PD CEN/TS 16794-1:2015

BSI Standards Publication

Public transport — Communication between contactless readers and fare media

Part 1: Implementation requirements for ISO/IEC 14443

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee EPL/278, Intelligent transport systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

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ISBN 978 0 580 87654 7

ICS 35.240.15

Compliance with a British Standard cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 May 2015.

Amendments issued since publication

Date	Text affected

TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

TECHNISCHE SPEZIFIKATION

CEN/TS 16794-1

April 2015

ICS 35.240.15

English Version

Public transport - Communication between contactless readers and fare media - Part 1: Implementation requirements for ISO/IEC 14443

Transport Public - Système billettique interopérable - Communication entre terminaux et objets sans contact - Partie 1: Exigences d'implémentation pour l'ISO/IEC 14443

Öffentlicher Verkehr - Kommunikation zwischen berührungslosen Ladegeräten und Fahrscheinmedien - Teil 1: Implementierungsanforderungen zur ISO/IEC 14443

This Technical Specification (CEN/TS) was approved by CEN on 24 February 2015 for provisional application.

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Ref. No. CEN/TS 16794-1:2015 E

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Foreword

This document (CEN/TS 16794-1:2015) has been prepared by Technical Committee CEN/TC 278 “Intelligent transport systems”, the secretariat of which is held by NEN.

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Introduction

These implementation requirements represent the first step in a process designed to ensure contactless communication interoperability between fare management system terminals and any fare media liable to be accepted by them. The end-purpose of this document is therefore to prepare the ground for European deployment of a certification process on contactless communication protocols guaranteeing technical interoperability between fare management system terminals and fare media.

These implementation requirements set out the requirements related to the use of ISO/IEC 14443 to ensure interoperability between fare management system terminals and multiple-form-factor contactless fare media (smartcards, e-tickets, mobile phones, USB keys, tablets, etc.).

These implementation requirements are not designed to repeat or duplicate the referenced specifications (essentially standards ISO/IEC 14443 and ISO/IEC 10373-6) but to finalize some specific points and to define their testing and use conditions, and thus ultimately to improve overall interoperability.

These implementation requirements have been built to facilitate co-compliance of a given fare management system terminal or fare media on both these implementation requirements and one or more other standard specifications like EMVCo Book D or NFC Forum Analog and Digital Technical specifications.

These implementation requirements include the following key clauses:

— Clause 6 presents general considerations applicable to fare management system terminals and fare media.

— Clause 7 sets out the requirements specific to contactless fare management system terminals.

— Clause 8 sets out the requirements specific to contactless fare media.

— Clause 9 sets out the test conditions for the certification of contactless fare management system terminals and contactless fare media under these implementation requirements. It also lists the implementation characteristics to be provided by fare management system terminal manufacturers and contactless fare media manufacturers as a prerequisite to the certification process.

— Various possible polling sequences are given in Annex A for information purposes.

1 Scope

This Technical Specification sets out the technical requirements to be met by contactless fare management system terminals and contactless fare media hosting a transport ticketing application in order to be able to interface together using the ISO/IEC 14443 standard contactless communications protocol.

This Technical Specification applies to:

— any **contactless fare management system terminal** acting as a PCD **contactless reader** based on ISO/IEC 14443 standard series;

— any **contactless fare media** acting as a PICC **contactless object** based on ISO/IEC 14443 standard series.

The purpose of these implementation requirements is to ensure contactless communications interoperability between contactless fare management system terminals and any contactless fare media liable to be accepted by them, once both terminal and fare media have been certified as meeting the requirements of these implementation requirements. An interface–oriented test approach will be used to evaluate the interoperability of relevant components and is defined in CEN/TS 16794-2*, Public transport — Communication between contactless readers and fare media — Part 2: Test plan for ISO/IEC 14443*.

Application-to-application exchanges executed once contactless communication has been established at RF level fall outside the scope of these implementation requirements. In line with the rules on independency between OSI protocol layers, these implementation requirements work on the assumption that application-to-application exchanges are not contingent on the type of contactless communication established or by the parameters used for the low-level protocol layers that serve as the platform for these application-to-application exchanges.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CEN/TS 16794-2, *Public transport — Communication between contactless readers and fare media — Part 2: Test plan for ISO/IEC 14443*

ISO/IEC 10373-6:2011, *Identification cards — Test methods — Part 6: Proximity cards*

ISO/IEC 10373-6:2011/Amd.1:2012, *Identification cards — Test methods — Part 6: Proximity cards / Amendment 1: Additional PICC classes*

ISO/IEC 10373-6:2011/Amd.2:2012, *Identification cards — Test methods — Part 6: Proximity cards / Amendment 2: Test methods for electromagnetic disturbance*

ISO/IEC 10373-6:2011/Amd.3:2012, *Identification cards — Test methods — Part 6: Proximity cards / Amendment 3: Exchange of additional parameters, block numbering, unmatched AFI and TR2*

ISO/IEC 10373-6:2011/Amd.4:2012, *Identification cards — Test methods — Part 6: Proximity cards / Amendment 4: Bit rates of fc/8, fc/4 and fc/2 and frame size from 512 to 4096 bytes*

ISO/IEC 10373-6:2011/Cor.1:2013, *Identification cards — Test methods — Part 6: Proximity cards / Technical Corrigendum 1: R2 value range, start of PICC transmission and program for EMD level measurement*

ISO/IEC 14443-1:2008, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 1: Physical characteristics*

ISO/IEC 14443-1:2008/Amd.1:2012, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 1: Physical characteristics / Amendment 1: Additional PICC classes*

ISO/IEC 14443-2:2010, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 2: Radio frequency power and signal interface*

ISO/IEC 14443-2:2010/Amd.1:2011, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 2: Radio frequency power and signal interface / Amendment 1: Limits of electromagnetic disturbance levels parasitically generated by the PICC*

ISO/IEC 14443-2:2010/Amd.2:2012, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 2: Radio frequency power and signal interface / Amendment 2: Additional PICC classes*

ISO/IEC 14443-2/Amd.3:2012, *Identification cards — Proximity cards — Part 2: Radio frequency power and signal interface / Amendment 3: Bits rates of fc/8, fc/4 and fc/2*

ISO/IEC 14443-3:2011, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 3: Initialization and anticollision*

ISO/IEC 14443-3:2011/Amd.1:2011, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 3: Initialization and anticollision / Amendment 1: Electromagnetic disturbance handling and single-size unique identifier*

ISO/IEC 14443-3:2011/Amd.2:2012, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 3: Initialization and anticollision / Amendment 2: Bit rates of fc/8, fc/4 and fc/2, frame size from 512 bytes to 4 096 bytes and minimum TR0*

ISO/IEC 14443-4:2008, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 4: Transmission protocol*

ISO/IEC 14443-4:2008/Amd.1:2012, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 4: Transmission protocol / Amendment 1: Exchange of additional parameters*

ISO/IEC 14443-4:2008/Amd.2:2012, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 4: Transmission protocol / Amendment 2: Bit rates of fc/8, fc/4 and fc/2, protocol activation of PICC Type A and frame size from 512 bytes to 4 096 bytes*

ISO/IEC 15693-2:2006, *Identification cards — Contactless integrated circuit cards — Vicinity cards — Part 2: Air interface and initialization*

ISO/IEC 18092:2013, *Information technology — Telecommunications and information exchange between systems — Near Field Communication — Interface and Protocol (NFCIP-1)*

EMV Contactless Communication Protocol Specification (2014), *EMV Contactless Specifications for Payment Systems — Book D — EMV Contactless Communication Protocol Specification — Version 2.4 February 2014*

NFC Forum™ - NFC Analog Specification (2012), *Technical Specification - NFC Forum™- ANALOG 1.0 - NFCForum-TS-Analog-1.0 - 2012-07-11*

NFC Forum™ - NFC Digital Specification (2014), *Technical Specification - NFC Forum™- DIGITAL 1.1 - NFCForum-TS-Digital-1.1 - 2014-05-20*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
"battery low" mode
in the case of battery-powered NFC systems, "battery low" mode is as defined in Section 3.5 of GSMA's white paper: GSM Association: Requirements For SWP NFC Handsets V4.0 – March 2011

