AEROSPACE STANDARD	AS5678™	REV. A
	Issued 2006-12 Revised 2015-12 Superseding AS5678	

Passive RFID Tags Intended for Aircraft Use

RATIONALE

Increased use of Radio Frequency Identification (RFID) in supply chain and logistics has led to increasing demand for, and subsequent development of, a myriad of low cost, disposable RFID tags. Such tags are designed to identify consumable products that will pass through the supply chain once and then be disposed of, thus having a relatively short service life. Meanwhile, RFID tags used for banking and security, such as identification badges and credit cards, are more durable, but have limited storage memory and require close proximity to RFID readers. At the other end of the capability/durability spectrum are tags intended for use on aircraft. Aerospace industry adoption of RFID technology will be enhanced significantly by standardization of the RFID tags.

The requirements for RFID tags to be used in the aerospace industry are very different from non-aviation uses. The parts identified by the RFID tags are high value items, which are often used for ten years or more. Reading and writing across a moderate distance, and over the life-spans of these tagged-parts, is expected to fulfill the promise of data automation for accuracy and cost savings. Furthermore, the aerospace industry is subject to unique considerations regarding qualification, regulations, and safety, which are enforced by national authorities such as the FAA, EASA, FCC, etc. These requirements, coupled with the relatively low manufacturing volumes, will drive up the per-part cost of tags developed for the aerospace industry. This will generate the need for a unique set of RFID tags specifically designed for use on aircraft. Adherence to this standard will decrease the development cost of these low-volume, high-capability RFID tags.

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http://www.sae.org/technical/standards/AS5678A

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1. SCOPE

The scope of this document is to:

1. Provide a requirements document for RFID Tag Manufacturers to produce passive-only UHF RFID tags for the aerospace industry.

2. Identify the minimum performance requirements specific to the Passive UHF RFID Tag to be used on aircraft parts, to be accessed only during ground operations.

3. Specify the test requirements specific to Passive UHF RFID tags for airborne use, in addition to RTCA DO-160 compliance requirements separately called out in this document.

4. Identify existing standards applicable to Passive UHF RFID Tag.

5. Provide a certification standard for RFID tags which will use permanently-affixed installation on aircraft and aircraft parts.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of manufacture. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AS9100 Quality Management Systems - Requirements for Aviation, Space and Defense Organizations

2.1.2 ISO/IEC Publications

Available from International Organization for Standardization, ISO Central Secretait, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland. Tel: +41 22 749 01 11, E-mail: central@iso.org.

ISO website: http://www.iso.org/iso/home/store/catalogue_tc/catalogue_tc_browse.htm?commid=45332.

ISO/IEC 18000-63 Information technology - Radio frequency identification for item management - Part 63: Parameters for air interface communications at 860 MHz to 960 MHz Type C

ISO/IEC 18000-6C Information technology - Radio Frequency Identification for Item Management - Part 6: Parameters for Air Interface Communications at 860 MHz to 960 MHz

NOTE: As of 2013, ISO/IEC 18000-6C has been superseded by ISO/IEC 18000-63.

2.1.3 RTCA Publications

Available from RTCA, Inc., 1150 18th Street, NW, Suite 910, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

RTCA DO-160 Environmental Conditions and Test Procedures for Airborne Equipment

2.1.4 EUROCAE Publications

Available from EUROCAE Secretariat, 102 rue Etienne Dolet, 92240 Malakoff, France, Tel: +33 1 40 92 79 30, www.eurocae.net.

EUROCAE ED-14E Environmental Conditions and Test Procedures for Airborne Equipment

2.1.5 U.S. Government Publications

Copies of these documents are available online at http://www.faa.gov.

