

User Manual

Tektronix

27120A

EMI Measurement System

070-9879-00

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In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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Service Assurance

If you have not already purchased Service Assurance for this product, you may do so at any time during the product's warranty period. Service Assurance provides Repair Protection and Calibration Services to meet your needs.

Repair Protection extends priority repair services beyond the product's warranty period; you may purchase up to three years of Repair Protection.

Calibration Services provide annual calibration of your product, standards compliance and required audit documentation, recall assurance, and reminder notification of scheduled calibration. Coverage begins upon registration; you may purchase up to five years of Calibration Services.

Service Assurance Advantages

- Priced well below the cost of a single repair or calibration
- Avoid delays for service by eliminating the need for separate purchase authorizations from your company
- Eliminates unexpected service expenses

For Information and Ordering

For more information or to order Service Assurance, contact your Tektronix representative and provide the information below. Service Assurance may not be available in locations outside the United States of America.

Name	VISA or Master Card number and expiration
Company	date or purchase order number
Address	Repair Protection (1,2, or 3 years)
City, State, Postal code	Calibration Services (1,2,3,4, or 5 years)
Country	Instrument model and serial number
Phone	Instrument purchase date

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

While using this product, you may need to access other parts of the system. Read the *General Safety Summary* in other system manuals for warnings and cautions related to operating the system.

To Avoid Fire or Personal Injury

Use Proper Power Cord. Use only the power cord specified for this product and certified for the country of use.

Use Proper Voltage Setting. Before applying power, ensure that the line selector is in the proper position for the power source being used.

Connect and Disconnect Properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

Observe All Terminal Ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

The common terminal is at ground potential. Do not connect the common terminal to elevated voltages.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Do Not Operate Without Covers. Do not operate this product with covers or panels removed.

Use Proper Fuse. Use only the fuse type and rating specified for this product.

Avoid Exposed Circuitry. Do not touch exposed connections and components when power is present.

Do Not Operate With Suspected Failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

Provide Proper Ventilation. Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

Symbols and Terms

Terms in this Manual. These terms may appear in this manual:



WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*



CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Terms on the Product. These terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

Symbols on the Product. The following symbols may appear on the product:



WARNING
High Voltage



Protective Ground
(Earth) Terminal



CAUTION
Refer to Manual



Double
Insulated

Preface

This Instruction Manual describes how to prepare your 27120A EMI Measurement System for precertification electromagnetic interference (EMI) measurements. The product is also referred to as the EMI measurement system throughout this manual.

This manual is divided into the following parts:

- Getting Started. Includes a brief system description, available accessories and options, installation, and functional tests.
- Operating Basics. Includes detailed descriptions of the system components, and pointers to the specifications for each system component.
- Reference. Includes sample procedures for radiated and conducted EMI tests using the system components.
- Appendix A: Servicing Information. Includes pointers to service information in the documentation supplied with each system component.

Related Manuals

The following manuals provide information for the other components of the EMI measurement system.

- The *EMC120 Precompliance Test Software User Manual* describes how to install and use the precompliance test software. This software automates EMI testing.
- The *2711/2712 Programmer Manual* includes all GPIB commands, queries, and responses for the instrument family. Applicable syntax diagrams and a functional command listing are also included.
- The *2711/2712 Service Manual* includes the performance check procedure, adjustment procedure, maintenance information, theory of operation, the replaceable electrical parts list, schematic diagrams, circuit board illustrations, component lookup tables, replaceable mechanical parts lists, and the exploded views.
- The *2712 Pocket Reference* includes a summary of instrument controls and their range, front- and rear-panel descriptions, and main instrument features.

Getting Started

This section describes the system components, how to install them, and a brief functional check. For specific power, cooling, and other setup requirements for each component, refer to the manuals for that component.

Product Description

The Tektronix 27120A EMI Measurement System provides the necessary components to perform precertification and postcertification EMI testing. The EMI measurement system minimizes both EMC laboratory testing cost and testing cycle time prior to applying for final certification. The EMI measurement system is also useful for conducting postcompliance measurements. Postcompliance measurements help to ensure continued compliance with certification standards.

The EMI measurement system includes the following components. For more detailed descriptions of their roles in the system, see the *EMI Measurement System Components* discussion on page 9.

- Tektronix EMC120 Precompliance Test Software controls testing on the EMI measurement system. The EMI test software runs under Microsoft® Windows® 3.1 or Windows 95®.
- Tektronix 2712 Option 12 Spectrum Analyzer acquires and analyzes the frequency spectrum of signals present at the RF input.
- Tektronix 2706 RF Stepping Preselector provides a series of bandpass filters covering successive frequency ranges for the signal input.
- Biconical Antenna provides reception of radiated RF signals over the frequency range of 20 to 300 MHz.
- Log Periodic Antenna provides reception of radiated RF signals over the frequency range of 200 to 1000 MHz.
- Non-conductive Tripod provides a sturdy, non-conductive mounting for the antenna.
- Coaxial Cable provides a flexible 50 Ω connection between the antenna and the RF preselector.
- Transient Limiter prevents damage to the sensitive RF input circuitry of the spectrum analyzer.
- Line Impedance Stabilization Network couples the conducted emissions from the equipment under test to the input of the spectrum analyzer.

Accessories

The only standard accessory shipped with the EMI measurement system is the *27120A EMI Measurement System User Manual*, this manual (Tektronix part number 070-9879-XX).

See the specific component manuals for information on accessories that ship with the system components.

