Making EMI Compliance Measurements

Application Note

Agilent Technologies

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Introduction to compliance measurements

Electrical or electronic equipment that uses the public power grid or has potential for electromagnetic emissions must pass EMC (electromagnetic compatibility) requirements. These requirements fall into four broad types of testing: radiated and conducted emissions testing, and radiated and conducted immunity testing.

Conducted emissions testing focuses on signals present on the AC mains that are generated by the equipment under test (EUT). The frequency range of these measurements is typically 9 kHz to 30 MHz. However, MIL-STD measurement may have a wider frequency range.

Radiated emissions testing searches for signals being emitted from the EUT through space. The typical frequency range for these measurements is 30 MHz to 1 GHz or 6 GHz, although FCC regulations require testing up to 40 GHz.

Figure 1 illustrates the difference between radiated emissions, radiated immunity, conducted emissions, and conducted immunity. Radiated immunity is the ability of a device or product to withstand radiated electromagnetic fields. Conducted immunity is the ability of a device or product to withstand electrical disturbances on power or data lines. Immunity testing will not be covered in this document.

For an electromagnetic compatibility problem to occur (such as when an electric drill interferes with TV reception), there must be a generator or source, a coupling path, and a receptor. Until recently, most efforts to remove EMC problems have focused on reducing the emissions of the source to an acceptable level—now both emissions and immunity tests are performed.

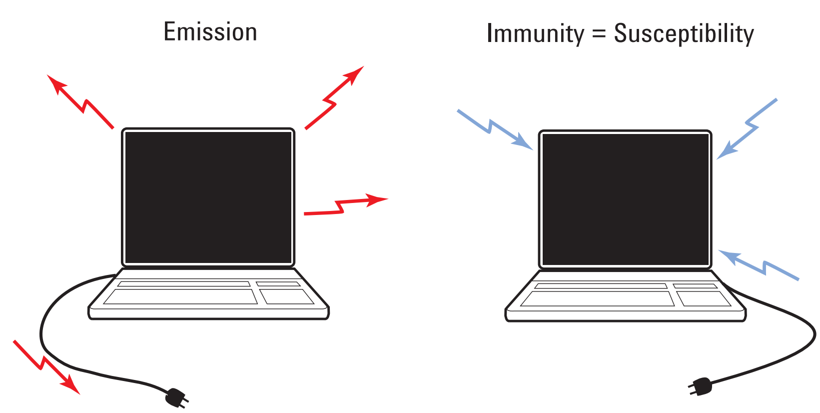


Figure 1. Four types of EMC measurements

The compliance measurements process

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

1. Where will the product be sold (for example, the United States, Europe, or Japan)?

2. What is the classification of the product (for example, information technology equipment (ITE); industrial, scientific, or medical (ISM); or automotive and communications)?

3. Where will the product be used (for example, home, commercial, light industry, or heavy industry)?

With the answers to the above questions, you can determine which testing requirements apply to your product by referring to Tables 1a and 1b below. For example, if you have determined that your product is an ITE device that will be sold in the U.S., then you need to test the product to FCC Part 15 regulations.

International regulations summary (emissions)

CISPR	FCC	EN	Description
11	Part 18	EN 55011	Industrial, scientific, and medical
13	Part 15	EN 55013	Broadcast receivers
14		EN 55014	Household appliances/tools
15		EN 55015	Fluorescent lights/luminaries
16-1-1			Measurement apparatus/methods
22	Part 15	EN 55022	Information technology equipment
25		EN 55025	Automotive
		EN 50081-1,2	Generic emissions standards

Table 1a. Comparison of regulatory agency requirements

European Norms (EN)

Equipment type	Emissions
Generic equipment	EN 50081-1
Residential	
Light industrial	
Industrial	EN 50081-2
Industrial, scientific, medical products (ISM)	EN 55011
Sound and broadcast receivers	EN 55013
Household appliances	EN 55014
Information technology equipment (ITE)	EN 55022
Automotive	EN55025

Table 1b. Major European requirements

European Norms
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 limits shown in Table 1c.

EN55014 Conducted household appliances QP
EN55014 Conducted household appliances AVE
EN55014 Conducted < 700 W motors QP
EN55014 Conducted < 700 W motors AVE
EN55014 Conducted > 700 W < 1000 W motors QP
EN55014 Conducted > 700 W < 1000 W motors AVE
EN55014 Conducted > 1000 W motors QP
EN55014 Conducted > 1000 W motors AVE
EN55014 Radiated household appliances QP
EN55014 Radiated household appliances AVE
EN55014 Radiated < 700 W motors QP
EN55014 Radiated < 700 W motors AVE
EN55014 Radiated > 700 W < 1000 W motors QP
EN55014 Radiated > 700 W < 1000 W motors AVE
EN55014 Radiated > 1000 W motors QP
EN55014 Radiated > 1000 W motors AVE

Note: The conducted range is 150 kHz to 30 MHz and the radiated range is 30 MHz to 300 MHz.

Table 1c. Tests based on power rating

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.

Federal Communications Commission (FCC)

Equipment	FCC
Broadcast receivers Household appliances/tools Fluorescent lights/luminaries Information technology equipment (ITE)	Part 15
Industrial, scientific, medical products (ISM) Conducted measurements: 450 kHz - 30 MHz Radiated measurements: 30 MHz - 1000 MHz, 40 GHz	Part 18

Table 1d. FCC regulations

Federal Communications Commission
FCC Part 15
Radio frequency devices—unintentional radiators
Equipment that unintentionally produces emissions that could interfere with other devices. (For example, TV broadcast receivers, FM broadcast receivers, CB receivers, scanning receivers, TV interface devices, cable system terminal devices, Class B personal computers and peripherals, Class B digital devices, Class A digital devices and peripherals, and 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.

For assistance, contact the agency for conformation of the applicable requirement—see Appendix E for contact information.

Compliance EMI receiver requirements

There are several requirements for making compliance EMI measurements. The first is an EMI receiver that meets CISPR 16-1-1 [1], such as the N9038A MXE EMI receiver.