Title 14, CFR part 25, app. F, Part 1 - Test Criteria and Procedures for Showing Compliance with §25.853 (a) (14 CFR part 25, Appendix F)

Title 47, CFR Chapter 1 Federal Communications Commission, part 15 - Radio Frequency Devices (47 CFR part 15)

2.1.6 Airlines for America, formerly known as Air Transport Association, Publications

Available from Airlines for America (A4A), 1301 Pennsylvania Avenue, NW, Suite 1100, Washington, DC 20004, Tel: 202-626-4000, www.airlines.org.

ATA Spec 2000, Chapter 9: Automated Identification and Data Capture.

2.1.7 GS1 EPC™ Publications

Available from GS1 EPC™ website: http://www.gs1.org/epc-rfid/latest.

EPC™ Radio-Frequency Identity Protocols Generation-2 UHF RFID, Specification for RFID Air Interface, Protocol for Communications at 860 MHz – 960 MHz, version 2.0.0 (2013)

EPC™ Radio-Frequency Identity Protocols Generation-2 UHF RFID Protocol for Communications at 860 MHz – 960 MHz, version 1.2.0 (2008)

NOTE: As of 2013, version 1.2.0 has been superseded by 2.0.0.

2.1.8 AIM Publications

Available from AIM Inc., 20399 Route 19, Suite 203, Cranberry Township, PA 16066, Tel: 1-724-742-4473, www.aimglobal.org.

AIM WP-98/002R Radio Frequency Identification - RFID: A Basic Primer.

https://aimglobal.site-ym.com/store/default.aspx

3. DEFINITIONS

14 CFR: Title 14 of the Code of Federal Regulations

A4A: AIRLINES FOR AMERICA (formerly AIR TRANSPORT ASSOCIATION/ATA): Airline trade association whose purpose is Airlines for America (A4A) advocates on behalf of its members to shape crucial policies and measures that promote safety, security and a healthy U.S. airline industry. A4A through the ATA e-Business Program coordinates standards creation within Engineering, Maintenance and Material.

ANCILLARY PART MARK: An RFID-based part mark. The data elements, as defined by ATA Spec 2000, are the same as those in a primary part mark, but embedded in digital format to an RF carrier to facilitate the collecting of part data using scanners. An ancillary part mark cannot exist by itself and shall be accompanied with a primary part mark.

ACTIVE: Tags that use batteries as a source of power to boost the effective operating range of the tag and to offer additional features over passive tags, such as temperature sensing.

AEROSPACE APPLICATIONS: Used on products created for the aerospace industry.

AIRBORNE USE: Used on aircraft while in flight - as opposed to Ground Service Equipment, which is used on aircraft, but only while the aircraft is on the ground.

BACKSCATTER: The reflected radio frequency (RF) energy that has been modulated by the RFID tag's chip and antenna. Backscatter is what the interrogator device "reads." An inert piece of aluminum will reflect RF energy, but in the absence of modulation, it is "reflection", not "backscatter."

BAR-CODE: A standard method of identifying items based on lines of varying widths and spacing that are visually read by a scanner.

BAP: Battery Assisted Passive - RFID tags that have an on-board battery to power the electronics in the tag, minimizing the power required from the reader RF Beam. They backscatter like a Passive UHF tag only when they are interrogated. BAP tags have greater read ranges than purely passive tags.

BLINK RATE: The rate at which an active CHIP: Tag sends out s signal to look for, this can be adjusted from hours to seconds depending on the application and desired battery life of the RFID tag.

CHIP: "Chip", or "microchip", refers to integrated circuits, or ICs. This is the "brain" of the RFID tag. RFID chips modulate reflected RF power to transmit data back to an RFID reader, or "interrogator."

EASA: European Aviation Safety Agency - Successor to the pan-European Joint Aviation Authorities (JAA), which was cooperatively formed by several European national aviation agencies.

EIRP: Equivalent Isotropically Radiated Power - the amount of power that would have to be emitted by an isotropic antenna (that evenly distributes power in all directions and is a theoretical construct) to produce the peak power density observed in the direction of maximum antenna gain.

