

How to get your product compliant and ready for your intended market as quickly and economically as possible.

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Exterior of our 10 Metre Semi-Anechoic EMC Ambient Free Chamber



FLEXTRONICS

1 THE PROBLEM

The cost, complexity and time it takes to get a functioning prototype ready for sale to its intended market is often underestimated.

Often the business decision to introduce a product with a known weakness in performance, manufacturability, reliability or cost, can be made based on the knowledge that, after securing initial sales, development will continue and subsequent versions will reduce or eliminate the frailty and its potential liability.

Unlike other product development activities where aspects of the product can be improved through design iterations after the product's initial launch, regulatory compliance is a hard gate. Not only can the product not be sold, it can't be imported into its intended market or even be given away until it has been successfully through some if not all of its certification cycle.

The implications of missing that initial sales window while waiting for certification can be fatal to the success of the product. This is particularly true of consumer products with fast design cycles and aggressive competitors.

2 COMPLIANCE TYPES

There are a wide variety of tests and assessments that need to be performed and subsequent reports, audits, registrations and certificates required to start selling products. Which of these are required will depend upon the product type, intended market and customer. For the purposes of this document, we have limited the scope to electronic assemblies intended for the consumer, enterprise or industrial markets and have excluded some categories with very specific requirements such as toys, automotive, aerospace and medical.

2.1 Regulatory Compliance

Most countries have national regulatory (controlled by law) bodies (e.g. FCC in the USA for EMC and radio) or de-facto national regulatory bodies and have a minimum requirement for all products for safety and electro-magnetic emissions. In some cases, a single suite of testing and a report can cover many countries. For Europe the IECCE CB scheme has 50+ members and while some of those member countries have additional requirements, many are fully covered by one suite of testing and one report.

In some cases, it is necessary to file the report(s) with the body and in other cases you “self-declare” by producing a declaration of conformity backed up with the ability to produce such reports if required.

Although some customers request a particular safety organization provides their regulatory approvals (such as UL for the USA and/or CSA for Canada) any NRTL can provide this service and there are many of them.

As part of the certification activity, factory audits will be required. An Initial Factory Inspection is required to assess the capability of each intended factory to make, test and track the product appropriately. Once the factory has been assessed, quarterly assessments are required which are usually handled by a local agent who will try to consolidate factory visits to cover multiple products. There are fees associated with all these audits which are the responsibility of the company that holds the certifications for the product.

Labelling the products happens at the factory but the label type and content is approved at the time of the product evaluation. There is a minimum set of information required on the label, manufacturer (OEM, not the factory), model number and power ratings plus the NRTL mark. There are also many country specific labelling requirements.

Wireless products are increasingly common and usually have additional requirements. One notable exception is when a wireless module and antenna combination are already approved by the FCC in which case only the usual system level FCC tests for a non-intentional radiators apply. *“The module must contain a permanently-attached antenna, or contain a unique antenna connector, and be marketed or operated only with specific antenna”*. However, if the antenna is not approved with the radio module then this exception does not apply and full FCC certification is required. There are standards applicable to different frequency bands and in the USA a TCB

can review and upload the results to the FCC. However, in the EU and some of the rest of the world a self-declaration model is used. Canada is similar to the USA and testing is often performed simultaneously. Many countries have in country test requirements.

2.2 Industry Specific Compliance

Many industrial segments have their own set of standards and requirements (e.g. NEBS for network infrastructure equipment) which require additional testing. These may be similar tests to the regulatory tests but with different (usually higher) limits or may be additional tests to demonstrate product robustness in a variety of environmental conditions. Demonstrating the ability to operate in or after a variety of EMC, power, temperature, humidity, vibration and shock conditions is usually the bare minimum with additional environmental (salt fog, altitude, water and dust ingress, fire, acoustic) and electrical (surges on the power and signal lines, lightning) test cases as defined by the operating environment. The intended end customer may have a requirements document defining what standards they require products sold to them to meet driven by product type and application.

It is not unusual for a product originally intended for one market to be later modified and/or retested for another as opportunities arise. The more of the product deployment plan visible at the time of testing the easier it will be to consolidate testing which can save time and money.