A CISPR 16-1-1 receiver must have the following functionality in the range 9 kHz - 18 GHz:

- A normal ±2 dB absolute amplitude accuracy
- CISPR-specified bandwidths (6 dB) as indicated in the chart below

Bandwidth	Frequency range
200 Hz	9 kHz to 150 kHz
9 kHz	150 kHz to 30 MHz
120 kHz	150 kHz to 1000 MHz
1 MHz impulse	1 GHz to 18 GHz

Note: The frequency response of the filters must also fall within a "mask" defined by CISPR 16-1-1.

- Peak, quasi-peak, EMI average, and RMS average detectors with specified charge, discharge time, and meter constants for the quasi-peak detector (see Appendix D for a description of these detectors)
- Specified input impedance with a nominal value of 50 ohms; deviations specified as VSWR
- Be able to pass product immunity in a 3 V/m field
- Be able to pass the CISPR pulse test
- Other specific harmonic and intermodulation requirements

The CISPR pulse test consists of broadband pulses of a defined spectral intensity of varying repetition frequency presented to the EMI receiver. The quasi-peak detector must measure these pulses at a specified level, within a specified accuracy. In order to meet this pulse test, it is implied, but not specified, that the receiver must have:

- Preselection—achieved by input filters that track the receiver tuning to reduce broadband noise overload at the front end mixer
- Sensitivity and dynamic range—the EMI receiver must have a noise floor low enough to measure signals at low PRFs

1. Comite International Special des Perturbations Radioelectriques

A recommended feature for ensuring accurate measurements is overload detection. To make an accurate measurement, the receiver must be in linear operating mode and not be in saturation at the front-end mixer because of large narrowband signals or broadband emissions. A useful overload detection scheme will alert the user to overload conditions in all frequency ranges and in all modes of operation. An advanced overload detection and measurement scheme will "autorange," or automatically put in enough attenuation prior to the first mixer to measure the signal in non-overload conditions.

Requirements above 1 GHz

Regulations require a 1 MHz bandwidth for measurements above 1 GHz. In addition, no quasi-peak detector is required for measurements above 1 GHz. The CISPR pulse test is not required above 1 GHz, but excellent sensitivity in the measuring system is important to achieve sufficient dynamic range in order to perform the measurements.

According to current FCC regulations, the maximum test frequency is the fifth harmonic of the highest clock frequency for an "unintentional radiator" (for example, computers without wireless connectivity) and the tenth harmonic for an intentional radiator (such as a cellular phone or wireless LAN).

Conducted emissions measurements

Emissions testing is divided into conducted emissions and radiated emissions testing. Follow the steps outlined below to set up the test equipment, accessories, and EUT.

Conducted test setup

ANSI C63.4 describes a specific test setup for conducted emissions. FCC Part 15 details the limits for these tests. Refer to ANSI C63.4 for the latest conducted emissions setup—CISPR 22 shows a similar conducted test setup for ENs.

Configuring the receiver

Interconnect the EMI receiver, such as the Agilent N9038A MXE, LISN, and EUT. The function of a LISN is detailed in Appendix A.

Note: The following sequence of steps for making a compliant measurement with the EMI measurement receiver assumes that the measurement setup and measuring receiver are compliant with the applicable standard and a system alignment has been completed, if required.

1. Disconnect the input to the receiver.

2. Set up the correct frequency range by selecting CISPR Band B, which also selects the correct bandwidth. Select the correct range in the scan table and switch on the RF preselector.

3. Based on the type of equipment and the regulatory agency requirements, select the appropriate limit line from a wide range of limits in the EMI receiver.

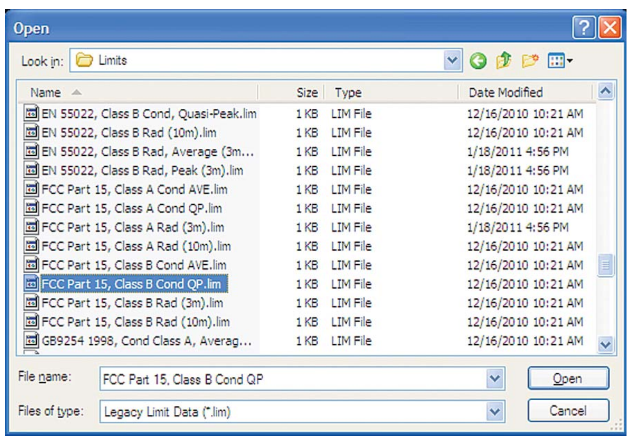


Figure 2a. FCC Part 15 limits

4. Next, load correction factors for the LISN from the transducer list available in the EMI receiver.

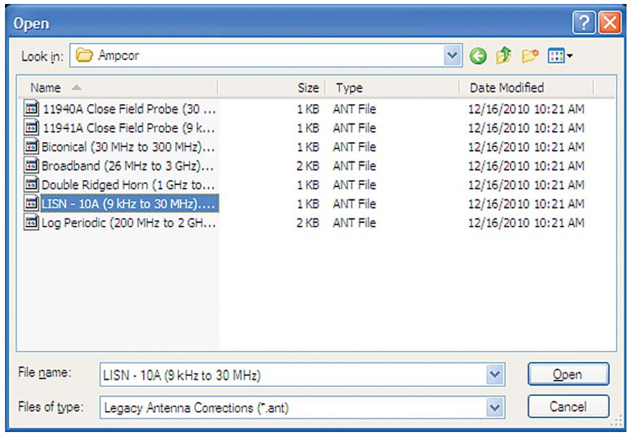


Figure 2b. Transducer correction factors with LISN

After loading the LISN correction factors and limit lines, and starting a scan, your display should look similar to Figure 3.