Optional Accessories

The following optional accessories are recommended for use with the EMI measurement system:

- National Instruments PCII/IIA or AT-GPIB/TNT IEEE 488 (GPIB) card
- 2 meter GPIB cable (Tektronix part number 012-0991-00)
- 1 meter GPIB cable (Tektronix part number 012-0991-01)

Order Options

The following options are available when you order an EMI measurement system. For additional option information, refer to the individual component documentation. To order an option, contact your local Tektronix Field Office or representative.

Options A1, A2, A3, A4, and A5. (applies only to the Tektronix 2706 and 2712)
Tektronix offers the six power cord options listed in Table 1.

Table 1: Power cord identification

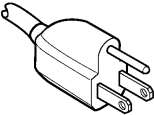
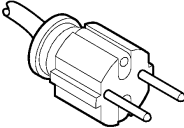
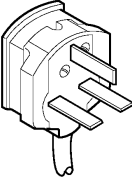
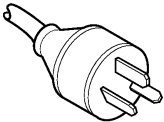
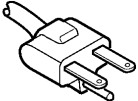
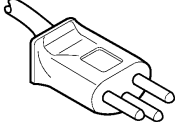
Plug configuration	Normal usage	Option number
	North America 125 V/15A Plug NEMA 5-15P	Standard
	Europe 230 V	A1
	United Kingdom 230 V	A2

Table 1: Power cord identification (cont.)

Plug configuration	Normal usage	Option number
	Australia 230 V	A3
	North America 230 V	A4
	Switzerland 230 V	A5

Option 05. Adds a Tektronix 2707 External Tracking Generator. This generator aids in measuring site attenuation (as required by ANSI standard C63.4) and for measuring characteristics of cables, filters, and other passive devices.

Option 10. (Tektronix 2712). Adds a raster-scan video monitor to the 2712 Spectrum Analyzer. The monitor displays video signals that conform to the recognized standards NTSC, PAL, and SECAM. For additional information, contact your local Tektronix Field Office or representative.

Option 11. Deletes antennas, tripod, and cable from the EMI measurement system. Use this option when you will measure only conducted emissions.

Option 16. Deletes the LISN and the Transient Limiter from the EMI measurement system. Use this option when you will measure only radiated emissions.

Option 17. Deletes the Tektronix 2706 RF Preselector.

Hardware Installation

The equipment included in the EMI measurement system must be properly connected to ensure accurate measurements. System configuration differs for radiated and conducted testing. To configure your system for radiated EMI testing, refer to Figure 2 on page 14 and perform the procedure following the figure. To configure your system for conducted EMI testing, refer to Figure 3 on page 18 and perform the procedure following the figure. Both procedures follow the same steps to connect the GPIB cables, the RF preselector, and the spectrum analyzer.

For specific power, cooling, and other setup requirements for each component, refer to the manuals for that component.

Ensure that your PC is equipped with an IEEE 488 interface card, such as the National Instruments PCII/IIA or AT-GPIB/TNT interface card. If necessary, run the diagnostic software included with the card to ensure it is functioning properly.

Tighten all cables as tight as possible using only your fingers to ensure a good connection. Do not overtighten connections as this can ruin the cable.

Refer to *Configuration* on page 5 for instructions on configuring the GPIB bus.

Software Installation

The EMC120 Precompliance Test Software performs precertification EMI testing and postcertification EMI monitoring. The EMI test software is packaged with the supporting user manual. The online help and Wizard tutorial included in the EMI test software provide instructions on test settings, data acquisition, viewing results, and saving test setups.

The EMI test software is designed to operate on a PC-compatible computer running Windows® 3.1 or Windows95®. Approximately 2.5 Mbytes of free hard disk space is required.

Familiarize yourself with the information in section 1, *General Information*, of the *EMC120 Precompliance Test Software User Manual*. The software provides detailed instructions for installation.

To install the EMI test software, follow the installation instructions in section 1 of the user manual. When the software is successfully installed, you should add the appropriate correction factors for the ancillary devices. For more information, refer to *Correction Factors* on page 6.

Configuration

The EMI test software requires the spectrum analyzer, and other GPIB-controlled test equipment, to have unique GPIB addresses. To set the GPIB addressing, follow these steps:

1. Configure your 2712 Spectrum Analyzer by selecting the UTIL/4/0/0 menu and then setting the following parameters:
 - Status: Online
 - GPIB Address: 1
 - Power On SRA: Off
 - EIO/LF Mode: EOI
 - Talk Only Mode: Off
2. Set unique addresses on the 2706 RF Preselector and any other GPIB equipment on the bus. The address is typically set in a configuration menu or with switches on the rear panel. Refer to your equipment manual. Set the address on the 2706 RF Preselector to 10, unless this address conflicts with another instrument with a preconfigured address of 10.
3. Configure the test software with the addresses you have set for each piece of equipment. Choose Options from the menu bar and select Hardware. Figure 1 shows the Hardware Setup window.



Figure 1: Setting the GPIB address in the Hardware Setup window

4. Select the type of spectrum analyzer, then set the GPIB address. This address should match the address set on the spectrum analyzer.

5. To configure a tower and turntable or a Tektronix 2706 Preselector, click on the appropriate box and enter the instrument GPIB address.
6. When done, select OK.

Correction Factors

To ensure accurate measurements, correction factors for ancillary devices, such as an antenna, must be applied to all EMI measurements. Correction factors are usually supplied by the equipment manufacturer to compensate for the effects of nonlinear frequency response and loss or gain inherent in the device. The correction factors must be available to the EMI test software before starting radiated or conducted testing. The correction factors for the antennas are included in the documentation and in ASCII files on the included PC disks.

The disks simplify loading antenna correction factors into the EMI software. Copy the correction factors from the disk to the correction factor directory created during installation of the EMI software.