3.2
common reader
contactless reader interface designed for terminals with reduced performance requirements

3.3
IFM Reader
contactless reader used in Interoperable Fare Management system terminals

3.4
PCD assembly
test PCD assembly (test reader) as defined in test method ISO/IEC 10373-6:2011

3.5
non ISO/IEC 14443-3 frame coding
frame using either:

— ISO/IEC 14443-2 type A modulation, with coding different from REQA or WUPA; or

— ISO/IEC 14443-2 type B modulation, with coding different from REQB or WUPB; or

— ISO/IEC 18092 modulation; or

— ISO/IEC 15693-2 modulation

3.6
Reference PICC
Reference PICC (test card) as defined in test method ISO/IEC 10373-6:2011

4 Symbols and abbreviations

The following abbreviated terms are used in this document:

AFI	Application Family Identifier, Type B
ATQB	Answer To Request, Type B
EMD	Electro Magnetic Disturbance
FWI	Frame Waiting time Integer
FSCI	Frame Size for proximity Card Integer
NFC	Near Field Communication
PCD	Proximity Coupling Device
PICC	Proximity IC Card
PTO	Public Transport Operator
PUPI	Pseudo-Unique PICC Identifier, Type B
REQA	Request Command, Type A

REQB Request Command, Type B

RF Radio Frequency

SFGI Start-up Frame Guard Time Integer

SFGT Start-up Frame Guard Time

t_{detect} Maximum Reference PICC time-to-detection

UID Unique Identifier, Type A

WUPA Wake-UP Command, Type A

WUPB Wake-UP Command, Type B

5 Conformance

Conformance to the present implementation requirements carries a number of requisites:

— For a contactless reader, to meet all the [Rdr*nn*] requirements listed herein that are applicable according to the applicant's stated implementation characteristics (ICS), under the test conditions stipulated in Clause 2 and following the PCD Reader test plan set out in CEN/TS 16794-2.

— For a contactless object, to meet all the [Obj*nn*] requirements listed herein that are applicable according to the applicant's stated implementation characteristics (ICS), under the test conditions stipulated in Clause 2 and following the PICC Media test plan set out in CEN/TS 16794-2.

The validation process to be carried out by contactless object and contactless reader manufacturers or integrators is out of scope of the present specification.

6 General considerations for fare media and contactless readers

6.1 Combining the present requirements with others industry standards

The implementation requirements are designed to facilitate the software and hardware migration roadmap for existing fare management system terminals and to minimize the allied roadmap costs by integrating existing contactless ticketing test specifications (regional or local test specifications used in population clusters aiming for transport interoperability). Moving forward along these lines, the specifications do not impose a unique predefined polling sequence for fare management system terminals, but define minimal requirements for polling sequence, thus leaving each transport network free to integrate into this sequence those contactless fare media that are off-scope, i.e. non-compliant to the ISO/IEC 14443 requirements on Type A or B as outlined herein.

These implementation requirements, for those transport networks that opt in, also give the possibility to get an EMVCo L1 certification on fare management system terminals designed to accept contactless payment as the transport network fare payment and access system, regardless of the type of media hosting the allied applications: contactless smartcards, NFC-enabled mobile phones, NFC-enabled secure memory cards, etc.

In order to facilitate joint compliance to these requirements and to EMVCO requirements, notes have been added where EMVCo imposes restricted implementation and these current implementation requirements are more open.

Similarly, when NFC devices are used as fare management system terminals or as fare media, additional certification such as NFC Forum certification may be requested for these devices. It should be possible for an NFC-enabled device to comply both with these implementation requirements and with NFC Forum’s Analog and Digital Technical specifications. Some discussions will take place between the CEN TC 278 Working Group 3 SG 5 and NFC Forum’s SIG Transport to look after requirements harmonization.

The requirements set out in these implementation requirements are applicable to contactless fare media, whether they are dedicated solely for use in a transport fare solution or whether they are designed to host a number of contactless applications from other sectors (telecom, banking, mass retail, etc.) in addition to a transport application. By this, transport-sector contracting authorities can require conformance to these requirements when making procurement orders for transport-network fare management system terminals and contactless fare media. It is equally desirable that the manufacturers of multi-capability contactless fare media (NFC-enabled smartphones, contactless USB keys, NFC-enabled secure memory cards, multi-application-carrying contactless cards) ensure their products conform to these implementation requirements to make them eligible for hosting fare management system applications.

NFC mobile devices designed and tested according to NFC Forum specifications will be covered in Edition 2 of this Technical Specification. The work on Edition 2 is intended to complement Edition 1 for NFC Forum devices and not to rework Edition 1. Edition 2 will ensure backward compatibility with Edition 1 requirements.

6.2 Progressive and flexible approach to the targeted interoperability

These implementation requirements should make it possible to accept a broad spectrum of contactless fare media, without distinction between form factors not smaller than Class 3 such as: contactless smartcards in ID-1 format (as defined in ISO/IEC 7810), contactless tickets, contactless USB keys and NFC-enabled mobile phones, or any other contactless fare media that is a PICC and is in conformance with the requirements stipulated in these implementation requirements. This requires that PT infrastructures follow the amendments on additional PICC classes that are provided with the latest version of ISO/IEC 14443 and ISO/IEC 10373-6 standards.

In the past, significant investments in PT infrastructures have been made by PTOs across Europe. These comply mainly with previous versions of ISO/IEC 14443 and support interoperability with Class 1 PICC (e.g. ID1-cards) only. The targeted interoperability with next generation fare media like NFC mobile devices and smart objects within PICC classes 2 or 3 would probably require an update of this reader infrastructure and generate significant cost. The following step-by-step approach will facilitate an economically viable transition that can be accepted and justified by the PTO:

a) In the first step, interoperability may be supported for classical fare media (Class 1 PICC) only. The reader infrastructure has to support ISO/IEC 14443 and ISO/IEC 10373-6 but not the amendments related to additional PICC classes.

b) As soon as the PTO wants to introduce mobile services and next generation fare media like NFC mobile devices and smart objects within PICC classes 2 or 3, the infrastructure has to be upgraded to comply with the latest version of ISO/IEC 14443 and ISO/IEC 10373-6 standards including the amendments on additional PICC classes. By this, a mandatory precondition for the targeted interoperability for all fare media in the scope will be reached. At this point, the investment into the update of the reader infrastructure has to be made but it can be justified by new services and enhanced customer value.

7 Requirements on contactless readers

7.1 General

This clause sets out the requirements applicable to contactless fare management system terminals acting as PCD **contactless readers** based on ISO/IEC 14443 standard.

— Requirements described in 7.3, 7.4 and 7.5 are normative and mandatory to achieve interoperability.

— Requirement described in 7.6 is informative only, hence not necessary to achieve interoperability.

Requirements on contactless readers are identified by a numbering format that reads [Rdrnn] where nn is the number of the requirement.

7.2 Categories for contactless reader

This Technical Specification reflects that contactless readers' requirements depend on particular use cases. Therefore two categories of readers are introduced:

— The first category, the "IFM Reader", covers use cases where performance (i.e. reading distance, transaction time) is key.

— The second reader category, the "Common Reader", is defined for scenarios that impose requirements on the contactless interface such as minimization of cost or maximisation of battery life of the reader. These requirements have been derived from use cases from the following parts of the PTO's system implementation:

  — sales infrastructure,

  — customer's home infrastructure,

  — mobile inspection terminals.

Some requirements given in this specification will be adapted for Common Readers.

There is no compromise against the cost of interoperability as all implementation requirements and tests that are necessary to achieve interoperability between contactless readers and fare media are mandatory for both reader categories.

As indicated in 6.1, Edition 2 will ensure backward compatibility with Edition 1 requirements. This will protect legacy investment in contactless readers and infrastructure equipment.