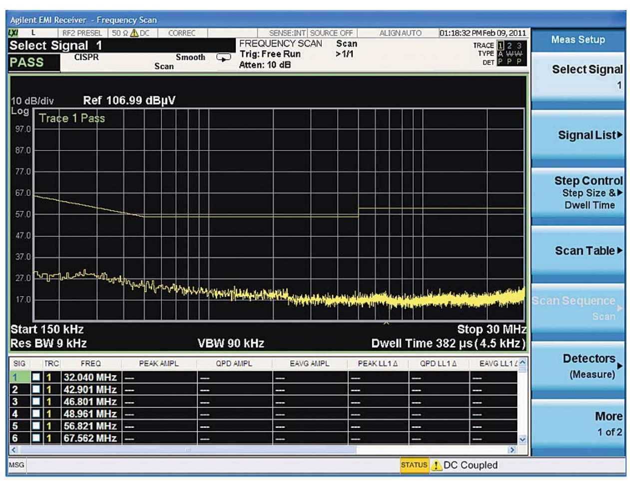


Figure 3. Display with limit line and correction factors for conducted emission testing

Performing conducted emissions measurements

At this point, the EMI receiver is set up with all of the correct parameters, including bandwidth, frequency range, LISN compensation, and limit line. However, before starting conducted measurements, consider the effect of the ambient environment on the results. The power cable between the LISN and the EUT can act as an antenna, which can cause false EUT responses on the display. To test that this phenomenon is not occurring, switch off the EUT and check the display to ensure that the noise floor is at least 6 dB below the limit line as shown in Figure 4.

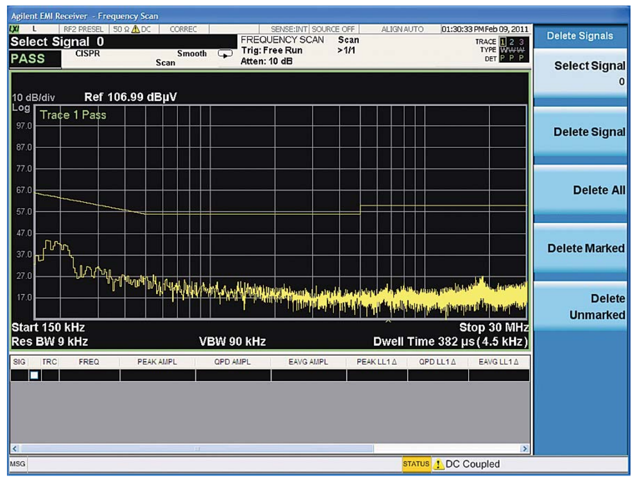


Figure 4. Test for ambient signals

Switch on the power to the EUT and observe the display. If there are no signals above the limit line, then your product passes the conducted emissions limit. Data and signals close to the limit may need to be collected for your report. Remember that line and neutral must be tested. If there are signals above the limit, closer analysis is needed.

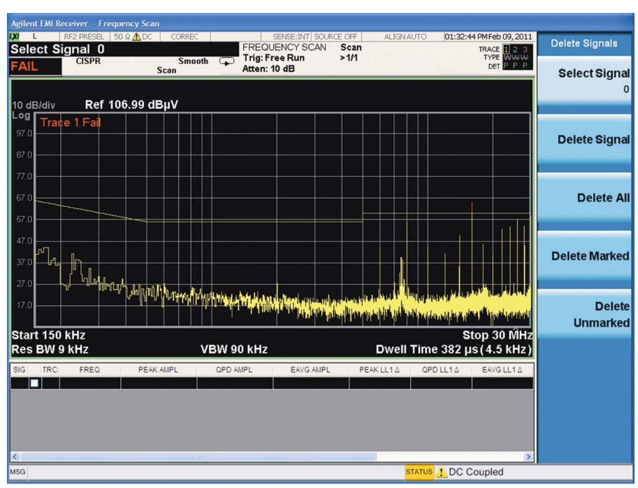


Figure 5. Conducted emissions from DUT

The next step is to perform a quasi-peak measurement on signals above the limit line. This is accomplished by placing the signal in the EMI receiver list and performing a remeasure using the selected detector. At this point, all of the measured signal values have been recorded.

The product passes this test if no measured quasi-peak values are above the quasi-peak limit, and no measured average values are above the average limit; or no measured quasi-peak values are above the average limit.

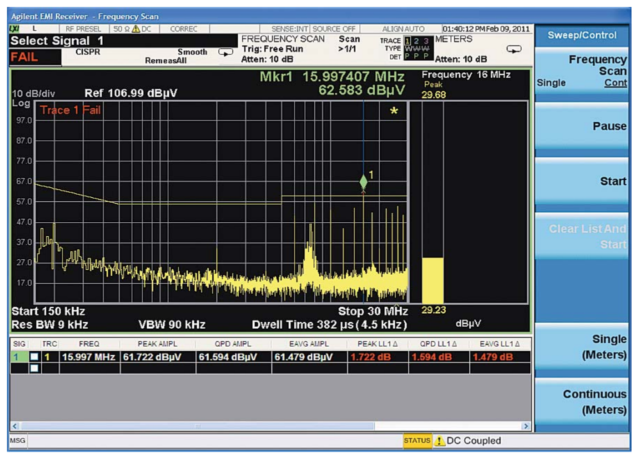


Figure 6. Conducted emissions failure QP measurement

Remember that all lines—such as line and neutral or all phases—must be tested. If some of the values are above the quasi-peak level using the quasi-peak detector, and are also above the average limit with the average detector, then some troubleshooting and redesign is required.

Radiated emissions measurements

Performing radiated emissions measurements is not as straightforward as performing conducted EMI measurements. There is the added complexity of the open air ambient environment, which can interfere with the emissions from the EUT. Fortunately, there are methods to differentiate between signals in the ambient environment such as TV, FM, and cellular radio.

