 3548; Class B Conducted, Quasi-Peak	150 kHz to 30 MHz	3548BCQP.lim
AS/NZS 3548; Class B Conducted, Average	150 kHz to 30 MHz	3548BCAV.lim
AS/NZS 3548; Class A Radiated (10m)	30 MHz to 1 GHz	3548AR10.lim
AS/NZS 3548; Class A Radiated (30m)	30 MHz to 1 GHz	3548AR30.lim
AS/NZS 3548; Class B Radiated (10m)	30 MHz to 1 GHz	3548BR10.lim
BellCore 1089; Conducted, Analog Voiceband Leads (Longitudinal)	8 kHz to 6 MHz	1089CVBL.lim
BellCore 1089; Conducted, Analog Voiceband Leads (Metallic)	8 kHz to 6 MHz	1089CVBM.lim
BellCore 1089; Class A Conducted, AC Power Leads (Quasi-Peak)	450 kHz to 69.5 MHz	1089CAPQ.lim
BellCore 1089; Class A Conducted, AC Power Leads - Voltage	450 kHz to 69.5 MHz	1089CAPV.lim
BellCore 1089; Class B Conducted, AC Power Leads - Voltage	450 kHz to 47.9 MHz	1089CBPV.lim
BellCore 1089; Radiated (3m) - Doors Open	10 kHz to 10 GHz	1089R3DO.lim
BellCore 1089; Radiated (3m) - Doors Closed	10kHz to 10 GHz	1089R3DC.lim

Table B-1 Limit Lines

Description	Frequency Range	DOS Filename
BellCore 1089; Radiated (10m) - Doors Open	10 kHz to 10 GHz	1089R1DO.lim
BellCore 1089; Radiated (10m) - Doors Closed	10 kHz to 10 GHz	1089R1DC.lim
EN 55011; Class A Conducted, Group 1, Quasi-Peak	150 kHz to 30 MHz	EN11AC1Q.lim
EN 55011; Class A Conducted, Group 1, Average	150 kHz to 30 MHz	EN11AC1A.lim
EN 55011; Class A Conducted, Group 2, Quasi-Peak	150 kHz to 30 MHz	EN11AC2Q.lim
EN 55011; Class A Conducted, Group 2, Average	150 kHz to 30 MHz	EN11AC2A.lim
EN 55011; Class B Conducted, Group 1 and 2, Quasi-Peak	150 kHz to 30 MHz	EN11BCQ.lim
EN 55011; Class B Conducted, Group 1 and 2, Average	150 kHz to 30 MHz	EN11BCA.lim
EN 55011; Class A Radiated, Group 1	30 MHz to 1 GHz	EN11AR1.lim
EN 55011; Class A Radiated, Group 2	150 kHz to 1 GHz	EN11AR2.lim
EN 55011; Class B Radiated, Group 1	30 MHz to 1 GHz	EN11BR1.lim
EN 55011; Class B Radiated, Group 2	30 MHz to 1 GHz	EN11BR2.lim
EN 55014; Conducted Household Appliances, Quasi-Peak	150 kHz to 30 MHz	EN14CHAQ.lim
EN 55014; Conducted Household Appliances, Average	150 kHz to 30 MHz	EN14CHAA.lim
EN 55014; Conducted < 700 W, Motors, Quasi-Peak	150 kHz to 30 MHz	EN14Cx7Q.lim
EN 55014; Conducted < 700 W, Motors, Average	150 kHz to 30 MHz	EN14Cx7A.lim
EN 55014; Conducted > 700 W < 1000 W, Motors, Quasi-Peak	150 kHz to 30 MHz	EN14Cx1Q.lim
EN 55014; Conducted > 700 W < 1000 W, Motors, Average	150 kHz to 30 MHz	EN14Cx1A.lim
EN 55014; Conducted > 1000 W, Motors, Quasi-Peak	150 kHz to 30 MHz	EN14C1xQ.lim
EN 55014; Conducted > 1000 W, Motors, Average	150 kHz to 30 MHz	EN14C1xA.lim
EN 55014; Radiated Household Appliances, Quasi-Peak	30 MHz to 300 MHz	EN14RHAQ.lim
EN 55014; Radiated Household Appliances, Average	30 MHz to 300 MHz	EN14RHAA.lim
EN 55014; Radiated < 700 W, Motors, Quasi-Peak	30 MHz to 300 MHz	EN14Rx7Q.lim