7.3 Normative requirements for contactless readers

[Rdr1] Contactless readers shall meet the mandatory normative requirements for PCD defined in the ISO/IEC 14443 standard and associated ISO/IEC 10373-6 test methods standards listed in Clause 2 with the following temporary waivers:

— The limits and test methods for electromagnetic disturbance parasitically generated by the PICC has recently been standardised (ISO/IEC 14443-2:2010/Amd.1:2011, ISO/IEC 14443-3:2011/Amd.1:2011 and ISO/IEC 10373-6:2011/Amd.2:2012) and contactless readers in the field may not be compliant with these standards. The electromagnetic disturbance requirements defined in these standards are therefore informative for existing readers. Existing readers should implement an EMD recovery algorithm to meet, as far as possible, the low EMD time $t_{E,PCD}$ specified in ISO/IEC 14443-3:2011/Amd.1:2011. These electromagnetic disturbance requirements are mandatory for contactless readers produced after the publication of this Technical Specification.

— Additional PICC classes (including e.g. different load modulation amplitude limits for PCD) have recently been standardised (ISO/IEC 14443-2:2010/Amd.2:2012, ISO/IEC 14443-1:2008/Amd.1:2012 and ISO/IEC 10373-6:2011/Amd.1:2012) and most contactless readers in the field may not be compliant with these standards. The requirements defined in these standards are therefore:

  — mandatory for all system infrastructures that use above mentioned additional PICC classes;

  — informative for a transitional period for system infrastructures that use only "Class 1" PICC fare media: this transition period ends as soon as the PTO wishes to support "Class 2" or "Class 3" PICC fare media.

NOTE 1 If contactless objects are introduced into a PT infrastructure using existing readers without EMD compliance, interoperability cannot be guaranteed.

NOTE 2 Contactless readers are tested against the Reference PICCs 1, 2 and 3 only, corresponding to mandatory classes 1, 2 and 3. No test is required with Reference PICCs 4, 5 and 6 corresponding to optional classes 4, 5 and 6.

NOTE 3 There are no particular restrictions to contactless objects using the UID values (Type A) or PUPI values (Type B) stipulated in the standard, including random UID/PUPI values.

NOTE 4 There are no particular restrictions to contactless objects using any value for Application data field (Type B).

NOTE 5 EMVCo Book D imposes that the extended ATQB option shall not be supported. ISO/IEC 14443-3 considers that the support of this feature is optional.

NOTE 6 These implementation requirements make it possible for contactless readers to accept a broad spectrum of contactless objects, without distinction between form factors, but not smaller than Class 3, such as: contactless smartcards in ID-1 format (as defined in ISO/IEC 7810), contactless tickets, contactless USB keys and NFC-enabled mobile phones, or any other contactless fare media that is a PICC and is in conformance with the requirements stipulated in these Technical Specifications.

7.4 Specific requirements for contactless readers

[Rdr2] All the [Rdr1] requirements tested with the Reference PICCs 1, 2 and 3 shall be complied with inside the operating distance of range A.

For Common Readers, the range A required is limited to positions A1 to A2. If those positions cannot be applied, because e.g. the fare media object shall be inserted into a card slot, a single position needs to be defined by the manufacturer of the Common Reader and tested accordingly. This single position shall be either marked in such way that a user can clearly position his contactless object in this position or the mechanical construction shall control the positioning of the contactless object in this position.

[Rdr3] When tested with Reference PICC 3 all the [Rdr1] requirements tested shall be complied with inside the operating distance range B. In addition, the contactless reader shall provide a field strength of at least 2 A/m on all positions in this range B.

For Common Readers, the range B required is limited to positions B1 to B2. If those positions cannot be applied, because e.g. the fare media object shall be inserted into a card slot, a single position needs to be defined by the manufacturer of the “Common Reader" and tested accordingly. This single position shall be either marked in such way that a user can clearly position his contactless object in this position or the mechanical construction shall control the positioning of the contactless object in this position.

NOTE 1 These minimum operating distance ranges are added as complementary requirements to ISO/IEC 14443-2. Operating distance ranges A and B are defined in 9.2.2.

NOTE 2 The minimum field strength requirement in range B is necessary to compensate in particular for the low load modulation issue of current NFC mobile handsets when used in RF field with low field strength.

[Rdr4] The contactless reader shall use an AFI of 00h (applicable to Type B only).

[Rdr5] The contactless reader shall comply with ISO/IEC 14443 recommendations on reception of bits and values reserved for future use.

NOTE 3 This requirement is intended to offer future proofed implementation that will allow the same behaviour to remain valid when new options in the ISO/IEC 14443 standard use any of the currently RFU bits and/or values.

7.5 Requirements on polling and recognizing contactless objects

This subclause describes the "listen" strategy for polling contactless objects found present in the operational field but does not address how they are handled once detected.

EMVCo Book D stipulates that for EMVCo L1 certification, once a contactless object has been detected, polling shall continue for the other RF type and possible other contactless modulation schemes, codings and protocols on the same carrier frequency that the contactless reader supports before opening a dialogue with the object first detected. This constraint slows the all-round transaction time, and consequently certain transport networks may prefer a response behaviour wherein the first object detected gets immediately treated rather than keep their terminal eligible for EMVCo L1 certification and thereby eligible for accepting payment cards.

[Rdr1] The time-to-detection by the contactless reader of a Reference PICC requiring minimum SFGT (no SFGI or SFGI=0) shall be under t_{detect} = 250 ms. This remains a valid requirement regardless of the moment when the Reference PICC is placed within range A or B of the contactless reader. The Reference PICC time-to-detection is defined between the moment when the Reference PICC is placed into the field and the send-out of the first I-block sent by the contactless reader. The Reference PICC time-to-detection shall be the average value measured on 10 consecutive measurements and shall be provided by the testing laboratory as part of the result report.

NOTE 1 For contactless readers that don't keep their field continuously active, the Reference PICC time-to-detection is counted from the moment when the field is started and assumes that the PICC is already in the operating volume.

NOTE 2 While complying with the full set of requirements stipulated in ISO/IEC 14443-3 using the commands of (REQA /or WUPA) and of (REQB and/or WUPB) specified in ISO/IEC 14443-3, the polling sequence may also poll for other objects non compliant with ISO/IEC 14443-3 using non ISO/IEC 14443-3 frame coding.

NOTE 3 In cases where objects non compliant with ISO/IEC 14443-3 are also polled for, it is possible to extend the polling window for a given type to longer times (up to the maximum time to detection defined in [Rdr6]) rather than go for performance speeds. This application-layer option to extend the polling time for a different type may be dependent on the number of cards of each type deployed locally at street-level.

When inserting field shut-offs in the polling sequence, the contactless reader should take care that contactless objects using a random identifier will respond with a different identifier and therefore should not consider such an object as two different objects.

When getting no response from a contactless object despite error detection and recovery defined in ISO/IEC 14443-4, contactless readers not using any field shut-off in their polling sequence should use a field shut-off to put the silent contactless object in IDLE state, allowing it to receive and answer request commands without need to manually remove it from the field.

NOTE 4 Contactless readers implementing a B-then-A polling subsequence immediately followed by a field shut-off, will not comply with EMVCo Book D specifications and thereby cannot be eligible for EMVCo L1 certification.

NOTE 5 Tests will need to be run to verify whether contactless objects non compliant with ISO/IEC 14443-3 affect the execution of the polling scenario described above, regardless of whether they are presented alone or simultaneously with a Type A or Type B contactless object. These cases are excluded from the scope of application of these implementation requirements.

[Rdr7] The contactless reader may give priority to applications using a proprietary protocol initiated by ISO/IEC 14443-3 polling commands (REQA/WUPA and/or REQB/WUPB), but shall come back to applications using the ISO/IEC 14443-4 protocol when no suitable application using such a proprietary protocol is found.

NOTE 6 This requirement is intended to ensure that the reader will not lock on a proprietary protocol when processing contactless objects supporting one or several other proprietary protocols initiated by ISO/IEC 14443-3 polling commands (REQA/WUPA and/or REQB/WUPB), in addition to ISO/IEC 14443-4 protocol.

The contactless reader may give priority to applications using a proprietary protocol initiated by a non ISO/IEC 14443-3 polling command (see A.1.1.3). When no suitable application using such a proprietary protocol is found, the contactless reader should continue its polling cycle until it sends the ISO/IEC 14443-3

polling commands (REQA/WUPA and REQB/WUPB), preferably after a field shut-off as the object may have locked in one of its proprietary protocols initiated by a non ISO/IEC 14443-3 polling command. [Rdr7] then applies so that the contactless reader returns to seek applications using the ISO/IEC 14443-4 protocol when no suitable application using a proprietary protocol is found.