Open site requirements

EUTs are measured in an open area test site (OATS). ANSI C63.4 and CISPR 16-1-1 specify the requirements for an OATS, including:

- Preferred measurement distances of 3, 10, and 30 meters
- Antenna positioning at 1 to 4 meter heights
- An area called the "CISPR ellipse" of major diameter 2X and minor diameter $\sqrt{3} \cdot X$, where X is the measurement distance; the ellipse must be free of any reflecting objects
- A metal ground plane for the measurement area

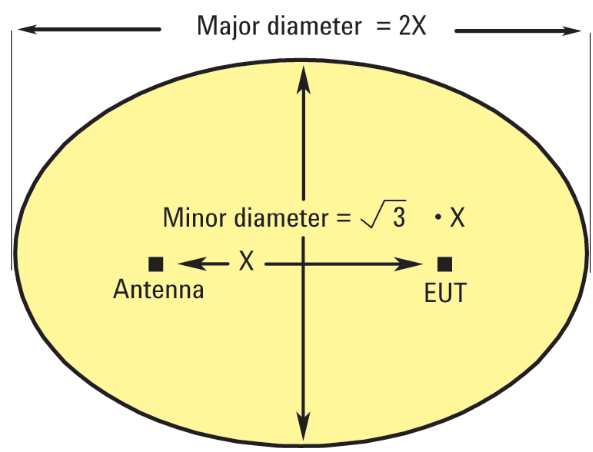


Figure 7. The CISPR ellipse

For complete details on OATS requirements, see CISPR 16-1-1 and ANSI C63.4, as well as ANSI C63.7. In addition, ANSI C63.7 describes OATS construction.

Note: 10 meter anechoic chambers and GTEM cells can also be used for radiated compliance measurements.

Radiated emissions test setup

Note: The following sequence of steps for making a compliant measurement with the analyzer assumes that the measurement setup is compliant with the applicable standard.

1. Arrange the antenna, EUT, and EMI receiver as shown in Figure 8. Separate the antenna and the EUT by 3 meters (10 meters if specified by the regulation). CISPR and ANSI require the EUT to be in worst-case mode of operation (for example, with cables and monitor attached).

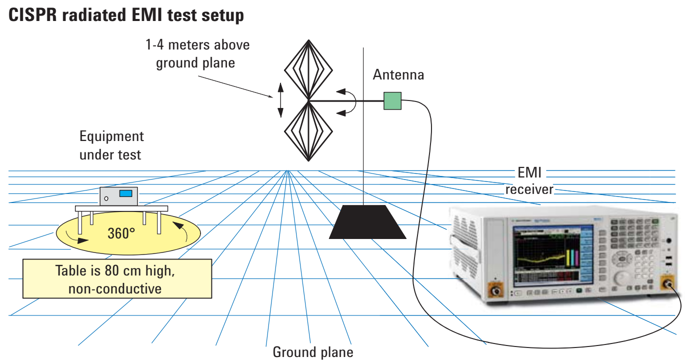


Figure 8. Radiated test setup

2. Use Table 1 to determine the regulation for which your product must be tested.

3. Set up the EMI receiver for the correct span, antenna correction factors, and limit line with a margin. In this case, we are testing to the FCC Part 15, Class B, 3-meter limit. Load in the appropriate limit line from the available limits in the receiver.

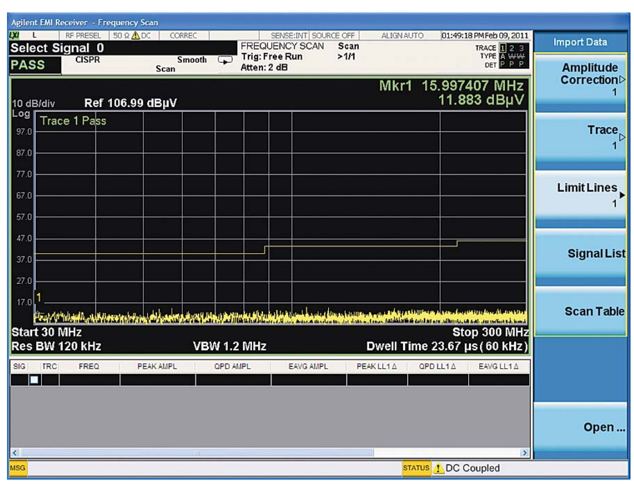


Figure 9. Loading FCC 3-meter Class B limit

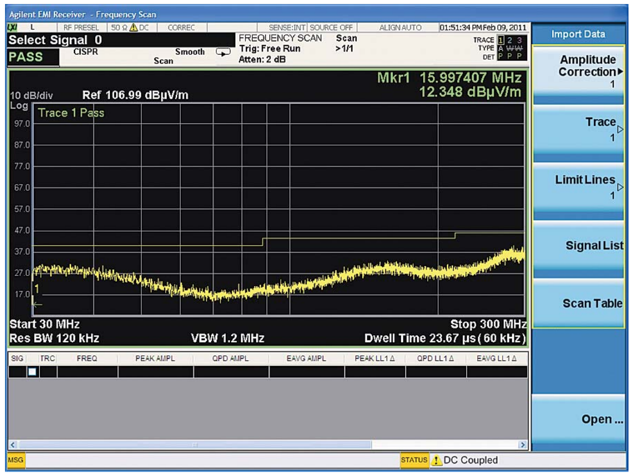


Figure 10. Load correction factors for the antenna

Load the appropriate antenna correction factors from the receiver. Since these are typical correction factors, you may need to edit them using the receiver's editing features.

So far, you have arranged the equipment with the EUT 3 meters from the antenna, chosen the appropriate limit line, and corrected the display for antenna loss.

Measuring radiated emissions

The next step is to evaluate the radiated emissions from your product. With the EUT off, sweep the frequency range of interest. This gives you a good idea of the ambient signal levels. The ideal situation is to have all the ambient signals below the limit line. In many cases, they are not, so it’s a good idea to measure and record them. The amplitude and frequency of the ambient signals above the limit or margin can be stored in the receiver's signal list for future comparison and removal.

