Specification for RFID Air Interface

# EPC™ Radio-Frequency Identity Protocols Class-1 Generation-2 UHF RFID Conformance Requirements Version 1.0.5

***This version was approved by the EPCglobal Technical Steering Committee on March 23, 2007.***

# Contents

# Foreword

This document specifies the requirements for a Class-1 radio-frequency identification (RFID) Tag or Interrogator to be certified as conformant to the *EPCglobal™ Class-1 Generation-2 UHF RFID Protocol for Communications at 860 MHz – 960 MHz* (**the Protocol**), where compliance, conformance, and certification shall have the following meanings:

## Compliance

Suitability of products, processes, or services, for use together, under specified conditions, without causing unacceptable interactions, in fulfillment of the requirements of a protocol.

## Conformance

Fulfillment by a product, process, or service of the specified compliance requirements.

## Certification

Measurement of a product, process, or service to ensure conformance.

# Introduction

This document specifies the conformance requirements for a passive-backscatter, Interrogator-talks-first (ITF), radio-frequency identification (RFID) system operating in the 860 MHz – 960 MHz frequency range. The system comprises Interrogators, also known as Readers, and Tags, also known as Labels.

An Interrogator transmits information to a Tag by modulating an RF signal in the 860 MHz – 960 MHz frequency range. The Tag receives both information and operating energy from this RF signal. Tags are passive, meaning that they receive all of their operating energy from the Interrogator's RF waveform.

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.

Interrogators and Tags are not required to talk simultaneously; rather, communications are half-duplex, meaning that Interrogators talk and Tags listen, or vice versa.

# 1. Scope

This document specifies:

- Compliance requirements for physical interactions (the signaling layer of the communications) between Interrogators and Tags, and
- Compliance requirements for Interrogator and Tag operating procedures and commands.

# 2. Conformance

## 2.1 Claiming conformance

A device shall not claim conformance with the Protocol unless certified, in writing, by EPCglobal, Inc., or one of its designated representatives. To conform, a device shall comply with all clauses in this document (except those marked as optional) and all local radio regulations. Conformance may also require a license from the owner of any intellectual property utilized by said device.

## 2.2 General conformance requirements

### 2.2.1 Interrogators

To conform to the Protocol, an Interrogator shall:

- Meet the requirements of the Protocol,
- Implement the mandatory commands defined in the Protocol,
- Modulate/transmit and receive/demodulate a sufficient set of the electrical signals defined in the signaling layer of the Protocol to communicate with conformant Tags, and
- Conform to all local radio regulations.

To conform to the Protocol, an Interrogator may:

- Implement any subset of the optional commands defined in the Protocol, and
- Implement any proprietary and/or custom commands in conformance with the Protocol.

To conform to the Protocol, an Interrogator shall not:

- Implement any command that conflicts with the Protocol, or
- Require using an optional, proprietary, or custom command to meet the requirements of the Protocol.

### 2.2.2 Tags

To conform to the Protocol, a Tag shall:

- Meet the requirements of the Protocol,
- Implement the mandatory commands defined in the Protocol,
- Modulate a backscatter signal only after receiving the requisite command from an Interrogator, and
- Conform to all local radio regulations when appropriately commanded by an Interrogator.

To conform to the Protocol, a Tag may:

- Implement any subset of the optional commands defined in the Protocol, and
- Implement any proprietary and/or custom commands as defined in 2.3.3 and 2.3.4, respectively.

To conform to the Protocol, a Tag shall not:

- Implement any command that conflicts with the Protocol,
- Require using an optional, proprietary, or custom command to meet the requirements of the Protocol, or
- Modulate a backscatter signal unless commanded to do so by an Interrogator using the signaling layer defined in the Protocol.

## 2.3 Command structure and extensibility

Subclause 6.3.2.10 of the Protocol defines the structure of the command codes used by Interrogators and Tags, as well as the availability of future extensions. Each command is defined and labeled as mandatory or optional.

### 2.3.1 Mandatory commands

Conforming Tags and Interrogators shall support all mandatory commands.

### 2.3.2 Optional commands

Conforming Interrogators may or may not support optional commands. Conforming Tags may or may not support optional commands. If an Interrogator or a Tag implements an optional command, it shall implement it in the manner specified.

### 2.3.3 Proprietary commands

Proprietary commands may be enabled in conformance with the Protocol, but are not specified in the Protocol. All proprietary commands shall be capable of being permanently disabled. Proprietary commands are intended for manufacturing purposes and shall not be used in field-deployed RFID systems.

### 2.3.4 Custom commands

Custom commands may be enabled in conformance with the Protocol, but are not specified in the Protocol. An Interrogator shall issue a custom command only after singulating a Tag and reading (or having prior knowledge of) the Tag manufacturer's identification in the Tag's TID memory. An Interrogator shall use a custom command only in accordance with the specifications of the Tag manufacturer identified in the TID.

# 3. Normative references

The following referenced documents are indispensable to the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition (including any amendments) applies.

*EPCglobal™: EPC™ Radio-Frequency Identity Protocols, Class-1 Generation-2 UHF RFID, Protocol for Communications at 860 MHz – 960 MHz, Version 1.1.0*

*EPCglobal™: EPC™ Tag Data Standards*

*EPCglobal™ (2004): FMCG RFID Physical Requirements Document (draft)*

*EPCglobal™ (2004): Class-1 Generation-2 UHF RFID Implementation Reference (draft)*

European Telecommunications Standards Institute (ETSI), EN 300 220 (all parts): *Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1000 MHz frequency range with power levels ranging up to 500 mW*

European Telecommunications Standards Institute (ETSI), EN 302 208: *Electromagnetic compatibility and radio spectrum matters (ERM) – Radio-frequency identification equipment operating in the band 865 MHz to 868 MHz with power levels up to 2 W, Part 1 – Technical characteristics and test methods*

European Telecommunications Standards Institute (ETSI), EN 302 208: *Electromagnetic compatibility and radio spectrum matters (ERM) – Radio-frequency identification equipment operating in the band 865 MHz to 868 MHz with power levels up to 2 W, Part 2 – Harmonized EN under article 3.2 of the R&TTE directive*

ISO/IEC Directives, Part 2: *Rules for the structure and drafting of International Standards*

ISO/IEC 3309: *Information technology – Telecommunications and information exchange between systems – High-level data link control (HDLC) procedures – Frame structure*

ISO/IEC 15961: *Information technology, Automatic identification and data capture – Radio frequency identification (RFID) for item management – Data protocol: application interface*

ISO/IEC 15962: *Information technology, Automatic identification and data capture techniques – Radio frequency identification (RFID) for item management – Data protocol: data encoding rules and logical memory functions*

ISO/IEC 15963: *Information technology — Radiofrequency identification for item management — Unique identification for RF tags.*

ISO/IEC 18000-1: *Information technology — Radio frequency identification for item management — Part 1: Reference architecture and definition of parameters to be standardized*

ISO/IEC 18000-6: *Information technology automatic identification and data capture techniques — Radio frequency identification for item management air interface — Part 6: Parameters for air interface communications at 860–960 MHz*

ISO/IEC 19762: *Information technology AIDC techniques – Harmonized vocabulary – Part 3: radio-frequency identification (RFID)*

U.S. Code of Federal Regulations (CFR), Title 47, Chapter I, Part 15: *Radio-frequency devices, U.S. Federal Communications Commission*

# 4. Terms and definitions

The principal terms and definitions used in this document are described in the Protocol and in ISO/IEC 19762.

## 4.1 Additional terms and definitions

Terms and definitions specific to this document that supersede any normative references are as follows:

- **By design**

  Design parameters and/or theoretical analysis that ensure compliance. A vendor submitting a component or system for compliance testing shall provide the necessary technical information, in the form of a technical memorandum or similar. A test laboratory approved by EPCglobal™ shall certify the technical analysis as being sufficient to ensure conformance of the component or system.

  For Protocol requirements that are verified **by design**, the method of technical analysis is at the discretion of the submitting vendor and, except in special cases, is not specified by this document. In general, the technical analysis shall have sufficient rigor and technical depth to convince a test engineer knowledgeable of the Protocol that the particular requirement has been met.

- **By demonstration**

  Laboratory testing of one, or if required for statistical reasons multiple, products, processes, or services to ensure compliance. A test laboratory certified by EPCglobal™ shall perform the indicated testing to ensure conformance of the component or system.

  For Protocol requirements that are verified **by demonstration**, the test conditions are specified by this document. The detailed test plan is at the discretion of the certifying test laboratory.

  Interrogators submitted for testing purposes shall include physical connections and test modes suitable for the certifying laboratory to evaluate Interrogator performance under the test conditions specified in this document.

  Tags submitted for testing purposes shall include all documentation required by 6.3.1.3.5 of the Protocol. The certifying laboratory's test plan will specify the submitted Tags' memory contents (i.e. the contents of Reserved, EPC, TID, and User memory as well as the lock status of these memory banks).

- **As implemented**

  If a Tag or Interrogator implements a subset of the Protocol, compliance shall be verified over the subset actually implemented. For example, although Interrogators may implement DSB-ASK, SSB-ASK, or PR-ASK modulation, a manufacturer may choose to only implement DSB-ASK modulation, in which case compliance testing shall only use DSB-ASK modulation. For parameters that are continuously variable, compliance shall be verified at the minimum and maximum values of the implemented range, unless the test conditions specifically state otherwise.

# 5. Symbols, abbreviated terms, and notation

The principal symbols and abbreviated terms used in this document are detailed in

- ISO/IEC 19762: *Information technology AIDC techniques – vocabulary*.
- *EPCglobal™: EPC™ Radio-Frequency Identity Protocols, Class-1 Generation-2 UHF RFID, Protocol for Communications at 860 MHz – 960 MHz, Version 1.1.0.*

Symbols, abbreviated terms, and notation specific to this document are as follows:

## 5.1 Symbols

**None**

## 5.2 Abbreviated terms

**None**

## 5.3 Notation

This document uses the following notational conventions:

- States and flags are denoted in bold. Example: **ready**.
- Commands are denoted in italics. Variables are also denoted in italics. Where there might be confusion between commands and variables, this specification will make an explicit statement. Example: *Query*.
- Command parameters are underlined. Example: <u>Pointer</u>.
- For logical negation, labels are preceded by '~'. Example: If **flag** is true, then **~flag** is false.
- The symbol, R=>T, refers to commands or signaling from an Interrogator to a Tag (Reader-to-Tag).
- The symbol, T=>R, refers to commands or signaling from a Tag to an Interrogator (Tag-to-Reader).