Annex A (informative) gives examples of PICC polling sequences for contactless readers.

7.6 Performance requirements (informative)

The following requirement is providing performance indications and is informative only.

[Rdr8] The frame size supported by the contactless reader in receiver mode should be at least 256 bytes. Consequently, the contactless reader should indicate a FSDI (Type A) or a Maximum Frame Size Code in ATTRIB (Type B), greater than or equal to 8.

NOTE The aim of this requirement is to avoid forcing the contactless object to segment its long answers into small frames, which would slow the transaction.

8 Requirements on contactless objects

8.1 General

This clause sets out the requirements applicable to **contactless objects** – PICC - hosting or liable to host contactless ticketing applications, based on ISO/IEC 14443 standard.

Requirements described in 8.2, 8.3 and 8.4 are normative and mandatory for achieving interoperability.

Requirements described in 8.5 is informative only, hence not necessary to achieve interoperability.

Requirements on contactless objects are identified by a numbering format that reads **[Obj*nn*]** where *nn* is the number of the requirement.

8.2 Normative requirements for contactless objects

[Obj1] Contactless objects shall meet the mandatory normative requirements for PICC defined in the ISO/IEC 14443 standard and associated ISO/IEC 10373-6 test methods standard listed in Clause 2 with the following temporary waiver:

The limits and test methods for electromagnetic disturbance parasitically generated by the PICC has recently been standardised (ISO/IEC 14443-2:2010/Amd.1:2011,ISO/IEC 14443-3:2011/Amd.1:2011 and ISO/IEC 10373-6:2011/Amd.2:2012) and contactless objects in the field may not be compliant with these standards. The electromagnetic disturbance requirements defined in these standards are therefore informative for existing contactless objects. These electromagnetic disturbance requirements are mandatory for contactless objects produced after the publication of this Technical Specification.

NOTE Contactless object manufacturers are free to opt to conform or not to the EMVCo requirements (which cap the bit rates capabilities indicated during the initialisation at 106 kbit/s in both directions).

8.3 Specific requirements for contactless objects

[Obj2] Contactless objects shall meet the "Class 1", "Class 2" or "Class 3" requirements of the ISO/IEC 14443 and ISO/IEC 10373-6 standards.

NOTE 1 Contactless objects with an antenna that doesn’t correspond to any of the ISO antenna classes will be declared as unclassified and tested as for "Class 1" PICCs.

NOTE 2 The FWI limit has to be optimized for any contactless object in order to avoid over-slow reaction times when withdrawing a contactless object or in response to communication bugs. This leaves, e.g. contactless object manufacturers free to opt to conform to the EMVCo requirements, which limits the FWI to 7.

[Obj3] The contactless object shall comply with ISO/IEC 14443 recommendations on reception of bits and values reserved for future use.

NOTE 3 This requirement is intended to offer future proofed implementation that will allow the same behaviour to remain valid once new options in the ISO/IEC 14443 may use any of the RFU bits and/or values.

NOTE 4 These implementation requirements do not deal with contactless objects that do not comply with ISO/IEC 14443-4, such as contactless tickets (or emulators thereof). This case is excluded from the scope of application of these implementation requirements.

8.4 Requirements concerning field ramp-ups and shut-offs

The following behaviour pattern is required from contactless objects liable to answer positively to a PCD reader polling sequence on several types of RF communication:

[Obj4] After a field ramp-up/re-ramp (whether due to an in-field movement of the contactless object or a contactless reader-triggered field shut-off), the contactless object shall only answer according to a single operating type (A or B), i.e. once it has sent back an ATQ in one type (A or B), it shall not emit any other message in any other type until its field has been shut-off.

NOTE The field shut-offs can continue for any length of time and can be used, for example, to reduce or minimize reader power demand (although this will mean slower transaction times for users).

8.5 Performance requirements (informative)

The following requirement is providing performance indications and is informative only.

[Obj5] The frame size supported by the contactless object in receiver mode should be at least 64 bytes. Consequently, the contactless object should indicate an FSCI (Type A) or Maximum Frame Size Code (Type B) greater than or equal to 6.

NOTE The aim of this requirement is to avoid forcing the contactless reader to segment its long commands into small frames, which would slow the transaction.

9 Test boundaries and test conditions

9.1 Implementation characteristics

9.1.1 General

This paragraph describes the **ICS** (Implementation Conformance Statements) that manufacturers need to provide, and listing the characteristics of the hardware to be tested:

— The ICS for contactless readers - PCD

— The ICS for contactless objects - PICC

NOTE 1 If a contactless device supports both modes (PCD and PICC) and the aim is to check its conformance under both these modes, the manufacturer will need to run through two separate test campaigns and complete two ICSs.

NOTE 2 These implementation requirements are focused solely on the protocol conformance and interoperability aspects. They do not describe performance tests or tests on the transaction times achieved with the contactless readers and contactless objects under test.

9.1.2 ICS for contactless readers – PCD

This paragraph sets out the information that needs to be provided by contactless reader manufacturers when filing a product validation request.

On top of the ICS describing the characteristics of the contactless reader to be tested, the manufacturer shall also provide the test laboratories with the additional tools that enable the tests to be executed.

This ICS is referencing some technical characteristics for PCD defined in 9.2.3.

```
[PCD.1]   Administrative data
   [PCD1.1]  Brand name:
   [PCD1.2]  Trade name:
   [PCD1.3]  Serial number:
   [PCD1.4]  Hardware/Software version:
[PCD.2]   General technical characteristics
   [PCD2.1]  Reader type:     IFM Reader (full range A and B):        ☐
             or           Common Reader (limited range A and B):  ☐
   [PCD2.2]  Operating mode supported:  PCD ☒
   [PCD2.3]  Contactless readers with a continuously active RF field:
             Yes o  No  o
             If no, precise event triggering field activation: …….
   [PCD2.4]  Antenna diagram and position on the contactless reader under test:

      Range A:
[PCD2.5]  Reference of PCD Zero Point – Range A (target ID marked on sample or
photo
          or diagram):
   [PCD2.6]  Orientation of the Z-axis – Range A (photo or diagram):
   [PCD2.7]  Height of PCD Zero Point – Range A in relation to reader surface in
the Z-axis
             (where applicable): ….mm
   [PCD2.8]  Positions of the X-axis and Y-axis of the Reference PICC above PCD
Zero Point –
             Range A (photo or diagram)
      Range B:
   [PCD2.9]  Reference of PCD Zero Point – Range B (target ID-marked on sample
or photo
             or diagram):
   [PCD2.10] Orientation of the Z-axis – Range B (photo or diagram):
   [PCD2.11] Height of PCD Zero Point – Range B in relation to reader surface in
the Z-axis
             (where applicable): ….mm
   [PCD2.12] Positions of the X-axis and Y-axis of the Reference PICC above PCD
Zero Point –
             Range B (photo or diagram)
   [PCD2.13] Operational temperature range supported:
                Class A (Ambient)          o
                Class B (-10°C to + 50°C)     o
                Class C (-20°C to + 70°C)     o
   [PCD2.14] List of supported PICC classes according to ISO/IEC 14443:
             "Class 1" ☒  "Class 2" ☒  "Class 3" ☒
[PCD.3]   Technical characteristics of the product in PCD
   [PCD3.1]  Protocols supported:       Type A ☒ and Type B ☒ Other: _________
   [PCD3.2]  CID support          YES o      NO  o
   [PCD3.3]  NAD support          YES o      NO  o
   [PCD3.4]  EMD support          YES o      NO  o
```

