Keysight Technologies
Save Time and Money with EMI Precompliance Testing

Application Brief

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KEYSIGHT TECHNOLOGIES

Save Time and Money with EMI Precompliance Testing

Electromagnetic interference (EMI) compliance testing presents the risk of a costly bottlneck, so many companies now rely on pre-compliance testing to find and fix problems earlier in the product development process.

Precompliance versus full compliance

Full compliance measurements require the use of a receiver that meets the requirements set forth in CISPR16-1-1 from the International Special Committee on Radio Interference (CISPR) for commercial compliance or MIL-STD 461 for military standards. Also required are a qualified open area test site or semi-anechoic chamber and an antenna tower and turntable to maximize signals from the device under test (DUT). Great effort is taken to get the best accuracy and repeatability, and the required facilities and equipment can be quite expensive.

At a fraction of the cost, precompliance measurements offer an approximation of the EMI performance of the DUT. With attention to detail in such factors as ensuring a good ground plane and minimizing the number of reflective objects, precompliance measurements can provide the insight needed to resolve design issues before heading into full compliance testing.

Systems for precompliance measurements

A typical system for precompliance measurements includes a signal analyzer with the Keysight N6141A EMI measurement application, a line impedance stabilization network (LISN), a transient limiter, and antennas (Figure 1). Close-field probes such as the Keysight N9311X-100 help isolate problems after they have been identified. The environment for precompliance testing is usually less controlled than full compliance testing environments, but it obviously needs to be relatively free from other electromagnetic interference.

FCC	CISPR	EN's	Description
18	11	EN 55011	Industrial, scientific and medical equipment
NA	12	NA	Automotive
15	13	EN 55013	Broadcast receivers
NA	14	EN 55014	Household appliances/tools
NA	15	EN 55015	Flourescent lights/luminaries
15	22	EN 55022	Information technology equipment
NA	NA	EN61000-6-3,4	Generic emissions standards
NA	16	NA	Measurement apparatus/methods
NA	16	EN 55025	Automotive component test

TABLE 1. The relevant EMI standards depend on the type of product, intended use, and geographic region. ENs are European Norms published by bodies such as the European Committee for Electrotechnical Standardization.

Identifying the relevant EMI standards

The precompliance measurement process is straightforward, but it is important to test against the appropriate standard(s) based on target markets and product type (Table 1).

Conducted precompliance emissions testing

After the appropriate regulations have been identified, the next step is to set up the test equipment and perform conducted emissions tests. Here is a brief overview of the process:

1. Connect the signal analyzer, limiter, LISN, and DUT (Figure 2). Measure the signals on the power line with the DUT turned off. If you see the signal approaching the established limit lines, some additional shielding may be required.

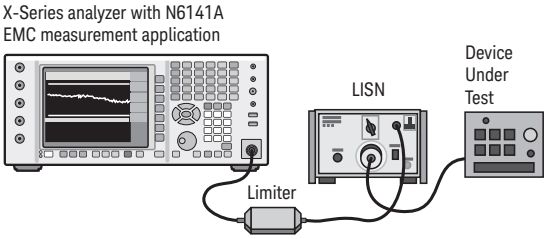

FIGURE 2. The device under test is connected to the analyzer via the LISN.

2. Verify that you are measuring within the appropriate frequency range for conducted emissions measurements (150 kHz to 30 MHz).

3. Load limit lines and correction factors. To compensate for measurement errors, add a margin to both limit lines.

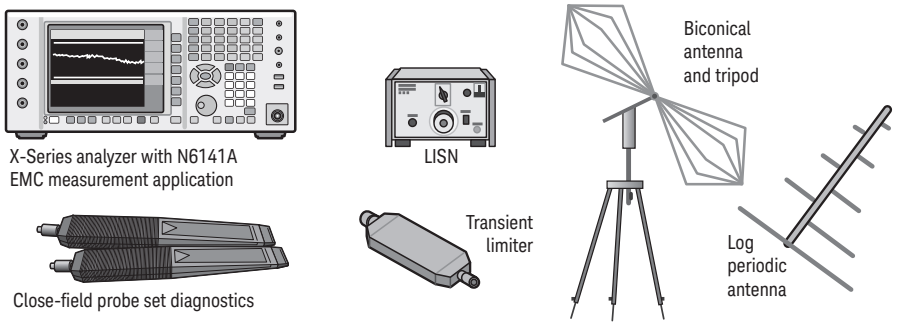

FIGURE 1. Here are the components of a typical pre-production EMI evaluation system.