# 6. Protocol requirements

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 1 | 6.1.1 | Tags shall not be required to demodulate Interrogator commands while backscattering. | Tag | **By design** |
| 2 | 6.1.1 | A Tag shall not respond to a mandatory or optional command using full-duplex communications. | Tag | **By design** |
| 3 | 6.3.1.1 | Tags shall receive power from and communicate with Interrogators within the frequency range from 860 MHz to 960 MHz, inclusive. | Tag | **By demonstration**<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: 860, 910, & 960 MHz<br>Power: 0 dBm at Tag antenna<br>Modulation: DSB-ASK<br>Tari: 25 µs<br>RTcal: 62.5 µs<br>PW: 0.5 Tari<br>Modulation depth: 90%<br>Rise/fall time: $\leq$ 0.33 Tari<br>TRcal: 100 µs<br>DR: 8<br>M: 1<br>TRext: 0 |
| 4 | 6.3.1.1 | Interrogators certified for operation in dense-Interrogator environments shall support, but are not required to always use, the dense-Interrogator mode described in Annex G. | Interrogator | **By design** |
| 5 | 6.3.1.2 | Interrogators shall use a fixed modulation format and data rate for the duration of an inventory round, where “inventory round” is defined in 4.1 | Interrogator | **By design** |
| 6 | 6.3.1.2.1 | Interrogators certified for operation in single- or multiple-Interrogator environments shall have a frequency accuracy that meets local regulations. | Interrogator | **By design** |
| 7 | 6.3.1.2.1 | Interrogators certified for operation in dense-Interrogator environments shall have a frequency accuracy of +/– 10 ppm over the nominal temperature range (–25 °C to +40 °C) and +/– 20 ppm over the extended temperature range (–40°C to +65°C) while transmitting, unless local regulations specify tighter accuracy, in which case the Interrogator frequency accuracy shall meet the local regulations. | Interrogator | **By demonstration**, for dense-Interrogator certification, unless local regulations specify tighter frequency accuracy than the Protocol, in which case the Interrogator manufacturer shall provide evidence of certification by the local regulatory body in lieu of laboratory demonstration.<br>Test conditions:<br>Temp: max(–40, minimum supported temperature) and min(65, maximum supported temperature). If supported temperature range exceeds –25 or 40 then testing shall also be performed at –25 or 40 respectively. All temperatures are in ºC (all +/– 3 ºC). See Annex A, Q7.<br>Freq: 5 test points situated at the band edges and linearly spanning the supported band at valid channel frequencies. |
| 8 | 6.3.1.2.2 | Interrogators shall communicate using DSB-ASK, SSB-ASK, or PR-ASK modulation, detailed in Annex H. | Interrogator | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 9 | 6.3.1.2.2 | Tags shall demodulate all three modulation types. | Tag | **By demonstration**<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: 860 & 960 MHz<br>Power: 0 dBm at Tag antenna<br>Modulation: DSB-ASK, SSB-ASK, & PR-ASK<br>Tari: 6.25, 12.5, & 25 µs<br>RTcal: 2.5×Tari<br>PW: min and max<br>Modulation depth: 90% ASK, 200% PR-ASK<br>DSB-ASK rise/fall time: $\le$ 0.33 Tari<br>SSB-ASK rise/fall time: $\le$ 0.33 Tari<br>PR-ASK rise/fall time: $\le$ 0.62×PW<br>TRcal: 2×RTcal<br>DR: 8<br>M: 1<br>TRext: 0 |
| 10 | 6.3.1.2.3 | The R=>T link shall use PIE, shown in Figure 6.1. | Interro-gator | **By design** |
| 11 | 6.3.1.2.3 | Pulse modulation depth, rise time, fall time, and PW shall be as specified in Table 6.5, and shall be the same for a data-0 and a data-1. | Interro-gator | **By demonstration**<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: At channel frequency closest to center of supported band.<br>Power: Maximum Interrogator transmit power, as imple-mented.<br>Other transmit parameters: As implemented<br>See Annex A, Q10. |
| 12 | 6.3.1.2.3 | Interrogators shall use a fixed modulation depth, rise time, fall time, PW, Tari, data-0 length, and data-1 length for the duration of an inventory round. | Interro-gator | **By design** |
| 13 | 6.3.1.2.3 | The RF envelope shall be as specified in Figure 6.2 [and Table 6.6]. | Interro-gator | **By demonstration**<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: At channel frequency closest to center of supported band.<br>Power: Maximum Interrogator transmit power, as imple-mented.<br>Other transmit parameters: As implemented<br>See Annex A, Q10. |
| 14 | 6.3.1.2.4 | Interrogators shall communicate using Tari values in the range of 6.25µs to 25µs.b | Interro-gator | **By design** |
| 15 | 6.3.1.2.4 | Interrogator compliance shall be evaluated using at least one Tari value between 6.25µs and 25µs with at least one value of the parameter *x*. | Interro-gator | This document uses vendor pre-ferred Tari and x values as consis-tent with the Protocol. |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 16 | 6.3.1.2.4 | The tolerance on all parameters specified in units of Tari shall be +/–1%. | Interro-gator | **By demonstration**<br>Test conditions:<br>Temp: Either (a) or (b) shown below<br>a) Single and Multi-Interrogators: 23 ºC +/– 3 ºC<br>b) Dense-Interrogators tested at modulation, data rate, and encoding parameters specified in Annex G of the Protocol specification: max(–40, minimum supported temperature) and min(65, maximum supported temperature). If supported temperature range exceeds –25 or 40 then testing shall also be performed at –25 or 40 respectively. All temperatures are in ºC (all +/– 3 ºC).<br>See Annex A, Q7.<br>Freq: At channel frequency closest to center of supported band.<br>Power: Maximum Interrogator transmit power, as implemented.<br>Other transmit parameters: As implemented |
| 17 | 6.3.1.2.4 | The choice of Tari value and *x* shall be in accordance with local radio regulations. | Interro-gator | **By design** |
| 18 | 6.3.1.2.5 | The R=>T RF envelope shall comply with Figure 6.2 and Table 6.5. | Interro-gator | Tested in compliance with 6.3.1.2.3 |
| 19 | 6.3.1.2.5 | An Interrogator shall not change the R=>T modulation type (i.e. shall not switch between DSB-ASK, SSB-ASK, or PR-ASK) without first powering down its RF waveform (see 6.3.1.2.7). | Interro-gator | **By design** |
| 20 | 6.3.1.2.6 | The Interrogator power-up RF envelope shall comply with Figure 6.3 and Table 6.6. | Interro-gator | **By demonstration**<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: At channel frequency closest to center of supported band.<br>Power: Maximum Interrogator transmit power, as implemented.<br>See Annex A, Q8. |
| 21 | 6.3.1.2.6 | Once the carrier level has risen above the 10% level, the power-up envelope shall rise monotonically until at least the ripple limit $M_l$. The RF envelope shall not fall below the 90% point in Figure 6.3 during interval $T_s$. | Interro-gator | **By demonstration**<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: At channel frequency closest to center of supported band.<br>Power: Maximum Interrogator transmit power, as implemented.<br>See Annex A, Q9. |
| 22 | 6.3.1.2.6 | Interrogators shall not issue commands before the end of the maximum settling-time interval in Table 6.6 (i.e. before $T_s$). | Interro-gator | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 23 | 6.3.1.2.7 | The Interrogator power-down RF envelope shall comply with Figure 6.3 and Table 6.7. | Interro-gator | **By demonstration**<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: At channel frequency closest to center of supported band.<br>Power: Maximum Interrogator transmit power, as imple-mented. |
| 24 | 6.3.1.2.7 | Once the carrier level has fallen below the 90% level, the power-down envelope shall fall monotonically until the power-off limit $M_s$. | Interro-gator | **By demonstration**<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: At channel frequency closest to center of supported band.<br>Power: Maximum Interrogator transmit power, as imple-mented.<br>See Annex A, Q9. |
| 25 | 6.3.1.2.7 | Once powered off, an Interrogator shall remain powered off for a least 1ms before powering up again. | Interro-gator | **By design** |
| 26 | 6.3.1.2.8 | An Interrogator shall begin all R=>T signaling with either a preamble or a frame-sync, both of which are shown in Figure 6.4. | Interro-gator | **By design** |
| 27 | 6.3.1.2.8 | A preamble shall precede a *Query* command (see 6.3.2.10.2.1) and denotes the start of an inventory round. | Interro-gator | **By design** |
| 28 | 6.3.1.2.8 | All other signaling shall begin with a frame-sync. | Interro-gator | **By design** |
| 29 | 6.3.1.2.8 | The tolerance on all parameters specified in units of Tari shall be +/–1%. | Interro-gator | Tested in compliance with 6.3.1.2.3 |
| 30 | 6.3.1.2.8 | PW shall be as specified in Table 6.5. | Interro-gator | Tested in compliance with 6.3.1.2.3 |
| 31 | 6.3.1.2.8 | The RF envelope shall be as specified in Figure 6.2. | Interro-gator | **By design** |
| 32 | 6.3.1.2.8 | A preamble shall comprise a fixed-length start delimiter, a data-0 symbol, an R=>T calibration (RTcal) symbol, and a T=>R calibration (TRcal) symbol. | Interro-gator | **By demonstration**<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: At channel frequency closest to center of supported band.<br>Power: Maximum Interrogator transmit power, as imple-mented.<br>Other transmit parameters: As implemented |
| 33 | 6.3.1.2.8 | An Interrogator shall set RTcal equal to the length of a data-0 symbol plus the length of a data-1 symbol (RTcal = $0_{length} + 1_{length}$). | Interro-gator | **By design** |
| 34 | 6.3.1.2.8 | A Tag shall measure the length of RTcal and compute *pivot* = RTcal / 2. | Tag | **By design** |
| 35 | 6.3.1.2.8 | The Tag shall interpret subsequent Interrogator symbols shorter than *pivot* to be data-0s, and subsequent Interro-gator symbols longer than *pivot* to be data-1s. | Tag | **By design** |
| 36 | 6.3.1.2.8 | The Tag shall interpret symbols longer than 4 RTcal to be bad data. | Tag | **By design** |
| 37 | 6.3.1.2.8 | Prior to changing RTcal, an Interrogator shall transmit CW for a minimum of 8 RTcal. | Interro-gator | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 38 | 6.3.1.2.8 | An Interrogator shall specify a Tag's backscatter link frequency (its FM0 datarate or the frequency of its Miller subcarrier) using the TRcal and divide ratio (DR) in the preamble and payload, respectively, of a *Query* command that initiates an inventory round. | Interrogator | **By design** |
| 39 | 6.3.1.2.8 | A Tag shall measure the length of TRcal, compute BLF, and adjust its T=>R link rate to be equal to BLF (Table 6.9 shows BLF values and tolerances). | Tag | Tested in compliance with 6.3.1.3.3 |
| 40 | 6.3.1.2.8 | The TRcal and RTcal that an Interrogator uses in any inventory round shall meet the constraints in Equation (2) | Interrogator | **By design** |
| 41 | 6.3.1.2.8 | An Interrogator, for the duration of an inventory round, shall use the same length RTcal in a frame-sync as it used in the preamble that initiated the round. | Interrogator | **By design** |
| 42 | 6.3.1.2.9 | When an Interrogator uses frequency-hopping spread spectrum (FHSS) signaling, the Interrogator's RF envelope shall comply with Figure 6.5 and Table 6.8. The RF envelope shall not fall below the 90% point in Figure 6.5 during interval $T_{hs}$. | Interrogator | **By demonstration**, for Interrogators that use FHSS:<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: At channel frequency closest to center of supported band.<br>Power: Maximum Interrogator transmit power, as implemented. |
| 43 | 6.3.1.2.9 | Interrogators shall not issue commands before the end of the maximum settling-time interval in Table 6.8 (i.e. before $T_{hs}$). | Interrogator | **By design** |
| 44 | 6.3.1.2.9 | The maximum time between frequency hops and the minimum RF-off time during a hop shall meet local regulatory requirements. | Interrogator | **By design** |
| 45 | 6.3.1.2.10 | Interrogators certified for operation in single-Interrogator environments shall meet local regulations for spread-spectrum channelization. | Interrogator | **By design** |
| 46 | 6.3.1.2.10 | Interrogators certified for operation in multiple- or dense-Interrogator environments shall meet local regulations for spread-spectrum channelization, unless the channelization is unregulated, in which case Interrogators shall adopt the channelization described by the algorithm in Figure G.1 (Annex G describes multiple- and dense-Interrogator channelized signaling). | Interrogator | **By demonstration**, for multiple- or dense-Interrogator certification.<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: Either (a) or (b) shown below<br>a) Interrogators that are capable of commanding Tags to backscatter using subcarrier signaling: 50 discrete center frequencies as specified in Table G.1 of the Protocol.<br>b) Interrogators that are not capable of commanding Tags to backscatter using subcarrier signaling: All center frequencies supported by the Interrogator (note: the certification laboratory reserves the right to test a random subset of the Interrogator's supported center frequencies).<br>Power: Maximum Interrogator transmit power, as implemented |
| 47 | 6.3.1.2.11 | Interrogators certified for operation according to this protocol shall meet local regulations for out-of-channel and out-of-band spurious radio-frequency emissions. | Interrogator | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 48 | 6.3.1.2.11 | Interrogators certified for operation in multiple-Interrogator environments, in addition to meeting local regulations, shall also meet the Multiple-Interrogator Transmit Mask defined in this specification. | Interro-gator | **By demonstration**, for multiple-Interrogator certification.<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: At channel frequency closest to center of supported band.<br>Power: Maximum Interrogator transmit power, as imple-mented.<br>Channel width: 200 kHz for Inter-rogators certified for operation in Europe; A maximum of 500 kHz for Interrogators certified for operation in North America.<br>Modulation: As implemented<br>Transmit data: Either (a) or (b), below<br>a) a continuous repeating 9-bit maximum length sequence with polynomial $x^9 + x^4 + 1$, ini-tially seeded with all ones, re-sulting in a repeating 511-bit sequence of FF83DF1732094ED1E7CD8A 91C6D5C4C44021184E5586F 4DC8A15A7EC92DF9353301 8CA34BFA2C759678FBA0D6 DD82D7D540A57977039D27 AEA243385ED9A1DE0$_h$, or<br>b) a single *Select* command with a 252 bit Mask value set to ACBCD2114DAE1577C6DBF 4C91A3CDA2F169B340989C 1D32C290465E5C1423CC$_h$<br>Bit sequences are listed MSB first.<br>Other transmit parameters: As implemented |
| 49 | 6.3.1.2.11 | Multiple-Interrogator Transmit Mask: For an Interrogator transmitting random data in channel *R*, and any other channel $S \neq R$, the ratio of the integrated power *P*() in channel *S* to that in channel *R* shall not exceed the speci-fied values: | Interro-gator | Tested in compliance with 6.3.1.2.11, Figure 6.6 |
| 50 | 6.3.1.2.11 | Each channel that exceeds the mask shall be counted as an exception. | | Tested in compliance with 6.3.1.2.11, Figure 6.6 |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 51 | 6.3.1.2.11 | Interrogators certified for operation in dense-Interrogator environments shall meet both local regulations and the Transmit Mask shown in Figure 6.6 of this specification, except when operating in the dense-Interrogator mode described in Annex G, in which case they shall instead meet the Dense-Interrogator Transmit Mask described below and shown in Figure 6.7. | Interro-gator | **By demonstration**, for dense-Interrogator certification.<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: At channel frequency closest to center of supported band.<br>Power: Maximum Interrogator transmit power, as implemented.<br>Reference bandwidth: 2.5/Tari<br>Modulation: As implemented<br>Transmit data: Either (a) or (b) below<br>a) a continuous repeating 9-bit maximum length sequence with polynomial $x^9 + x^4 + 1$, initially seeded with all ones, resulting in a repeating 511-bit sequence of FF83DF1732094ED1E7CD8A91C6D5C4C44021184E5586F4DC8A15A7EC92DF93533018CA34BFA2C759678FBA0D6DD82D7D540A57977039D27AEA243385ED9A1DE0$_h$, or<br>b) a single *Select* command with a 252 bit Mask value set to ACBCD2114DAE1577C6DBF4C91A3CDA2F169B340989C1D32C290465E5C1423CC$_h$<br>Bit sequences are listed MSB first.<br>Tari: 25 µs<br>Backscatter data rate: One or more of the dense-interrogator data rates specified in Annex G of the Protocol specification, as implemented.<br>Other transmit parameters: As implemented |
| 52 | 6.3.1.2.11 | Regardless of the mask used, Interrogators certified for operation in dense-Interrogator environments shall not be permitted the two exceptions to the transmit mask that are allowed for Interrogators certified for operation in multiple-Interrogator environments. | Interro-gator | Tested in compliance with 6.3.1.2.11, Figure 6.7 |
| 53 | 6.3.1.2.11 | For Interrogator transmissions centered at a frequency $f_c$, a 2.5/Tari bandwidth $R_{BW}$ also centered at $f_c$, an offset frequency $f_o$ = 2.5/Tari, and a 2.5/Tari bandwidth $S_{BW}$ centered at $(n \times f_o) + f_c$ (integer $n$), the ratio of the integrated power $P()$ in $S_{BW}$ to that in $R_{BW}$ with the Interrogator transmitting random data shall not exceed the specified values: | Interro-gator | Tested in compliance with 6.3.1.2.11, Figure 6.7 |
| 54 | 6.3.1.3 | A Tag shall backscatter using a fixed modulation format, data encoding, and data rate for the duration of an inventory round, where “inventory round” is defined in 6.3.2.8. | Tag | **By design** |
| 55 | 6.3.1.3.1 | Tag backscatter shall use ASK and/or PSK modulation. | Tag | **By design** |
| 56 | 6.3.1.3.1 | Interrogators shall demodulate both modulation types. | Interro-gator | **By design** |