EPCglobal®: EPCglobal® was a GS1 initiative to develop of industry-driven standards for the Electronic Product Code™ (EPC) to support the use of Radio Frequency Identification (RFID) in today's fast-moving, information rich, trading networks. Standards were developed in two areas: EPC/RFID tags, and EPC Information Services (EPCIS). EPCglobal is now known as GS1 EPC™.

EPCglobal® Class 1 Gen 2 UHF Tag: Also known as GS1 EPC™ Gen 2 UHF Tag, a passive-backscatter, Interrogator-talks-first (ITF), RFID tag operating in the 860 to 960 MHz frequency range as defined in the GS1 EPC™ Gen 2 publication above.

ETSI: European Telecommunications Standards Institute - produces globally-applicable standards for Information and Communications Technologies (ICT), including fixed, mobile, radio, converged, broadcast and internet technologies.

FAA: Federal Aviation Administration - The airworthiness and aviation authority in the United States of America.

FCC: Federal Communications Commission - The regulator of radio-magnetic spectrum uses in the United States of America.

HF: High Frequency (HF) RFID systems operate at 13.56 MHz with a typical maximum read range of ~3 feet (~1 m).

HUMAN-READABLE: Human-readable refers to a representation of information that can be naturally read by humans. In most contexts, the alternative representation is data primarily designed for reading by a machine, e.g., scanner/computer/etc.

IEC: INTERNATIONAL ELETROTECHNICAL COMMISSION

INLAY: The RFID inlay is comprised of four primary components: chip, attachment harness, antenna, and substrate. An antenna is either laid or printed on a substrate material (typically a polymer). Designers create antenna patterns to satisfy specific performance requirements. The “chip” is harnessed to the antenna pattern so that the contacts on the chip make contact with the appropriate legs of the antenna.

INTEGRATED CIRCUIT: (IC) See “Chip.”

INTEGRATED NAMEPLATE: An Integrated Nameplate is an identification and/or marking that contains and/or is enabled with an embedded RFID chip or device that may be utilized in the same manner as other identification and markings as shown in 14 CFR Parts 21.185 and 45.

The RFID enabled segment of the Integrated Nameplate shall have the same part identification information, i.e. part Birth Record elements as defined in ATA Spec 2000 encoded in digital and printed in text formats. Bar code representation of the same data is typically included. For Integrated Nameplates the human readable segment will act as primary part marking and the RFID enabled segment is considered ancillary part marking. Integrated Nameplate, as used in this standard only, is only interchangeable with an identical Integrated Nameplate

INTERROGATOR (READER/WRITER): Radio Frequency device whose purpose is to read data from RFID tags or write data to them. There exist both hand-held versions and desk-top versions. Hand-held interrogators have battery power and on-board modulator/demodulators to allow reading permanently-affixed tags while moving past them, and are usually limited in power output.

ISO: INTERNATIONAL ORGANIZATION FOR STANDARDIZATION: An international association that manages the process of setting global standards for communications and information exchange.

ISO/IEC 18000-63 (formerly known as ISO/IEC 180000-6C) RFID Tag: A passive-backscatter, Interrogator-talks-first (ITF), RFID tag operating in the 860 to 960 MHz frequency range as defined in the ISO publication above.

LABEL: RFID label is comprised of three primary components: an RFID inlay, an outer surface (often used for printing), and a bonding surface. Other layers and components are often added to provide addition features and performance to the label.

LRU: Line Replaceable Unit - A component that can be pulled off the aircraft by “line” mechanics and replaced with an identical part, as opposed to requiring depot-level or manufacturer’s AOG (airplane on the ground) teams to do maintenance in situ.

MACHINE-READABLE: The term machine-readable (or computer-readable) refers to information encoded in a form which can be read (i.e., scanned/sensed) by a machine/computer and interpreted by the machine's hardware and/or software. Machine-readable technologies include optical character recognition (OCR) and barcodes.