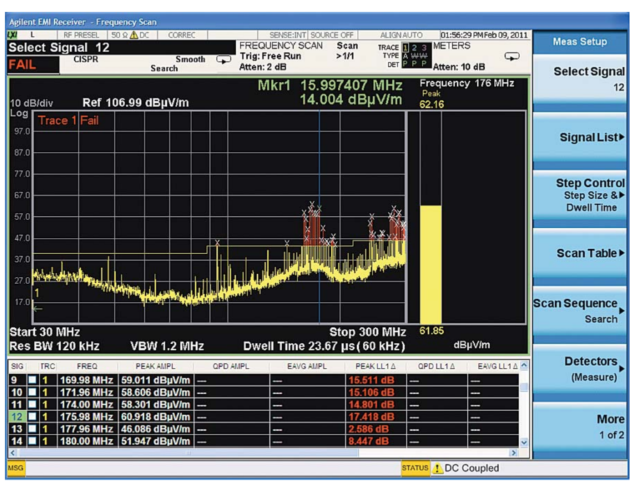


Figure 11. Ambient signals placed in signal list

Placement of EUT for maximum signals (manual measurement process)

Radiated emissions from electronic devices are not uniform. The strongest emissions may be from the rear panel, front panel, or slots in the shielding. To ensure that you are measuring the worst-case emissions from your device, follow the steps below:

1. With the EMI receiver adjusted to view the span of interest, move the EUT through a 360° rotation in 45° increments

2. At each 45° step, note the amplitude of the largest signal—save the screen to an internal file for later reference

After all the screens have been captured, upload them into a graphics application so you can compare the screen captures side-by-side. In some cases, you may find that there are worst-case emissions for different frequencies at different positions. For example, you may find worst-case for 100 MHz emissions at 90°, and at 270° for 200 MHz. In this example, the emissions tests must be performed at both positions. If you are not sure whether the signal you are looking at is an ambient or EUT signal, switch off the EUT—an ambient signal will not change. Worst-case emissions must be found for both horizontal and vertical antenna polarizations.

Ambient plus EUT measurements

Orient the EUT to one of the worst-case positions. There may be more than one EUT position with emissions above the limit line. A quasi-peak measurement must be performed on each of these above-the-line emissions. If the quasi-peak measurement still indicates a failure, then some troubleshooting and repair is required. The solution could be as simple as poor cable grounding or unwanted slots in the shielding.

If there are several signals above the limit that are not identified as ambient signals, you should zoom in on one or two at a time, measuring the quasi-peak value of each. Using software to perform the above processes allows for more repeatable measurements and documentation.

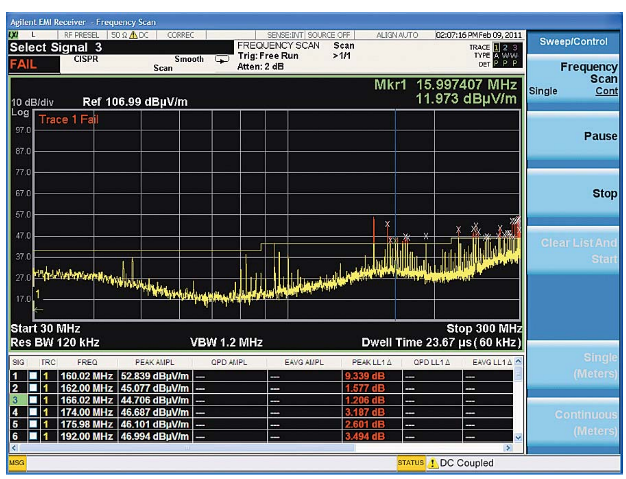


Figure 12. Ambient environment plus DUT emissions

Appendix A

Line impedance stabilization networks

Purpose of a LISN
A line impedance stabilization network serves three purposes:

1. The LISN isolates the power mains from the EUT. The power supplied to the EUT must be as clean as possible. Any noise on the line will be coupled to the EMI receiver and interpreted as noise generated by the EUT.

2. The LISN isolates any noise generated by the EUT from being coupled to the power mains. Excess noise on the power mains can cause interference with the proper operation of other devices on the line.

3. The signals generated by the EUT are coupled to the EMI receiver using a high-pass filter, which is part of the LISN. Signals which are in the pass band of the high-pass filter show a 50 Ω load, which is the input to the EMI receiver.

LISN operation
The diagram in Figure A-1 below shows the circuit for one side of the line relative to earth ground.

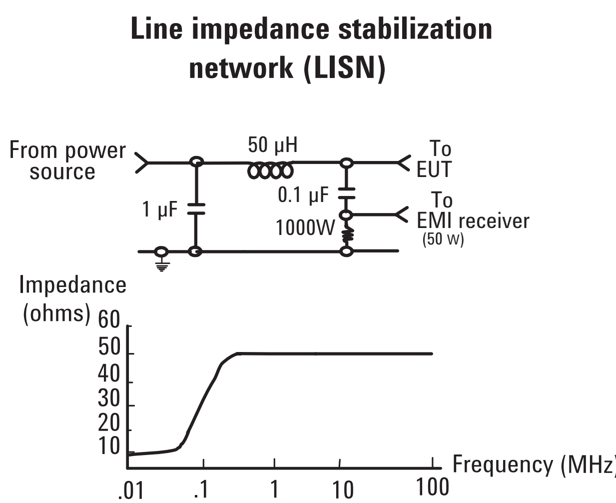
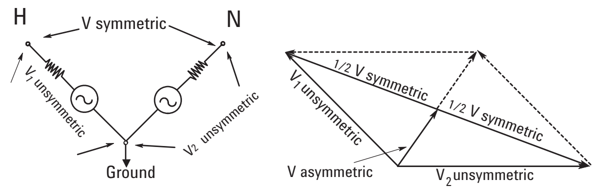


Figure A-1. Typical LISN circuit diagram

The 1 µF capacitor-in combination with the 50 µH inductor, is the filter that isolates the mains from the EUT. The 50 µH inductor isolates the noise generated by the EUT from the mains. The 0.1 µF capacitor couples the noise generated by the EUT to the EMI receiver. At frequencies above 150 kHz, the EUT signals are presented with a 50 Ω impedance.