| 57 | 6.3.1.3.2 | Tags shall encode the backscattered data as either FM0 baseband or Miller modulation of a subcarrier at the data rate. | Tag | Tested in compliance with 6.3.1.3.2.1 and 6.3.1.3.2.3 |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 58 | 6.3.1.3.2.1 | The duty cycle of a 00 or 11 sequence, measured at the modulator output, shall be a minimum of 45% and a maximum of 55%, with a nominal value of 50%. | Tag | **By demonstration**<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: 860 & 960 MHz<br>Power: 0 dBm at Tag antenna<br>Modulation: DSB-ASK<br>PW: 0.5 Tari<br>Modulation depth: 90%<br>Rise/fall time: ≤ 0.33 Tari<br>TRext: 0<br>Test # 1<br>Tari: 6.25 µs<br>RTcal: 18.75 µs<br>TRcal: 33.3 & 50 µs<br>DR: 64/3<br>M: 1<br>Test # 2<br>Tari: 12.5 µs<br>RTcal: 31.25 µs<br>TRcal: 66.7, 83.3 µs<br>DR: 64/3<br>M: 1 |
| 59 | 6.3.1.3.2.1 | FM0 signaling shall always end with a “dummy” data-1 bit at the end of a transmission, as shown in Figure 6.10. | Tag | **By design** |
| 60 | 6.3.1.3.2.2 | T=>R FM0 signaling shall begin with one of the two preambles shown in Figure 6.11. | Tag | **By demonstration**<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: 860 & 960 MHz<br>Power: 0 dBm at Tag antenna<br>Modulation: DSB-ASK<br>PW: 0.5 Tari<br>Modulation depth: 90%<br>Rise/fall time: ≤ 0.33 Tari<br>Tari: 25 µs<br>RTcal: 75 µs<br>TRcal: 100 µs<br>DR: 8<br>M: 1<br>TRext: 0 & 1 |
| 61 | 6.3.1.3.2.2 | The choice depends on the value of the TRext bit specified in the *Query* command that initiated the inventory round, unless a Tag is replying to a command that writes to memory, in which case a Tag shall use the extended preamble regardless of TRext (i.e. the Tag replies as if TRext=1 regardless of the TRext value specified in the *Query*—see 6.3.2.10.3). | Tag | By demonstration<br>Tested in compliance with 6.3.2.4, Figure 6.19 |
| 62 | 6.3.1.3.2.3 | Figure 6.13 shows Miller-modulated subcarrier sequences; the Miller sequence shall contain exactly two, four, or eight subcarrier cycles per bit, depending on the M value specified in the *Query* command that initiated the inventory round (see Table 6.10). | Tag | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 63 | 6.3.1.3.2.3 | The duty cycle of a 0 or 1 symbol, measured at the modulator output, shall be a minimum of 45% and a maximum of 55%, with a nominal value of 50%. | Tag | **By demonstration**<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: 860 & 960 MHz<br>Power: 0 dBm at Tag antenna<br>Modulation: DSB-ASK<br>PW: 0.5 Tari<br>Modulation depth: 90%<br>Rise/fall time: ≤ 0.33 Tari<br>TRext: 0<br>Test # 1<br>Tari: 6.25 µs<br>RTcal: 18.75 µs<br>TRcal: 33.3 & 50 µs<br>DR: 64/3<br>M: 2, 4, 8<br>Test # 2<br>Tari: 12.5 µs<br>RTcal: 31.25 µs<br>TRcal: 66.7, 83.3 µs<br>DR: 64/3<br>M: 2, 4, 8 |
| 64 | 6.3.1.3.2.3 | Miller signaling shall always end with a “dummy” data-1 bit at the end of a transmission, as shown in Figure 6.14. | Tag | **By design** |
| 65 | 6.3.1.3.2.4 | T=>R subcarrier signaling shall begin with one of the two preambles shown in Figure 6.15. | Tag | **By demonstration**<br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: 860 & 960 MHz<br>Power: 0 dBm at Tag antenna<br>Modulation: DSB-ASK<br>PW: 0.5 Tari<br>Modulation depth: 90%<br>Rise/fall time: ≤ 0.33 Tari<br>Tari: 25 µs<br>RTcal: 75 µs<br>TRcal: 100 µs<br>DR: 8<br>M: 2, 4, 8<br>TRext: 0 & 1 |
| 66 | 6.3.1.3.2.4 | The choice depends on the value of the TRext bit specified in the *Query* command that initiated the inventory round, unless a Tag is replying to a command that writes to memory, in which case a Tag shall use the extended preamble regardless of TRext (i.e. the Tag replies as if TRext=1 regardless of the TRext value specified in the *Query*—see 6.3.2.10.3). | Tag | By demonstration<br>Tested in compliance with 6.3.2.4, Figure 6.19 |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 67 | 6.3.1.3.3 | Tags shall support all R=>T Tari values in the range of 6.25µs to 25µs, over all parameters allowed by 6.3.1.2.3.<br><br>Tags shall support the T=>R link frequencies and tolerances specified in Table 6.9 and the T=>R data rates specified in Table 6.10. | Tag | The FT requirements in Table 6.9 of the Protocol shall be verified **by design**. Tag manufacturers shall provide plots of worst-case FT error versus TRcal. Tag manufacturers shall also provide measured data used to generate the FT plots, including:<br>1. Tag oscillator frequency tolerance<br>2. Tag oscillator frequency drift<br>3. TRcal measurement error budget<br>4. Other contributors to FT error<br><br>The frequency-variation during backscatter requirements in Table 6.9 of the Protocol shall be verified **by demonstration**. The testing laboratory shall measure the minimum, median, and maximum symbol length (M=1) or subcarrier period (M=2, 4, 8) during backscatter of a 128-bit sequence (16-bit PC, 96-bit EPC, and a CRC-16). The minimum and maximum values shall not deviate by more than 2.5% from the median. The test conditions are:<br><br>Temp: 23 +/– 3 ºC<br>Freq: 860 & 960 MHz<br>Power: 0 dBm at Tag antenna<br>Modulation: DSB-ASK<br>PW: 0.5 Tari<br>Modulation depth: 90%<br>Rise/fall time: $\leq$ 0.33 Tari<br>TRext: 0<br>Test # 1<br>Tari: 6.25 µs<br>RTcal: 18.75 µs<br>TRcal: 33.3 & 50 µs<br>DR: 64/3<br>M: 1, 2, 4, 8<br>Test # 2<br>Tari: 25 µs<br>RTcal: 75 µs<br>TRcal: 200 µs<br>DR: 8<br>M: 1, 2, 4, 8 |
| 68 | 6.3.1.3.4 | Tags energized by an Interrogator shall be capable of receiving and acting on Interrogator commands within a period not exceeding the maximum settling-time interval specified in Table 6.6 or Table 6.8, as appropriate (i.e. within $T_s$ or $T_{hs}$, respectively). | Tag | **By design** |
| 69 | 6.3.1.3.5 | For a Tag certified to this protocol, the Tag manufacturer shall specify: free-space, interference-free sensitivity, minimum relative backscattered modulated power (ASK modulation) or change in radar cross-section or equivalent (phase modulation), and the manufacturer's normal operating conditions for the Tag mounted on one or more manufacturer-selected materials. | Tag | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 70 | 6.3.1.4 | The transmission order for all R=>T and T=>R communications shall be most-significant bit (MSB) first. | Tag and Interrogator | **By design** |
| 71 | 6.3.1.4 | Within each message, the most-significant word shall be transmitted first. | Tag and Interrogator | **By design** |
| 72 | 6.3.1.4 | Within each word, the MSB shall be transmitted first. | Tag and Interrogator | **By design** |
| 73 | 6.3.1.5 | To generate a CRC-16 a Tag or Interrogator shall first generate the CRC-16 precursor shown in Table 6.11, and then take the ones-complement of the generated precursor to form the CRC-16. | Tag and Interrogator | **By design** |
| 74 | 6.3.1.5 | A Tag or Interrogator shall verify the integrity of a received message that uses a CRC-16. | Tag and Interrogator | **By design** |
| 75 | 6.3.1.5 | Tags shall append a CRC-16 to those replies that use a CRC-16 — see 6.3.2.10 for command-specific reply formats. | Tag | **By design** |
| 76 | 6.3.1.5 | To generate a CRC-5 an Interrogator shall use the definition in Table 6.12. | Interrogator | **By design** |
| 77 | 6.3.1.5 | A Tag shall verify the integrity of a received message that uses a CRC-5. | Tag | **By design** |
| 78 | 6.3.1.5 | Interrogators shall append the appropriate CRC to R=>T transmissions as specified in Table 6.16. | Interrogator | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 79 | 6.3.1.6 | Tags and Interrogators shall meet all timing requirements shown in Table 6.13. | Tag and Interro-gator | **By demonstration**<br><br>Interrogator test conditions:<br>Verify Interrogator meets $T_2$, $T_3$, & $T_4$<br>Temp: 23 +/– 3 ºC<br>Freq: At channel frequency closest to center of supported band.<br>Power: Maximum Interrogator transmit power, as imple-mented.<br>Other transmit parameters: As implemented<br><br>Tag test conditions:<br>Verify Tag meets $T_1$ over $T_2$ ex-tremes<br>Temp: 23 +/– 3 ºC<br>Freq: 860 & 960 MHz<br>Power: 0 dBm at Tag antenna<br>Modulation: DSB-ASK<br>PW: 0.5 Tari<br>Modulation depth: 90%<br>Rise/fall time: $\leq$ 0.33 Tari<br>TRext: 0<br>Minimum $T_2$ condition:<br>Tari: 6.25 µs<br>RTcal: 18.75 µs<br>TRcal: 33.3 & 50 µs<br>DR: 64/3<br>M: 1<br>Maximum $T_2$ condition:<br>Tari: 25 µs<br>RTcal: 75 µs<br>TRcal: 200 µs<br>DR: 8<br>M: 2, 4, 8 |
| 80 | 6.3.1.6 | As described in 6.3.1.2.8, an Interrogator shall use a fixed R=>T link rate for the duration of an inventory round. | Interro-gator | **By design** |
| 81 | 6.3.1.6 | Prior to changing the R=>T link rate, an Interrogator shall transmit CW for a minimum of 8 RTcal. | Interro-gator | **By design** |
| 82 | 6.3.1.6 | The maximum value for $T_2$ shall apply only to Tags in the **reply** or **acknowledged** states (see 6.3.2.4.3 and 6.3.2.4.4). | Tag | **By design** |
| 83 | 6.3.1.6<br>Table 6.13 | For a Tag in the **reply** or **acknowledged** states, if $T_2$ expires (i.e. reaches its maximum value) without the Tag receiving a valid command, the Tag shall transition to the **arbitrate** state (see 6.3.2.4.2). | Tag | **By design** |
| 84 | 6.3.1.6<br>Table 6.13 | For a Tag in the **reply** or **acknowledged** states, if $T_2$ expires (i.e. reaches its maximum value) during the re-ception of a valid command, the Tag shall execute the command. | Tag | **By design** |
| 85 | 6.3.1.6<br>Table 6.13 | For a Tag in the **reply** or **acknowledged** states, if $T_2$ expires (i.e. reaches its maximum value) during the reception of an invalid command, the Tag shall transi-tion to **arbitrate** upon determining that the command is invalid. | Tag | **By design** |
| 86 | 6.3.1.6<br>Table 6.13 | In all other states the maximum value for $T_2$ shall be un-restricted. | Tag | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 87 | 6.3.1.6 | $T_1$+$T_3$ shall not be less than $T_4$ | Tag | **By design** |
| 88 | 6.3.2.1 | Tag memory shall be logically separated into four distinct banks, each of which may comprise zero or more memory words. | Tag | **By design** |
| 89 | 6.3.2.1 | Reserved memory shall contain the kill and and/or access passwords, if passwords are implemented on the Tag. | Tag | **By design** |
| 90 | 6.3.2.1 | The kill password shall be stored at memory addresses $00_h$ to $1F_h$. | Tag | **By design** |
| 91 | 6.3.2.1 | The access password shall be stored at memory addresses $20_h$ to $3F_h$. | Tag | **By design** |
| 92 | 6.3.2.1 | EPC memory shall contain a CRC-16 at memory addresses $00_h$ to $0F_h$, Protocol-Control (PC) bits at memory addresses $10_h$ to $1F_h$, and a code (such as an EPC, and hereafter referred to as an EPC) that identifies the object to which the Tag is or will be attached beginning at address $20_h$. | Tag | **By design** |
| 93 | 6.3.2.1 | TID memory shall contain an 8-bit ISO/IEC 15963 allocation class identifier at memory locations $00_h$ to $07_h$. TID memory shall contain sufficient identifying information above $07_h$ for an Interrogator to uniquely identify the custom commands and/or optional features that a Tag supports. | Tag | **By demonstration**<br>Singulate the Tag, read its TID memory, and verify the contents.<br><br><u>Tag test conditions:</u><br>Temp: 23 +/– 3 ºC<br>Freq: 860 & 960 MHz<br>Power: 0 dBm at Tag antenna<br>Modulation: DSB-ASK<br>PW: 0.5 Tari<br>Modulation depth: 90%<br>Rise/fall time: $\leq$ 0.33 Tari<br>Tari: 25 µs<br>RTcal: 75 µs<br>TRcal: 100 µs<br>DR: 8<br>M: 1<br>TRext: 0 |
| 94 | 6.3.2.1 | The logical addressing of all memory banks shall begin at zero ($00_h$). | Tag | **By design** |
| 95 | 6.3.2.1 | When Tags backscatter memory contents, this backscatter shall fall on word boundaries (except in the case of a truncated reply – see 6.3.2.10.1.1). | Tag | **By design** |
| 96 | 6.3.2.1 | Operations in one logical memory bank shall not access memory locations in another bank. | Tag | **By design** |
| 97 | 6.3.2.1 | A *Write*, *BlockWrite*, or *BlockErase* shall not alter a Tag's **killed** status regardless of the memory address (whether valid or invalid) specified in the command. | Tag | **By design** |
| 98 | 6.3.2.1.1 | If a Tag does not implement the kill and/or access password(s), the Tag shall logically operate as though it has zero-valued password(s) that are permanently read/write locked (see 6.3.2.10.3.5), and the corresponding physical memory locations in Reserved memory need not exist. | Tag | **By design** |
| 99 | 6.3.2.1.1.1 | The default (unprogrammed) value shall be zero. | Tag | **By design** |
| 100 | 6.3.2.1.1.1 | An Interrogator shall use a kill password once, to kill the Tag and render it nonresponsive thereafter. | Interrogator | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 101 | 6.3.2.1.1 | A Tag shall not execute a kill operation if its kill password is zero. | Tag | **By demonstration**<br>Issue a *Kill* command to a Tag with a zero-valued kill password. Verify that the Tag backscatters an error code and does not execute the kill.<br><br><u>Tag test conditions:</u><br>Temp: 23 +/– 3 ºC<br>Freq: 860 & 960 MHz<br>Power: 0 dBm at Tag antenna<br>Modulation: DSB-ASK<br>PW: 0.5 Tari<br>Modulation depth: 90%<br>Rise/fall time: $\leq$ 0.33 Tari<br>Tari: 25 µs<br>RTcal: 75 µs<br>TRcal: 100 µs<br>DR: 8<br>M: 1<br>TRext: 0 |
| 102 | 6.3.2.1.1.2 | The default (unprogrammed) value shall be zero. | Tag | **By design** |
| 103 | 6.3.2.1.1.2 | A Tag with a nonzero access password shall require an Interrogator to issue this password before transitioning to the **secured** state. | Tag | **By design** |
| 104 | 6.3.2.1.2 | The CRC-16, PC, and EPC shall be stored MSB first (the EPC's MSB is stored in location $20_h$). | Tag | **By design** |
| 105 | 6.3.2.1.2.1 | At power-up a Tag shall compute this CRC-16 over EPC memory location $10_h$ to the end of the EPC (not necessarily to the end of EPC memory, but to the end of the EPC specified by the length field in the PC — see 6.3.2.1.2.2) and map the computed CRC-16 into EPC memory $00_h$ to $0F_h$, MSB first. | Tag | **By demonstration**<br><br><u>Test for rewriteable Tags:</u><br>Sequentially write a Tag's EPC, one 16-bit word at a time. Following each write, update the length field specified in the PC bits, power down the Tag, then power it up again and singulate it. Verify that the backscattered CRC-16 matches the backscattered EPC after each write operation.<br><br><u>Test for prewritten Tags:</u><br>Power up the Tag and singulate it. Verify that the backscattered CRC-16 matches the backscattered EPC.<br><br><u>Tag test conditions for either case:</u><br>Temp: 23 +/– 3 ºC<br>Freq: 860 & 960 MHz<br>Power: 0 dBm at Tag antenna<br>Modulation: DSB-ASK<br>PW: 0.5 Tari<br>Modulation depth: 90%<br>Rise/fall time: $\leq$ 0.33 Tari<br>Tari: 25 µs<br>RTcal: 75 µs<br>TRcal: 100 µs<br>DR: 8<br>M: 1<br>TRext: 0 |
| 106 | 6.3.2.1.2.1 | Because the {PC+EPC} is stored in EPC memory on word boundaries, this CRC-16 shall be computed on word boundaries. | Tag | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 107 | 6.3.2.1.2.1 | Tags shall finish this CRC-16 computation and memory mapping by the end of interval $T_s$ or $T_{hs}$ (as appropriate) in Figure 6.3 or Figure 6.5, respectively. | Tag | **By design** |
| 108 | 6.3.2.1.2.1 | Tags shall not recalculate this CRC-16 for a truncated reply (see 6.3.2.10.1.1). | Tag | **By design** |
| 109 | 6.3.2.1.2.2 | Bits $15_h$ – $16_h$: RFU (shall be set to $00_2$ for Class-1 Tags). | Tag | **By demonstration**<br><br><u>Tag test conditions:</u><br>Temp: 23 +/– 3 ºC<br>Freq: 860 & 960 MHz<br>Power: 0 dBm at Tag antenna<br>Modulation: DSB-ASK<br>PW: 0.5 Tari<br>Modulation depth: 90%<br>Rise/fall time: $\leq$ 0.33 Tari<br>Tari: 25 µs<br>RTcal: 75 µs<br>TRcal: 100 µs<br>DR: 8<br>M: 1<br>TRext: 0 |
| 110 | 6.3.2.1.2.2 | If bit $17_h$ contains a logical 0, then the application is referred to as an EPCglobal™ Application and PC bits $18_h$ – $1F_h$ shall be as defined in the EPC™ Tag Data Standards. If bit 17h contains a logical 1, then a application is referred to as a non-EPCglobal™ Application and PC bits 18h – 1Fh shall contain the entire AFI defined in ISO/IEC 15961. | Tag | **By demonstration**<br><br><u>Tag test conditions:</u><br>Temp: 23 +/– 3 ºC<br>Freq: 860 & 960 MHz<br>Power: 0 dBm at Tag antenna<br>Modulation: DSB-ASK<br>PW: 0.5 Tari<br>Modulation depth: 90%<br>Rise/fall time: $\leq$ 0.33 Tari<br>Tari: 25 µs<br>RTcal: 75 µs<br>TRcal: 100 µs<br>DR: 8<br>M: 1<br>TRext: 0 |
| 111 | 6.3.2.1.2.2 | The default (unprogrammed) PC value shall be $0000_h$. | Tag | **By demonstration**<br><br><u>Tag test (unwritten Tags only):</u><br>Power up the Tag and singulate it. Verify that the backscattered PC bits are $0000_h$.<br><br><u>Tag test conditions:</u><br>Temp: 23 +/– 3 ºC<br>Freq: 860 & 960 MHz<br>Power: 0 dBm at Tag antenna<br>Modulation: DSB-ASK<br>PW: 0.5 Tari<br>Modulation depth: 90%<br>Rise/fall time: $\leq$ 0.33 Tari<br>Tari: 25 µs<br>RTcal: 75 µs<br>TRcal: 100 µs<br>DR: 8<br>M: 1<br>TRext: 0 |
| 112 | 6.3.2.1.2.2 | A Tag shall backscatter an error code (see Annex I) if an Interrogator attempts to write a (PC + EPC) length that is not supported by the Tag to the first 5 bits of the Tag's PC. | Tag | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 113 | 6.3.2.1.2.2 | At power-up a Tag shall compute its CRC-16 over the number of (PC + EPC) words designated by the first 5 bits of the PC rather than over the length of the entire EPC memory (see 6.3.2.1.2.1). | Tag | Tested in compliance with 6.3.2.1.3 |
| 114 | 6.3.2.1.2.3 | The EPC structure for an EPCglobal™ Application shall be as defined in the EPC™ Tag Data Standards. | Tag | **By design** |
| 115 | 6.3.2.1.2.4 | The EPC structure for a non-EPCglobal™ Application shall be as defined in ISO/IEC 15961. | Tag | **By design** |
| 116 | 6.3.2.1.3 | TID memory locations $00_h$ to $07_h$ shall contain one of two ISO/IEC 15963 class-identifier values — either $E0_h$ or $E2_h$. | Tag | **By design** |
| 117 | 6.3.2.1.3 | TID memory locations above $07_h$ shall be defined according to the registration authority defined by this class-identifier value and shall contain, at a minimum, sufficient identifying information for an Interrogator to uniquely identify the custom commands and/or optional features that a Tag supports. | Tag | **By design** |
| 118 | 6.3.2.1.4.1 | If User memory is included on a Tag then its encoding shall be as defined in the EPC™ Tag Data Standards (version 1.3 and above). | Tag | **By design** |