The types supported by the contactless reader device under test shall compulsorily be types A and B. The only informal requirement shall be the option to indicate whether other protocols on top of A and B are also supported.

```
[PCD.4]   Type A
   [PCD4.1]  PCD->PICC bit rates supported:   fc/128 (~106 kbit/s)   ☒
             Other supported bit rates: …
   [PCD4.2]  PICC->PCD bit rates supported:   fc/128 (~106 kbit/s)   ☒
             Other supported bit rates: …
   [PCD4.3]  FSDI:
[PCD.5]   Type B
   [PCD5.1]  PCD->PICC bit rates supported:   fc/128 (~106 kbit/s)   ☒
             Other supported bit rates: …
   [PCD5.2]  PICC->PCD bit rates supported:   fc/128 (~106 kbit/s)   ☒
             Other supported bit rates: …
   [PCD5.3]  Maximum Frame Size Code in ATTRIB:
   [PCD5.4]  Extended ATQB support         YES o      NO  o
[PCD.6]   Test Parameters
   [PCD6.1a] UT_TEST_COMMAND1 APDU definition:          … (hexa value)
   [PCD6.1b] UT_TEST_COMMAND1 Answer to ADPU definition:… (hexa value)
   [PCD6.2a] UT_TEST_COMMAND2 APDU definition:          … (hexa value)
   [PCD6.2b] UT_TEST_COMMAND2 Answer to ADPU definition:… (hexa value)
[PCD.7]   Proprietary Test Parameters
   [PCD7.1]  PROPRIETARY_COMMAND APDU(S) definition:          … (hexa value)
   [PCD7.2]  PROPRIETARY_COMMAND Answer to ADPU(S) definition: … (hexa value)
```

NOTE Usages of UT_TEST_COMMAND1 & UT_TEST_COMMAND2 for PCD tests are defined in ISO/IEC 10373-6:2011, H.1.9.1.

When the support of proprietary protocol initiated by ISO/IEC 14443-3 polling commands is indicated in [PCD3.1] and when the reader may give priority to applications using such proprietary protocol compared to applications using Type A or Type B, in order to perform the testing of [Rdr7], the reader manufacturer shall describe:

— in [PCD7.1], the proprietary command(s) used to select an application using a proprietary protocol initiated by ISO/IEC 14443-3 polling commands:

  — for ISO/IEC 14443-3 fully compliant products, the command(s) following the anticollision procedure;

  — for ISO/IEC 14443-3 partially compliant products, the command(s) following the request command.

— in [PCD7.2] the expected response(s) to these commands:

  — compliant with the proprietary protocol;

  — indicating that no suitable application is available.

9.1.3 ICS for contactless objects - PICC

This paragraph sets out the information that needs to be provided by contactless object manufacturers when filing a product validation request.

This ICS is referencing some technical characteristics for PICC defined in 9.2.4.

```
[PICC.1]  Administrative data
   [PICC1.1] Brand name:
   [PICC1.2] Trade name:
```

```
   [PICC1.3] Serial number:
   [PICC1.4] Hardware/Software version:
[PICC.2]  General technical characteristics
   [PICC2.1] Operational mode of the product:     PICC   ☒
   [PICC2.2] Antenna diagram and position on the contactless object under test:
   [PICC2.3] Reference of PICC Zero Point (target ID-marked on sample or photo
or diagram):
   [PICC2.4] Operational temperature range supported:
               Class A (Ambient)          o
               Class B (-10°C to + 50°C)     o
               Class C (-20°C to + 70°C)     o
   [PICC2.55]    Antenna class according to ISO/IEC 14443:
            Unclassified o  "Class 1" o  "Class 2" o  "Class 3  o "
   [PICC2.66]    Battery-powered object: Yes   o  No        o
[PICC.3]  Technical characteristics of the product in PICC
   [PICC3.1] Protocols supported:       Type A o   Type B o      Other:
```

The object may support more than one Type. When more than one Type is supported, the object shall apply for conformance for each supported Type according to ISO/IEC 14443.

```
[PICC.4]  Type A (where applicable)
   [PICC4.1] PCD->PICC bit rates supported:    fc/128 (~106 kbit/s)    ☒ Other
supported bit rates: …
   [PICC4.2] PICC->PCD bit rates supported:    fc/128 (~106 kbit/s)    ☒ Other
supported bit rates: …
   [PICC4.3] UID:   Single size (4 bytes)   o  Double Size (7 bytes)   o  Triple
size (10 bytes)  o
   [PICC4.4] UID value:    fixed number     o      random number o
   [PICC4.5] FWI:
   [PICC4.6] SFGI:
   [PICC4.7] FSCI:
   [PICC4.8] CID support      YES o      NO  o
   [PICC4.9] NAD support      YES o      NO  o
[PICC.5]  Type B (where applicable)
   [PICC5.1] PCD->PICC bit rates supported:    fc/128 (~106 kbit/s) ☒    Other
supported bit rates: …
   [PICC5.2] PICC->PCD bit rates supported:    fc/128 (~106 kbit/s) ☒    Other
supported bit rates: …
   [PICC5.3] PUPI value:      fixed number  o      random number o
   [PICC5.4] FWI:
   [PICC5.5] Maximum Frame Size Code in ATQB:
   [PICC5.6] CID support      YES o      NO  o
   [PICC5.7] NAD support      YES o      NO  o
[PICC.6]  Test Parameters
[PICC6.1a]    TEST_COMMAND1 APDU definition:          … (hexa value)
[PICC6.1b]    TEST_COMMAND1 Answer to ADPU definition:    … (hexa value)
[PICC6.1c]    Precondition sequence for TEST_COMMAND_1 : …
[PICC6.2a]    TEST_COMMAND2 APDU definition:          … (hexa value)
[PICC6.2b]    TEST_COMMAND2 Answer to ADPU definition:       … (hexa value)
[PICC6.2c]    Precondition sequence for TEST_COMMAND_2 : …
[PICC6.3a]    TEST_COMMAND3 APDU definition:              … (hexa value)
[PICC6.3b]    TEST_COMMAND3 Answer to ADPU definition:       … (hexa value)
[PICC6.3c]    Precondition sequence for TEST_COMMAND_3 : …
[PICC6.4] TEST_COMMAND_SEQUENCE : …
```

NOTE 1 Usages of TEST_COMMAND1, TEST_COMMAND2 & TEST_COMMAND3 for PICC tests are defined in ISO/IEC 10373-6:2011, 3.2.

NOTE 2 If the PICC requires additional sequences to be ready to accept TEST_COMMAND1, TEST_COMMAND_2 or TEST_COMMAND_3, those sequences should be described in the precondition sequence fields.

A test sequence (list of APDUs) shall be defined. The list shall contain at minimum 2 APDUs with their respective expected answer.

Since the use of cryptographic functions have strong influence on the power consumption of the carrier medium and therefore on the parameters of its contactless interface, testing of the RF interface shall be conducted with those cryptographic functions that are employed by the specific application-to-application transactions.

9.2 Test conditions

9.2.1 General

This paragraph sets out the conditions under which tests are performed to determine the conformance of a contactless reader or contactless object to the requirements of this Technical Specification.

9.2.2 Temperature

Given that contactless readers or objects operate under only short distances, it is necessary to verify that the contactless reader or contactless object are able to respect this operating distance regardless of ambient temperature.

For contactless readers and objects, the manufacturer will indicate in the PCD or PICC ICS whether he wishes to get a conformance for ambient temperature only or for ambient and extreme temperatures. This will be determined by the Temperature class that the PCD or PICC under test shall conform to.

Three temperature classes have been defined as described in Table 1 — Temperature ranges for contactless readers and contactless objects.

The tests are executed at ambient temperature (+23 °C) in all cases. According to the Temperature Class to which the contactless reader or contactless object belongs to, additional tests are performed at minimum and maximum temperatures of the Temperature Class indicated in Table 3.

The list of tests to be run at ambient and non-ambient temperature on contactless readers and objects will be identified in CEN/TS 16794-2, *Public transport — Communication between contactless readers and fare media — Part 2: Test plan for ISO/IEC 14443*.

