



EMC Pre-Compliance Fundamentals

Once you've designed your electronic product, it's time to release it to market, right? Well, not exactly. As with any product development, you need to first test the device you're designing to validate that it behaves as expected. One such important test that all electronic devices must eventually pass are EMI (electromagnetic interference) compliance tests. Passing EMI tests demonstrate that your device's electromagnetic emissions are at an acceptable level, as defined by the respective regulatory body's standard the device is being tested against.

EMI, or electromagnetic interference, falls under the umbrella term 'EMC' which stands for electromagnetic compatibility. When performing pre-compliance tests, you are concerned about testing for EMI which is the actual phenomena – or emissions – coming from your device.

However, acquiring certification for EMI compliance testing is rather expensive – and in the off chance that you don't pass – you not only have to rework your design but this will also throw off your product development schedule and cost you a lot of money.



Conducting pre-compliance tests are important to do so that you not only ensure your device is certified for compliance at a test facility, but also to maintain an on-schedule product development cycle.

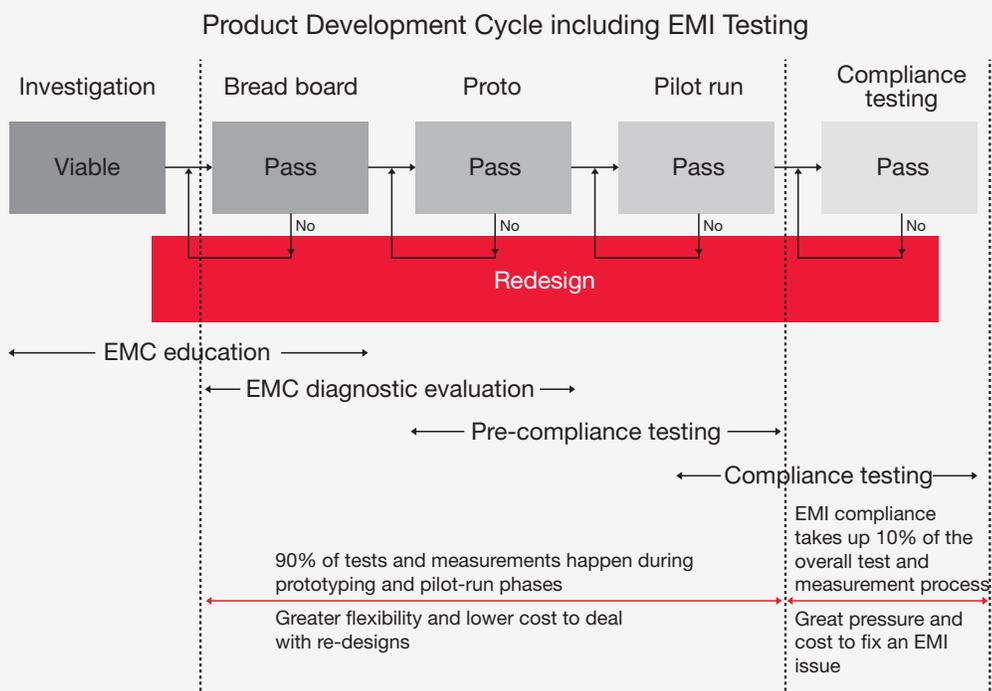


Figure 1: A typical product development cycle and where EMC testing should occur

Being able to conduct EMI tests of your own can help ensure that your device passes as soon as it is sent to a test facility for certification.

Basics of EMI Pre-Compliance

EMC testing is the interaction of electrical equipment with its electromagnetic environment, and other equipment. All electronic devices have the potential to emit electromagnetic fields, so it is important to identify whether or not your device is emitting at an appropriate level and compliance testing is the final stage of testing that ensures the electronic devices meet the appropriate standard. Pre-Compliance testing can be thought of as a dress rehearsal for compliance testing. Everything you do during pre-compliance testing ensures that your device passes when it is sent in for compliance testing, the final stage of EMC testing, at a certified test facility. You can test your device against the same standards that these test facilities will, but in the convenience of your own test lab.

All products, from your laptop to your smartphone, have to pass compliance tests at a certified test facility. These test facilities perform a variety of tests to check to see if your device complies with the appropriate standard. Depending on your device's product category, a selected sub-set is usually applied to a particular product classification. In this document we'll discuss 4 tests in particular which can be broken down into two categories – emissions testing and immunity testing and within each of those categories there are both radiated and conducted tests.

Radiated tests characterize unintentional electromagnetic energy release from an electronic device via a non-physical medium (over the air testing).

Conducted tests characterize unintentional electromagnetic energy release from an electronic device via conductive material or a physical medium (cable testing).

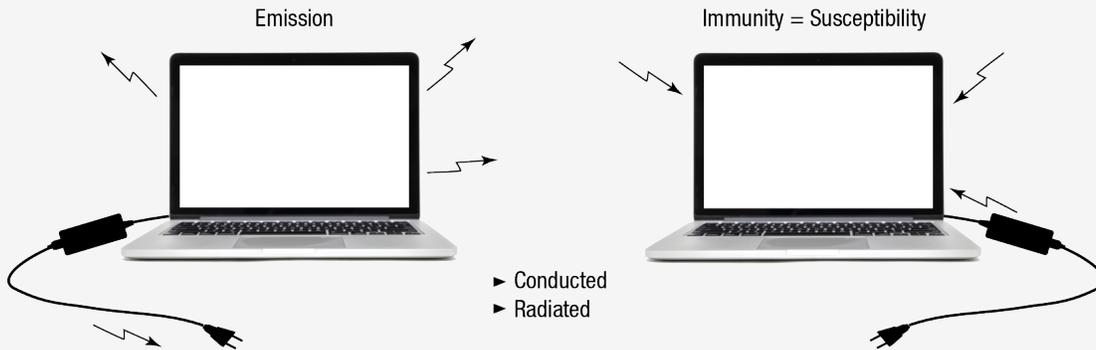


Figure 2: Four types of EMC Measurements

Emissions Testing

Emissions testing is concerned with the amount of electromagnetic energy emitted from your device.