You can also load into the software correction factors for other devices not included in the EMI measurement system. The EMI test software includes sample files which you can copy and modify. See the online help information on correction factors for instructions. Modify the sample correction factor files to meet the specifications of your particular device(s). Change the default name assigned to the correction factor files to the unique serial number of the ancillary device.

You can name the correction factor files whatever you like, but you must use the following filename extensions:

- .RAD for radiated factors
- .CON for conducted factors
- .FCT for generic factors, such as cable loss or preamplifier gain

Functional Check

The following procedure provides a brief functional check to check the spectrum analyzer, the RF Preselector and GPIB communication between these components and the PC. For a more complete check on instrument functionality, perform the EMI measurement procedures starting on page 13 in the *Reference* section.

1. Set up the system components as described under *Hardware Installation* and *Software Installation* and *Configuration* beginning on page 4. All instruments, except the LISN, should now be connected to AC power and the GPIB configuration should be complete.
2. Stack the spectrum analyzer on top of the RF preselector as shown in Figure 2 on page 14.
3. Connect the spectrum analyzer RF input to the RF preselector output using the short, rigid cable. Connect a short coaxial cable to the RF input of the RF preselector to serve as an antenna for this check.
4. Power on the RF Preselector then the spectrum analyzer. Check that each powers on without obvious errors.
5. Start the EMI test software and select File Open.
6. In the EMC120 installation directory, select the test file FCCB_RAD.TST. This file configures the EMI test software to perform a test using the spectrum analyzer and RF preselector.
7. Select the RUN button in the window icon bar. The purpose of this test is to ensure that the PC can control the spectrum analyzer and that the spectrum analyzer is receiving a signal from the RF preselector.

The EMI test software will first initialize the spectrum analyzer and RF preselector. If GPIB communications are a problem, the PC will indicate an error with communication. Check the configuration of the GPIB addresses on the instruments and check that the addresses entered in the EMI test software match the instrument addresses. Ensure that your cables are good and that they are snugly connected.

8. The test will proceed giving status at the bottom of the test window. The band LEDs on the RF preselector should light in sequence.

At the prompt to move the antenna, click on OK to proceed. After a short time the PC should display a results graph, which indicates the test is complete. The graphed data is just ambient signals picked by the coaxial cable.

You have completed the functional checks.

Operating Basics

This section discusses the system and the components that comprise it and provides references to standards organizations. Operating information for the Tektronix 2712 Spectrum Analyzer and for the 2706 RF Preselector is located in their respective user manuals.

User information for the antennas, field probes, and LISN is located in their respective manuals.

EMI Measurement System Components

The EMI measurement system includes all the components you need to measure conducted and radiated emissions.

The EMI measurement system includes the following components:

- Tektronix EMC120 Precompliance Test Software. Operates on a personal computer (PC) to control testing on the EMI measurement system. The EMI test software runs under Microsoft® Windows® 3.1 or Windows 95®. The required PC is not included with the 27120A EMI Measurement System. For best results, use a PC with a 33 MHz 486DX or better processor.

With the EMI test software, you configure each test using standard Windows controls. Tests, graphic displays, and reports are automatically generated based on your selections. When you have the test configured, selecting Run sends the appropriate commands to the system equipment to perform the test. The EMI test software graphs the test results and can print the results graph on any printer available in your Windows environment. You can perform the following measurements with the EMI test software:

- Radiated emissions tests
- Conducted emissions tests
- Tektronix 2712 Option 12 Spectrum Analyzer. Acquires and analyzes the frequency spectrum of signals present at the RF input. The 2712 Spectrum Analyzer with Option 12 is a portable RF scanning spectrum analyzer including quasi-peak detection and special EMC resolution bandwidth filters (200 Hz, 9 kHz, and 120 MHz). The PC running the EMI test software controls the spectrum analyzer settings during testing of the signal input from the antenna or LISN.
- Tektronix 2706 RF Stepping Preselector. Provides a series of bandpass filters covering successive frequency ranges for the signal input. The RF preselector helps prevent signal overload and gain compression by limiting the

bandwidth of signals entering the spectrum analyzer. It also increases the sensitivity of the spectrum analyzer to low-level signals by attenuating strong signals that are outside the frequency range being measured.

- **Biconical Antenna.** Provides reception of radiated RF signals over the frequency range of 20 to 300 MHz. The balun, feedline, and element cage design contribute to produce a response curve that is almost linear. The linear response makes the biconical antenna ideal for measurements of vertical and horizontal swept site attenuation. The antenna is factory calibrated, and the correction factors are included on the disks that accompany the antenna.
- **Log Periodic Antenna.** Provides reception of radiated RF signals over the frequency range of 200 to 1000 MHz. The linearly polarized design permits separate measurement of horizontal and vertical electric field components over its frequency range. The antenna is factory calibrated, and the correction factors are included on the disks that accompany the antenna.
- **Non-conductive Tripod.** Provides a sturdy, non-conductive mounting for the antenna. It is constructed of wooden legs and metal mounting brackets.
- **Coaxial Cable.** Provides a flexible 50 Ω connection between the antenna and the RF preselector. The cable is 10 meters long with N type connectors.
- **Near Field RF Probe Set.** The probe set, containing both E-field and H-field probes, serves as a versatile aid for diagnostic testing of radiated emissions over a broad range of frequencies from less than 100 kHz to greater than 1 GHz.
- **Transient Limiter.** Prevents damage to the sensitive RF input circuitry of the spectrum analyzer from power line transients which can occur when using a LISN to measure conducted emissions.
- **Line Impedance Stabilization Network (LISN).** Provides a reference AC mains source impedance and makes any EMI signal from the equipment under test available to the spectrum analyzer. The LISN derives the RF source from the AC line cords for conducted emissions tests. The LISN isolates the equipment under test from AC mains power. The LISN is a two-terminal, low-pass filter network. Included with the LISN are six 25 amp pin plugs for use with the LISN. You wire these plugs to your AC line cords.