Table 1 — Temperature ranges for contactless readers and contactless objects

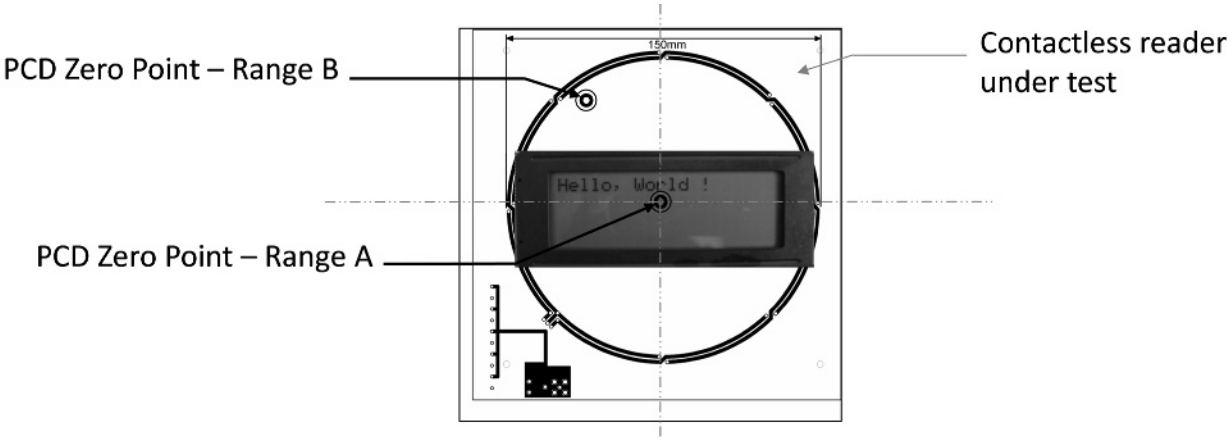
Temperature class	Contactless readers - PCD	Contactless objects - PICC
A	• Ambient: +23 °C • Minimum: N.A • Maximum: N.A	• Ambient: +23 °C • Minimum: N.A. • Maximum: N.A.
B	• Ambient: +23 °C • Minimum: -10 °C • Maximum: +50 °C	• Ambient: +23 °C • Minimum: -10 °C • Maximum: +50 °C
C	• Ambient: +23 °C • Minimum: -20 °C • Maximum: +70 °C	• Ambient: +23 °C • Minimum: -20 °C • Maximum: +70 °C

9.2.3 Test positions for contactless readers

9.2.3.1 General

These implementation requirements define two operating ranges A and B for the contactless reader test.

These two ranges do not necessarily localize to the same places on the contactless reader under test. They may correspond to two distinctly separate targets where the PCD Zero Point – Range A and the PCD Zero Point – Range B are the centres.



NOTE For Common Readers, the range A required is limited to positions A1 to A2 and the range B is limited to positions B1 to B2.

Figure 1 —Example of a contactless reader with different A and B ranges

9.2.3.2 Operating distance – Range A

These implementation requirements define range A under which measurements shall be taken for contactless readers to be tested with Reference PICCs 1, 2 and 3 (see [Rdr2]). This subclause details how range A is defined.

The contactless reader supplier defines the following two characteristics in their contactless reader's ICS so as to determine their contactless reader's range A:

— **PCD Zero Point – Range A**: This is a point at the centre of **target A** on the contactless reader , which may be located at the same height or positively higher in relation to the contactless reader surface under the rules listed below:

  — The position of PCD Zero Point – Range A is determined by the contactless reader manufacturer. It is recommended (but not mandatory) that it corresponds to the centre of the contactless reader antenna.

  — For a flat-surface or domed-surface reader, PCD Zero Point – Range A corresponds to the point on the contactless reader surface that is at the centre of target A (see Figure 2 — Testing a flat-surface reader).

  — For a concave-surface or hollowed-surface contactless PCD reader, the contactless reader manufacturer has the option of setting PCD Zero Point – Range A either at the point on the contactless reader surface that is at the centre of target A or at a point positively higher in relation to the contactless reader surface in the Z-axis – Range A (see Figure 5 — Testing a concave-surface contactless reader with a high-raised PCD zero point).

— Under no circumstances may PCD Zero Point – Range A be situated below the contactless reader-surface height (which would equate to artificially reducing the max. operating distance).

— Z-axis – Range A:

— For a contactless reader with a flat surface, Z-axis – Range A is the axis perpendicular to the contactless reader surface through PCD Zero Point – Range A.

— For a contactless reader that does not have a flat surface, Z-axis – Range A shall correspond to the axis along which contactless object would habitually be held to the contactless reader. Z-axis – Range A shall be coherent with contactless reader ergonomics; if not, the test laboratory may elect to redefine it (directionally).

Range A is mapped by all the points located between PCD Zero Point – Range A of the contactless reader device under test and the Reference PICC positioned at the maximum distance for test along the Z-axis – Range A.

The antenna position of the contactless reader under test shall be communicated to the test laboratory, for information purposes. This position may be situated at a relatively large distance from the contactless reader surface and relatively offset from the centre of target A. Unless the test laboratory requalifies the position of PCD Zero Point or the Z-axis, these tests shall be led in different positions defined in relation to ICS information input and not in relation to the position of the contactless reader antenna.

The plane of the Reference PICC is positioned orthogonally to the Z-axis – Range A. The orientation of the Reference PICC along the X- and Y-axes in relation to the contactless reader device under test is defined by the hardware manufacturer.

The schematic diagrams below illustrate a number of examples of how PCD Zero Point – Range A and Z-axis – Range A is defined according to ergonomics of the contactless reader under test.