2.3 Customer Specific Compliance

Many customer have their own set of standards and requirements and as with industry specific requirements, these are usually application driven. It is important to understand as much about your intended customers as early as possible so that testing can be consolidated where appropriate. This is not only required for testing as there may be design decisions to be made to ensure the product meets the customer's need.

Some customers are opinionated about where testing is performed and maintain their own list of approved vendors based on audits or other assessments. It is important to understand these when choosing test labs.

2.4 Environmental Compliance

Demonstrating the environmental compliance of your product has more to do with material content than with performance testing. Most important are the selection of compliant parts and working with the chosen manufacturer on the Bill of Materials and manufacturing processes.

2.5 Homologation or Global Market Access

While much mentioned above could be considered homologation or "*the granting of approval by an official authority*", the term is often used to refer to region specific approvals. In many cases, there is no additional testing or certification required to access a particular market but for others there are a variety of requirements which might include a paperwork exercise, additional testing and even in-country (e.g. China, Brazil, India) testing for certain product types

How you choose to classify your product can influence what process you will need to follow for particular markets. For example, declaring your product as a server will drive different requirements than if the same product was declared as network equipment. It is also possible that one country's definition is different to another's. For some countries the product's HTS code

will define its type (e.g. China, Taiwan) but for others the country has its own definitions (e.g. India).

It is not uncommon for a customer to request the ability to sell their product to anyone, anywhere in the world. While achievable, this is an expensive and time consuming process so it is more usual to have a phased approach to market access based upon the opportunity size. If there is not a single market driver, a common deployment plan is North America and Europe (and other CB scheme members) in phase 1, other markets for which additional testing is not required in phase 2 and those involving in-country testing in phase 3. Factors that will influence the chosen approach are availability of hardware, software and support for parallel testing, size and complexity of the product.

3 DESIGNING FOR COMPLIANCE

What can you do during the design of the product to minimize testing and certification risk ?

3.1 Who's doing what ?

The first thing is to decide is who's going to do what, internal or external resources or a mix of both. If your organization has enough products to justify having an internal resource dedicated to the task of compliance then that's a possibility. If not, the rate of change and complexity of standards and processes mean that somebody who is only occasionally focused on compliance might not be the best choice. Understanding the principals of EMC is common among electrical engineers, understanding the various EMC standards less so. Many organizations can handle compliance for you for a fee and some of those will offer compliance strategy creation, electrical and mechanical design support, board and system reviews, de-risk testing, test plan preparation, test management, compliance testing, report writing and submissions. It's usually the case that the fewer organizations you have to deal with, the easier your life will be so whether an external organization can handle every test case might be less important than their understanding of the end to end process required for your product type and market. Oddball tests can easily be subcontracted by them on your behalf.

3.2 The compliance matrix

A document showing which standards apply to which products will help you make appropriate design decisions and consolidate testing to minimize cost and duration. If it is unreasonable to expect all such information to be available at the design start, the matrix can evolve to include late arriving requirements with the understanding that the test execution and certification process might not be optimal.

3.3 Design reviews

It is easier, cheaper and more effective to design compliance solutions into the product than to try to retrofit features in production.

System level mechanical and electrical architecture and board level features all need to be reviewed at various stages of the design process and this needs to be done with an understanding of the standards to which the product is being designed. It is easy to build in a frailty which will cause a product to fail evaluation and to miss a feature required by the

standard. An understanding of the compliance strategy documented in the compliance matrix will help you make the right decisions during reviews.

Checklists for activities with a high potential contribution to compliance performance can also be included, for example the execution of a tolerance analysis can help ensure shielding effectiveness of your enclosure and help with EMC radiated emissions performance.

3.4 Test...and test again

As soon as you can, start de-risk testing of the product and its elements. Bought in items that do not come with documentation of their performance against your compliance criteria should also be tested. A history of past data should inform your supplier choices. Depending upon what other testing is planned (HALT, EVT, DVT, PRT) it may be possible to piggyback off such testing to gain valuable de-risk testing data without adding test cycles or additional samples.