| 119 | 6.3.2.1.4.2 | If User memory is included on a Tag then User memory locations $00_h$ to $07_h$ shall be the DSFID defined in ISO/IEC 15961. The encoding of User memory locations above $07_h$ shall be as defined in ISO/IEC 15962. | Tag | **By design** |
| 120 | 6.3.2.2 | Interrogators shall support and Tags shall provide 4 sessions (denoted S0, S1, S2, and S3). | Tag and Interrogator | **By design** |
| 121 | 6.3.2.2 | Tags shall participate in one and only one session during an inventory round. | Tag | **By design** |
| 122 | 6.3.2.2 | Tags shall maintain an independent **inventoried** flag for each session. | Tag | **By design** |
| 123 | 6.3.2.2 | Tags participating in an inventory round in one session shall neither use nor modify the **inventoried** flag for a different session. | Tag | **By design** |
| 124 | 6.3.2.2 | A Tag's **inventoried** flags shall have the persistence times shown in Table 6.14. | Tag | **By design** |
| 125 | 6.3.2.2 | A Tag shall power-up with its **inventoried** flags set as follows: the S0 **inventoried** flag shall be set to *A*. | Tag | **By design**<br>Tested in compliance with 6.3.2.3, Table 6.14 |
| 126 | 6.3.2.2 | A Tag shall power-up with its **inventoried** flags set as follows: the S1 **inventoried** flag shall be set to either *A* or *B*, depending on its stored value, unless the flag was set longer in the past than its persistence time, in which case the Tag shall power-up with its S1 **inventoried** flag set to *A*. | Tag | **By design** |
| 127 | 6.3.2.2 | A Tag shall power-up with its **inventoried** flags set as follows: the S2 **inventoried** flag shall be set to either *A* or *B*, depending on its stored value, unless the Tag has lost power for a time greater than its persistence time, in which case the Tag shall power-up with the S2 **inventoried** flag set to *A*. | Tag | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 128 | 6.3.2.2 | A Tag shall power-up with its **inventoried** flags set as follows: the S3 **inventoried** flag shall be set to either *A* or *B*, depending on its stored value, unless the Tag has lost power for a time greater than its persistence time, in which case the Tag shall power-up with its S3 **inventoried** flag set to *A*. | Tag | **By design** |
| 129 | 6.3.2.2 | A Tag shall set any of its **inventoried** flags to either *A* or *B* in 2 ms or less, regardless of the initial flag value. | Tag | **By design** |
| 130 | 6.3.2.2 | Tag shall refresh its S2 and S3 flags while powered, meaning that every time a Tag loses power its S2 and S3 **inventoried** flags shall have the persistence times shown in Table 6.14. | Tag | **By design** |
| 131 | 6.3.2.2 | The value of the S1 **inventoried** flag shall not change as a result of a persistence timeout while a Tag is participating in an inventory round. | Tag | **By design** |
| 132 | 6.3.2.2 | If the S1 persistence time expires during an inventory round then the Tag shall change its S1 flag to *A* at the end of the round. | Tag | **By design** |
| 133 | 6.3.2.3 | Tags shall implement a selected flag, **SL**, which an Interrogator may assert or deassert using a *Select* command. | Tag | **By design** |
| 134 | 6.3.2.3 | A Tag's **SL** flag shall have the persistence times shown in Table 6.14. | Tag | **By design**<br>Tested in compliance with 6.3.2.3, Table 6.14 |
| 135 | 6.3.2.3 | A Tag shall power-up with its **SL** flag either asserted or deasserted, depending on the stored value, unless the Tag has lost power for a time greater than the **SL** persistence time, in which case the Tag shall power-up with its **SL** flag deasserted (set to ~**SL**). | Tag | **By design** |
| 136 | 6.3.2.3 | A Tag shall be capable of asserting or deasserting its **SL** flag in 2 ms or less, regardless of the initial flag value. | Tag | **By design** |
| 137 | 6.3.2.3 | A Tag shall refresh its **SL** flag when powered, meaning that every time a Tag loses power its **SL** flag shall have the persistence times shown in Table 6.14. | Tag | **By design** |
| 138 | 6.3.2.3, Table 6.14 | For a randomly chosen and sufficiently large Tag population, 95% of the Tag persistence times shall meet the persistence requirement, with a 90% confidence interval. | Tag | **By design**<br>Tag manufacturers shall provide data and analysis demonstrating that Tags meet the persistence requirements of Table 6.14. |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 139 | 6.3.2.4 | Tags shall implement the states and the slot counter shown in Figure 6.19. | Tag | **By demonstration**<br><br><u>Tag test:</u><br>Tag manufacturers shall supply a population of Tags for testing. The testing laboratory shall exercise all of the states and state transitions shown in Figure 6.19 by selecting, singulating, inventorying, reading, writing, accessing, and (for Tags that implement kill) killing the Tags.<br><br><u>Tag test conditions:</u><br>Temp: 23 +/– 3 ºC<br>Freq: 860 & 960 MHz<br>Power: 0 dBm at Tag antenna<br>Modulation: DSB-ASK<br>PW: 0.5 Tari<br>Modulation depth: 90%<br>Rise/fall time: $\leq$ 0.33 Tari<br>Tari: 25 µs<br>RTcal: 75 µs<br>TRcal: 100 µs<br>DR: 8<br>M: 1<br>TRext: 0 |
| 140 | 6.3.2.4.1 | Tags shall implement a **ready** state. | Tag | Tested in compliance with 6.3.2.4, Figure 6.19 |
| 141 | 6.3.2.4.1 | Upon entering an energizing RF field a Tag that is not **killed** shall enter **ready**. | Tag | **By design** |
| 142 | 6.3.2.4.1 | The Tag shall remain in **ready** until it receives a *Query* command (see 6.3.2.10.2.1) whose <u>**inventoried**</u> parameter (for the <u>session</u> specified in the *Query*) and <u>sel</u> parameter match its current flag values. | Tag | **By design** |
| 143 | 6.3.2.4.1 | Matching Tags shall draw a *Q*-bit number from their RNG (see 6.3.2.5), load this number into their slot counter, and transition to the **arbitrate** state if the number is nonzero, or to the **reply** state if the number is zero. | Tag | **By design** |
| 144 | 6.3.2.4.1 | If a Tag in any state except **killed** loses power it shall return to **ready** upon regaining power. | Tag | **By design** |
| 145 | 6.3.2.4.2 | Tags shall implement an **arbitrate** state. | Tag | Tested in compliance with 6.3.2.4, Figure 6.19 |
| 146 | 6.3.2.4.2 | A Tag in **arbitrate** shall decrement its slot counter every time it receives a *QueryRep* command (see 6.3.2.10.2.3) whose <u>session</u> parameter matches the session for the inventory round currently in progress, and it shall transition to the **reply** state and backscatter an RN16 when its slot counter reaches $0000_h$. | Tag | **By design** |
| 147 | 6.3.2.4.2 | Tags that return to **arbitrate** (for example, from the **reply** state) with a slot value of $0000_h$ shall decrement their slot counter from $0000_h$ to $7FFF_h$ at the next *QueryRep* (with matching <u>session</u>) and, because their slot value is now nonzero, shall remain in **arbitrate**. | Tag | **By design** |
| 148 | 6.3.2.4.3 | Tags shall implement a **reply** state. | Tag | Tested in compliance with 6.3.2.4, Figure 6.19 |
| 149 | 6.3.2.4.3 | Upon entering **reply** a Tag shall backscatter an RN16. | Tag | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 150 | 6.3.2.4.3 | If the Tag receives a valid acknowledgement (*ACK*) it shall transition to the **acknowledged** state, backscattering its PC, EPC and CRC-16. | Tag | **By design** |
| 151 | 6.3.2.4.3 | If the Tag fails to receive an *ACK* within time $T_{2(max)}$, or receives an invalid *ACK* or an *ACK* with an erroneous RN16, it shall return to **arbitrate**. | Tag | **By design** |
| 152 | 6.3.2.4.3 | In the reply state, Tag and Interrogator shall meet all timing requirements specified in Table 6.13. | Tag | Tested in compliance with 6.3.1.6, Table 6.13 |
| 153 | 6.3.2.4.4 | Tags shall implement an **acknowledged** state. | Tag | Tested in compliance with 6.3.2.4, Figure 6.19 |
| 154 | 6.3.2.4.4 | If a Tag in the **acknowledged** state receives a valid *ACK* containing the correct RN16 it shall re-backscatter its PC, EPC, and CRC-16. | Tag | **By design** |
| 155 | 6.3.2.4.4 | If a Tag in the **acknowledged** state fails to receive a valid command within time $T_{2(max)}$ it shall return to **arbitrate**. | Tag | **By design** |
| 156 | 6.3.2.4.4 | In the open state, Tag and Interrogator shall meet all timing requirements specified in Table 6.13. | Tag | Tested in compliance with 6.3.1.6, Table 6.13 |
| 157 | 6.3.2.4.5 | Tags shall implement an **open** state. | Tag | Tested in compliance with 6.3.2.4, Figure 6.19 |
| 158 | 6.3.2.4.5 | A Tag in the **acknowledged** state whose access password is nonzero shall transition to **open** upon receiving a *Req_RN* command, backscattering a new RN16 (denoted handle) that the Interrogator shall use in subsequent commands and the Tag shall use in subsequent replies. | Tag | **By design** |
| 159 | 6.3.2.4.5 | If a Tag in the **open** state receives a valid *ACK* containing the correct handle it shall re-backscatter its PC, EPC, and CRC-16. | Tag | **By design** |
| 160 | 6.3.2.4.5 | In the open state, Tag and Interrogator shall meet all timing requirements specified in Table 6.13 except $T_{2(max)}$; in the **open** state the maximum delay between Tag response and Interrogator transmission is unrestricted. | Tag | Tested in compliance with 6.3.1.6, Table 6.13 |
| 161 | 6.3.2.4.6 | Tags shall implement a **secured** state. | Tag | Tested in compliance with 6.3.2.4, Figure 6.19 |
| 162 | 6.3.2.4.6 | A Tag in the **acknowledged** state whose access password is zero shall transition to **secured** upon receiving a *Req_RN* command, backscattering a new RN16 (denoted handle) that the Interrogator shall use in subsequent commands and the Tag shall use in subsequent replies. | Tag and Interrogator | **By design** |
| 163 | 6.3.2.4.6 | A Tag in the **open** state whose access password is nonzero shall transition to **secured** upon receiving a valid *Access* command sequence, maintaining the same handle that it previously backscattered when it transitioned from the **acknowledged** to the **open** state. | Tag | **By design** |
| 164 | 6.3.2.4.6 | If a Tag in the **secured** state receives a valid *ACK* containing the correct handle it shall re-backscatter its PC, EPC, and CRC-16. | Tag | **By design** |
| 165 | 6.3.2.4.6 | In the secured state, Tag and Interrogator shall meet all timing requirements specified in Table 6.13 except $T_{2(max)}$; in the **secured** state the maximum delay between Tag response and Interrogator transmission is unrestricted. | Tag | Tested in compliance with 6.3.1.6, Table 6.13 |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 166 | 6.3.2.4.7 | Tags shall implement a **killed** state. | Tag | Tested in compliance with 6.3.2.4, Figure 6.19 |
| 167 | 6.3.2.4.7 | A Tag in either the **open** or **secured** states shall enter the **killed** state upon receiving a *Kill* command sequence (see 6.3.2.10.3.4) with a valid nonzero kill password and valid handle. | Tag | **By design** |
| 168 | 6.3.2.4.7 | Upon entering the **killed** state a Tag shall notify the Interrogator that the kill operation was successful, and shall not respond to an Interrogator thereafter. | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 169 | 6.3.2.4.7 | **Killed** Tags shall remain in the **killed** state under all circumstances, and shall immediately enter **killed** upon subsequent power-ups. | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 170 | 6.3.2.4.8 | Tags shall implement a 15-bit slot counter. | Tag | **By design** |
| 171 | 6.3.2.4.8 | Upon receiving a *Query* or *QueryAdjust* command a Tag shall preload into its slot counter a value between 0 and $2^Q-1$, drawn from the Tag's RNG. | Tag | **By design** |
| 172 | 6.3.2.4.8 | Tags in the **arbitrate** state shall decrement their slot counter every time they receive a *QueryRep*, transitioning to the **reply** state and backscattering an RN16 when their slot counter reaches $0000_h$. | Tag | **By design** |
| 173 | 6.3.2.4.8 | Tags whose slot counter reached $0000_h$, who replied, and who were not **acknowledged** (including Tags that responded to an original *Query* and were not **acknowledged**) shall return to **arbitrate** with a slot value of $0000_h$ and shall decrement this slot value from $0000_h$ to $7FFF_h$ at the next *QueryRep*. | Tag | By demonstration<br>Test in compliance with 6.3.2.4, Figure 6.19 |
| 174 | 6.3.2.4.8 | The slot counter shall be capable of continuous counting, meaning that, after the slot counter rolls over to $7FFF_h$ it begins counting down again, thereby effectively preventing subsequent replies until the Tag loads a new random value into its slot counter. | Tag | By demonstration<br>Test in compliance with 6.3.2.4, Figure 6.19 |
| 175 | 6.3.2.5 | Tags shall implement a random or pseudo-random number generator (RNG). | Tag | **By design** |
| 176 | 6.3.2.5 | The RNG shall meet the following randomness criteria independent of the strength of the energizing field, the R=>T link rate, and the data stored in the Tag (including the PC, EPC, and CRC-16). | Tag | **By design** |
| 177 | 6.3.2.5 | Tags shall generate 16-bit random or pseudo-random numbers (RN16) using the RNG, and shall have the ability to extract *Q*-bit subsets from an RN16 to preload the Tag's slot counter (see 6.3.2.4.8). | Tag | **By design** |
| 178 | 6.3.2.5 | Tags shall have the ability to temporarily store at least two RN16s while powered, to use, for example, as a handle and a 16-bit cover-code during password transactions (see Figure 6.23 or Figure 6.25). | Tag | **By design** |
| 179 | 6.3.2.5 | The probability that any RN16 drawn from the RNG has value RN16 = *j*, for any *j*, shall be bounded by $0.8/2^{16} < P(RN16 = j) < 1.25/2^{16}$. | Tag | **By design**<br>Tag manufacturers shall provide data and analysis demonstrating that Tags meet the requirements of 6.3.2.5. |
| 180 | 6.3.2.5 | For a Tag population of up to 10,000 Tags, the probability that any two or more Tags simultaneously generate the same sequence of RN16s shall be less than 0.1%, regardless of when the Tags are energized. | Tag | **By design**<br>Tag manufacturers shall provide data and analysis demonstrating that Tags meet the requirements of 6.3.2.5. |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 181 | 6.3.2.5 | An RN16 drawn from a Tag's RNG 10ms after the end of $T_r$ in Figure 6.3 shall not be predictable with a probability greater than 0.025% if the outcomes of prior draws from the RNG, performed under identical conditions, are known. | Tag | **By design**<br>Tag manufacturers shall provide data and analysis demonstrating that Tags meet the requirements of 6.3.2.5. |
| 182 | 6.3.2.7 | A *Select* that modifies **SL** shall not modify **inventoried**, and vice versa. | Tag | **By design** |
| 183 | 6.3.2.9 | If the Interrogator issues a command with new data or half-password, then it shall first issue a *Req_RN* to obtain a new RN16 and shall use this RN16 for the cover-coding. | Interro-gator | **By design** |
| 184 | 6.3.2.10 | Interrogator-to-Tag commands shall have the format shown in Table 6.16. | Interro-gator | **By design** |
| 185 | 6.3.2.10 | *QueryRep*, *ACK*, *Query*, *QueryAdjust,* and *NAK* have the unique command lengths shown in Table 6.16; no other commands shall have these lengths. | Interro-gator | **By design** |
| 186 | 6.3.2.10 | If a Tag receives one of these commands with an incorrect length it shall ignore the command. | Tag | **By design** |
| 187 | 6.3.2.10 | Tags shall ignore invalid commands. | Tag | **By design** |
| 188 | 6.3.2.10.1.1 | Interrogators and Tags shall implement the *Select* command shown in Table 6.17. | Tag and Interro-gator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 189 | 6.3.2.10.1.1 | Target shall indicate whether the *Select* modifies a Tag's **SL** or **inventoried** flag, and in the case of the **inventoried** flag, for which session. | Tag | **By design** |
| 190 | 6.3.2.10.1.1 | Action shall elicit the Tag response shown in Table 6.18. | Tag | **By design** |
| 191 | 6.3.2.10.1.1 | Truncate indicates whether a Tag's backscattered reply shall be truncated to include only those EPC and CRC-16 bits following Mask. | Tag | **By design** |
| 192 | 6.3.2.10.1.1 | Class-1 Tags shall ignore *Select* commands whose Target is $101_2$, $110_2$, or $111_2$. | Tag | **By design** |
| 193 | 6.3.2.10.1.1 | *Select* commands shall apply to a single memory bank. | Tag | **By design** |
| 194 | 6.3.2.10.1.1 | MemBank shall not specify Reserved memory; if a Tag receives a *Select* specifying MemBank = $00_2$ it shall ignore the *Select*. | Tag | **By design** |
| 195 | 6.3.2.10.1.1 | If Pointer and Length reference a memory location that does not exist on the Tag then the Tag shall consider the *Select* to be non-matching. | Tag | **By design** |
| 196 | 6.3.2.10.1.1 | If Length is zero then all Tags shall be considered matching, unless Pointer references a memory location that does not exist on the Tag or Truncate = 1 and Pointer is outside the EPC specified in the PC bits, in which case the Tag shall consider the *Select* to be non-matching. | Tag | **By design** |
| 197 | 6.3.2.10.1.1 | If an Interrogator asserts Truncate, and if a subsequent *Query* specifies Sel=10 or Sel=11, then a Tag shall truncate its reply to an *ACK* to that portion of the EPC immediately following Mask, followed by the CRC-16 stored in EPC memory $00_h$ to $0F_h$. | Tag | **By design** |
| 198 | 6.3.2.10.1.1 | If an Interrogator asserts Truncate, it shall assert it in the last *Select* that the Interrogator issues prior to sending a *Query*, only if the *Select* has Target = $100_2$, and only if Mask ends in the EPC. | Interro-gator | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 199 | 6.3.2.10.1.1 | Tags shall power-up with Truncate deasserted. | Tag | **By design** |
| 200 | 6.3.2.10.1.1 | Tags shall decide whether to truncate their backscattered EPC on the basis of the most recently received *Select*. | Tag | **By design** |
| 201 | 6.3.2.10.1.1 | If a Tag receives a *Select* with Truncate=1 but Target<>$100_2$ the Tag shall ignore the *Select*. | Tag | **By design** |