PASSIVE-BACKSCATTER, INTERROGATOR-TALK-FIRST (ITF) System: As defined in the ISO/IEC 18000-63 and GS1’s EPC Gen 2 publications above the system consists of interrogators, also known as readers, and tags. “*An Interrogator receives information from a tag by transmitting a continuous-wave (CW) RF signal to the tag; the tag responds by modulating the reflection coefficient of its antenna, thereby backscattering an information signal to the Interrogator. The system is ITF, meaning that a tag modulates its antenna reflection coefficient with an information signal only after being directed to do so by an Interrogator*.”

PASSIVE UHF RFID Tag: Also known as: GS1 EPC™ Gen Tag, EPCglobal® Class 1 Gen 2 UHF Tag, ISO/IEC 18000-6C Tag, or ISO/IEC 18000-63 Tag

RANGE: The straight line distance between two articles, e.g., an RFID tag and an RFID interrogator.

RANGE, MINIMUM REQUIRED: The minimum distance between the RFID chip and the interrogator’s antenna that satisfies a requirement for a customer’s specifications or the performance grades included in this specification.

READER/WRITER: See “Interrogator.”

RFID: Radio Frequency Identification - A mechanism of applying a unique identifier to an artifact, plant, person or animal for the purpose of tracking, tracing and locating, using machine readable, non-line of sight technologies. RFID technology provides for non-line of sight creation, modification and deletion of the unique identifier. RF is defined as Radio Frequency, which describes non-line of sight transmission of data and energy between a radio transmitter/receiver known as an interrogator (reader) and the ID chip that contains the identifier (ID).

RTCA: RADIO TECHNICAL COMMISSION FOR AERONAUTICS: RTCA, Inc. is a private, not-for-profit corporation that develops consensus-based recommendations regarding communications, navigation, surveillance, and air traffic management (CNS/ATM) system issues. RTCA functions as a Federal Advisory Committee.

SAE: SAE INTERNATIONAL: SAE is a technical standards development organization.

SCD: Specification Control Document - A requirements document used in lieu of, or in addition to, engineering drawings, and which specifies required performance, physical envelope, and interfaces with adjacent equipment and systems.

SECURITY: Some minimum level of encoding or password-protecting a data source in order to prevent tampering or inadvertent loss.

SMART LABEL: A smart label is any label that has the ability to respond or change in response to the environment or characteristics of the item attached. A smart label can have chemical attributes that change colors in reaction to an event or condition. A smart label can be a logging mechanism with sensor(s) to log events and state. A smart label can have characteristics that enable authentication and tamper protection. A smart label can also be an RFID label with the ability to contain an identification nomenclature that can be created, modified or deleted without line of sight. “Smart Label,” as used in this standard only, is interchangeable with “label” and “RFID label.”

TAG: RFID tag, see “LABEL.”

TEMPERATURE, OPERATING: The temperature at which the RFID device will normally be interrogated or used.

TEMPERATURE, SURVIVAL: The extreme temperatures to which an RFID device will be exposed. The RFID device is not expected to function at these temperatures.

UHF: Ultra-High Frequency (UHF) RFID systems operate at multiple frequencies, including 868 MHz (in Europe), a band centered at 915 MHz in the U.S., and another band centered at 953 MHz in Japan. Read range is typically 3 to 10 feet (approximately 1 to 3 m), but systems operating in the 915 MHz band may achieve read ranges of 20 feet (6 m) or more.

3.1 The following terminology defines the applicability of the processes described in this document:

a. ‘shall’ is used to express a required process step

b. ‘should’ is used to express a recommended process step

c. ‘may’ is used to express an optional process step

d. ‘will’ is used to express a declaration of intent

4. GENERAL REQUIREMENTS

This SAE Aerospace Standard (AS) establishes the documentation required for the development of a passive-only Radio Frequency (RFID) Standard tag.