Specifications

Specifications and characteristics for the individual EMI measurement system components are located in their respective component manuals.

Regulatory Agencies

The test and operations included in this manual are not specific to any regulatory agency. Familiarize yourself with the requirements, specifications, references, and procedures of the specific agency to which you will apply for certification. The *Reference* section of the User manual for the EMI test software contains a good discussion of general test methods and a summary of the FCC and CISPR standards. The definitive statement of requirements should always be the standards agencies.

NOTE. *Because regulatory agency requirements vary widely (for example measurement distances and heights) the procedures described in this document are general and do not attempt to address the specific requirements of the certification regulatory agencies. Obtain the standards publications from the certifying agency for complete and applicable specifications, references, and procedures.*

Additional References

Tektronix can provide you with many helpful application notes and other resources to help you understand EMI measurements. For information, contact your Tektronix Field Office.

For a good overview of many important issues in EMI testing, read the *Reference* section in the *EMC120 Precompliance Test Software User Manual*.

Reference

This section contains two EMI test examples; one for radiated emissions and one for conducted emissions. You can use these procedures to verify system functionality by performing real measurements using all system components and the EMI test software.

NOTE. *Because regulatory agency requirements vary widely (for example measurement distances and heights) the procedures described in this document are general and do not attempt to address the specific requirements of the certification regulatory agencies. Obtain the standards publications from the certifying agency for complete and applicable specifications, references, and procedures.*

Radiated Measurements

This procedure describes the general setup necessary to perform radiated tests with an antenna. Read the complete set of steps before you begin this procedure. Refer to the information supplied by the regulatory agency with which you are dealing for specific test instructions.

Equipment Required

The following equipment, supplied with the EMI measurement system, is necessary for radiated measurement tests. Refer to Figure 2 during the procedure for correct equipment connections.

- EMC120 Precompliance Test Software
- 2712 Spectrum Analyzer
- 2706 RF Preselector
- Biconical antenna
- Log periodic antenna
- Tripod
- Coaxial cable, 10 meter

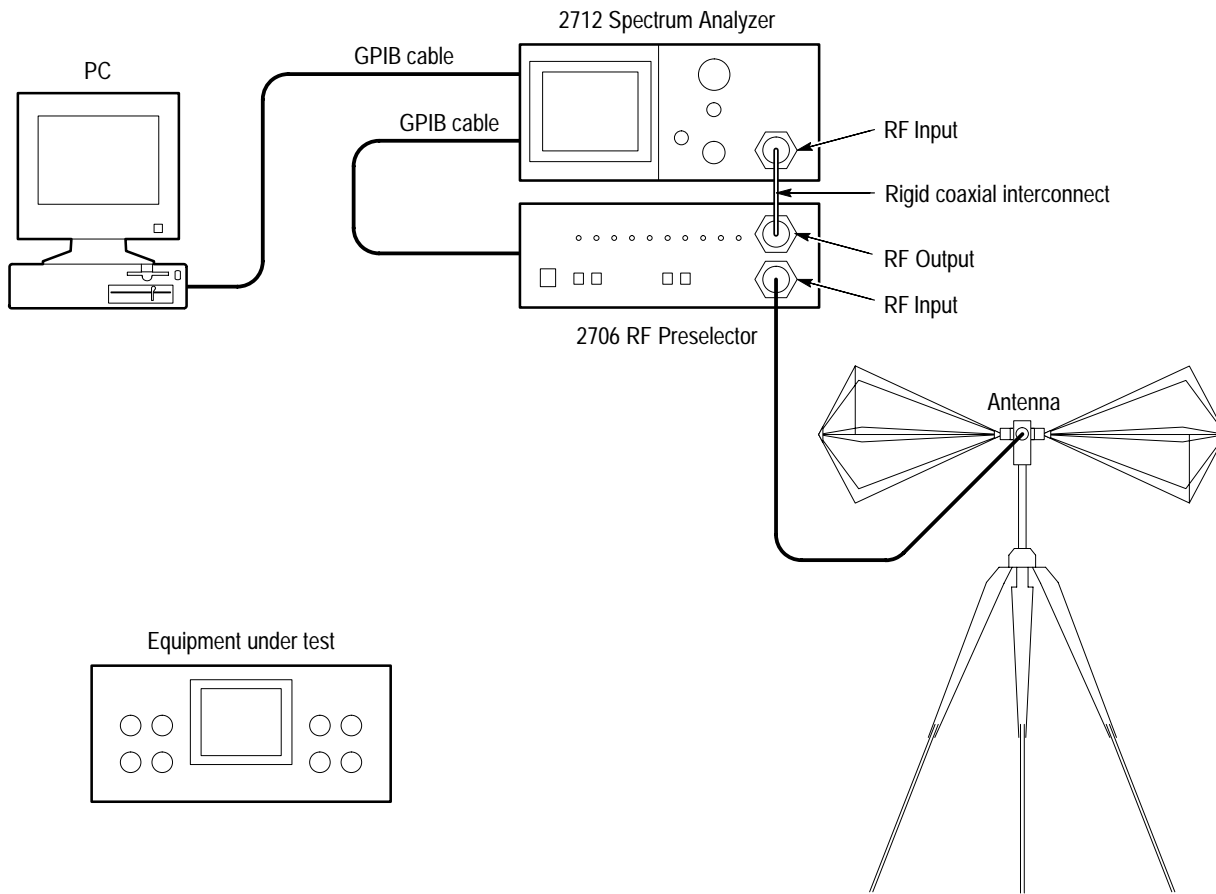


Figure 2: Equipment connections for radiated EMI measurements

NOTE. This procedure uses local broadcast signals as a signal source. Normally, the equipment under test (EUT) is the potential source of any EMI signals.