| 202 | 6.3.2.10.1.1 | If a Tag receives a *Select* in which Truncate=1 but MemBank<>01, the Tag shall consider the *Select* to be invalid. | Tag | **By design** |
| 203 | 6.3.2.10.1.1 | If a Tag receives a *Select* in which Truncate=1, MemBank=01, but Mask ends outside the EPC specified in the PC bits, the Tag shall consider the *Select* to be not matching. | Tag | **By design** |
| 204 | 6.3.2.10.1.1 | Mask may end at the last bit of the EPC, in which case a selected Tag shall backscatter its CRC-16. | Tag | **By design** |
| 205 | 6.3.2.10.1.1 | A Tag shall preface its truncated reply with five leading zeros ($00000_2$) inserted between the preamble and the truncated reply. | Tag | **By design** |
| 206 | 6.3.2.10.1.1 | Interrogators shall prepend a *Select* with a frame-sync (see 6.3.1.2.8). | Interrogator | **By design** |
| 207 | 6.3.2.10.1.1 | Tags shall not reply to a *Select*. | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 208 | 6.3.2.10.2.1 | Interrogators and Tags shall implement the *Query* command shown in Table 6.19. | Tag and Interrogator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 209 | 6.3.2.10.2.1 | Interrogators shall prepend a *Query* with a preamble (see 6.3.1.2.8). | Interrogator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 210 | 6.3.2.10.2.1 | If a Tag receives a *Query* with a CRC-5 error it shall ignore the command. | Tag | **By design** |
| 211 | 6.3.2.10.2.1 | Upon receiving a *Query*, Tags with matching Sel and Target shall pick a random value in the range $(0, 2^Q-1)$, inclusive, and shall load this value into their slot counter. | Tag | **By design** |
| 212 | 6.3.2.10.2.1 | If a Tag, in response to the *Query*, loads its slot counter with zero, then its reply to a *Query* shall be as shown in Table 6.20; otherwise the Tag shall remain silent. | Tag | **By design** |
| 213 | 6.3.2.10.2.1 | If a Tag in the **acknowledged**, **open**, or **secured** states receives a *Query* whose session parameter matches the prior session it shall invert its **inventoried** flag (i.e. $A \rightarrow B$ or $B \rightarrow A$) for the session before it evaluates whether to transition to **ready**, **arbitrate**, or **reply**. | Tag | **By design** |
| 214 | 6.3.2.10.2.1 | If a Tag in the **acknowledged**, **open**, or **secured** states receives a *Query* whose session parameter does not match the prior session it shall leave its **inventoried** flag for the prior session unchanged when beginning the new round. | Tag | **By design** |
| 215 | 6.3.2.10.2.1 | Tags shall support all DR and M values specified in Table 6.9 and Table 6.10, respectively. | Tag | **By design** |
| 216 | 6.3.2.10.2.1 | Tags in any state other than **killed** shall execute a *Query* command, starting a new round in the specified session and transitioning to **ready**, **arbitrate**, or **reply**, as appropriate (see Figure 6.19). | Tag | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 217 | 6.3.2.10.2.1 | Tags in the **killed** state shall ignore a *Query*. | Tag | **By design** |
| 218 | 6.3.2.10.2.2 | Interrogators and Tags shall implement the *QueryAdjust* command shown in Table 6.21. | Tag and Interro-gator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 219 | 6.3.2.10.2.2 | If a Tag receives a *QueryAdjust* whose session number is different from the session number in the *Query* that initiated the round it shall ignore the command. | Tag | **By design** |
| 220 | 6.3.2.10.2.2 | If a Tag receives a *QueryAdjust* with an UpDn value different from those specified above it shall ignore the command. | Tag | **By design** |
| 221 | 6.3.2.10.2.2 | If a Tag whose *Q* value is 15 receives a *QueryAdjust* with UpDn = 110 it shall change UpDn to 000 prior to executing the command; likewise, if a Tag whose *Q* value is 0 receives a *QueryAdjust* with UpDn = 011 it shall change UpDn to 000 prior to executing the command. | Tag | **By design** |
| 222 | 6.3.2.10.2.2 | Tags shall maintain a running count of the current *Q* value. | Tag | **By design** |
| 223 | 6.3.2.10.2.2 | A *QueryAdjust* shall be prepended with a frame-sync (see 6.3.1.2.8). | Interro-gator | **By design** |
| 224 | 6.3.2.10.2.2 | If a Tag, in response to the *QueryAdjust*, loads its slot counter with zero, then its reply to a *QueryAdjust* shall be shown in Table 6.22; otherwise, the Tag shall remain silent. | Tag | **By design** |
| 225 | 6.3.2.10.2.2 | Tags shall respond to a *QueryAdjust* only if they received a prior *Query*. | Tag | **By design** |
| 226 | 6.3.2.10.2.2 | Tags in any state except **ready** or **killed** shall execute a *QueryAdjust* command if, and only if, (i) the session parameter in the command matches the session parameter in the *Query* that started the round, and (ii) the Tag is not in the middle of a *Kill* or *Access* command sequence (see 6.3.2.10.3.4 or 6.3.2.10.3.6, respectively). | Tag | **By design** |
| 227 | 6.3.2.10.2.2 | Tags in the **acknowledged**, **open**, or **secured** states that receive a *QueryAdjust* whose session parameter matches the session parameter in the prior *Query*, and who are not in the middle of a *Kill* or *Access* command sequence (see 6.3.2.10.3.4 or 6.3.2.10.3.6, respectively), shall invert their **inventoried** flag (i.e. $A \rightarrow B$ or $B \rightarrow A$, as appropriate) for the current session and transition to **ready**. | Tag | **By design** |
| 228 | 6.3.2.10.2.3 | Interrogators and Tags shall implement the *QueryRep* command shown in Table 6.23. | Tag and Interro-gator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 229 | 6.3.2.10.2.3 | If a Tag receives a *QueryRep* whose session number is different from the session number in the *Query* that initiated the round it shall ignore the command. | Tag | **By design** |
| 230 | 6.3.2.10.2.3 | A *QueryRep* shall be prepended with a frame-sync (see 6.3.1.2.8). | Interro-gator | **By design** |
| 231 | 6.3.2.10.2.3 | If a Tag, in response to the *QueryRep*, decrements its slot counter and the decremented slot value is zero, then its reply to a *QueryRep* shall be as shown in Table 6.24; otherwise the Tag shall remain silent. | Tag | **By design** |
| 232 | 6.3.2.10.2.3 | Tags shall respond to a *QueryRep* only if they received a prior *Query*. | Tag | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 233 | 6.3.2.10.2.3 | Tags in any state except **ready** or **killed** shall execute a *QueryRep* command if, and only if, (i) the session parameter in the command matches the session parameter in the *Query* that started the round, and (ii) the Tag is not in the middle of a *Kill* or *Access* command sequence (see 6.3.2.10.3.4 or 6.3.2.10.3.6, respectively). | Tag | **By design** |
| 234 | 6.3.2.10.2.3 | Tags in the **acknowledged**, **open**, or **secured** states that receive a *QueryRep* whose session parameter matches the session parameter in the prior *Query*, and who are not in the middle of a *Kill* or *Access* command sequence (see 6.3.2.10.3.4 or 6.3.2.10.3.6, respectively), shall invert their **inventoried** flag (i.e. $A \rightarrow B$ or $B \rightarrow A$, as appropriate) for the current session and transition to **ready**. | Tag | **By design** |
| 235 | 6.3.2.10.2.4 | Interrogators and Tags shall implement the *ACK* command shown in Table 6.25. | Tag and Interrogator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 236 | 6.3.2.10.2.4 | If an Interrogator issues an *ACK* to a Tag in the **reply** or **acknowledged** states, then the echoed RN16 shall be the RN16 that the Tag previously backscattered as it transitioned from the **arbitrate** state to the **reply** state. | Interrogator | **By design** |
| 237 | 6.3.2.10.2.4 | If an Interrogator issues an *ACK* to a Tag in the **open** or **secured** states, then the echoed RN16 shall be the Tag's handle (see 6.3.2.10.3.1). | Interrogator | **By design** |
| 238 | 6.3.2.10.2.4 | An *ACK* shall be prepended with a frame-sync (see 6.3.1.2.8). | Interrogator | **By design** |
| 239 | 6.3.2.10.2.4 | The Tag reply to a successful *ACK* shall be as shown in Table 6.26. | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 240 | 6.3.2.10.2.4 | A Tag that receives an *ACK* with an incorrect RN16 or an incorrect handle (as appropriate) shall return to **arbitrate** without responding, unless the Tag is in **ready** or **killed**, in which case it shall ignore the *ACK* and remain in its present state. | Tag | **By design** |
| 241 | 6.3.2.10.2.5 | Interrogators and Tags shall implement the *NAK* command shown in Table 6.27. | Tag and Interrogator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 242 | 6.3.2.10.2.5 | Any Tag that receives a *NAK* shall return to the **arbitrate** state without changing its **inventoried** flag, unless the Tag is in **ready** or **killed**, in which case it shall ignore the *NAK* and remain in its current state. | Tag | **By design** |
| 243 | 6.3.2.10.2.5 | A *NAK* shall be prepended with a frame-sync (see 6.3.1.2.8). | Interrogator | **By design** |
| 244 | 6.3.2.10.2.5 | Tags shall not reply to a *NAK*. | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 245 | 6.3.2.10.3 | When in either of these two states, Tags shall verify that the handle is correct prior to executing an access command, and shall ignore access commands with an incorrect handle. | Tag | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 246 | 6.3.2.10.3 | A Tag's reply to all access commands that write memory (i.e. *Write*, *Kill*, *Lock*, *BlockWrite*, and *BlockErase*) shall use the extended preamble shown in Figure 6.11 or Figure 6.15, as appropriate (i.e. the Tag shall reply as if TRext=1 regardless of the TRext value specified in the *Query* command that initiated the inventory round). | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 247 | 6.3.2.10.3 | If an Interrogator attempts to write directly to EPC memory $00_h$ to $0F_h$ using either a *Write* or a *BlockWrite* command, the Tag shall respond with an error code (see Annex I for error-code definitions and for the reply format). | Tag | **By design** |
| 248 | 6.3.2.10.3 | Tags shall ignore optional access commands that they do not support. | Tag | **By design** |
| 249 | 6.3.2.10.3.1 | Interrogators and Tags shall implement the *Req_RN* command shown in Table 6.28. | Tag and Interrogator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 250 | 6.3.2.10.3.1 | When issuing a *Req_RN* command to a Tag in the **acknowledged** state, an Interrogator shall include the Tag's last backscattered RN16 as a parameter in the *Req_RN*. | Interrogator | **By design** |
| 251 | 6.3.2.10.3.1 | If the Tag receives the *Req_RN* with a valid CRC-16 and a valid RN16 it shall generate and store a new RN16 (denoted handle), backscatter this handle, and transition to the **open** or **secured** state. | Tag | **By design** |
| 252 | 6.3.2.10.3.1 | If the Tag receives the *Req_RN* command with a valid CRC-16 but an invalid RN16 it shall ignore the *Req_RN* and remain in the **acknowledged** state. | Tag | **By design** |
| 253 | 6.3.2.10.3.1 | When issuing a *Req_RN* command to a Tag in the **open** or **secured** states, an Interrogator shall include the Tag's handle as a parameter in the *Req_RN*. | Interrogator | **By design** |
| 254 | 6.3.2.10.3.1 | If the Tag receives the *Req_RN* with a valid CRC-16 and a valid handle it shall generate and backscatter a new RN16. | Tag | **By design** |
| 255 | 6.3.2.10.3.1 | If the Tag receives the *Req_RN* with a valid CRC-16 but an invalid handle it shall ignore the *Req_RN*. | Tag | **By design** |
| 256 | 6.3.2.10.3.1 | In either case the Tag shall remain in its current state (**open** or **secured**, as appropriate). | Tag | **By design** |
| 257 | 6.3.2.10.3.1 | Tags that receive an *ACK* with an invalid handle shall return to **arbitrate** (Note: If a Tag receives an *ACK* with an invalid handle it returns to **arbitrate**, whereas if it receives an access command with an invalid handle it ignores the command). | Tag | **By design** |
| 258 | 6.3.2.10.3.1 | The first bit of the backscattered RN16 shall be denoted the MSB; the last bit shall be denoted the LSB. | Tag | **By design** |
| 259 | 6.3.2.10.3.1 | A *Req_RN* shall be prepended with a frame-sync (see 6.3.1.2.8). | Interrogator | **By design** |
| 260 | 6.3.2.10.3.1 | The Tag reply to a *Req_RN* shall be as shown in Table 6.29. | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 261 | 6.3.2.10.3.2 | Interrogators and Tags shall implement the *Read* command shown in Table 6.30. | Tag and Interrogator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 262 | 6.3.2.10.3.2 | *Read* commands shall apply to a single memory bank. | Tag | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 263 | 6.3.2.10.3.2 | If WordCount = $00_h$ the Tag shall backscatter the contents of the chosen memory bank starting at WordPtr and ending at the end of the bank, unless MemBank = 01, in which case the Tag shall backscatter the EPC memory contents starting at WordPtr and ending at the length of the EPC specified by the first 5 bits of the PC if WordPtr lies within the EPC, and shall backscatter the EPC memory contents starting at WordPtr and ending at the end of EPC memory if WordPtr lies outside the EPC. | Tag | **By design** |
| 264 | 6.3.2.10.3.2 | If a Tag receives a *Read* with a valid CRC-16 but an invalid handle it shall ignore the *Read* and remain in its current state (**open** or **secured**, as appropriate). | Tag | **By design** |
| 265 | 6.3.2.10.3.2 | A *Read* shall be prepended with a frame-sync (see 6.3.1.2.8). | Interrogator | **By design** |
| 266 | 6.3.2.10.3.2 | If all of the memory words specified in a *Read* exist and none are read-locked, the Tag reply to the *Read* shall be as shown in Table 6.31. | Tag | **By design** |
| 267 | 6.3.2.10.3.2 | If a one or more of the memory words specified in the *Read* command either do not exist or are read-locked, the Tag shall backscatter an error code, within time $T_1$ in Table 6.13, rather than the reply shown in Table 6.31 (see Annex I for error-code definitions and for the reply format). | Tag | **By design** |
| 268 | 6.3.2.10.3.3 | Interrogators and Tags shall implement the *Write* command shown in Table 6.32. | Tag and Interrogator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 269 | 6.3.2.10.3.3 | Before each and every *Write* the Interrogator shall first issue a *Req_RN* command; the Tag responds by backscattering a new RN16. | Interrogator | **By design** |
| 270 | 6.3.2.10.3.3 | The Interrogator shall cover-code the data by EXORing it with this new RN16 prior to transmission. | Interrogator | **By design** |
| 271 | 6.3.2.10.3.3 | If a Tag in the **open** or **secured** states receives a *Write* with a valid CRC-16 but an invalid handle, or it receives a *Write* before which the immediately preceding command was not a *Req_RN*, it shall ignore the *Write* and remain in its current state. | Tag | **By design** |
| 272 | 6.3.2.10.3.3 | A *Write* shall be prepended with a frame-sync (see 6.3.1.2.8). | Interrogator | **By design** |
| 273 | 6.3.2.10.3.3 | After issuing a *Write* an Interrogator shall transmit CW for the lesser of $T_{REPLY}$ or 20ms, where $T_{REPLY}$ is the time between the Interrogator's *Write* command and the Tag's backscattered reply. | Interrogator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 274 | 6.3.2.10.3.3 | After completing the *Write* a Tag shall backscatter the reply shown in Table 6.33 and Figure 6.23 comprising a header (a 0-bit), the Tag's handle, and a CRC-16 calculated over the 0-bit and handle. | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 275 | 6.3.2.10.3.3 | The Tag shall backscatter an error code during the CW period rather than the reply shown in Table 6.33 (see Annex I for error-code definitions and for the reply format). | Tag | **By design** |
| 276 | 6.3.2.10.3.3 | Upon receiving a valid *Write* command a Tag shall write the commanded Data into memory. | Tag | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 277 | 6.3.2.10.3.3 | The Tag's reply to a *Write* shall use the extended preamble shown in Figure 6.11 or Figure 6.15, as appropriate (i.e. a Tag shall reply as if TRext=1 regardless of the TRext value in the *Query* that initiated the round). | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 278 | 6.3.2.10.3.4 | Interrogators and Tags shall implement the *Kill* command shown in Table 6.34. | Tag and Interrogator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 279 | 6.3.2.10.3.4 | When communicating with Class-1 Tags, Interrogators shall set these bits to $000_2$. | Interrogator | **By design** |
| 280 | 6.3.2.10.3.4 | Class-1 Tags shall ignore these bits. | Tag | **By design** |
| 281 | 6.3.2.10.3.4 | To kill a Tag, an Interrogator shall follow the multi-step kill procedure outlined in Figure 6.23. | Interrogator | **By design** |
| 282 | 6.3.2.10.3.4 | Each EXOR operation shall be performed MSB first (i.e. the MSB of each half-password shall be EXORed with the MSB of its respective RN16). | Interrogator | **By design** |
| 283 | 6.3.2.10.3.4 | Tags shall incorporate the necessary logic to successively accept two 16-bit subportions of a 32-bit kill password. | Tag | **By design** |
| 284 | 6.3.2.10.3.4 | Interrogators shall not intersperse commands other than *Req_RN* between the two successive *Kill* commands. | Interrogator | **By design** |
| 285 | 6.3.2.10.3.4 | If a Tag, after receiving a first *Kill*, receives any valid command other than *Req_RN* before the second *Kill* it shall return to **arbitrate**, unless the intervening command is a *Query*, in which case the Tag shall execute the *Query* (inverting its **inventoried** flag if the <u>session</u> parameter in the *Query* matches the prior session). | Tag | **By design** |
| 286 | 6.3.2.10.3.4 | The Tag reply to the first *Kill* shall be as shown in Table 6.35. | Tag | **By design** |
| 287 | 6.3.2.10.3.4 | The reply shall use the TRext value specified in the *Query* command that initiated the round. | Tag | **By design** |