This standard does not cover:

- The reader (interrogator) - Readers will be addressed appropriately by FAA and individual applicants.
- Active RFID devices or battery assisted passive (BAP) RFID devices.
- RFID tags designed to operate outside the 860 to 960 MHz frequency range.

This standard's requirements will produce RFID tags that:

- Are "passive-only"
- Are approved for attachment to aircraft (regulations limit operation to use only while on the ground),
- Operate in the frequency band of 860 to 960 MHz (UHF), and do not produce spurious emissions that interfere with critical or essential on-board electrical equipment,
- Can be integrated into labels with machine-readable and human-readable data (print and barcode),
- Use an GS1 EPC™ Gen 2 UHF integrated circuit (chip) for memory and communication,
- Are used for new airplane certification as well as retrofitting on previously-certified aircraft,
- Can be used as a part of RFID systems where the reader is: installed on the aircraft; installed on ground equipment; or is a handheld device,
- Use digital data for SUPPLEMENTAL part marking and tracking, but these data are not intended to meet airworthiness requirements,
- Shall be restricted to ground interrogation only, i.e., aircraft not-in-motion, and while aircraft is clear of active taxiways or runways.

4.1 General Configuration

The AS5678-x (see 7.1, marking) RFID tag consists of a silicon chip (integrated circuit), attached to an antenna, both of which are mounted on a dielectric substrate. The tag shall include identification markings, and shall have a cover layer that can be written on, or to which adhesive labels may be applied, in order to meet human- and machine-readable requirements of purchasers. RFID tags shall be permanently affixed to aircraft parts using approved adhesives, methods, and processes.

Different tag configurations may be developed based on intended usage of the tags, to include environment, type and material of parts being labeled, memory capacity, and expected read-range performance.

5. APPLICABILITY

This document establishes the documentation required for the development of a passive-only UHF RFID Standard tags for aircraft use. These tags are for part-marking and/or maintenance data recording for approved aviation parts that will be installed in, and flown on, aircraft.

This standard does not cover:

- The reader (interrogator) - Readers will be addressed appropriately by regulatory authorities such as the FAA and individual applicants.
- Active RFID devices or battery assisted passive (BAP) RFID devices.
- On-board point of sale (POS) systems using RFID.

6. REQUIREMENTS

6.1 RFID Chip (Integrated Circuit) Functional Specifications/Requirements

- Passive only
- Reader talk first protocol
- 860 to 960 MHz frequency range
- Read/write memory with security
- GS1 EPC™ Gen 2 UHF compliant, or higher for air interface
- Complies with ATA SPEC 2000 Chapter 9 (data format).

6.2 Tag Requirements

RFID tags shall:

- Have no on-tag power source and no active transmitter, i.e., operate in the “passive-only” mode, and
- Perform a ground operated, non-essential function (i.e., the absence or failure of an RFID tag will have no effect on safety or the normal operation of the aircraft), and
- Not be potential sources of radio frequency (RF) interference or RF susceptibility.

The SAE G-18 Passive RFID for Aerospace Applications committee has conducted analysis and experimental electro-magnetic effects laboratory testing that demonstrates there is no detrimental environmental influence of backscatter RF using a modified test setup from RTCA DO-160, Rev. E Section 21 (Radiated Emissions). This indicates that the RFID tags, themselves, meet the intent of the provisions of the FAA Policy Memo of 13 May 2005 to prevent the tags from interfering with critical or essential aircraft equipment or systems. However, parts manufacturers retain the responsibility to ensure that the form, fit, and function of their parts are not adversely affected by the installation of the intended AS5678-compliant RFID tag.

- Further requirements may be levied by purchaser.

6.3 Performance Standard

6.3.1 Read Range

Read range is the distance at which the RFID tag can return correct information to the interrogator device, and can be influenced by many factors such as tag shape, orientation, the material to which it is attached, the environment it is in and the power of the reader. It is not the intent of this section to guarantee a read range in actual use, but rather to provide guidance on the selection of the RFID tag for a given application. A minimum read range may be specified by the users of the tag. If a user minimum read range is specified by the user, the specification shall include a description of the orientation, substrate material, environment, and key interrogator characteristics that will be present to demonstrate the minimum specified read range has been achieved.