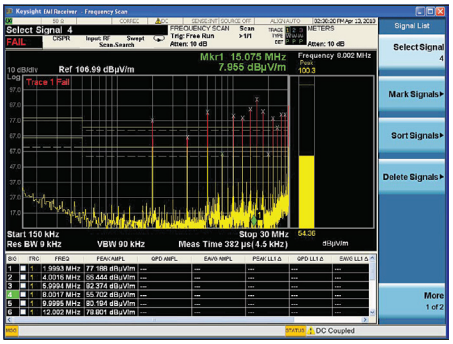

FIGURE 3.
Scan and search identifies signals above the limit.

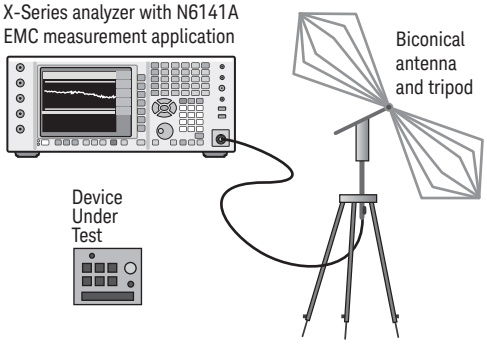

FIGURE 4.
Setting up for radiated measurements.

4. View the ambient emissions with the DUT turned off. If emissions above the limit are noted, the power cord between the LISN and the DUT may be acting as an antenna; shorten the cord as much as possible.

5. Switch on the DUT to find signals above the limit lines. To identify the signals above the margin of either limit line, select scan and search to get the peak amplitude and frequency (Figure 3).

6. Measure the quasi-peak and average of signals and compare them to their respective limits.

With these results in hand, you can use a close-field probe to look for the sources of any signals that exceed relevant limits.

Radiated emissions testing

The ambient environment adds complexity, which can interfere with measuring the emissions from the DUT. Therefore, radiated emissions measurements are not as straightforward as conducted emissions measurements. In metropolitan areas, for example, ambient environments can be extremely dense with emissions that overpower those from the DUT. Testing in a semi-anechoic chamber can simplify and accelerate measurements, although this approach is more expensive than open-area testing.

To see if an ambient signal is present, try these methods:

1. If you can, power down the DUT and see if the signal remains.

2. Use the tune and listen feature of the signal analyzer to determine if the signal is a local radio station. This method is useful for AM, FM, and PM signals.

3. If the DUT is on a turntable, rotate the table while observing the signal in question. If the signal amplitude remains constant, the signal is likely to be an ambient signal.

4. Place one antenna at the prescribed distance as called out by the regulatory body and a second antenna at twice that distance. Connect the two antennas to the signal analyzer through a switch. If the signal is the same amplitude at both antennas, it is likely to be an ambient signal.

To set up for radiated emissions measurements, start by arranging the antenna, DUT, and signal analyzer as shown in Figure 4. Separate the antenna and the DUT as specified by the regulatory agency. If space is limited, move the antenna closer to the DUT and edit the limits to reflect the new position. However, don't place the antenna in the near field of the radiating device, which is $\lambda/2\pi$ or 3 meters for 15.9 MHz Most commercial radiated emissions start at 30 MHz.

Next, set up the signal analyzer for the correct span, bandwidths, and limit lines with margin included. To get the best sensitivity, switch on the signal analyzer's preamplifier and set the attenuator to 0 dB, but be aware that strong ambients can overload the signal analyzer.

Follow these steps to measure each face of the DUT:

1. With the DUT turned off, perform a scan and search of the signals over the band of interest and store the list of frequency/amplitude pairs to a file.

2. With the DUT turned on and oriented at the 0 degree position, perform a scan and search.

3. A second group of signals will be added to the existing ambient signals in the list.

4. Search for duplicates using the "mark all duplicates" function.

5. Delete the marked signal, which now leaves only the DUT signals and those that were not present during the ambient scan However, this does not always work if signals have FM content or varying peak amplitudes, in which case, the recorded frequencies for the two ambient measurements will be slightly different.

6. Perform measurements using the QP detector and compare them to the delta limit.

Repeat the process for each position of the turntable to measure every face of the DUT. (If you see a signal at the same amplitude for all four sides of the DUT, it could be an ambient signal that was missed during the ambient scan.) As with conducted emissions, use a close-field probe to begin the process of identifying sources of EMI that exceeded regulatory limits during testing.

For a more in-depth look at EMI precompliance testing and troubleshooting, visit www.Keysight.com/find/emi and download a free copy of *"Making Conducted and Radiated Emissions Measurements"*, 5990-6152EN.

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