While final compliance testing has to be done at a finished product level, pre-compliance testing of sub-elements can provide valuable information. For example, using a battery powered noise source, the shielding effectiveness of an enclosure can be measured long before the circuitry within is available. As systems generate more heat, characterizing fan and/or fan tray performance for airflow against acoustic performance can help you evaluate trade-offs and avoid an unpleasant surprise during compliance testing. Actual measured characteristics can also be used to optimize your thermal modelling tool variables to help tune performance.

4 COMPLIANCE READINESS

4.1 The product

A frequently asked question is *“how much like the final product must the tested product be ?”* The IEC 60950-1 standard states that *“The sample or samples under test shall be representative of the equipment the User would receive, or shall be the actual equipment ready for shipment to the User.”* which is unambiguous. Most standards are similarly clear. FCC part 2.953 states that *“each unit of equipment marketed under the verification procedure will be identical to the unit tested and found acceptable with the standards”*. If you change your product you should retest. Some OEMs collect changes and perform a reassessment periodically depending upon the nature of the changes, having performed a de-risk test of each change for critical test cases. FCC again *“Verified equipment shall be re-verified if any modification or change adversely affects the emanation characteristics of the modified equipment. The party designated in 2.909 bears responsibility for continued compliance of subsequently produced equipment.”*

Customers also have to exercise their product in a meaningful way in each of its modes of operation. This can be done by duplicating how the product is intended to operate by using equipment to drive and monitor the product during tests, simulating the product's typical operation using software scripts or a combination of both.

Also consider that for immunity testing, the product's functionality will need to be monitored continuously in real time during testing. The pass/fail criteria for immunity test cases will also need to be meaningful and defensible, usually monitoring of the products intended function. For

radio products customers also need to supply a method to adjust bandwidth, modulation, carrier frequency and power levels.

The effort and cost required to provide a means to enable meaningful performance monitoring is often underestimated.

4.2 The product configurations and variants to be covered

The next most frequently asked question is “*How many product variants do I need to test to cover my product range ?*” and the standards are equally unambiguous. If you sell it, you should test it. If you feel that you can comfortably demonstrate and defend a test suite that you feel covers all combinations through the use of a worst case configuration(s) you will need to document the process by which you arrived at that configuration(s). It is important to remember that the test lab is executing a test suite defined by their customer against the requirements of regulatory bodies and the intended end customer and it is the product owner who is responsible for the suitability and scope of the test configurations. Presuming that test results from one product covered a full range of products resulted in a one million dollar fine from the FCC for one manufacturer.

4.3 The scope of testing

Another frequently asked question is “*Do I really have to do all this testing ? Can't I demonstrate through engineering analysis that my product is compliant ?*” The test suite is defined by you against the requirements of regulatory bodies and your customer and any debate about suitability and scope is one you should be having with them, not with the test lab although they can also be a helpful resource. Any decisions a customer makes not to test will be clearly identified in the test report, usually as “Not Requested” which is not the same thing as “Not Applicable”. If the product class and standard have already been selected appropriately, there should be few reasons for “Not Applicable” and they should be as unambiguous as “This device is not AC powered”.

Since the customer is ultimately responsible for the liability regarding compliance, the test lab can advise based on experience but is not the final arbiter of whether a test should be completed or not.

Using a compliance by similarity argument to avoid duplicate testing is not unusual but needs to be supported by engineering analysis and should be well documented and defensible.

4.4 The test lab and other partners

The choice of a test lab is usually fairly straightforward.

- Are they appropriately accredited ? Consider standards, intended market and intended end customer.
- Are they convenient for me to use ? Consider geography, existing vendor status, product knowledge, booking flexibility and price.

For partners who are going to provide in-country testing and country specific processing services, it might be difficult to find one supplier with a presence in all the countries required. It is not unusual to engage several geography-specific partners.

5 WHAT WORKS ?

The practices that are going to minimize risk are predictable but the frequency with which they are ignored is surprising. Customers should...