| 288 | 6.3.2.10.3.4 | After issuing the second *Kill* an Interrogator shall transmit CW for the lesser of $T_{REPLY}$ or 20ms, where $T_{REPLY}$ is the time between the Interrogator's second *Kill* command and the Tag's backscattered reply. | Interrogator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 289 | 6.3.2.10.3.4 | After completing the *Kill* the Tag shall backscatter the reply shown in Table 6.36 and Figure 6.22 comprising a header (a 0-bit), the Tag's <u>handle</u>, and a CRC-16 calculated over the 0-bit and <u>handle</u>. | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 290 | 6.3.2.10.3.4 | Immediately after this reply the Tag shall render itself silent and shall not respond to an Interrogator thereafter. | Tag | **By design** |
| 291 | 6.3.2.10.3.4 | The Tag shall backscatter an error code during the CW period rather than the reply shown in Table 6.36 (see Annex I for error-code definitions and for the reply format). | Tag | **By design** |
| 292 | 6.3.2.10.3.4 | A *Kill* shall be prepended with a frame-sync (see 6.3.1.2.8). | Interrogator | **By design** |
| 293 | 6.3.2.10.3.4 | Upon receiving a valid *Kill* command sequence a Tag shall render itself **killed**. | Tag | **By design** |
| 294 | 6.3.2.10.3.4 | The Tag's reply to the second *Kill* command shall use the extended preamble shown in Figure 6.11 or Figure 6.15, as appropriate (i.e. a Tag shall reply as if TRext=1 regardless of the TRext value in the *Query* that initiated the round). | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 295 | 6.3.2.10.3.5 | Interrogators and Tags shall implement the *Lock* command shown in Table 6.37 and Figure 6.24. | Tag and Interrogator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 296 | 6.3.2.10.3.5 | Only Tags in the **secured** state shall execute a *Lock* command. | Tag | **By design** |
| 297 | 6.3.2.10.3.5 | A Tag shall interpret these bit values as follows: Mask = 0: Ignore the associated Action field and retain the current lock setting; Mask = 1: Implement the associated Action field and overwrite the current lock setting. | Tag | **By design** |
| 298 | 6.3.2.10.3.5 | A Tag shall interpret these bit values as follows: Action = 0: Deassert lock for the associated memory location; Action = 1: Assert lock or permalock for the associated memory location. | Tag | **By design** |
| 299 | 6.3.2.10.3.5 | The payload of a *Lock* command shall always be 20 bits in length. | Tag | **By design** |
| 300 | 6.3.2.10.3.5 | If an Interrogator issues a *Lock* command whose Mask and Action fields attempt to change the lock status of a nonexistent memory bank or nonexistent password, the Tag shall ignore the entire *Lock* command and instead backscatter an error code (see Annex I). | Tag | **By design** |
| 301 | 6.3.2.10.3.5 | If a Tag receives a *Lock* whose payload attempts to deassert a previously asserted permalock bit, the Tag shall ignore the *Lock* and backscatter an error code (see Annex I). | Tag | **By design** |
| 302 | 6.3.2.10.3.5 | If a Tag receives a *Lock* whose payload attempts to reassert a previously asserted permalock bit, the Tag shall simply ignore this particular Action field and implement the remainder of the *Lock* payload. | Tag | **By design** |
| 303 | 6.3.2.10.3.5 | All Tags shall implement memory locking and all Tags shall implement the *Lock* command. | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 304 | 6.3.2.10.3.5 | Specifically, if a Tag receives a *Lock* it cannot execute because one or more of the passwords or memory banks do not exist, or one or more of the Action fields attempt to change a previously permalocked value, or one or more of the passwords or memory banks are either not lockable or not unlockable, the Tag shall ignore the entire *Lock* and instead backscatter an error code (see Annex I). | Tag | **By design** |
| 305 | 6.3.2.10.3.5 | The only exception to this general rule relates to Tags whose only lock functionality is to permanently lock all memory (i.e. all memory banks and all passwords) at once; these Tags shall execute a *Lock* whose payload is $FFFFF_h$, and shall backscatter an error code for any payload other than $FFFFF_h$. | Tag | **By design** |
| 306 | 6.3.2.10.3.5 | A *Lock* shall be prepended with a frame-sync (see 6.3.1.2.8). | Interrogator | **By design** |
| 307 | 6.3.2.10.3.5 | After issuing a *Lock* an Interrogator shall transmit CW for the lesser of $T_{REPLY}$ or 20ms, where $T_{REPLY}$ is the time between the Interrogator's *Lock* command and the Tag's backscattered reply. | Interrogator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 308 | 6.3.2.10.3.5 | After completing the *Lock* the Tag shall backscatter the reply shown in Table 6.38 and Figure 6.22 comprising a header (a 0-bit), the Tag's handle, and a CRC-16 calculated over the 0-bit and handle. | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 309 | 6.3.2.10.3.5 | The Tag shall backscatter an error code during the CW period rather than the reply shown in Table 6.38 (see Annex I for error-code definitions and for the reply format). | Tag | **By design** |
| 310 | 6.3.2.10.3.5 | Upon receiving a valid *Lock* command a Tag shall perform the commanded lock operation. | Tag | **By design** |
| 311 | 6.3.2.10.3.5 | The Tag's reply to a *Lock* shall use the extended preamble shown in Figure 6.11or Figure 6.15, as appropriate (i.e. a Tag shall reply as if TRext=1 regardless of the TRext value in the *Query* that initiated the round). | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 312 | 6.3.2.10.3.6 | Interrogators and Tags may implement an *Access* command; if they do, the command shall be as shown in Table 6.40. | Tag and Interrogator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 313 | 6.3.2.10.3.6 | To access a Tag, an Interrogator shall follow the multi-step procedure outlined in Figure 6.25. | Interrogator | **By design** |
| 314 | 6.3.2.10.3.6 | Each EXOR operation shall be performed MSB first (i.e. the MSB of each half-password shall be EXORed with the MSB of its respective RN16). | Interrogator | **By design** |
| 315 | 6.3.2.10.3.6 | Tags shall incorporate the necessary logic to successively accept two 16-bit subportions of a 32-bit access password. | Tag | **By design** |
| 316 | 6.3.2.10.3.6 | Interrogators shall not intersperse commands other than *Req_RN* between the two successive *Access* commands. | Interrogator | **By design** |
| 317 | 6.3.2.10.3.6 | If a Tag, after receiving a first *Access*, receives any valid command other than *Req_RN* before the second *Access* it shall return to **arbitrate**, unless the intervening command is a *Query*, in which case the Tag shall execute the *Query* (inverting its **inventoried** flag if the <u>session</u> parameter in the *Query* matches the prior session). | Tag | **By design** |
| 318 | 6.3.2.10.3.6 | An *Access* shall be prepended with a frame-sync (see 6.3.1.2.8). | Interrogator | **By design** |
| 319 | 6.3.2.10.3.6 | The Tag reply to an *Access* command shall be as shown in Table 6.41. | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 320 | 6.3.2.10.3.7 | Interrogators and Tags may implement a *BlockWrite* command; if they do, they shall implement it as shown in Table 6.42. | Tag and Interrogator | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 321 | 6.3.2.10.3.7 | *BlockWrite* commands shall apply to a single memory bank. | Tag | **By design** |
| 322 | 6.3.2.10.3.7 | If <u>WordCount</u> = $00_h$ the Tag shall ignore the *BlockWrite*. | Tag | **By design** |
| 323 | 6.3.2.10.3.7 | If <u>WordCount</u> = $01_h$ the Tag shall write a single data word. | Tag | **By design** |
| 324 | 6.3.2.10.3.7 | <u>Data</u> contains the 16-bit words to be written, and shall be 16×<u>WordCount</u> bits in length. | Interrogator | **By design** |
| 325 | 6.3.2.10.3.7 | If a Tag receives a *BlockWrite* with a valid CRC-16 but an invalid <u>handle</u> it shall ignore the *BlockWrite* and remain in its current state (**open** or **secured**, as appropriate). | Tag | **By design** |
| 326 | 6.3.2.10.3.7 | A *BlockWrite* shall be prepended with a frame-sync (see 6.3.1.2.8). | Interrogator | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 327 | 6.3.2.10.3.7 | After issuing a *BlockWrite* an Interrogator shall transmit CW for the lesser of $T_{REPLY}$ or 20ms, where $T_{REPLY}$ is the time between the Interrogator's *BlockWrite* command and the Tag's backscattered reply. | Interro-gator | **By design** Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 328 | 6.3.2.10.3.7 | After completing the *BlockWrite* a Tag shall backscatter the reply shown in Table 6.43 and Figure 6.22 comprising a header (a 0-bit), the Tag's handle, and a CRC-16 cal-culated over the 0-bit and handle. | Tag | **By design** Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 329 | 6.3.2.10.3.7 | The Tag shall backscatter an error code during the CW period rather than the reply shown in Table 6.43 (see Annex I for error-code definitions and for the reply for-mat). | Tag | **By design** Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 330 | 6.3.2.10.3.7 | Upon receiving a valid *BlockWrite* command a Tag shall write the commanded Data into memory. | Tag | **By design** |
| 331 | 6.3.2.10.3.7 | The Tag's reply to a *BlockWrite* shall use the extended preamble shown in Figure 6.11 or Figure 6.15, as appro-priate (i.e. a Tag shall reply as if TRext=1 regardless of the TRext value in the *Query* that initiated the round). | Tag | **By design** Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 332 | 6.3.2.10.3.8 | Interrogators and Tags may implement a *BlockErase* command; if they do, they shall implement it as shown in Table 6.44. | Tag and Interro-gator | **By design** Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 333 | 6.3.2.10.3.8 | *BlockErase* commands shall apply to a single memory bank. | Tag | **By design** |
| 334 | 6.3.2.10.3.8 | If WordCount = $00_h$ the Tag shall ignore the *BlockErase.* | Tag | **By design** |
| 335 | 6.3.2.10.3.8 | If WordCount = $01_h$ the Tag shall erase a single data word. | Tag | **By design** |
| 336 | 6.3.2.10.3.8 | If a Tag receives a *BlockErase* with a valid CRC-16 but an invalid handle it shall ignore the *BlockErase* and re-main in its current state (**open** or **secured**, as appropri-ate). | Tag | **By design** |
| 337 | 6.3.2.10.3.8 | A *BlockErase* shall be prepended with a frame-sync (seev6.3.1.2.8). | Interro-gator | **By design** |
| 338 | 6.3.2.10.3.8 | After issuing a *BlockErase* an Interrogator shall transmit CW for the lesser of $T_{REPLY}$ or 20ms, where $T_{REPLY}$ is the time between the Interrogator's *BlockErase* command and the Tag's backscattered reply. | Interro-gator | **By design** Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 339 | 6.3.2.10.3.8 | After completing the *BlockErase* a Tag shall backscatter the reply shown in Table 6.45 and Figure 6.22 comprising a header (a 0-bit), the Tag's handle, and a CRC-16 cal-culated over the 0-bit and handle. | Tag | **By design** Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 340 | 6.3.2.10.3.8 | The Tag shall backscatter an error code during the CW period rather than the reply shown in Table 6.45 (see Annex I for error-code definitions and for the reply for-mat). | Tag | **By design** |
| 341 | 6.3.2.10.3.8 | Upon receiving a valid *BlockErase* command a Tag shall erase the commanded memory words. | Tag | **By design** |
| 342 | 6.3.2.10.3.8 | The Tag's reply to a *BlockErase* shall use the extended preamble shown in Figure 6.11 or Figure 6.15, as appro-priate (i.e. a Tag shall reply as if TRext=1 regardless of the TRext value in the *Query* that initiated the round). | Tag | **By design** Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 343 | Annex A | Although a general EBV may contain blocks of varying lengths, Tags and Interrogators manufactured according to this specification shall use blocks of length 8 bits (EBV-8). | Tag and Interro-gator | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 344 | Annex A | Tags and Interrogators shall use the EBV-8 word format specified in Table A.1. | Tag and Interro-gator | **By design** |
| 345 | Annex B | State-transition tables B1 to B7 shall define a Tag's re-sponse to Interrogator commands. | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 346 | Table B.1 | "Invalid" shall mean an erroneous command, an unsup-ported command, a command with invalid parameters, a command with a CRC error, or any other command ei-ther not recognized or not executable by the Tag. | -- | Definition. Not verified. |
| 347 | Table B.2 | "Invalid" shall mean an erroneous command, an unsup-ported command, a command with invalid parameters, a command with a CRC error, a command (other than a Query) with a session parameter not matching that of the inventory round currently in progress, or any other command either not recognized or not executable by the Tag. | -- | Definition. Not verified. |
| 348 | Table B.3 | "Invalid" shall mean an erroneous command, an unsup-ported command, a command with invalid parameters, a command with a CRC error, a command (other than a Query) with a session parameter not matching that of the inventory round currently in progress, or any other command either not recognized or not executable by the Tag. | -- | Definition. Not verified. |
| 349 | Table B.4 | "Invalid" shall mean an erroneous command, an unsup-ported command, a command with invalid parameters, a command with a CRC error, a command (other than a Query) with a session parameter not matching that of the inventory round currently in progress, or any other command either not recognized or not executable by the Tag. | -- | Definition. Not verified. |
| 350 | Table B.5 | "Invalid" shall mean an erroneous command, an unsup-ported command, a command with invalid parameters, a command with a CRC error, a command (other than a *Query*) with a <u>session</u> parameter not matching that of the inventory round currently in progress, or any other command either not recognized or not executable by the Tag. | -- | Definition. Not verified. |
| 351 | Table B.6 | "Invalid" shall mean an erroneous command, an unsup-ported command, a command with invalid parameters, a command with a CRC error, a command (other than a *Query*) with a <u>session</u> parameter not matching that of the inventory round currently in progress, or any other com-mand either not recognized or not executable by the Tag. | -- | Definition. Not verified. |
| 352 | Table B.7 | "Invalid" shall mean an erroneous command, an unsup-ported command, a command with invalid parameters, a command with a CRC error, or any other command either not recognized or not executable by the Tag. | -- | Definition. Not verified. |
| 353 | Annex C | Command-response tables C.1 to C.17 shall define a Tag's response to Interrogator commands. | Tag | **By design**<br>Also tested in compliance with 6.3.2.4, Figure 6.19 |
| 354 | Table C.17 | "Invalid" shall mean an erroneous command, an unsup-ported command, a command with invalid parameters, a command with a CRC error, or any other command either not recognized or not executable by the Tag. | -- | Definition. Not verified. |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 355 | Table C.17 | "Invalid" shall mean an erroneous command, an unsupported command, a command with invalid parameters, a command with a CRC error, a command (other than a *Query*) with a session parameter not matching that of the inventory round currently in progress, or any other command either not recognized or not executable by the Tag. | -- | Definition. Not verified. |
| 356 | Annex G.1 | If permitted by local regulations, Interrogators certified for operation in dense-Interrogator environments shall support one of the TDM or FDM methods described below, determined using the algorithm in Figure G.1. | Interrogator | **By design** |
| 357 | Annex G.1 | Regardless of the choice, Interrogator signaling (both modulated and CW) shall be centered in a channel with the frequency accuracy specified in 6.3.1.2.1, and Interrogator transmissions shall satisfy the dense-Interrogator transmit mask in Figure 6.7. | Interrogator | **By design**<br>Also tested in compliance with 6.3.1.2.1 and 6.3.1.2.11 |
| 358 | Annex G.1 | If an Interrogator uses SSB-ASK modulation, the transmit spectrum shall be centered in the channel during R=>T signaling, and the CW shall be centered in the channel during Tag backscatter. | Interrogator | **By demonstration** (only for Interrogators that implement SSB modulation in dense-Interrogator environments)<br><br>Test conditions:<br>Temp: 23 +/– 3 ºC<br>Freq: At channel frequency closest to center of supported band.<br>Power: Maximum Interrogator transmit power, as implemented.<br>Modulation: SSB<br>Tari: 25 µs<br>Backscatter data rate: One or more of the dense-interrogator data rates specified in Annex G of the Protocol specification, as implemented.<br>Other transmit parameters: As implemented |
| 359 | Annex G.1 | Interrogator transmissions and Tag responses shall be separated temporally, with synchronized Interrogators first commanding Tags, then all Interrogators transmitting CW and listening for Tag responses. | Interrogator | **By design** |
| 360 | Annex G.1 | Interrogator transmissions and Tag responses shall be separated spectrally, using one of the three frequency plans described below. | Interrogator | **By design** |
| 361 | Annex G.1 | Interrogator transmissions shall be centered in channels, and Tag backscatter shall be situated at channel boundaries. | Interrogator | **By design** |
| 362 | Annex G.1 | Interrogator transmissions shall be centered in odd-numbered channels, and Tag backscatter shall be situated in even-numbered channels. | Interrogator | **By design** |
| 363 | Annex G.1 | Interrogator transmissions shall be centered in channels, and Tag backscatter shall be situated near but within the channel boundaries. | Interrogator | **By design** |
| 364 | Annex G.2 | When Interrogators in multiple- and dense-Interrogator environments instruct Tags to use subcarrier backscatter, the Interrogators shall adopt the channelization determined by the algorithm in Figure G.1. | Interrogator | **By design** |