6.3.1.1 Tag Performance Grade Measurement

The classification of performance grade is a guide that enables comparisons of similar RFID tags under rigid and consistent reference laboratory conditions.

Table 1 - Performance grades

Performance Grades (minimum required range)	Metallic/CFRP (conductive)	Polymeric (non-conductive)
0.15 m	A	D
1.50 m	B	E
3.00 m	C	F
>3.0 m	X	Y

NOTE: This table is 3.28 Watts EIRP only.

The RFID tag should be classified with the highest ranking it can achieve for both metal and plastic. An RFID tag with a high letter is also certified for the shorter read range on that same material. For example an RFID tag with an F rating on plastic also meets the rating requirements for E and D. The same tag may have only a B rating on metal but also meets the requirements of A.

The following method shall be used to measure performance grade. The method is based on varying the output power of the RFID test equipment while keeping the distance between the tag and the antenna constant. The measurement is performed across the frequency band of 860 to 930 MHz in 1 MHz steps with a 0.1 dBm power increment.

The minimum power P_{min} required to communicate with the tag is recorded. The tag's read range can be determined as:

$$r = d\sqrt{\frac{EIRP}{P_{min} G_t L_{cable}}} \quad \text{(Eq. 1)}$$

where:

d = Separation distance between the tag and the antenna

EIRP = Maximum Effective Isotropic Radiated Power (e.g., 3.28 W EIRP for the purposes of this test)

G_t = Gain of the antenna

L_{cable} = Loss of the cable connecting RFID test equipment and the antenna

r = Read range

NOTE: This is only applicable outside the near-field read range.

The tag is placed on the sample of material (as noted in Table 1) positioned inside the anechoic, or semi anechoic, chamber at 0.5 m from the antenna and oriented in the direction of maximum gain and to match the polarization of the transmitting antenna as shown in Figure 1.