Radiated Measurements Procedure

Perform the following steps to measure radiated emissions:

1. Stack the spectrum analyzer on top of the RF preselector.
2. Connect the spectrum analyzer RF input to the RF preselector output using the short, rigid cable.
3. Connect the PC GPIB card to the spectrum analyzer with a standard GPIB cable, and connect the spectrum analyzer to the RF preselector with another GPIB cable. Configure the spectrum analyzer and other GPIB equipment as described on page 5 under *Configuration*.
4. Install the tripod at a stable location.

5. Secure the biconical antenna to the tripod.
6. Connect the supplied 10 meter coaxial cable between the RF preselector input and the biconical antenna. Use an N-BNC adapter to connect the cable to the biconical antenna.
7. Carefully orient the antenna to the horizontal position and securely lock it in place.
8. Power on the RF preselector, then the spectrum analyzer.



CAUTION. To avoid permanently damaging the spectrum analyzer and the RF preselector, do not apply signals with a combined amplitude greater than 20 dBm, or with a DC component greater than 100 volts. Refer to the safety summaries in the spectrum analyzer user manual and the RF preselector instruction manual for additional precautions.

9. Set the spectrum analyzer to the following settings:

Center Frequency: 100 MHz

Reference Level: 20 dBm

Span: 20 MHz/div

10. Ensure that the RF preselector is in the Bypass state, which is indicated by the lighted BYPASS LED.
11. If you are in an area with local radio and TV broadcasts, the spectrum analyzer will now display the spectrum for the local broadcast signals.
12. Adjust the reference level until the signal peaks are near the top of the spectrum analyzer screen.

This signal display confirms that you have made the proper connections between the antenna, the RF preselector, and the spectrum analyzer. If you do not see a signal with peaks on screen, recheck this initial set-up procedure and all cable connections.

13. Start the EMI test software on the PC according to the instructions in the *Getting Started* section of the user manual. Select the Advanced User mode.
14. Select Setup Test.
15. In the Test Setup window, make the following selections:
 - a. Select Test Type: Radiated.
 - b. Click in the Start Frequency field and enter 25. You are prompted about changing the table. Answer yes.
 - c. Set the Stop Frequency to 205.

- d.** Set Polarization Prompt to YES. When set to YES, you are prompted to change the orientation of the antenna while the test pauses.
 - e.** Set Combine Polarizations to YES. When set to YES, the results graph combines the highest amplitudes from the vertical and horizontal antenna scans into a single trace. When you set Combine Polarizations to NO, the vertical and horizontal traces both appear on the results graph.
 - f.** Select Preselector to enable control of the RF preselector.
 - g.** Ensure that Sub-band Overlap is set to 3%.
 - h.** Select Limit Lines at the right side. The Limit Lines window allows you to load a file that indicates the spec limit for emissions for the selected standard (such as FCC Part 15) on the results graph.
 - i.** Select the file FCCB_RAD.LIB from the list of Available Files. Select Add to include it in the Selected Files list at the center of the window. Select OK to exit the window.
 - j.** Select OK to return to the top level window.
- 16.** Select Run/Peak Test.
- a.** Set Sweep Number to 5. Select OK to exit.
 - b.** Select View/Graph Setup.
 - c.** Set Y–Axis to Autoscale and then select OK. This setting will vertically scale the results waveform appropriately.
- 17.** To start the EMI test, click on the Run Test button. As the test runs, you can monitor its status at the lower left of the test window.
- 18.** The RF preselector cycles through the 3 MHz to 30 MHz, 30 MHz to 125 MHz, and 125 MHz to 250 MHz filter bands. Each band LED will light while the band filter is in use.
- 19.** When the test reaches the midpoint, you are prompted to change the antenna orientation to vertical position and to select OK. The test resumes with sweeps of all frequency bands for the vertical antenna orientation.
- 20.** When the test has completed, the results are graphed on the PC screen. The FCC Part 15, Class B radiated spec limit appears across the graph to help you identify where the measurement exceeds the standard.

21. Having completed this section, you have demonstrated that the setup for radiated emissions testing is properly assembled and functioning. You can choose to save this setting for latter use. Select File Save and enter a destination and filename. Later you can load this file to run this test with identical software settings.
22. Turn off the power to the RF preselector and spectrum analyzer.

Diagnostic Procedures

Following a radiated EMI test, you can connect any of the supplied probes to the spectrum analyzer to locate the sources of EMI. This procedure requires a BNC to BNC cable and the RF probe set, which includes the three H-field (magnetic) probes and two E-field (electric) probes, plus an extender.

To locate the point of leakage, connect the selected magnetic or electric field probe to the spectrum analyzer RF Input with a BNC to BNC cable. Set the spectrum analyzer to the continuous sweep mode and slowly move around the equipment under test. Watch the spectrum analyzer display for the appearance of narrow peaks indicating strong RF sources. For specific information on the probe use and sensitivity, refer to the *Near Field Probe Set Instruction Manual*.

Conducted Measurements

This procedure describes the general setup necessary to perform conducted tests with the LISN. Read the complete set of steps before you begin this procedure. Refer to the information supplied by the regulatory agency with which you are dealing for specific test instructions.

Equipment Required

The following equipment, supplied with the EMI measurement system, is necessary for conducted measurement tests. Refer to Figure 3 during the procedure for correct equipment connections.

