



EPCglobal Inc™

**Hardware Certification:
An Overview**



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1 INTRODUCTION

EPCglobal Inc™ has been entrusted to facilitate the adoption and implementation of the EPCglobal Network™. Because of that, the End User community requested EPCglobal to provide neutral testing in order to support industry mandates. Pursuant to that request, EPCglobal Inc began the development of its certification services. In order to accommodate the information needs of End Users today and in the future, EPCglobal is currently developing hardware certification on two tracks: *Interoperability Testing of Generation 1* and *Certification for Generation 2 and Beyond*.

Generation 1 standards for the EPCglobal Network hardware components (*formerly known as Version 1*) were approved by the Auto ID Center Board of Governors and transferred to EPCglobal Inc for commercialisation in November 2003. Since that time, vendors have released hardware, specifically tags, tag printers/encoders and readers, based on those Generation 1 standards. End User Companies are moving forward with their pilot tests and initial implementations today using the Generation 1 hardware currently on the market and are seeking guidance for their purchasing decisions. In order to serve the immediate need for information about Generation 1 hardware, EPCglobal Inc is providing the *Generation 1 Interoperability Testing*.

Generation 2 standards are expected to be released in the fourth quarter of 2004. Generation 2 will mark a significant and constructive change in the approach to EPC hardware that will streamline the development of tags and readers going forward. As a result, the full *EPCglobal Hardware Certification* will commence with Generation 2. In preparation for implementing the full certification, EPCglobal has been working to develop program, including designing a uniform approach to certification, finding labs to manage and perform testing, and preparing use cases for test procedures.

2 PURPOSE OF THIS DOCUMENT

With all of those efforts underway, this paper seeks to clarify some aspects of certification in general, as well as describe EPCglobal efforts to develop a uniform hardware certification that serves its Subscribers needs as well as the evolution of the technology and standards across the globe.

3 CERTIFICATION

The International Organisation for Standardization (ISO) defines certification as a “procedure by which a [neutral] third party gives written assurance that a product, process or service conforms to specified requirements.” This written assurance often comes in the form of a certification mark or label applied to a product or its documentation, and/or a listing in a publicly available registry.

3 - 1 TYPES OF CERTIFICATION TESTS

The hardware components of the EPCglobal Network utilize radio frequency technology, a tool of telecommunications. As a result, the techniques used to test telecommunications devices are also applicable for testing EPCglobal Network hardware. There are three types of tests commonly employed for the certification of products in the telecommunications industry:

- **Conformance Testing:** testing conducted to measure a device's compliance to a given standard;
- **Interoperability Testing:** testing conducted to measure a device's ability to operate with other devices; and
- **Performance Testing:** testing conducted to measure a device's performance under real world conditions and within specified environments.

Any of those tests, or a combination of those tests, may be utilised to certify devices. The selection of the tests to be used in a certification depends on the goals of the specific certification.

3 - 2 CERTIFICATION TEST CONSIDERATIONS

Although the scope and parameters of tests vary depending on the device(s) being tested, there are three preliminary determinations that must be made for any certification test: test environment, test equipment and test performer. The various options for each of those determinations are presented in the table below:

TEST ENVIRONMENT	<p><i>Where will the tests be conducted?</i></p> <ul style="list-style-type: none"> ▪ Lab ▪ Simulated field environment ▪ Actual field environment
TEST EQUIPMENT	<p><i>What equipment will be used to conduct the test?</i></p> <ul style="list-style-type: none"> ▪ Standard test equipment ▪ Validated reference devices ▪ Actual devices
TEST PERFORMER	<p><i>Who will perform the tests?</i></p> <ul style="list-style-type: none"> ▪ Certifying organisation's own lab ▪ Accredited 1st party lab (i.e. lab owned and operated by an End User company) ▪ Accredited 3rd party labs (i.e. lab owned and operated by either an independent testing company or an accredited solution partner)

3 - 3 OBTAINING RELIABLE INFORMATION

The purpose of a certification is to provide reliable information to End Users and the marketplace. In order to provide reliable information, the certification must be consistent across geography and time. All devices of the same type, regardless of their origin or testing location, should be certified utilising the same, uniform testing procedures. Moreover, the certification must be designed to adapt to change. Although standards and requirements will change over time, careful management is necessary to ensure that the overall certification process, as well as the procedures for certifying individual components, remain stable.