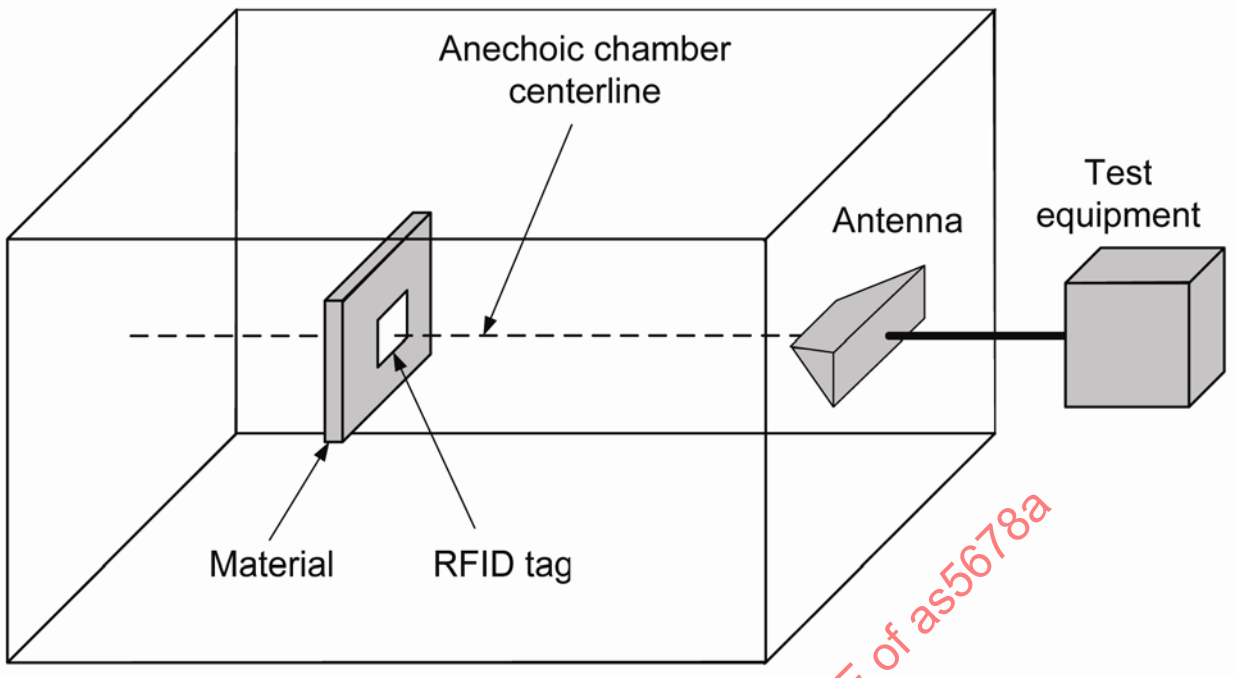

Figure 1 - RFID tag range measurement setup

The test equipment is then used to scan across the frequency range from 860 to 930 MHz in 1 MHz intervals. At each frequency the minimum power required to energize the tag is recorded. The lowest value recorded is then used in Equation 1 to calculate the read range, normalized for 3.28W* EIRP. This value is then used to classify the tag using Table 1.

Table 2 - Proposed standards for tag range measurement setup

Equipment/Parameter	Description/Specification
Anechoic or semi anechoic chamber	Any available, at least 1 m x 1 m x 1.5 m
Test equipment	Specialized broadband RFID equipment
Frequencies	860 to 930 MHz
Read/write data rate	GS1 EPC™ standard, section 6.3
Antenna	6 dBi, linearly polarized gain, 860 to 930 MHz
Coaxial cable	Low loss, semi-rigid type
Distance between antenna and tag	1.0 m (3.25 feet)
Material properties and size	See details below

*Maximum EIRP is changed to 3.28 W to reflect the more restrictive European regulations lower than the 4W allowed by FCC in the US

6.3.1.2 Comments and Discussion

a. Measurement equipment:

Various options for broadband tag-testing equipment are possible. Such equipment should be able to generate query commands with desired modulation and coding formats for RFID UHF tags operating at specified frequencies with variable output RF power. Such equipment can be based on RFID reader design or based on a separate RF modular hardware platform.

b. Frequencies:

860 to 930 MHz UHF.

NOTE: After reviewing the global spectrum regulations in the UHF band 860 to 930 MHz (instead of 960 MHz) is sufficient to have a functional tag for use on aircraft parts and operate worldwide

c. Read/write data rate:

40 to 640 Kbits/second, per GS1 EPC™ standard (Reference 2.1.7), section 6.3, Table 6.x (Tag-to-Interrogator data rate).

To make sure that tag performance is not affected by the test equipment characteristics, broadband test equipment shall have a good sensitivity and proper signal processing algorithms. This ensures tag detection/reading/writing at the minimum possible power level allowed by the tag, as soon as the tag responds.

d. Antenna:

A standard patch antenna.

e. Distance:

The distance is such that the tag is sufficiently close to the transmitting antenna, which allows lower testing power levels, but is in the far field zone. The tag and the antenna are positioned on the centerline of the chamber to minimize the effect of possible reflections by maximizing the distance to the walls.

f. Materials:

Tag performance will change when it is placed on different materials. The backplanes specified below simulate the two general types of parts on which RFID tags can be mounted: conductive and non-conductive. Aluminum and Carbon-Fiber Reinforced Plastics (CFRP) behave generally the same for purposes of this test, and therefore 7072-0 aluminum sheet or plate is used as the standard coupon for conductive materials. As a class, non-conductive materials behave similarly, as well, and therefore PMMA (Poly-Methyl Methacrylate) (Plexiglass) is used as the test coupon for non-conductive materials.