| Item | Protocol Subclause | Requirement | Applies To | How Verified |
|---|---|---|---|---|
| 365 | Annex G.2 | When Interrogators in multiple- and dense-Interrogator environments instruct Tags to use FM0 backscatter, the Interrogators shall adopt a channelization that is in accordance with local regulations. | Interrogator | **By design** |
| 366 | Annex G.2 | Regardless of the backscatter data encoding, Interrogator transmissions shall satisfy the multiple- or dense-Interrogator transmit mask in 6.3.1.2.11, as appropriate. | Interrogator | Tested in compliance with 6.3.1.2.11,<br>Figure 6.6 or Figure 6.7 |
| 367 | Annex I.1 | If a Tag encounters an error when executing an access command that reads from or writes to memory, and if the command is a handle-based command (i.e. *Read*, *Write*, *Kill*, *Lock*, *BlockWrite*, or *BlockErase*), then the Tag shall backscatter an error code as shown in Table I.1 instead of its normal reply. | Tag | **By design** |
| 368 | Annex I.1 | If the Tag supports error-specific codes, it shall use the error-specific codes shown in Table I.2. | Tag | **By design** |
| 369 | Annex I.1 | If the Tag does not support error-specific codes, it shall backscatter error code $00001111_2$ (indicating a non-specific error) as shown in Table I.2. | Tag | **By design** |
| 370 | Annex I.1 | Tags shall backscatter error codes only from the **open** or **secured** states. | Tag | **By design** |
| 371 | Annex I.1 | A Tag shall not backscatter an error code if it receives an invalid access command; instead, it shall ignore the command. | Tag | **By design** |
| 372 | Annex I.1 | If an error is described by more than one error code, the more specific error code shall take precedence and shall be the code that the Tag backscatters. | Tag | **By design** |
| 373 | Annex J.1 | A Tag in the **arbitrate** state shall decrement its slot counter every time it receives a *QueryRep* command, transitioning to the **reply** state and backscattering an RN16 when its slot-counter value reaches $0000_h$. | Tag | **By design** |
| 374 | Annex J.1 | A Tag that returns to **arbitrate** with a slot-counter value of $0000_h$ shall decrement its slot-counter from $0000_h$ to $7FFF_h$ (i.e. the slot counter rolls over) at the next *QueryRep* with matching session. | Tag | **By design** |