Table B-1 Limit Lines

Description	Frequency Range	DOS Filename
EN 55014; Radiated < 700 W, Motors, Average	30 MHz to 300 MHz	EN14Rx7A.lim
EN 55014; Radiated > 700 W < 1000 W, Motors, Quasi-Peak	30 MHz to 300 MHz	EN14Rx1Q.lim
EN 55014; Radiated > 700 W < 1000 W, Motors, Average	30 MHz to 300 MHz	EN14Rx1A.lim
EN 55014; Radiated > 1000 W, Motors, Quasi-Peak	30 MHz to 300 MHz	EN14R1xQ.lim
EN 55014; Radiated > 1000 W, Motors, Average	30 MHz to 300 MHz	EN14R1xA.lim
EN 55022; Class A Conducted, Quasi-Peak	150 kHz to 30 MHz	EN22ACQP.lim
EN 55022; Class A Conducted, Average	150 kHz to 30 MHz	EN22ACAV.lim
EN 55022; Class B Conducted, Quasi-Peak	150 kHz to 30 MHz	EN22BCQP.lim
EN 55022; Class B Conducted, Average	150 kHz to 30 MHz	EN22BCAV.lim
EN 55022; Class A Radiated (10m)	30 MHz to 1 GHz	EN22AR10.lim
EN 55022; Class A Radiated (30m)	30 MHz to 1 GHz	N22AR30.lim
EN 55022; Class B Radiated (10m)	30 MHz to 1 GHz	N22BR10.lim
FCC Part 15; Class A Conducted	450 kHz to 30 MHz	FCC15AC.lim
FCC Part 15; Class B Conducted	450 kHz to 30 MHz	FCC15BC.lim
FCC Part 15; Class A Radiated (10m)	30 Hz to 5 GHz	FCC15A10.lim
FCC Part 15; Class B Radiated (3m)	30 MHz to 40 GHz	FCC15B3.lim
FCC Part 15; Class B Radiated (10m)	30 MHz to 5 GHz	FCC15B10.lim
GB9254 1998; Conducted Class A, Quasi-Peak	150 kHz to 30 MHz	G9254CAQ.lim
GB9254 1998; Conducted Class A, Average	150 kHz to 30 MHz	G9254CAA.lim
GB9254 1998; Conducted Class B, Quasi-Peak	150 kHz to 30 MHz	G9254CBQ.lim
GB9254 1998; Conducted Class B, Average	150 kHz to 30 MHz	G9254CBA.lim
GB9254 1998; Radiated Class A	30 MHz to 1 GHz	G9254RA.lim
GB9254 1998; Radiated Class B	30 MHz to 1 GHz	G9254RB.lim