Radiated emissions tests entail testing over the air electromagnetic energy emitted by your device and ensuring they abide by the appropriate standard. Radiated emissions testing looks for signals broadcast by the DUT through space. Radiated emissions from a device are responsible for the most frequent test failure during compliance testing – so it is imperative to invest time into measuring your device’s radiated emissions.

Conducted emissions tests entail testing electromagnetic disturbances that are caused by electrical activity within your device that are conducted outside the device along its interconnecting cables – for instance, power, signal, or data cables. Conducted disturbances, in particular, can couple directly into another electronic device or component within the same device. Conducted emissions tests focus on these unwanted signals generated from the AC mains of a device and sources can include, but are not limited to, switches, regulators, and low frequency clocks.

Emissions are important to test for because you do not want your device to unintentionally interfere with neighboring devices.

Immunity Testing

Immunity testing is concerned with how susceptible your device is to electromagnetic energy being emitted from neighboring devices.

Radiated immunity tests entail testing the susceptibility of your device to over the air emissions from other surrounding devices.

Conducted immunity tests entail testing the susceptibility of your device via cables from other neighboring devices.

Immunity is important to test for because you do not want your device to be influenced by neighboring devices. Some other immunity tests covered by EMC, but are not discussed in this document, include power line surge and quality, electrostatic discharge (ESD), operating magnetic, etc.

EMC Compliance Process & Regulatory Standards

EMC tests are regulated for standard compliance. These standards help regulate and make uniform product performance. There are umbrella standards designed for each specific product classification. An example of one of the standards is CISPR. It is important to note that CISPR is the foundation for the emissions tests discussed in this document, but not representative of all EMC regulatory standards. CISPR's work involves the equipment and methods for measuring interference. Additionally, CISPR establishes the required limits for electronic devices depending on what industry and what country the product will be sold in.

Compliance testing is a formal process that is heavily regulated from place to place, so it is best to ensure your devices are likely to pass compliance testing with the confidence pre-compliance testing provides.

Before making measurements of your device, it is important to ask yourself some preliminary questions:

1. Where will the product be sold (Europe, United States, Japan, etc...)?
2. What is the classification of the product?
 - a. Information technology equipment (ITE)
 - b. Industrial, scientific or medical equipment (ISM)
 - c. Automotive
 - d. Communication
 - e. Generic / household items
 - f. Where will the product be used (home, commercial, industry)?

With the answers to these questions, you can determine what standards your products need to be tested against, and see which measurements need to be performed.

Emissions Regulation Summary

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

Table 1: Comparison of regulatory agency requirements

EMC Testing Process & Troubleshooting

The equipment needed to accurately conduct your own EMC radiated emissions and conducted emissions pre-compliance measurements varies depending on the type of test you're doing.

For *pre-compliance radiated emissions* testing you'll need:

1. Signal Analyzer w/ EMC application
2. Calibrated EMI Antenna



Figure 3: A signal analyzer with an EMC application and a calibrated EMI antenna are used during radiated emissions testing

It's ideal to perform radiated tests in an area large enough and away from other electronic equipment, to avoid electromagnetic interference. Ideally, your device would be placed at a distance of at least 3 meters away from the antenna. The antenna would then be connected to the signal analyzer at a distance of at least 3 meters as well.

Some signal analyzers have an optional built-in application that makes this testing quick and easy. Having built-in CISPR and MIL-STD compliant bandwidths, detectors and band presets, along with automated testing and regulatory limits, you can quickly tell whether your device passes or fails the appropriate standard.

For *pre-compliance conducted emissions* testing you'll need the following equipment:

1. Signal Analyzer w/ EMC application
2. Transient Limiter
3. Line Impedance Stabilization Network (LISN)

N6141EM0E X-SERIES MEASUREMENT APPLICATION WITH MULTI-TOUCH UI



Figure 4: A transient limiter + LISN are used during conducted emissions testing

In this paper we won't cover how immunity testing is carried out.

Once you've determined that you have emissions issues from your device, you need to then determine the source. This is where close-field probes will come in handy.



Figure 5: Close-field probes used to troubleshoot where exactly emissions are coming from your device.

The goal of general troubleshooting is to identify relative changes in measurements and also where the source of your emissions are.

Conclusion

With this information you now have a fundamental understanding about what EMC pre-compliance is and the equipment required to perform your own EMC tests. As mentioned earlier, conducting pre-compliance tests are important to do so that you not only ensure your device is certified for compliance at a test facility, but also to maintain an on-schedule product development cycle.

Now that you know some of the key areas to evaluate for your device's emissions, consider reevaluating your test set up, calibration tools and techniques. Learn more about Keysight's EMC pre-compliance solutions:

- [N9010B EXA Signal Analyzer](#)
- [N9020B MXA Signal Analyzer](#)
- [N9311X-100 Close Field Probe Set, 30 MHz – 3 GHz](#)
- [N6141EM0E X-Series Measurement Application with Multi-touch UI](#)

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