- EMC120 Precompliance Test Software
- 2712 Spectrum Analyzer
- 2706 RF Preselector
- Transient limiter
- LISN

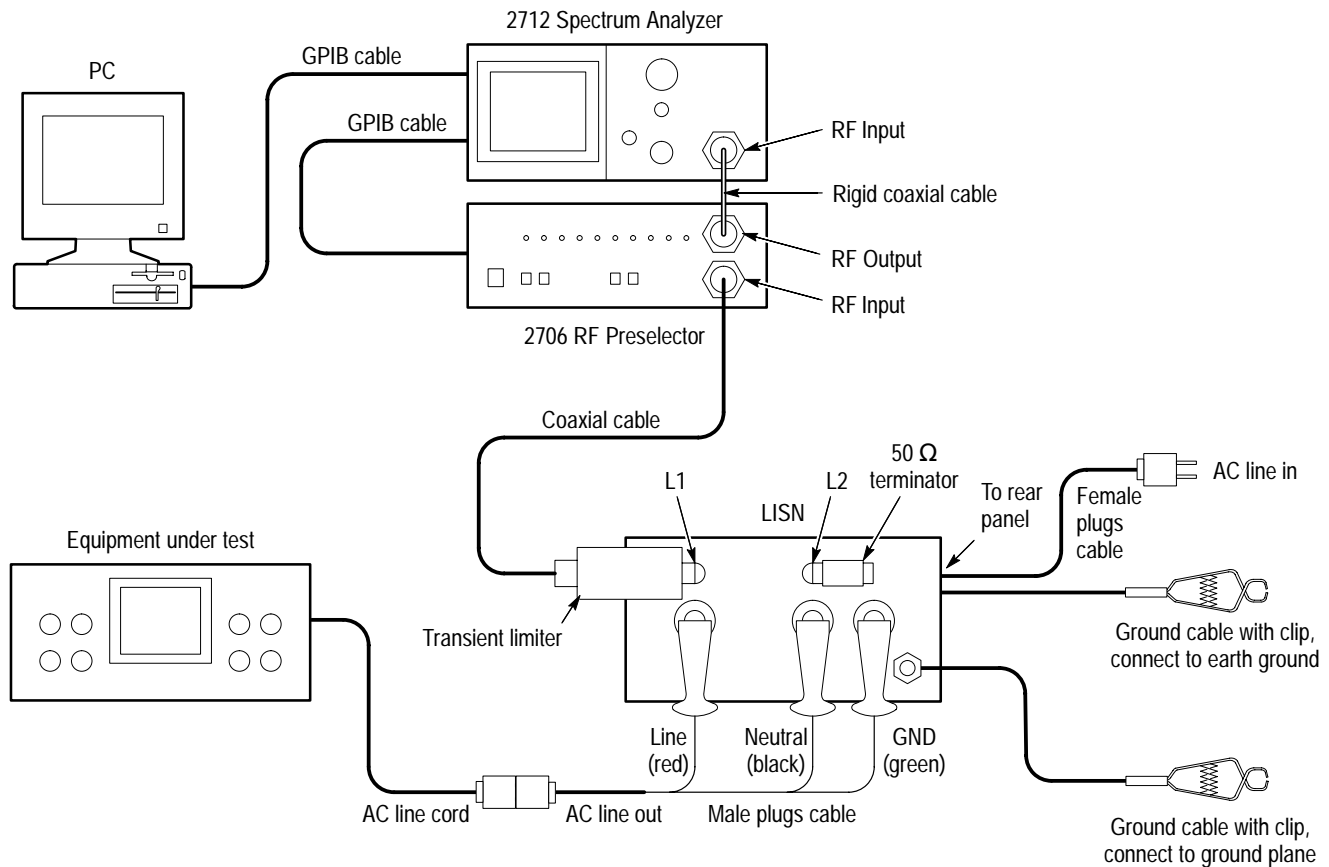


Figure 3: Equipment connections for conducted EMI measurements

NOTE. You may use any piece of equipment drawing less than 25 A as the sample EUT for this test. For example, use a device with a switching power supply or a computer.

AC Line to LISN Power Cords

The LISN includes six, 25 A pin plugs that you must connect to your AC power cords. Refer to Figure 3. Connect the three, colored, female pin plugs to the appropriate wires in the AC line cord that will connect to the AC mains. See the Female plugs cable in Figure 3. Connect the three, colored, male pin plugs to the appropriate wires in the female AC line-out cord. The AC line-out cord supplies power from the LISN, through the AC line cord, to the equipment under test (EUT). See the Male plugs cable in Figure 3. *Do not connect the line cords to power at this time.* Refer to the procedure on page 19 for the proper connection method and an important warning.

Refer to the manual shipped with the LISN instrument for information on proper use and connection of the LISN.

Conducted Measurements Procedure

Perform the following steps to measure conducted emissions:

1. Stack the spectrum analyzer on top of the RF preselector.
2. Connect the spectrum analyzer RF output to the RF preselector input using the rigid coaxial cable.
3. Connect the PC GPIB card to the spectrum analyzer with a standard GPIB cable, and connect the spectrum analyzer to the RF preselector with another GPIB cable. Configure the spectrum analyzer and other GPIB equipment as described on page 5 in *Configuration*.



WARNING. To prevent possible electric shock, you must ensure the LISN is properly connected. At the input power side of the LISN, always connect the safety ground (green) plug first and disconnect it last.

The LISN can render electric shock if not connected and disconnected properly. Always connect the ground plug (green) first and disconnect it last. Never connect or disconnect any of the plugs while the LISN is connected to an input AC power source or equipment under test that has power applied.

Read the DANGER information on the LISN front and rear panels.