Table B-1 Limit Lines

Description	Frequency Range	DOS Filename
VCCI; Conducted Class 1, Quasi-Peak	150 kHz to 30 MHz	VCCIC1QP.lim
VCCI; Conducted Class 1, Average	150 kHz to 30 MHz	VCCIC1AV.lim
VCCI; Conducted Class 2, Quasi-Peak	150 kHz to 30 MHz	VCCIC2QP.lim
VCCI; Conducted Class 2, Average	150 kHz to 30 MHz	VCCIC2AV.lim
VCCI; Radiated Class 1 (3m)	30 MHz to 1 GHz	VCCIR13.lim
VCCI; Radiated Class 1 (10m)	30 MHz to 1 GHz	VCCIR110.lim
VCCI; Radiated Class 2 (10m)	30 MHz to 1 GHz	VCCIR210.lim
MIL-STD CE101-1 Conducted, Power Leads	30 Hz to 10 kHz	MC101x1.lim
MIL-STD CE101-2 Conducted, Power Leads, <1kVA	30 Hz to 10 kHz	MC101x2a.lim
MIL-STD CE101-2 Conducted, Power Leads, ≥1kVA	30 Hz to 10 kHz	MC101x2b.lim
MIL-STD CE101-3 Conducted, Power Leads, 400 Hz, <0.2 kVA	30 Hz to 10 kHz	MC101x3a.lim
MIL-STD CE101-3 Conducted, Power Leads, 400 Hz, ≥0.2 kVA	30 Hz to 10 kHz	MC101x3b.lim
MIL-STD CE101-4 Conducted, Power Leads, >28 V	30 Hz to 10 kHz	MC101x4a.lim
MIL-STD CE101-4 Conducted, Power Leads, ≤28 V	30 Hz to 10 kHz	MC101x4b.lim
MIL-STD CE102-1 Conducted, Power Leads	30 kHz to 10 MHz	MC102x1.lim
MIL-STD RE101-1 Radiated, Magnetic Field, Army applications	30 Hz to 100 kHz	MR101x1.lim
MIL-STD RE101-2 Radiated, Magnetic Field, Navy applications	30 Hz to 100 kHz	MR101x2.lim
MIL-STD RE102-1 Radiated, Electric Field, surface ship	10 kHz to 18 GHz	MR102x1.lim
MIL-STD RE102-2 Radiated, Electric Field, submarine internal	10 kHz to 18 GHz	MR102x2a.lim
MIL-STD RE102-2 Radiated, Electric Field, submarine external	10 kHz to 18 GHz	MR102x2b.lim
MIL-STD RE102-3 Radiated, Electric Field, fixed wing external	10 kHz to 18 GHz	MR102x3a.lim
MIL-STD RE102-3 Radiated, Electric Field, aircraft, ≥25 m	10 kHz to 18 GHz	MR102x3b.lim

Table B-1 Limit Lines

Description	Frequency Range	DOS Filename
MIL-STD RE102-3 Radiated, Electric Field, aircraft, <25 m	10 kHz to 18 GHz	MR102x3c.lim
MIL-STD RE102-4 Radiated, Electric Field, Navy Fixed & AF	10 kHz to 18 GHz	MR102x4a.lim
MIL-STD RE102-4 Radiated, Electric Field, Navy Mobile & AF	10 kHz to 18 GHz	MR102x4b.lim

Table B-2 Transducer Factors

Description	DOS Filename
HP/Agilent 11909A; Preamplifier (9 kHz to 1 GHz)	HP11909A.amp
HP/Agilent 11940A; Close Field Probe (30 MHz to 1 GHz)	HP11940A.ant
HP/Agilent 11941A; Close Field Probe (9 kHz to 30 MHz)	HP11941A.ant
HP/Agilent 11947A; Transient Limiter (9 kHz to 200 MHz)	HP11947A.oth
HP/Agilent 11955A; Biconical Antenna (30 MHz to 300 MHz)	HP11955A.ant
HP/Agilent 11956A; Log Periodic Antenna (200 MHz to 1 GHz)	11956A1G.ant
HP/Agilent 11956A; Log Periodic Antenna (200 MHz to 2 GHz)[a]	11956A2G.ant
HP/Agilent 11966A; Active Loop Antenna (10 kHz to 30 MHz)	HP11966A.ant
HP/Agilent 11966B; Active Monopole Antenna (30 Hz to 50 MHz)	HP11966B.ant
HP/Agilent 11966C; Biconical Antenna (30 MHz to 300 MHz)	HP11966C.ant
HP/Agilent 19966D; Log Periodic Antenna (200 MHz to 1 GHz)	11966D1G.ant
HP/Agilent 19966D; Log Periodic Antenna (200 MHz to 2 GHz)[a]	11966D2G.ant
HP/Agilent 11966E; Double Ridged Horn Antenna (1 GHz to 18 GHz)	HP11966E.ant
HP/Agilent 11966F; Conical Log Spiral Antenna (200 MHz to 1 GHz)	HP11966F.ant
HP/Agilent 11966G; Conical Log Spiral Antenna (1 GHz to 10 GHz)	HP11966G.ant
HP/Agilent 11966H; Dipole Antenna Set (28 MHz to 1 GHz)	
Balun 1, (28 MHz to 60 MHz)	11966HB1.ant
Balun 2, (60 MHz to 140 MHz)	11966HB2.ant
Balun 3, (140 MHz to 400 MHz)	11966HB3.ant
Balun 4, (400 MHz to 1 GHz)	11966HB4.ant
HP/Agilent 11966I; Double Ridged Horn Antenna (200 MHz to 2 GHz)	HP11966I.ant
HP/Agilent 11966J; Horn Antenna (18 GHz to 40 GHz)	HP11966J.ant