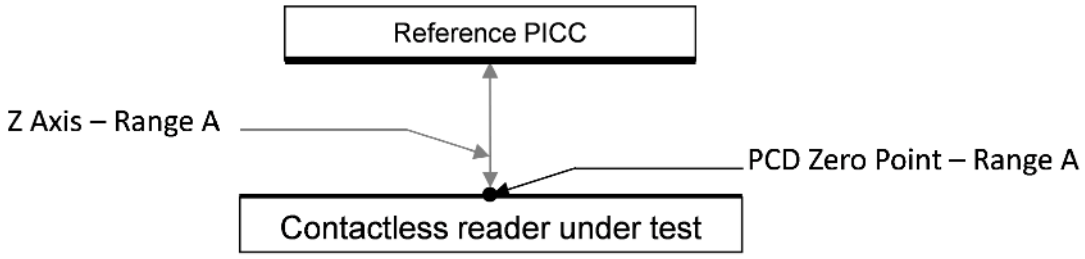


Figure 2 — Testing a flat-surface reader

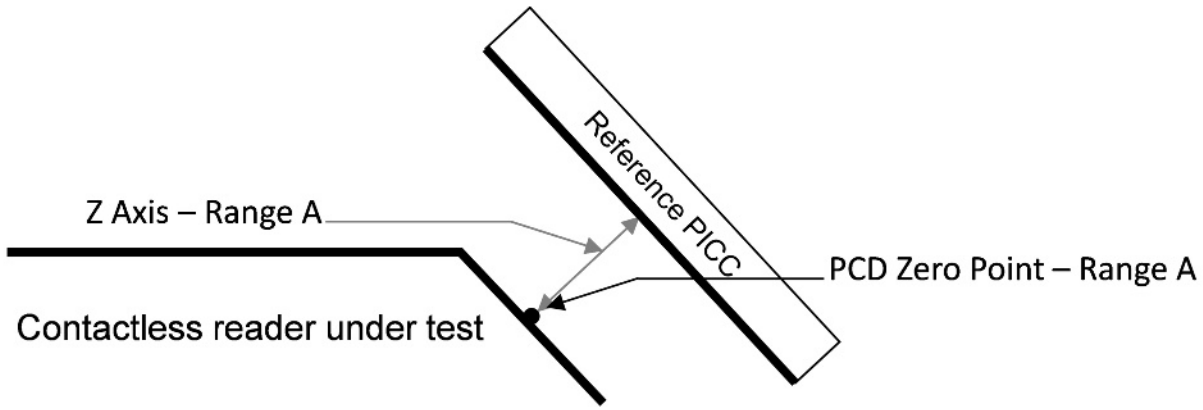


Figure 3 — Testing a flat and tilted-surface reader

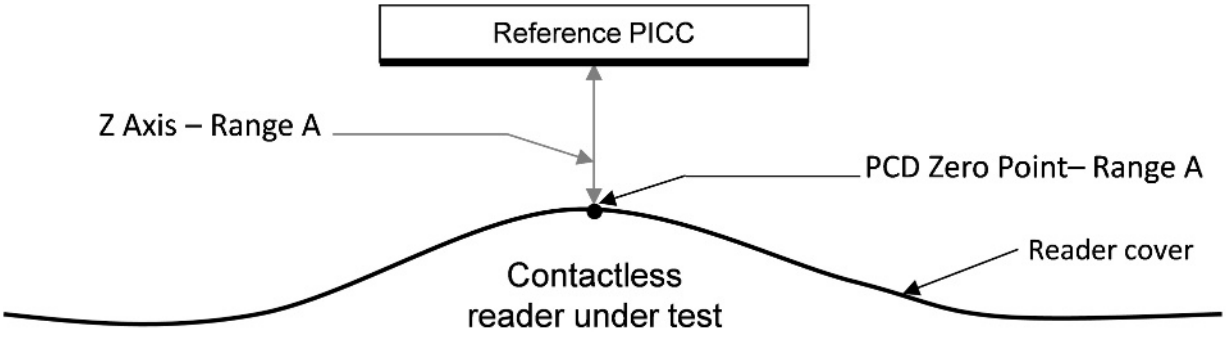


Figure 4 — Testing a convex-surface reader

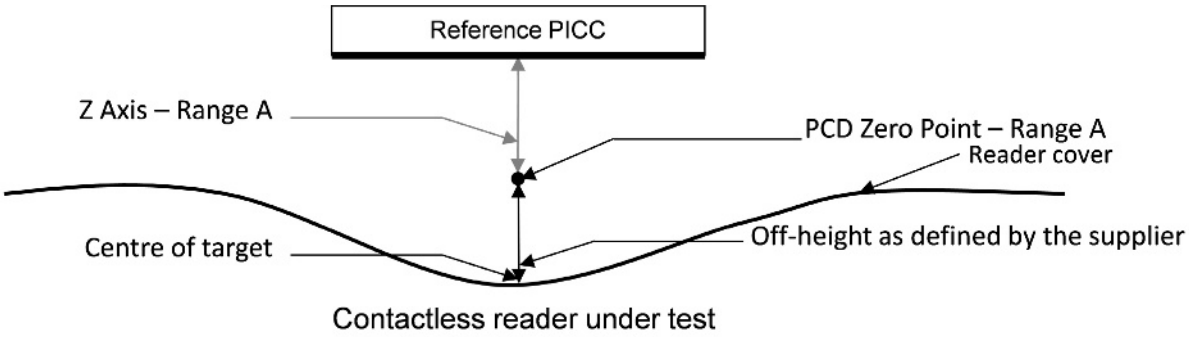


Figure 5 — Testing a concave-surface contactless reader with a high-raised PCD Zero Point

9.2.3.3 Table of positions – Range A

The tests are performed from the minimum distance achievable when the Reference PICC and the contactless reader under test are in contact, and while moving the Reference PICC away along Z-axis – Range A up to the maximum test distance for Range A (20 mm).

Table 2 below gives the positions that are eligible (unless otherwise stated) for all contactless reader tests.

These positions run height-wise from PCD Zero Point – Range A up to the inner surface of the Reference PICC and as measured along the Z-axis – Range A of the contactless reader under test.

Table 2 — List of test positions for range A

Measurement Positions	Height from PCD Zero Point – Range A along Z-axis
Position A1 (= PCD Zero Point – Range A)	0 mm
Position A2	5 mm
Position A3	10 mm
Position A4	15 mm
Position A5	20 mm

EXAMPLE 1: In the example below, the Reference PICC is in Position A5 of the contactless reader under test, and measurements can be taken up to contact with the Reference PICC in Position A1:

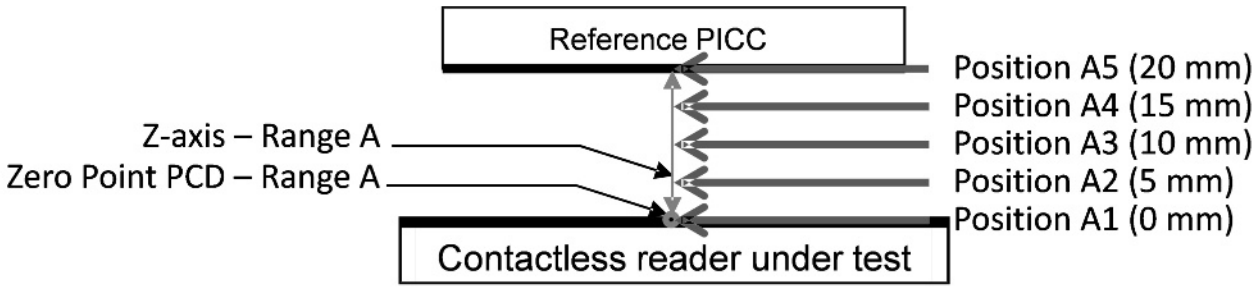


Figure 6 — Example 1: Reference PICC in Position A5

EXAMPLE 2: In configurations involving a contactless reader that does not have a flat surface, it is possible that the measurements cannot be taken from Position A1. If this is the case, the measurements shall be taken from the Position A1' where Reference PICC is in contact with the contactless reader under test (see Figure 7) and then at all subsequent Positions that can be reached from this Position.

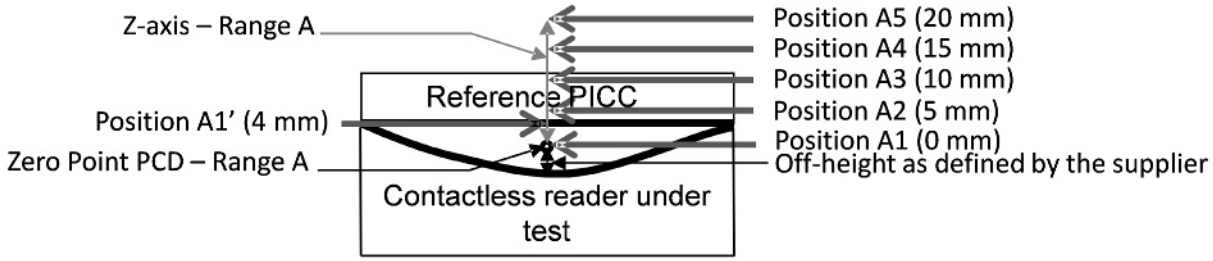


Figure 7 — Example 2: Reference PICC in Position A1'

PCD Zero Point – Range A may be defined at a positive height from the contactless reader surface (as in the example outlined above). The off-height value of PCD Zero Point – Range A shall be indicated by the supplier in the contactless reader ICS in that case.

If the ergonomics of the contactless reader under test doesn't make it possible to perform the tests on at least 4 out of the 5 measurement positions, the statement of conformance to these implementation requirements shall be issued via a waiver process.

9.2.3.4 Operating distance – Range B

These implementation requirements define an operating distance range B under which measurements shall be taken for contactless readers to be tested with Reference PICC 3 (see [Rdr3]). This subclause details how range B is defined.

The contactless reader supplier defines the following two characteristics in their contactless reader's ICS so as to determine their contactless reader's range B:

— **PCD Zero Point – Range B**: This is a point at the centre of **target B** on the contactless reader, which may be located at the same height or positively higher in relation to the contactless reader surface under the rules listed below:

  — The position of PCD Zero Point – Range B is determined by the contactless reader manufacturer. It is recommended (but not mandatory) that this position is the same position as PCD Zero Point – Range A.

  — For a flat-surface or domed-surface contactless reader, PCD Zero Point – Range B corresponds to the point on the contactless reader surface that is at the centre of target B (see Figure 2 — Testing a flat-surface reader).

- For a concave-surface or hollowed-surface contactless reader, the contactless reader manufacturer has the option of setting PCD Zero Point – Range B either at the point on the contactless reader surface that is at the centre of target B or at a point positively higher in relation to the contactless reader surface in the Z-axis – Range B (see Figure 5 — Testing a concave-surface contactless reader with a high-raised PCD zero point).

- Under no circumstances may PCD Zero Point – Range B be situated below contactless reader-surface height (which would equate to artificially reducing the max. operating distance).

— Z-axis – Range B:

- For a contactless reader with a flat surface, Z-axis – Range B is the axis perpendicular to the contactless reader surface through PCD Zero Point – Range B.