4. Before applying power to the LISN, make the following connections. Refer to Figure 3.
 - a. Locate the two cables supplied with the LISN that have a ring connection on one end and battery clip on the other end.
 - b. Securely attach the ring end of one cable to the brass stud ground connection on the LISN front panel. Attach the ring end of the other cable to the brass stud ground connection on the LISN rear panel.
 - c. Securely attach each battery clip to a grounded structural support in accordance with your local and NEC requirements.
 - d. Ensure that your LISN power cables are properly wired and ready for use. Refer to page 18 for a description.
 - e. Connect, in this order, the green (ground), black (neutral), and red (line) female plugs to the rear panel of the LISN.
 - f. Connect, in this order, the green (ground), black (neutral), and red (line), male plugs to the front panel of the LISN.
5. Connect the power output of the LISN to the power cord from the equipment under test (EUT).
6. Connect the power input of the LISN to AC mains power.

7. Power on the EUT and wait for the equipment to sufficiently warm up.



CAUTION. To avoid permanently damaging the spectrum analyzer and the RF preselector, do not apply signals with a combined amplitude greater than 20 dBm, or with a DC component greater than 100 volts. Refer to the safety summaries in the spectrum analyzer user manual and the RF preselector instruction manual for additional precautions. Be sure you install the transient limiter as specified in the following steps.

8. Use one of the following two steps to connect the LISN output to the RF preselector input:
 - Connect the transient limiter input to the L1 connector on the LISN front panel. Connect a coaxial cable from the transient limiter output to the RF preselector input (or follow the alternate procedure).
 - Connect the transient limiter output to the RF preselector input using a BNC female-to-female adapter. Connect a coaxial cable between the transient limiter input and the L1 connector on the LISN front panel.
9. Terminate L2 on the LISN front panel with the supplied 50 Ω termination.
10. Power on the RF preselector, then the spectrum analyzer.
11. Set the spectrum analyzer to the following settings.
 - Center Frequency: 50 MHz
 - Reference Level: 20 dBm
 - Span: 10 MHz/div
12. Ensure that the RF preselector is in the Bypass state, which is indicated by the lighted BYPASS LED.
13. Adjust the reference level on the spectrum analyzer until the signal peaks are near the top of the screen. If you do not see a signal with peaks on screen, recheck this initial set-up procedure and all cable connections.

This signal display confirms that you have made the proper connections between the LISN, the RF preselector, and the spectrum analyzer. The signal conducted by the EUT to the power line feeding it. The EUT contribution is easy to see if you momentarily disconnect and reconnect the cable at the transient limiter.
14. Start the EMI test software on the PC according to the instructions in the *Getting Started* section of the user manual. Select the Advanced User mode.
15. Select Setup Test.
16. In the Test Setup window, make the following selections:

- a. Set Test Type to Conducted.
 - b. Click in the Start Frequency field and enter 0.45. You are prompted that your selection will change the frequency table. Answer yes.
 - c. Set the Stop Frequency to 30.
 - d. Set the LISN Lead Prompt to YES. When set to YES, the test prompts you to change the coaxial cable from the high lead (L1) on the LISN to the low lead (L2).
 - e. Set Combine Leads to YES. When set to YES, the results graph combines the highest amplitudes from the high and low leads into a single trace.
 - f. Select Preselector to enable control of the RF preselector.
 - g. Ensure that Sub-band Overlap is set to 3%.
 - h. Select Limit Lines at the right side. This window allows you to load a file that indicates the spec limit for the selected standard, such as FCC Part 15. The selected spec limit appears on the results graph.
 - i. Select the file FCCB_CND.LIM from the Available Files list. Select Add to include it in the Selected Files list at the center of the window. Select OK to exit the window.
 - j. Select OK to return to the top level window.
17. Select Run/Peak Test.
 18. Set Sweep Number to 1. Select OK to exit.
 19. Select View/Graph Setup.
 20. Set Y-Axis to Autoscale then select OK. This setting will vertically scale the results waveform appropriately.
 21. To start the EMI conducted test, click on the Run Test button. As the test runs, you can monitor its status at the lower left of the test window.
 22. The RF preselector cycles through the 150 kHz to 3 MHz and 3 MHz to 30 MHz filter bands. Each band LED turns on while its band filter is in use.
 23. When the test reaches the midpoint, the EMI test software prompts you to move the coaxial cable with the transient limiter from the high lead to the low lead on the LISN. When you are done, click the OK button. The test resumes, performing all test sweeps on the low lead signal.
 24. When the test has run to completion, the results are graphed on the PC screen. The spec limit for the FCC Part 15 Class B conducted specification

appears as a line across the graph to help you identify where the measurement exceeds the standard.

25. Having completed this section, you have demonstrated that the setup for conducted emissions testing is properly assembled and functioning.



CAUTION. *It is possible to permanently damage the RF preselector and spectrum analyzer with power transients while disconnecting the system components. To eliminate the possibility, disconnect the equipment as indicated in the following steps.*

26. Disconnect the system components by carefully performing the following steps in order.
- a. Disconnect the coaxial cable from the transient limiter, then from L1 of the LISN.
 - b. Turn off the EUT.
 - c. Disconnect the LISN from the power source.
 - d. Disconnect the LISN leads from its front and rear panel.
 - e. Turn off the power to the RF preselector and spectrum analyzer.

Appendix A: Servicing Information

The 27120A EMI Measurement System requires no special servicing information as a composite system. Servicing information is included in the specific documentation for each component. If the system is not operating correctly, first check all cable connections and configuration settings.

Refer to the service information included in the manual for a suspect system component.