The telecommunications industry has well-developed certifications for its products, like mobile phone, Bluetooth, and WiFi devices. Those certifications were examined during the development of the EPCglobal Hardware Certification in order to leverage experience and learning. An overview of some of the telecommunications certification programs is provided in Appendix A of this document.

4 THE CHALLENGE

EPCglobal Network hardware includes the tags and readers, as well as the printers/encoders developed to generate label with EPC tags. The challenges for developing the EPCglobal Hardware Certification stem from the complexity of the various hardware components themselves. For example, EPC tag complexity varies depending on the functionality of the tag, how it communicates and whether or not it has a power source. In addition, the selection of specific frequencies on which the tags will operate is constrained not only by differing radio frequency regulations around the world, but also by other telecommunications equipment in existence today that occupy, and therefore restrict, the use of certain frequencies (e.g. mobile phones).

Although reader specifications are coordinated with tag specifications, EPC readers have their own complexities. EPC readers communicate the information from the tags to the EPCglobal Network. As a result, reader specifications must also define the communications and protocol for sending the information to the network. All of these considerations make the product development process very complex, necessitating not only a strict standards development process for vendors, but also a reliable certification process for End Users.

5 ADDRESSING THE GENERATION GAP

Generation 1 standards for the EPCglobal Network were released in November, 2003. Since that time, vendors have released hardware, specifically tags, tag printers/encoders and readers, based on those Generation 1 standards. Generation 1 provided different air interface protocols for Class 0 and Class 1 tags. However, subsequent review of the Generation 1 standards by the EPCglobal Action Groups determined that the End User community desired a single foundational protocol be established to replace the multiple protocols defined in Generation 1.

Pursuant to that finding, Generation 2 standards, specifically the *UHF Generation 2 Air Interface Protocol*, are being developed. They will provide one foundational protocol upon which not only Class 1 tags will be based, but also upon which all other passive communication tag classes (i.e. Class 2 and Class 3) will be based when they are developed. (It is anticipated that a similar foundational protocol will also be developed for the active communication tags classes, specifically Class 4 and Class 5). Hence, Generation 2 will mark a significant and constructive change in the approach to EPC hardware that will streamline the development of tags and readers going forward. As a result, it was determined that the full EPCglobal Hardware Certification should commence with Generation 2. (NOTE: *An overview of the EPC tag classes is provided in Appendix B of this document.*)

Generation 2 standards are expected to be released in the Fall of 2004, and there will be significant lead time before production quantities based on those standards will be available to End Users. However, companies are moving forward with their pilot tests and initial implementations today using the Generation 1 hardware currently on the market. As they work to design their systems, they are seeking information and guidance from EPCglobal to assist them with their purchasing decisions. In order to respond to this “generation gap,” it was decided that there would be two tracks for certification: *Interoperability Testing of Generation 1* and *Certification for Generation 2 and Beyond*. Both tracks are discussed in detail below.

6 INTEROPERABILITY TESTING OF GENERATION 1

At this phase, what companies are actually seeking is quick access to information about the interoperability of the various Generation 1 tags, readers and printers/encoders on the market today. In order to serve the immediate need for information about Generation 1, the EPCglobal community decided that Generation 1 Hardware Certification would consist only of interoperability testing of tags, printers/encoders and readers. This would provide End Users with the information they need to select products that work together for their initial implementations, while providing the time necessary to fully develop the formal EPCglobal Hardware Certification for Generation 2 and beyond.