The chart in Figure A-1 represents the impedance of the EUT port versus frequency.

Types of LISNs



V-LISN **Vector diagram**

V-LISN: Unsymmetric emissions (line-to-ground)
△-LISN: Symmetric emissions (line-to-line)
T-LISN: Asymmetric emissions (mid point line-to-line)

Figure A-2. Three different types of LISNs

The most common type of LISN is the V-LISN. It measures the asymmetric voltage between line and ground. This is done for both the hot and the neutral lines, or for a three-phase circuit in a “Y” configuration, between each line and ground. There are some other specialized types of LISNs. A delta LISN measures the line-to-line or symmetric-emissions voltage. The T-LISN, sometimes used for telecommunications equipment, measures the asymmetrical voltage, which is the potential difference between the midpoint potential between two lines and ground.

Appendix B

Antenna factors

Field strength units

Radiated EMI emissions measurements measure the electric field. The field strength is calibrated in dBμV/m. Field strength in dBμV/m is derived from the following:

P_t = total power radiated from an isotropic radiator

P_D = the power density at a distance **r** from the isotropic radiator (far field)

$P_D = P_t / 4\pi \mathbf{r}^2$ $\mathbf{R} = 120\pi\Omega$

$P_D = E^2/\mathbf{R}$

$E^2/R = P_t / 4\pi \mathbf{r}^2$

$E = (P_t \times 30)^{1/2} / \mathbf{r}$ (V/m)

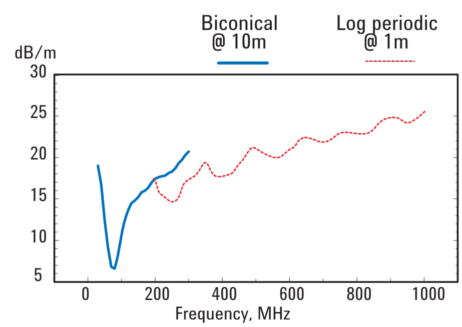
Far field* is considered to be $>\lambda s/2\pi$

* Far field is the minimum distance from a radiator where the field becomes a planar wave.

Antenna factors

The definition of antenna factors is the ratio of the electric field in volts per meter present at the plane of the antenna, versus the voltage out of the antenna connector. *Note: Antenna factors are not the same as antenna gain.*

Antenna factors



Linear units: AF = Antenna factor (1/m)
E = Electric field strength (V/m)
V = Voltage output from antenna (V)

$$AF = \frac{\text{Ein}}{\text{V out}}$$

Log units: AF(dB/m) = E(dBμV/m) - V(dBμV)
E(dBμV/m) = V(dBμV) + AF(dB/m)

Figure B-1. Typical antenna factor shapes

Types of antennas used for commercial radiated measurements

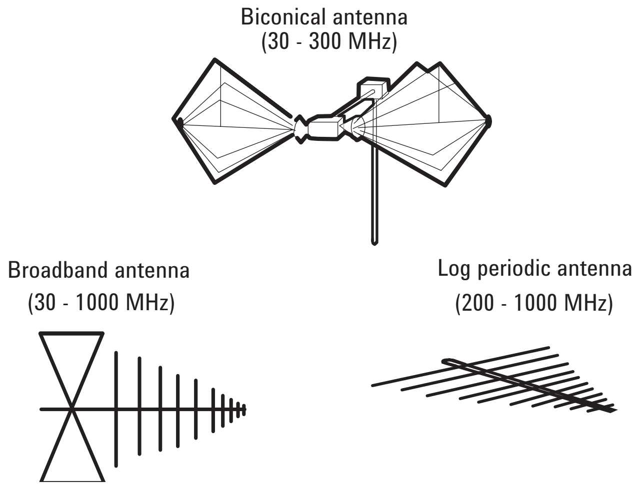


Figure B-2. Antennas used in EMI emissions measurements

There are three types of antennas used for commercial radiated emissions measurements.

Biconical antenna:	30 MHz to 300 MHz
Log periodic antenna:	200 MHz to 1 GHz (the biconical and log periodic overlap frequency)
Broadband antenna:	30 MHz to 1 GHz (larger format than the biconical or log periodic antennas)

Appendix C

Basic electrical relationships

The decibel is used extensively in electromagnetic measurements. It is the log of the ratio of two amplitudes. The amplitudes are in power, voltage, amps, electric field units, and magnetic field units.

$$\text{decibel} = \text{dB} = 10 \log (P_2/P_1)$$

Data is sometimes expressed in volts or field strength units.

In this case, replace P with V^2/R.

If the impedances are equal, the equation becomes:

$$\text{dB} = 20 \log(V_2/V_1)$$

A unit of measure used in EMI measurements is dBμV or dBμA. The relationship of dBμV and dBm is as follows:

$$\text{dB}\mu\text{V} = 107 + P_{dBm}$$

This is true for an impedance of 50 Ω.

Wavelength (l) is determined using the following relationship:

$$\lambda = 3x10^8 \,/\, f\ (\text{Hz}) \quad \text{or } \lambda = 300/f\ (\text{MHz})$$

Appendix D

Detectors used in EMI measurements—peak, quasi-peak, and average

Peak detector
Initial EMI measurements are made using the peak detector.

This mode is much faster than quasi-peak, or average modes of detection. Signals are normally displayed on spectrum analyzers or EMI receivers in peak mode. Since signals measured in peak detection mode always have amplitude values equal to or higher than quasi-peak or average detection modes, it is a very easy process to take a sweep and compare the results to a limit line. If all signals fall below the limit, then the product passes, and no further testing is needed.

Peak detector operation
The EMI receiver has an envelope or peak detector in the IF chain with a constant time such that the voltage at the detector output follows the peak value of the IF signal at all times. In other words, the detector can follow the fastest possible changes in the envelope of the IF signal, but not the instantaneous value of the IF sine wave (see Figure D-1).