We recommend that you do not service the antennas, tripod, coaxial cable, probe set, LISN, or transient limiter. In the event that any component must be returned to a Tektronix service center for replacement, repair, or warranty considerations, package the component in the original packaging material, if available. If the original material is not available, follow repackaging instructions in the component manual. In all cases, package the component carefully in protective material and secure it in a sturdy shipping container that assures at least 3 inches of foam or dunnage on all sides of the component. Attach a tag to the component that clearly shows the following information:

- Owner's name and address
- Name of the person at your location to contact
- Component model and serial number
- Description of the problem and the service expected

Glossary

Accuracy

Conformity or degree of conformity to a performance requirement; usually expressed as allowable error, a range of permissible values, or an upper or lower limit.

Acquire

To capture a waveshape as a series of numeric values, through a process called digitizing. The software uses 500 acquired points in each waveform captured from Tektronix spectrum analyzers. A data set from an EMI test may include more than one waveform.

Address, primary

A selectable value that identifies a unique GPIB-configured device and enables a controller to differentiate between devices connected to the bus.

Amplitude

The magnitude of an electrical signal, usually expressed in dBm.

ANSI

American National Standards Institute.

ASCII

American Standard Code for Information Exchange.

Auto-Acquisition

A software operating mode that allows the software to automatically acquire a waveform, without operator intervention.

Average

A spectrum analyzer operating mode that allows the mean of several acquisitions to be analyzed as a single waveform. Averaging allows the software to analyze noisy signals, since the random noise is mathematically reduced by the averaging. The software is configured to achieve average detection through the use of video filtering.

Band

The basic building block of any EMI test. When performing EMI tests, a band is a range of frequencies to be tested using a single transducer and a set of correction factors.

Bandwidth

The difference between the limiting frequencies of a continuous frequency band. See also *Resolution Bandwidth*.

Broadband

Any pulsed signal having a pulse repetition frequency that is less than the

measuring instrument's bandwidth setting. The frequencies in a broadband signal fill its entire occupied bandwidth. Because a broadband signal is widely dispersed spectrally, its power level at one frequency is a function of the measuring bandwidth used. See *Broadband Versus Narrowband EMI* in the *Reference* section of this manual for a discussion of differentiating broadband and narrowband signals. See also *Narrowband*.

Calibrate

To compare actual performance against a standard, and to adjust into conformity with a standard.

Compression

A spectrum analyzer condition caused by an input signal with an amplitude greater than the spectrum analyzer is capable of measuring. Compression is the difference between the measured and actual signal amplitude.

Digitize

To convert an analog measurement of a physical variable into a numerical value expressing the quantity in digital form.

EMC

Electromagnetic Compatibility. The absence of signals that interfere with the intended operation of a particular electronic device.

EMI

Electromagnetic Interference. The presence of signals that may interfere with the intended operation of electronic devices. EMI may prevent a device from meeting compliance standard(s) of a regulatory agency or agencies.

Frequency

The rate at which a signal oscillates, or changes polarity, expressed as Hertz, or number of cycles per second.

Frequency Range

The range of frequencies over which the performance of the instrument is specified. Frequency span is expressed in Hertz or Hertz per division.

Gain Compression

Maximum input level where the scale linearity error starts increasing.

GPIB

General Purpose Interface Bus. A system enabling remote operation between the spectrum analyzer and external equipment, such as controllers, printers, plotters, and display units.

Limits

The amount of EMI acceptable by various regulatory agencies and their respective standards, such as FCC, CISPR and VDE.

LISN

Line Impedance Stabilization Network. A transducer used for conducted EMI measurements on equipment under test.

Low-Pass Filter

A filter that passes all signal frequencies below a nominal cut-off frequency while attenuating all higher frequencies.

Maximum Input Level

The maximum input signal amplitude that can be safely handled.

Maximum Safe Input Power (Without Damage)

The maximum power applied at the input that will not cause damage to the measuring instrument.

Narrowband

A discrete signal appearing only at particular frequency positions. The indicated power does not change as a function of measurement bandwidth. See also *Broadband*.

NEC

National Electrical Code. An international standard document published by the National Fire Protection Association

Peak

The point or points of a waveform having the highest amplitude. Also, the usual method of acquiring a signal with a spectrum analyzer.

Peak Detection

A detection scheme where the peak amplitude of a signal is measured and displayed.

Preselector

A tracking filter located ahead of the first mixer that allows only a narrow band of frequencies to pass into the mixer. A preselector prevents out-of-band signals from overloading the spectrum analyzer input.

Quasi-Peak

A method of acquiring a signal that yields the effective amount of energy in the signal. Quasi-peak analysis takes into account not only the peak amplitude of the signal, but also its bandwidth characteristics and pulse repetition rate. Refer to *Peak Versus Quasi-Peak Detection*, in the *Reference* section of this manual, for further information.

Quasi-Peak Detector

A voltage detector with specified charge and discharge times.

Reference Level

The signal level required to deflect the CRT display to the top graticule line.

Span Per Division (Span/Div)

The frequency difference represented by each major horizontal division of the graticule.

Spectrum

The frequency domain representation of a signal where it is represented by displaying its frequency distribution.

Spectrum Analysis

The technique or process for determining the frequency distribution of a signal.

Spectrum Analyzer

A device for determining the frequency components of a signal. A spectrum analyzer displays the power distribution of an incoming signal as a function of frequency.

Start Frequency

The frequency at the left-hand edge of the spectrum analyzer display.

Stop Frequency

The frequency at the right-hand edge of the spectrum analyzer display.

Sweep Rate

The speed, expressed in time per horizontal division, at which the spectrum analyzer is tuned.

Test

A complete set of measurements made on an EMI source. A test may consist of measurements made at multiple frequencies, distances, and orientations, with multiple transducers and polarizations.

Transducer

Any device that changes energy from one form into energy of another. EMI transducers are typically either antennas or LISNs.

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