Interoperability testing by EPCglobal is designed to provide a level of assurance to End Users that the products they have selected to use in their initial implementations of EPC technologies will work together. Toward that end, EPCglobal contracted with an independent third party lab to conduct Generation 1 interoperability testing on actual equipment in a standard lab setting (i.e. vendors provide their tags, printers/encoders and readers, and then submitted tags and tags programmed by submitted printers/encoders will be tested against all submitted readers depending on their class). Participation in the interoperability testing is restricted to EPCglobal Solution Providers. Generation 1 Interoperability testing was designed with two phases:

- **Interoperability Testing Phase I:** EPCglobal Hardware Providers were invited to a two-day event held at MET Labs facilities in Santa Clara, California in June, 2004. At that event, a private series of interoperability beta tests for Generation 1 Class 0 and Class 1 tags, readers and printers/encoders were conducted under test case procedures designed by MET Labs and EPCglobal. The results of this initial testing were kept confidential, released to only the individual provider. This event was designed to hone testing procedures and prepare solution providers for the formal interoperability testing in Phase II.
- **Interoperability Testing Phase II:** EPCglobal Hardware Providers were invited to a three-day event held at MET Labs facilities in Baltimore, Maryland on August 3-5, 2004. At that event, formal interoperability tests were conducted on Generation 1 Class 0 and Class 1 tags, readers and printers/encoders from participating vendors. All submitted tags and tags programmed by submitted printers/encoders were tested against all appropriate readers depending on the class of tag. The test results have been formally published by EPCglobal Inc as an interoperable products matrix in order to provide the EPCglobal Subscriber community with workable product combinations. This information will enable End User companies to make appropriate hardware purchase decisions to begin their initial implementations. (To review the detailed results of Interoperability Testing Phase II, please go to www.EPCglobalinc.org/interoperability.)

7 CERTIFICATION OF GENERATION 2 AND BEYOND

The official launch of the EPCglobal Hardware Certification will commence with Generation 2. EPCglobal Inc will own the hardware certification, including:

- Accreditation of all test labs worldwide
- Design, development, implementation and maintenance of all test plans and procedures based upon standards and End User requirements
- Certification verification and report management for vendor hardware

In addition, the certification methodology will input into various ISO/IEC standards.

7-1 GOALS

In order to support the industry mandates, the End User community has requested EPCglobal to provide a neutral testing program. Toward that end, the primary goal of the EPCglobal Hardware Certification is to build a complete and sustainable certification for various EPCglobal Network components that serves the information needs of the EPCglobal community and drives the adoption of the EPCglobal Network by eliminating delays and confusion. The secondary goal is to use various test results over time to create usage and application guidelines that minimise the need for additional testing by End Users to determine which certified products are appropriate for their specific uses, environments and conditions.

7-2 A UNIFORM APPROACH

Due to the complexities of Radio Frequency Identification (RFID) and the fact that standards development is and should be an on-going process, a single certification for EPCglobal Network hardware will be utilised in order to provide certification services that are uniform throughout the world and consistent over time. All devices of the same type, regardless of their origin or testing location, will be certified utilising the same, uniform testing procedures.

In order to support this uniform approach to certification, a third party lab will be engaged to manage the full certification process, instead of passing responsibility for various aspects of certification to different labs. For conformance and interoperability testing, the selected third party lab will be responsible for designing and developing test facilities, designing and developing testing cases and procedures, and conducting the tests themselves. For performance testing, the selected third party lab will design and manage a program to accredit third and first party labs. This uniform approach will ensure that the certification process, as well as the procedures for certifying individual components, will remain stable while being easily adaptable to changing standards. Moreover, it will enable the EPCglobal Hardware Certification to provide reliable information to Subscribers.

7 - 3 HARDWARE COMPONENTS TO BE CERTIFIED

The hardware components of the EPCglobal Network to be certified are the tags, printers/encoders and readers.