Secure the RFID tags to the test coupons in the same manner as it will be secured in operational use.

g. Dimensions of backplanes:

Metallic: minimum 1/16 inch (0.063 inch) (1.6 mm) thick, 7072-0 aluminum, minimum 0.3 m length x 0.3 m width
Polymeric: minimum 1/16 inch (0.063 inch) (1.6 mm) thick, polymethyl methacrylate (Plexiglass), minimum 0.3 m length x 0.3 m width.

6.3.1.3 Procedure

Use EPC™ Radio-Frequency Identity Protocols Class-1 Generation-2 UHF RFID Protocol for Communications at 860 MHz to 960 MHz, Version 1.2.0 (or 2.0.0), section 6.3, Description of Operating Procedure.

Range is the minimum found across the entire band from 860 to 960 MHz, as opposed to the range at the optimum frequency design point within the band. (These tags will be used throughout the world on varying frequencies, and they shall work throughout the entire range.)

Read ranges shall be normalized to 3.28W EIRP (using Equation [1] in section 6.3.1.1).

6.3.2 Write Capability

All tags must be write-capable per GS1 EPC™ requirements for the class and frequency for which it is certified.

6.3.3 Data Integrity

This test must be performed using the reader/interrogator that is used to write data to the chip. You must use a GS1 EPC™ compliant reader or a test system that can emulate a GS1 compliant reader. Range between tag and interrogator is immaterial in this test.

6.3.3.1 Procedure

1. Fill all the available memory with random data.

2. Subject the tag to testing conditions.

3. Read memory and ensure that 100% of data is in its original form.

6.3.4 RFID Tag Installation

The RFID tag installation instructions shall be defined and provided with the tags. The installation instructions shall define the acceptable materials, surface finishes and surface shapes for the parts and equipment that will host the RFID tag. Materials, including adhesives or mechanical fasteners, and processes for installing the RFID tag on the host parts and equipment shall be defined in the RFID tag installation instructions.

Tags shall be permanently affixed, as applicable.

6.3.5 Environmental Performance

RFID Tags shall meet all performance requirements, including but not limited to: read/write range distance, and installation requirements as defined in 6.3.4, without physical or electrical degradation after exposure to the airplane environment. Typically the Specification Control Drawing (SCD) or source requirements will define which environment is to be selected. The following identifies three environmental classes:

- Interior - Any place inside the pressurized portion of the aircraft
- Exterior - Any place not inside the pressurized portion of the aircraft
- Powerplant - Mounted on or in the engine nacelle/strut/cowling or the APU/APU compartment

Table 3 summarizes the performance requirements for the three environments and the appropriate resource documents that define the testing:

Table 3 - Environmental performance requirements

Environmental Requirement	Environmental Test Reference Document	Applicable Category or Guidelines				Applicable Performance Standard	Comments
		Interior	Exterior	Power Plant	*		
Temperature Altitude							
4.5.1 - Ground survival low temperature and short time operating temperature test	RTCA DO-160 Rev. E or latest, Section 4	Category A1	Category D2	Category D3		Data Integrity (5.3.3)	After the RFID device has been subjected to the short-time low operating temperature for at least 30 minutes it should be returned to room temperature and tested to determine compliance with applicable equipment performance standards.
4.5.2 - Operating low temperature test (N/A)	RTCA DO-160 Rev. E or latest, Section 4	N/A	N/A	N/A		Data Integrity	Optional
4.5.3 - Ground survival high temperature and short time operating high temperature	RTCA DO-160 Rev. E or latest, Section 4	Category A1	Category D2	Category D3		Data Integrity	After the RFID device has been subjected to the short-time operating high temperature for at least 30 minutes it should be returned to room temperature and tested to determine compliance with applicable equipment performance standards.
4.5.4 - Operating high temperature test (N/A)	RTCA DO-160 Rev. E or latest, Section 4	N/A	N/A	N/A		Data Integrity	Optional