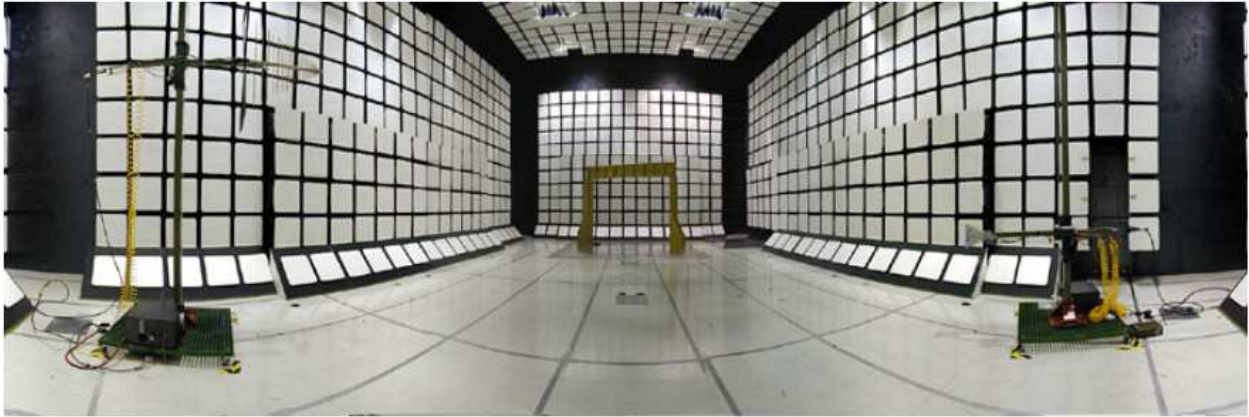
- Before starting the design, create, review and approve a compliance strategy identifying product types and configurations and intended markets (segment, geography and customer). Ensure that the latest applicable standards have been used.
- Design for Compliance through discipline expert's input to component selection, mechanical and electrical architecture and reviews at key stages of development.
- Have a clear understanding of the pass/fail criteria of the product and the test lab should agree that you are using meaningful criteria.
- Minimize the flavors of product, the more customer or market specific variants you have, the harder and more expensive it will be obtain, track and maintain your compliance story.
- Track the status of your product(s) using a compliance certification status tool will enable you to avoid missing renewals or under or over claiming your product's readiness. The amount of information contained within escalates quickly as products, product variants and standards are added and soon becomes most easily managed in a database.
- Choose suppliers who have already done your work for you and can demonstrate that their product meets the standards you are designing to. While this is not proof of their efficacy in the context of your product, it helps minimize risk. It also helps you focus on potential trouble areas if things go badly. Use pre-approved modules wherever possible.
- Ensure the availability and clarity of documentation of bought in items (e.g. PSU reports and laser certificates for safety, TCB reports for radios).
- Have enough samples available to ensure the parallelism you require to meet schedule and also cover damage, failure and shipping losses.
- Perform pre-compliance testing.

6 HOW CAN WE HELP ?

As well as our extensive global network of manufacturing facilities in more than 30 countries, Flextronics has design and test centers around the world dedicated to supporting strategic customers. These can help support your compliance needs by providing...

- New product design.
- Existing product performance improvements
- Design for Compliance services.
- Test execution at appropriately accredited test centers.
- Failure analysis
- Global Market Access
- Sustaining services for your product portfolio

Interior of our 10 Metre Semi-Anechoic EMC Ambient Free Chamber



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Appendix

CB	Certified Body
NEBS	Network Equipment-Building System – A Telcordia (now Ericsson) Industry Requirement
UL	Underwriters Laboratories
NRTL	Nationally Recognized Testing Laboratory
CSA	Canadian Standards Association
DVT	Design Verification Testing
EMC	Electro-Magnetic Compatibility
EU	European Union
EVT	Engineering Verification Testing
FCC part 2.953	FCC standard 47 CFR 2.953 - Responsibility for compliance
FCC	Federal Communications Commission
HALT	Highly Accelerated Life Testing
HTS	Harmonized Tariff Schedule
IEC	International Electrotechnical Commission
IEC 60950-1	International Standard for the Safety of Information Technology Equipment
NCB	National Certification Body
OEM	Original Equipment Manufacturer
PRT	Product Robustness Testing
TCB	Telecommunication Certification Body
USA	United States of America