# 7. Revision History

| Date & Version Number | Section(s) | Change | Approved by |
|---|---|---|---|
| Nov 14, 2004<br>Version 1.0.0 | All | Original document | |
| Dec 11, 2004<br>Version 1.0.1 | Multiple | Modified per the Gen2 conformance V1.0.0 comment resolution. | |
| Jan 26, 2005<br>Version 1.0.2 | Multiple | Modified per the Gen2 V1.0.8 errata and AFI enhancement requests. | |
| August 10, 2005<br>Version 1.0.3 | Multiple | Modified per the Test and Certification Working Group recommendations. | |
| February 15, 2006<br>Version 1.0.4 | Multiple | Modified per the Test and Certification Working Group recommendations.<br>Added Annex A. | |
| February 28, 2007<br>Version 1.0.5 | Multiple | Modified per the Gen2 V1.0.0. | |

# Annex A

## A.1 Scope

This annex provides additional explanation of conformance items, testing parameters, and equipment badging. Some of the questions answered here are referenced in the **How Verified** column of in the Protocol Requirements table in section 6, while others relate generally to the conformance process.

The terms Reader and Interrogator are synonymous.

## A.2 Q and A

**Q1:** How does a reader vendor specify R=>T and T=>R parameters to be tested?

**A:** The reader vendor specifies modulation type, PIE ratio, DR and mask type (dense, multi or single) for each Tari/Backscatter Data Rate (BDR)/encoding combination they wish to have tested in the Mode Table (Table A-1 is a sample completed table). BDR is defined as Backscatter Link Frequency (BLF) divided by M.

Field entry options are:

| | |
|---|---|
| Modulation types | DSB-ASK, SSB-ASK or PR-ASK |
| PIE ratio | A value in the range 1.5:1 to 2:1, inclusive |
| DR | 8 or 64/3 |
| Mask type | DI (Dense Interrogator), MI (Multi Interrogator), or SI (Single Interrogator) |

The vendor enters up to six Tari's to be tested. If more than one Tari value is to be tested, the vendor must list their minimum and maximum Tari.

The same encoding/BDR values can appear more than once (note M=8, BDR=32 entries in the subcarrier and FDM DI categories in Table A-1). This is necessary if a different modulation type, PIE ratio, DR value, or mask type is to be tested for the same Tari/BDR/encoding values.

A "mode" is defined as a combination of Tari, modulation type, PIE, DR, BDR, mask type, and encoding (i.e. a particular entry in the Mode Table). For example, Table A-1 indicates six "modes" for testing.

**Table A-1 – Sample of completed Reader Mode Table**

| Backscatter Encoding | M | Backscatter Data Rate (kbps) | Tari (µs) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 25 | 7.14 | 10 | | | |
| FM0 | 1 | 160 | | | PR/2:1/8 | | | |
| | 1 | 320 | | DS/1.5:1/8 | | | | |
| | 1 | 640 | | DS/1.5:1/64 | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| Subcarrier | 8 | 64 | PR/2:1/64 | | | | | |
| | 8 | 32 | PR/1.5:1/64 | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| FDM DI | 8 | 32 | PR/2:1/64 | | | | | |
| | | | | | | | | |
| TDM DI | | | | | | | | |
| | | | | | | | | |

Key:

- (green) Dense interrogator mask met (necessary but not sufficient for DI certification)
- (yellow) Multiple interrogator mask met
- (pink) Single interrogator mask met

| | |
|---|---|
| DS | DSB-ASK |
| SS | SSB-ASK |
| PR | PR-ASK |
| X:1 | PIE ratio |
| 8 | DR=8 |
| 64 | DR=64/3 |

Table A-2 is a Mode Table template where VS indicates Vendor Selection, parameters to be chosen by the vendor. Limits such as >1, indicate parameter restrictions.

**Table A-2 – Reader Mode Table template**

| Backscatter Encoding | M | Backscatter Data Rate (kbps) | Tari (μs) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | VS max | VS min | VS | VS | VS | VS |
| FM0 | 1 | VS | | | | | | |
| | 1 | VS | | | | | | |
| | 1 | VS | | | | | | |
| | 1 | VS | | | | | | |
| | 1 | VS | | | | | | |
| | 1 | VS | | | | | | |
| Subcarrier | VS >1 | VS | | | | | | |
| | VS >1 | VS | | | | | | |
| | VS >1 | VS | | | | | | |
| | VS >1 | VS | | | | | | |
| | VS >1 | VS | | | | | | |
| | VS >1 | VS | | | | | | |
| FDM DI | VS >2 | VS | | | | | | |
| | VS >2 | VS | | | | | | |
| TDM DI | VS | VS | | | | | | |
| | VS | VS | | | | | | |

Parameters declared in the table are tested. The entries uniquely determine the expected RTcal and TRcal values. The test facility will derive test limits from these values.

**Q2:** The Mode Table is informative but contains an overwhelming amount of information. Is the HW certified or not?

**A:** EPCglobal will list a Conformance Badge for Readers and Tags. For Readers, the Conformance Badge will direct the viewer to the mode table for more detailed information. The following are examples of Reader and Tag badges.

| **Reader Conformance Badge** | | **Options** |
|---|---|---|
| Reader or Module | Reader | *Reader, Module* |
| Intended Operating Region | US | *Intended region of operation* |
| Frequency Range | 902 – 928 MHz | *Band of operation* |
| Modulation Types | PR-ASK and DSB-ASK | *PR-ASK, DSB-ASK, SSB-ASK* |
| Tari's | 7.14 µs, 25 µs, 10 µs | *Tested Tari's* |
| Backscatter Encoding Support | FM0, Miller Subcarrier | *FM0, Miller Subcarrier* |
| Frequency Scheme | FHSS | *FHSS, Agility, Fixed* |
| Temperature Range | -40°C to 65°C | *Product temperature range* |
| Environment | Dense and Multi Interrogator | *Dense, Multi Interrogator* |
| Dense Operation* | FDM and TDM | *N/A, FDM, TDM* |
| Optional Command Support | Access, BlockWrite | *Access, BlockWrite, BlockErase* |

* TDM only Dense Interrogator operators should not be used in a dense FDM deployment.

| **Tag Conformance Badge** | | **Options** |
|---|---|---|
| Frequency Range | 860 – 960 MHz | *Band of operation* |
| Backscatter Modulation Type | ASK | *ASK, PSK* |
| Temperature Range | -40°C to 65°C | *Product temperature range* |
| Optional Command Support | Access, BlockWrite | *Access, BlockWrite, BlockErase* |

**Q3:** What are the criteria for receiving a DI or MI certification? Does DI or MI certified mean the Reader meets the respective mask in all modes tested?

**A:** To receive DI certification the vendor shall declare himself an FDM (Frequency Division Multiplexed) and/or TDM (Time Division Multiplexed) operator. An FDM operator intends to participate in a cooperative frequency plan with other FDM operators such that Reader transmissions do not spectrally interfere with Tag backscatter signaling. A TDM operator intends to be on/off multiplexed such that two near-by Readers never transmit simultaneously. **TDM DI only Readers should not be operated in an FDM DI deployment.**

Criteria for getting DI certification are as follows:

1a) If FDM then test with Tari of 25 µs, PR-ASK or SSB-ASK, using a subcarrier with M=4 or 8, and declare other mode parameters

1b) If TDM then test in declared mode

2) Pass DI mask in tested mode

3) Pass channelization test (frequency accuracy)

MI certification is granted in the Conformance Badge if the MI mask is met for any one of the modes in the Mode Table; that is, at least one entry contains a yellow mark.

The vendor may choose to be tested against the DI mask in any mode. If the mask is met, this will be indicated in the Mode Table by a green mark. A mark, in itself, is not sufficient to achieve DI certification in the Conformance Badge. The other DI criteria must also be met, and if they are, a green mark will be indicated in the FDM DI or TDM DI portion of the Mode Table.

DI or MI certified does not mean the Reader meets the respective mask for all modes tested.

**Q4:** Can a Reader get a MI (yellow) and DI (green) mask mark at the same Tari, modulation type, PIE ratio, DR, BDR, and encoding values in the Mode Table?

**A:** No, either a DI, MI, or SI mask mark is given for a particular set of these parameters. If a DI mask is met, it supercedes MI and SI, so DI credit is given (green mark). Likewise, MI supercedes SI. The vendor chooses DI, MI, or SI testing for a particular set of these parameters. The vendor has the option to move to a less stringent mask if they can not meet the more stringent mask during test.

If at least one of the parameters listed above is unique this will appear as a separate entry in the Mode Table. Both DI and MI certification can be achieved if at least two modes are specified and DI mask testing is performed for one and MI performed for the other. SI is not listed in the Conformance Badge unless neither the DI nor MI criteria are met.

**Q5:** If table entries are optional, what is the incentive for a vendor to attempt certification in multiple modes? The more modes elected, the greater possibility for failure. A vendor can get credit in the Conformance Badge by passing in just one mode. At the other extreme, test time can become excessive for vendors wishing testing at a large number of Tari's. What are the minimal and maximal test requirements?

**A:** Vendors are required to test at least one mode at their minimum and maximum Tari. If a Reader only supports one Tari, that Tari is tested and it is shown in the Conformance Badge. If a Reader supports two or more Tari's, testing must occur at minimum and maximum Tari (at least two modes). The vendor can choose to get tested at up to six Tari's, at as many modulation types, PIE ratios, DR's, BDR's, and encoding values as they wish. The Conformance Badge will indicate the Tari's tested, not to exceed six values.

**Q6:** Numerous interrogator **by demonstration** items in the conformance document specify testing "At center frequency closest to center of supported band". What exactly does this mean?

**A:** The Gen2 protocol accommodates Readers from any region that regulates UHF RFID between 860 and 960 MHz. Multiple operational frequency bands must therefore be supported in conformance testing. For tests in which "At center frequency closest to center of supported band" is specified as a test condition, the vendor declares this frequency to the testing facility according to the following criteria:

a) If the Reader is to be certified for operation in North America and supports subcarrier signaling, then the channelization specified in Table G.1 must be supported and the Reader is tested at 915.25 MHz which is the supported channel frequency closest to the center of the band.

b) If the Reader is to be certified for operation in North America and does not support subcarrier signaling, the Reader is tested at the channel frequency closest to the band center that the Reader supports. The vendor declares that frequency. The vendor may support a sub-band of the FCC band.

c) If the Reader is to be certified for operation in a region other than North America, the Reader is tested at the channel frequency closest to the band center that the Reader supports. The vendor declares that frequency. The vendor may support a sub-band of the regional band.

If a Reader supports multiple regions, certification is achieved by separately testing each band according to the above guidelines.

The center frequency definition has significance for Multi-Interrogator spectral mask testing (6.3.1.2.11, Figure 6.6). The following clarifies the procedures for Multi-Interrogator testing:

a) If the Reader is to be certified for operation in North America and supports subcarrier signaling, the spectral mask requirement (Figure 6.6) is centered at a valid channel frequency (Table G.1) for purposes of compliance test. For the purposes of defining the testing mask, a channel is 500 kHz wide.

b) If the Reader is to be certified for operation in North America and does not support subcarrier signaling, the spectral mask is centered at the vendor declared frequency for purposes of compliance test. For the purposes of defining the test mask, a channel is a maximum of 500 kHz wide. The vendor declares the channel width.

c) If the Reader is to be certified for operation in a region other than North America, the spectral mask is centered at the vendor declared frequency for purposes of compliance test. For the purposes of defining the test mask, channel width is determined by local regulations and is 200 kHz for a CEPT-regulated region.

**Q7:** The conformance document (6.3.1.2.1) specifies that dense-interrogator testing can be limited to the minimum or maximum temperature at which the Reader supports (see Test Condition excerpt below). How does this statement affect me in conformance testing?

Test conditions:

Temp: max(–40, minimum supported temperature) and min(65, maximum supported temperature). If supported temperature range exceeds –25 or 40 then testing will also be performed at –25 or 40 respectively. All temperatures are in ºC (all +/– 3 ºC)

**A:** The intent of this wording to provide a certification path for Readers rated for narrower or wider temperature ranges while preventing spectral pollution when they are operated outside their rated range.

The reader vendor declares their rated temperature range on the conformance application form and shows evidence in their by-design documentation that the rated temperature is specified in their product specification. The test facility tests over the declared range. If the vendor passes, the tested range is listed in the vendors Conformance Badge. It is the end users responsibility to deploy the Reader in an environment that does not exceed the tested limits.

For Readers with rated ranges beyond the –40 or 65 limits, testing shall also be performed at –40 or 65, respectively. For Readers with rated ranges between –25 and –40 or between 40 and 65, testing shall also be performed at –25 or 40, respectively.

**Q8:** For purposes of testing Reader power-up settling time, what defines the end of the settling time interval? The $T_s$ and $T_{hs}$ settling time intervals are shown in Figures 6.3 and 6.5, respectively, in the Gen2 protocol specification.

**A:** The $T_s$ and $T_{hs}$ intervals end when the envelope settles to within 5% of its 100% electric field strength level.

**Q9:** The conformance document (6.3.1.2.6 and 6.3.1.2.7) specifies that the Reader RF envelope shall rise and fall monotonically between the specified power limits. Measurement parameters are not specified, so it is feasible that a Reader can fail the monotonicity test due to measurement uncertainty. What is the test procedure that accounts for measurement uncertainty?

**A:** The test set recovers a time-sampled profile of the rising and falling ramp of the RF envelope. Within the regions that the monotonicity requirements apply, samples are compared to all previous samples. In the case of a falling ramp, the current sample must be less than the previous sample within the measurement tolerance of the test set. For example, if the test set power measurement error is ±2%, than the current sample can not exceed any of the previous samples by more than 2%. The test facility shall establish the measurement accuracy of the test set.

**Q10:** Testing of Reader modulated RF envelope characteristics and symbol durations are specified in 6.3.1.2.3 and 6.3.1.2.5 of the conformance document. These parameters are determined based on A and B measurements as shown in Figure 6.2 of the Gen2 protocol specification. In test, how is A determined?

**A:** In 6.3.1.2.5 of the Gen2 protocol specification, A is referred to as the maximum amplitude of the RF envelope. In Figure 6.2, A is shown as the midpoint between the maximum and minimum ripple excursions. The ripple represents inter-symbol interference associated with the band-limiting of the transmit symbols. Inter-symbol interference can case the RF envelope to exceed the maximum amplitude of an un-modulated signal with the same power. For consistency with the Gen2 protocol specification, the value of A in 6.3.1.2.3 and 6.3.1.2.5 shall be determined by measuring the un-modulated envelope immediately preceding modulation from the first Reader command issued after the end of the settling interval following a power-up. The test facility shall determine the optimal measurement time to establish an accurate estimate of A.