Output of the envelope detector follows the peaks of the IF signal

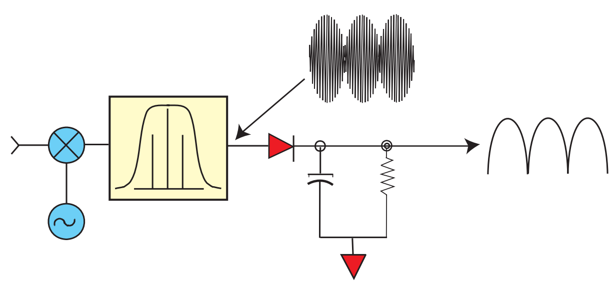


Figure D-1. Peak detector diagram

Quasi-peak detector
Most radiated and conducted limits are based on quasi-peak detection mode. Quasi-peak detectors weigh signals according to their repetition rate, which is a way of measuring their annoyance factor. As the repetition rate increases, the quasi-peak detector does not have time to discharge as much, resulting in a higher voltage output. (See Figure D-2 below.) For continuous wave (CW) signals, the peak and the quasi-peak are the same.

Since the quasi-peak detector always gives a reading less than or equal to peak detection, why not use quasi-peak detection all the time? Though quasi-peak measurements can help you more easily pass EMI compliance tests, they are much slower by 2 or 3 orders of magnitude, compared to using the peak detector.

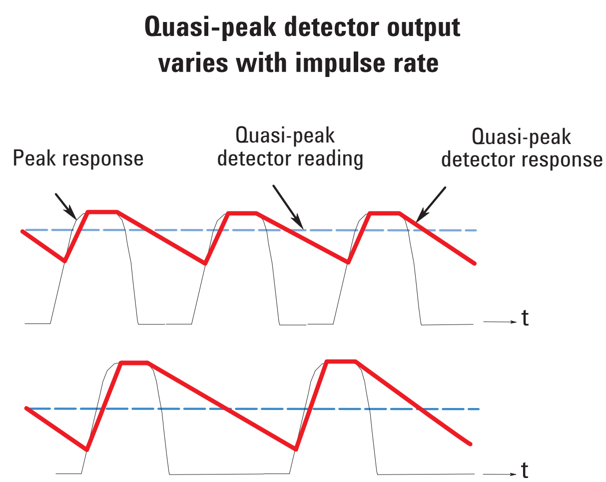


Figure D-2. Quasi-peak detector response diagram

Quasi-peak detector operation
The quasi-peak detector has a charge rate much faster than the discharge rate, therefore the higher the repetition rate of the signal, the higher the output of the quasi-peak detector. The quasi-peak detector also responds to different amplitude signals in a linear fashion. High-amplitude, low-repetition rate signals could produce the same output as low-amplitude, high-repetition-rate signals.

Average detector
The average detector is required for some conducted emissions tests in conjunction with using the quasi-peak detector. Also, radiated emissions measurements above 1 GHz are performed using average detection. The average detector output is always less than or equal to peak detection.

Average detector operation
Average detection is similar in many respects to peak detection. Figure D-3 shows a signal that has just passed through the IF and is about to be detected. The output of the envelope detector is the modulation envelope. Peak detection occurs when the post detection bandwidth is wider than the resolution bandwidth. For average detection to take place, the peak detected signal must pass through a filter with a bandwidth much less than the resolution bandwidth. The filter averages the higher frequency components, such as noise, at the output of the envelope detector.

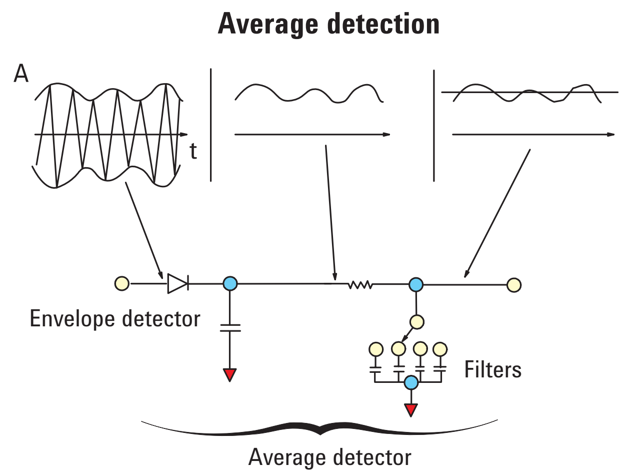


Figure D-3. Average detection response diagram

RMS average detector
RMS average weighting receivers employ a weighting detector that is a combination of the rms detector (for pulse repetition frequencies above a corner frequency fc) and the average detector (for pulse repetition frequencies below the corner frequency fc), thus achieving a pulse response curve with the following characteristics: 10 dB/decade above the corner frequency, and 20 dB/decade below the corner frequency. See CISPR 16-1-1 2010 for detailed response characteristics.

Appendix E
EMC regulatory agencies

IEC (CISPR)
IEC Central Office Sales Department
PO Box 131
3, Rue de Verembe
1121 Geneva 20, Switzerland
www.iec.ch
http://www.iec.ch/zone/emc/emc_cis.htm#guide

ITU-R (CCIR)
ITU, General Secretariat, Sales Service
Place de Nation
1211 Geneva, Switzerland
Telephone: +41 22 730 5111
Fax: +41 22 733 7256
http://www.itu.int/ITU-R

Australia
Australia Electromechanical Committee
Standards Association of Australia
PO Box 458
North Sydney N.S.W. 2060
Telephone: +61 2 963 41 11
Fax: +61 2 963 3896
AustraliaElecto-technical Committee
http://www.ihs.com.au/standards/iec/

Belgium
Comite Electrotechnique Belge
Boulevard A. Reyerslaan, 80
B-1030 BRUSSELS
Telephone: Int +32 2 706 85 70
Fax: Int +32 2 706 85 80
http://www.bec-ceb.be

Canada
Standards Council of Canada
Standards Sales Division
270 Albert Street, Suite 200
Ottawa, Ontario K1P 6N7
Telephone: 613 238 3222
Fax: 613 569 7808
http://www.scc.ca