Table B-2 Transducer Factors

Description	DOS Filename
HP/Agilent 11966K; Magnetic Field Pickup Coil (20 Hz to 50 kHz)	HP11966K.ant
HP/Agilent 11966L; Coaxial Cable (Type-N)	HP11966L.cbl
HP/Agilent 11966N; Log Periodic Antenna (200 MHz to 5 GHz)	HP11966N.ant
HP/Agilent 11966P; Broadband Antenna (30 MHz to 1 GHz)	11966P1G.ant
HP/Agilent 11966P; Broadband Antenna (30 MHz to 2 GHz)[a]	11966P2G.ant
HP/Agilent 11967C; LISN (25 A)	HP11967C.ant
HP/Agilent 11967D; LISN (10 A)	HP11967D.ant
HP/Agilent 11967E; LISN (25 A)	HP11967E.ant
HP/Agilent 8447F, Option H64; Dual Preamp	
Band 1, (9 kHz to 50 MHz)	447FLO.amp
Band 2, (100 kHz to 1.3 GHz)	8447FHI.amp

a. Currently selling versions have an upper frequency limit of 2 GHz. Earlier models have an upper frequency limit of only 1 GHz . Refer to the information for your antenna to determine which correction file to use.

The Conducted and Radiated Setup files consist of the following limit line and correction factor files.

Table B-3 Setups

	File Type	File Name
Conducted Setup (CONDEMO.set) CISPR Band B, 150 kHz to 30 MHz	Limit Line 1 Limit Line 2 Antenna Correction Other Correction	EN22BCQP.lim EN22BCAV.lim HP11967D.ant HP11947A.oth
Radiated Setup (RADDEMO.set) CISPR Band C, 30 MHz to 300 MHz	Limit Line 1 Antenna Correction Cable Correction	EN14R1XQ.lim HP11966C.ant HP11966L.cbl

Glossary of Acronyms and Terms

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.
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.

AMN (Artificial Mains Network)

See LISN

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 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.
2. A shielded room which is lined with radio absorbing material to reduce reflections from all internal surfaces. Fully lined anechoic chambers have such material on all internal surfaces: 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.

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 voltage to the strength of the field component being measured.
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.

BSI

British Standards Institute.

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.

CEN

Comité Europeen de Normalisation.

CENELEC

Comité Europeen de Normalisation Electronique

CISPR

Comité International Spécial des Perturbations Radioélectriques

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.

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.

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.

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.

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.

Emission

Electromagnetic energy propagated from a source by radiation or conduction.

ETSI

European Telecommunications Standards Institute.

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.

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 band

A continuous range of frequencies extending between two limits.

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.

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.

Impulse

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

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

Interconnecting leads

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.

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.

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.

Isotropic

Isotropic means having properties of equal values in all directions.

ITU

International Telecomm Union

LISN

Line Impedence Stabilization Network

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.

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

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".

Polarization

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

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.

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.

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).

Shielded 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.

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.

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.

VCCI

Japanese Voluntary Control Council for Interference by Information Technology Equipment.

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