7 - 4 CONFORMANCE TESTING

Conformance testing forms the basis for certification. The conformance tests will evaluate hardware's conformance to the applicable standards based on a methodology developed by the third party lab contracted to work on behalf of EPCglobal. (EPCglobal Inc will retain ownership of that methodology and all detailed test plans.) If a product passes the conformance tests, it is awarded a mark or "seal of compliance" from EPCglobal Inc. (The mark or seal of compliance is also referred to as "badging.") There are generally two parameters to be tested:

- **RF Conformance:** verification that the device utilises the specified radio frequency techniques in communicating with other devices
- **Air interface protocol:** verification that the radio frequency conforming device communicates using the command set specified in the air interface protocol standard

NOTE: *Although the standards are designed with regulatory standards in mind, EPCglobal hardware compliance testing does not include regulatory compliance. Regulatory compliance is conducted by official bodies appointed by the respective regulators.*

The selected third party lab will be responsible for developing the testing cases and procedures, and conducting the conformance tests. Results will be reported to the provider in the form of a matrix presenting the rating (i.e. pass or fail) for each test conducted. Passing conformance test results will be reported through the EPCglobal website and the passing products would then qualify to carry the EPCglobal certification mark. (Failing conformance test results are only shared with the company in question, along with guidance to help them prepare for a retest.) The certification will also provide the rules for using and maintaining the seal of certification, as well as for communicating it to the EPCglobal community and the public.

Conformance testing will commence with the release of products based on Generation 2. It is currently estimated that Generation 2 products should reach the market in 2005.

7 - 5 INTEROPERABILITY TESTING

Interoperability tests will be conducted with varying combinations of conforming products to ensure that each product can reliably operate with a range of other conforming products. The selected third party lab will be responsible for developing the testing cases and procedures, and conducting the interoperability tests. EPCglobal will publish a listing of which hardware devices are interoperable in accordance with the test cases. Only products passing interoperability testing will be reported to the End User community by EPCglobal.

7 - 6 PERFORMANCE TESTING

The selected third party lab will design and manage a program to accredit third and first party labs to conduct performance testing. Although the accreditation criteria and testing methodologies are still being developed, two types of performance tests are being considered:

- **Simulated Performance Testing:** testing designed to build a performance profile for certain types of EPC tags and readers in combination with certain types of materials (e.g. *How does an EPCglobal-compliant tag perform on a variety of materials, such as wood, metal, glass with a liquid, corrugated and wax corrugated?*)
- **End User Case & Pallet Performance Testing:** testing performed on EPC-tagged cases and pallets (i.e. “tagged units”) under a set of simulated real-world conditions to judge readability of EPC tags on the items. Testing involves units moving at speed through a variety of different types of readers in different orientations under different operating conditions.

Results of performance testing may be used to develop application guidelines and best practices to assist vendors and End Users.

7 - 7 SELECTING THE THIRD PARTY LAB

A team comprised of EPCglobal and GS1 representatives was created to manage the Request for Proposal (RFP) process for contracting with a third party testing lab to develop and manage the EPCglobal Hardware Certification Program.

7- 7. 1 RFP Candidates & Recipients

The RFP Project Team researched and solicited feedback from the EPCglobal community to establish a list of candidates to whom the RFP could be circulated. The resulting list, called the “Super-Set,” consisted of twenty vendors from around the world. That Super-Set was then evaluated under additional criteria. (The criteria used to evaluate RFP candidates is provided in the table below.) The result was an international contingent of five vendors selected to receive the RFP. On November 18, 2003, the RFP was circulated to those vendors.

SUPER SET	<p><i>Initial list of twenty research lab candidates passing the following criteria:</i></p> <ul style="list-style-type: none"> ▪ Certification testing lab with experience in RFID, wireless, Bluetooth, GSM or similar technologies; ▪ Familiarity with telecommunications certification testing and government regulations; ▪ Could not be a tag or reader manufacturer; and ▪ Global presence.
RFP RECIPIENTS	<p><i>The five candidates from the Super Set that passed the following additional criteria:</i></p> <ul style="list-style-type: none"> ▪ Ability to perform the full Statement of Work; ▪ Ability to do conformance, performance and interoperability tests as defined by the EPCglobal user community; ▪ Signed the EPCglobal Non-Disclosure Agreement and the EPCglobal Non-Compete Agreement; and ▪ Global presence with a lab in the United States.*

* Because the initial pilot testing will occur in the United States, End Users requested that there be a lab in the United States to accommodate those early phases of implementation.