Canadians Standards Association (CSA)
5060 Spectrum Way
Mississauga, Ontario L4W 5N6
Telephone: 416 747 4000
800 463 6727
Fax: 416 747 2473
http://www.csa.ca

Denmark
Dansk Elektroteknisk Komite
Strandgade 36 st
DK-1401 Kobenhavn K
Telephone: +45 72 24 59 00
Fax: +45 72 24 59 02
http://www.en.ds.dk

France
Comite Electrotechnique Francais
UTE CEdex 64
F-92052 Paris la Defense
Telephone: +33 1 49 07 62 00
Fax: +33 1 47 78 71 98
http://www.ute-fr.com/FR

Germany
VDE VERLAG GmbH
Bismarckstr. 33
10625 Berlin
Telephone: + 49 30 34 80 01 - 0
Fax: + 49 30 341 70 93
email: vertrieb@vde-verlag.de

India
Bureau of Indian Standards, Sales Department
Manak Bhavan
9 Bahadur Shah Zafar Marg.
New Delhi 110002
Telephone: + 91 11 331 01 31
Fax: + 91 11 331 40 62
http://www.bis.org.in

Italy
CEI-Comitato Elettrotecnico Italiano
Sede di Milano
Via Saccardo, 9
20134 Milano
Telephone: 02 21006.226
Fax: 02 21006.222
http://www.ceiweb.it

Japan
Japanese Standards Association
1-24 Akasaka 4
Minato-Ku
Tokyo 107
Telephone: + 81 3 583 8001
Fax: + 81 3 580 14 18
http://www.jsa.or.jp/default_english.asp

Netherlands
Nederlands Normalisatie-Instituut
Afd. Verdoop en Informatie
Kalfjeslaan 2, PO Box 5059
2600 GB Delft
Telephone: (015) 2 690 390
Fax: (015) 2 690 190
www.nni.nl

Norway
Norsk Elektroteknisk Komite
Harbizalleen 2A
Postboks 280 Skoyen
N-0212 Oslo 2
Telephone: 67 83 87 00
Fax: 67 83 87 01
http://www.standard.no/imaker.exe?id=4170

South Africa
South African Bureau of Standards
Electronic Engineering Department
Private Bag X191
Pretoria
0001 Republic of South Africa
https://www.sabs.co.za/Sectors/Electrotechnical/index.aspx

Spain
Comite Nacional Espanol de la CEI
Francisco Gervas 3
E-28020 Madrid
Telephone: + 34 91 432 60 00
Fax: + 34 91 310 45 96
http://www.aenor.es

Sweden
Svenska Elektriska Kommissionen
PO Box 1284
S-164 28 Kista-Stockholm
Telephone: 08 444 14 00
Fax: 08 444 14 30
http://www.elstandard.se/standarder/emc_standarder.asp

Switzerland
Swiss Electrotechnical Committee
Swiss Electromechanical Association
Luppmenstrasse 1
CH-8320 Fehraltorf
Telephone: + 41 44 956 11 11
Fax: + 41 44 956 11 22
http://www. electrosuisse.ch/

United Kingdom
BSI Standards
389 Chiswick High Road
London
W4 4AL
Telephone: +44 (0)20 8996 9001
Fax: +44 (0)20 8996 7001
www.bsi-global.com

British Defence Standards
DStan Helpdesk
UKDefence Standardization
Room 1138
Kentigern House
65 Brown Street
Glasgow
G2 8EX
Telephone: +44 (0) 141 224 2531
Fax: +44 (0) 141 224 2503
http://www.dstan.mod.uk

United States of America
America National Standards Institute Inc.
Sales Dept.
1430 Broadway
New York, NY 10018
Telephone: 212 642 4900
Fax: 212 302 1286
http://webstore.ansi.org/ansidocstore/default.asp

FCC Rules and Regulations
Technical Standards Branch
2025 M Street N.W.
MS 1300 B4
Washington DC 20554
Telephone: 202 653 6288
http://www.fcc.gov

FCC Equipment Authorization Branch
7435 Oakland Mills Road
MS 1300-B2
Columbia, MD 21046
Telephone: 301 725 1585
http://www.fcc.gov

Glossary of Acronyms and Definitions

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.

Amplitude modulation

1. In a signal transmission system, the process, or the result of the process, where 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. 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: wall, ceiling, and floor. It's 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 radiated 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 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 and a magnetic field strength in amperes per meter.

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 associated equipment appearing at the antenna terminals.

Auxiliary equipment

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

Balun

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

Broadband emission

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

Broadband interference (measurements)

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.

Conducted interference

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

Cross coupling

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

Decoupling network

A decoupling network is an electrical circuit for preventing test signals, which are applied to the EUT interfering with 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 one box or they can be in separate networks.

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 hat of an elementary electric dipole.

Electromagnetic compatibility (EMC)

1. The capability of electronic equipment systems to be operated within defined margins 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.

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

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.

Far field
The region where the power flux density from an antenna approximately obeys an inverse squares law of the distance. For a dipole, this corresponds to distances greater than l/2 where l is the wavelength of the radiation.

Ground plane
1. A conducting surface of 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.

Intermodulation
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.

Isotropic
Having properties of equal values in all directions.

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

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

Open area
A 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 these factors are negligible. This site should have a sufficiently low level of ambient interference to permit testing to the required limits.

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

Radiated interference
Radio interference resulting from radiated noise of unwanted signals. Compare radio frequency interference.

Radiation
The emission of energy in the form of electromagnetic waves.

Radio frequency interference
RFI is the high-frequency interference with radio reception. This occurs when undesired electromagnetic oscillations find entrance to the high-frequency input of a receiver or antenna system.

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

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 as well as prevent emissions from causing interference to outside activities.

Stripline
Parallel plate transmission line to generate an electromagnetic field for testing purposes.

Susceptibility
The characteristic of electronic equipment that permits undesirable responses when subjected to electromagnetic energy.

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Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
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	*0.125 €/minute
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