7- 7. 2 RFP Requirements

The RFP sought a single, worldwide hardware certification to include conformance, performance and interoperability testing that could be rapidly delivered. In addition, the RFP included the following requirements:

- Intellectual Property to be owned by EPCglobal Inc;
- Certification process, including all testing procedures, to be owned by EPCglobal Inc; and
- Vendor must propose the methodology and price for designing, developing, implementing and operating the EPCglobal Hardware Certification Program pursuant to a detailed Statement of Work for each part of the certification process as provided by EPCglobal Action Groups.

7 - 7.3 MET Labs

The RFP Project Team evaluated the submissions to the RFP and, in January, 2004, recommended MET Labs to the executive team. The executive team approved that recommendation in March, 2004. The following table provides an overview of MET labs credentials.

MET LABORATORIES
<p><i>Founded in 1959, MET Labs is an accredited third party test laboratory offering complete product compliance/certification services. They have labs in three locations in the United States, and have partnerships linking them to labs around the globe.*</i></p> <ul style="list-style-type: none"> ▪ NRTL (Nationally Recognised Testing Laboratory - US) ▪ NVLAP (National Voluntary Laboratory Accreditation - US) ▪ A2LA (American Association for Laboratory Accreditation - US) ▪ TCB (Telecommunications Certification Body - US) ▪ NCB (National Certification Body – International IECCE) ▪ CAB/NB (Conformity Assessment & Notified Body – EU) ▪ SCC (Standards Council of Canada) ▪ VCCI (Voluntary Council for the Control of Interference – Japan) ▪ ACA (Australian Communications Authority) ▪ CB (Certification Body - Canada) ▪ BQTF (Bluetooth Qualification Testing Facility - International)

* Many international accrediting bodies have mutual recognition agreements with each other. Pursuant to such agreements, a lab accredited by one is recognised by the other. For example, the United States and the European Union have such an agreement in place. For countries that require in-country certification, there are certification houses, like the SGS and NEMKO, with laboratories across the globe. In such instances, MET Labs has an agreement in place with those certification houses so that MET Labs performs the testing, and then those certification houses review the test results and certify them as required by the particular country.

NOTE: *The market for certification labs for conformance and interoperability testing is quite limited. Therefore, the selection of additional labs for conformance and interoperability testing seems unlikely. However, the current approach to performance testing envisions the accreditation of additional third party labs as well as first party labs to conduct performance testing.*

7 - 8 ROLE OF THE GS1 MEMBER ORGANISATIONS

The role of Member Organisations in the certification process is evolving. One recommendation is for Member Organisations to participate in the accreditation of performance labs. Under the model described above, two types of labs will be accredited: first party performance labs (i.e. large End User companies who build their own performance lab facilities) and third party labs (i.e. organizations working with a Member Organisation(s) and/or technology companies that want to conduct performance testing). Although the certification process will be global, the business model may vary by market. With the participation of Member Organisations, the accreditation process can

be a collaboration where the certifying third party lab representing EPCglobal accredits performance labs in conjunction with a GS1 Member Organisation.

Another recommendation is for Member Organisations to manage the relationships and promote the certification within their respective regions. For example, the Member Organisations can be the certification's point of contact for the Solution Providers and End User companies headquartered in their particular geography. Because the role of the Member Organisations is evolving, further details about Member Organisation participation, rollout dates, and business models will be provided at a later date.

8 CONCLUSION

Today, the Generation 1 Interoperability Tests are providing the EPCglobal Subscriber community with workable product combinations that will assist End User companies in building their EPC-enabled supply chain operations. On a parallel track, the development of the full EPCglobal Hardware Certification program continues: negotiations with the third party lab to manage the certification process are underway, and the EPCglobal Action Groups are developing the standards upon which certification will be based. This approach has enabled EPCglobal to provide Subscribers with the information they need to select products that work together for their pilot tests, while providing the time necessary to fully develop the formal EPCglobal Hardware Certification Program for Generation 2 and beyond.

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9 APPENDIX A: OVERVIEW OF CERTIFICATION IN THE TELECOMMUNICATIONS INDUSTRY

The telecommunications industry has well-developed certification for its products, like mobile phone, Bluetooth, and WiFi devices. Because the EPCglobal Network utilizes radio frequency technology, it is appropriate to look to the telecommunications industry certification to leverage their experience and learning in the development of the EPCglobal Hardware Certification.

As discussed in this paper, there are three preliminary determinations that must be made for any certification test: test environment, test equipment and test performer. The various options for each of those determinations are presented in the table below:

TEST ENVIRONMENT	<p><i>Where will the tests be conducted?</i></p> <ul style="list-style-type: none"> ▪ Lab ▪ Simulated field environment ▪ Actual field environment
TEST EQUIPMENT	<p><i>What equipment will be used to conduct the test?</i></p> <ul style="list-style-type: none"> ▪ Standard test equipment ▪ Validated reference devices ▪ Actual devices
TEST PERFORMER	<p><i>Who will perform the tests?</i></p> <ul style="list-style-type: none"> ▪ Certifying organisation's own lab ▪ Accredited 1st party lab (i.e. vendor self testing) ▪ Accredited 3rd party labs ▪ Contract the entire process to a single 3rd party lab to manage all aspects of the testing process

All of those options are used throughout the telecommunications industry. For example, in terms of test environment, CTIA cellular phone protocol testing, Bluetooth, and WiFi conformance testing is done in labs, while Global Certification Forum GSM interoperability testing is done in the actual field environment. For test devices, Bluetooth software certification utilises validated reference devices, and Bluetooth RF hardware certification utilises a validated Bluetooth tester as well as standard test equipment. For the test performer, there are notable examples in telecommunications industry of each option. Cable Labs created their own lab for certification of cable modems. CTIA qualifies independent 3rd party labs, whereas Bluetooth Special Interest Group established a test facility qualification lab for accrediting both 1st party labs and independent 3rd party labs. WiFi Alliance contracted its process to a single global certification lab to manage both the testing and the overall process.

10 APPENDIX B: EPC TAG CLASSES

EPC tags are data carriers that are attached (or affixed) to an item and carry that item's EPC number. The complexity of an EPC tag varies depending on the functionality of the tag, how it communicates and whether or not it has a power source. Increasing the complexity of tags also increases the cost. Tags with advanced functions require more expensive microchips, and tags with a power source require a battery. Although most sectors require only the simplest, lowest cost tag, the potential value of more complicated tags justifies their increased cost in certain industries. For example, the food industry may want to add temperature tracking by adding a temperature sensor on tags.

In order to accommodate varying levels of complexity, six tag classifications have been defined.

EPC Tag Class	Tag Class Capabilities
Class 0	Read only (<i>i.e. the EPC number is encoded onto the tag during manufacture and can be read by a reader</i>).
Class 1	Read, write once (<i>i.e. tags are manufactured without the EPC number which can be encoded onto the tag later in the field</i>).
Class 2	Read, write.
Class 3	Class 2 capabilities plus a power source to provide increased range and/or advanced functionality.
Class 4	Class 3 capabilities plus active communication and the ability to communicate with other active tags.
Class 5	Class 4 capabilities plus the ability to communicate with passive tags as well.

11 REFERENCES

1. ISO/IEC Guide 2 (1996).
2. Auto-ID Center, “Compliance & Certification: Ensuring RFID Interoperability”, Tom Scharfeld, MIT-AUTOID-TR-017, June 1, 2003.
3. CTIA Certification (<http://www.wow-com.com/consumer/devices/certification/articles.cfm?id=76>).
4. ETSI, ETS 30046, “Methods for Testing and Specifications (MTS); Protocol and Profile Conformance Testing Specifications; Standardisation Methodology, April 1995.
5. Test Specification: RF, Specification 1.1, Bluetooth SIG, February 1, 2000.
6. WECA, “Wi-Fi System Interoperability Test Plan, Version 1.1a”, December 11, 2001.
7. GSM Association, “GSM Certification Forum Program Overview,” 3GPP TSG SA, October 1999.
8. BITE, “RF Tester Version 2.2,” CETECOM S.A., Malaga, Spain, 2002.
9. Bluetooth Qualification Website (<http://qualweb.bluetooth.org/Template2.cfm>).