- For a contactless reader that does not have a flat surface, Z-axis – Range B shall correspond to the axis along which contactless object would habitually be held to the contactless reader. Z-axis – Range B shall be coherent with contactless reader ergonomics; if not, the test laboratory may elect to redefine it (directionally).

Range B is mapped by all the points located between PCD Zero Point – Range B of the contactless reader under test and the Reference PICC positioned at the maximum distance for test along the Z-axis – Range B.

The antenna position of the contactless reader device under test shall be communicated to the test laboratory, for information purposes. This position may be situated at a relatively large distance from the contactless reader surface and relatively offset from the centre of target B. Unless the test laboratory requalifies the position of PCD Zero Point or the Z-Axis, these tests shall be led in different positions defined in relation to this information input and not in relation to the position of the contactless reader antenna.

The plane of the Reference PICC is positioned orthogonally to Z-axis – Range B. The orientation of the Reference PICC along the X- and Y-axes in relation to the contactless reader under test is defined by the hardware manufacturer.

The earlier schematic diagrams illustrating a number of examples of how PCD Zero Point and Z-axis are determined according to contactless reader under test ergonomics for range A remain applicable for the determination of PCD Zero Point and Z-axis points for range B.

9.2.3.5 Table of positions – Range B

The tests are performed from the minimum distance achievable when the Reference PICC and the contactless reader under test are in contact, and while moving the Reference PICC away along Z-axis – Range B up to the maximum test distance for Range B (10 mm).

Table 3 below gives the positions that are eligible (unless otherwise stated) for all contactless reader tests.

These positions run height-wise from PCD Zero Point – Range B up to the inner surface of the Reference PICC and as measured along the Z-axis – Range B of the reader device under test.

Table 3 — List of test positions for range B

Measurement Positions	Height from PCD Zero Point – Range B along Z-axis
Position B1 (= PCD Zero Point – Range B)	0 mm
Position B2	5 mm
Position B3	10 mm

EXAMPLE 1: In the example below, the Reference PICC is in Position B3 of the contactless reader under test, and measurements can be taken up to contact with the Reference PICC in Position B1:

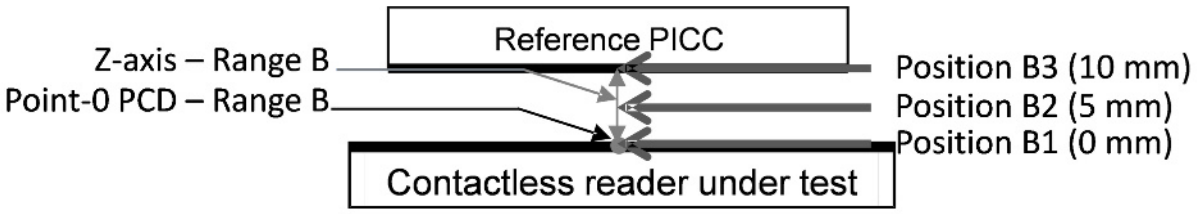


Figure 8 — Example 1: Reference PICC in Position B3

EXAMPLE 2: In configurations involving a contactless reader that does not have a flat surface, it is possible that the measurements cannot be taken from Position B1. If this is the case, the measurements shall be taken from the Position B1' where the Reference PICC is in contact with the contactless reader under test and then at all subsequent Positions that can be reached from this Position.

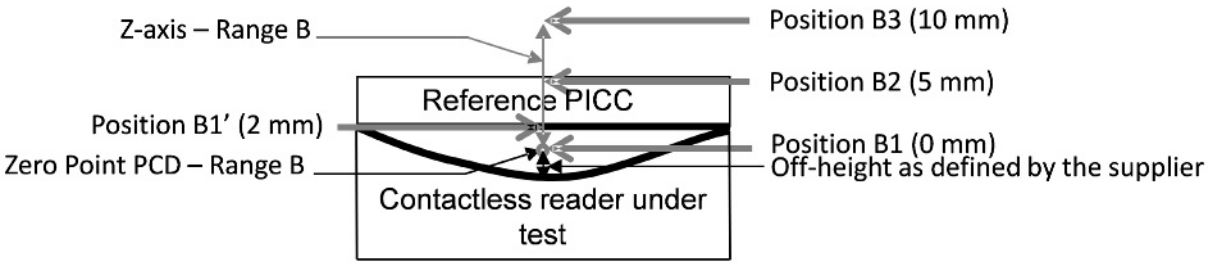


Figure 9 — Example 2: Reference PICC in Position B1'

PCD Zero Point – Range B may be defined at a positive height from the the contactless reader surface (as in the example outlined above). The Off-height value of PCD Zero Point – Range B shall be indicated by the supplier in the contactless reader ICS in that case.

If the ergonomics of the contactless reader under test don't make it possible to perform the tests on at least 2 out of the 3 measurement Positions, the statement of conformance to these implementation requirements shall be issued via a waiver process.

9.2.4 Test positions for contactless object

Objects are tested with the contactless object under test placed on the PCD Assembly and by varying the field of the PCD Assembly field in compliance with the test conditions defined in ISO/IEC 10373-6 standard.

These implementation requirements define how the contactless object under test shall be positioned in the PCD Assembly in order to carry out the contactless object tests.

The PCD Assembly works along 3 axes:

— X-axis and Y-axis of the PCD Assembly: orthogonal axes in the plane of the PCD Assembly and travelling through the centre of the PCD Assembly antenna, X-axis being parallel to the largest side of the sense coil, Y-axis being parallel to the smallest side.

  Z-axis of the PCD Assembly: axis perpendicular to the plane of the PCD Assembly and travelling through the centre of the PCD Assembly antenna.

The contactless object supplier defines the following characteristic in their contactless object's ICS so as to determine the contactless object's in-tests position in relation to the X, Y and Z-axes of the PCD Assembly:

— PICC Zero Point:

- This is a point at the surface of the contactless object. The position of this point is determined by the manufacturer of the contactless object. It is recommended for this point to be positioned at the centre of the contactless object's antenna.

- The contactless object's antenna position, which may be situated at a relatively large distance from contactless object surface, is not integrated as a factor when determining PICC Zero Point.

— Orientation in relation to the X, Y and Z-axes of the PCD Assembly:

- PICC orientation in relation to the X, Y and Z-axes of the PCD Assembly is defined by the hardware manufacturer.

If the indications stated for PICC Zero Point and the positions in relation to X- and Y-axes of the PCD Assembly, as given by the manufacturer, mean that the contactless object position while under test is offset too far from the X- and Y-axes of the PCD Assembly, then the test laboratory may elect to redefine the contactless object positioning.

The tests are performed using a PCD Assembly 1 as the contactless object shall meet the "Class 1", "Class 2" or "Class 3" requirements of ISO/IEC 14443.

The schematic diagrams below illustrating a number of examples of how contactless object under test shall be positioned on the PCD Assembly according to their form factor.

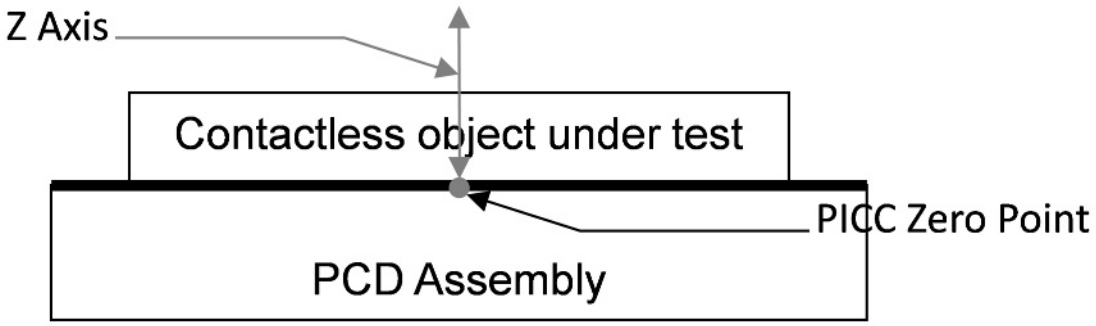


Figure 10 — Positioning for flat-surfaced contactless object under test

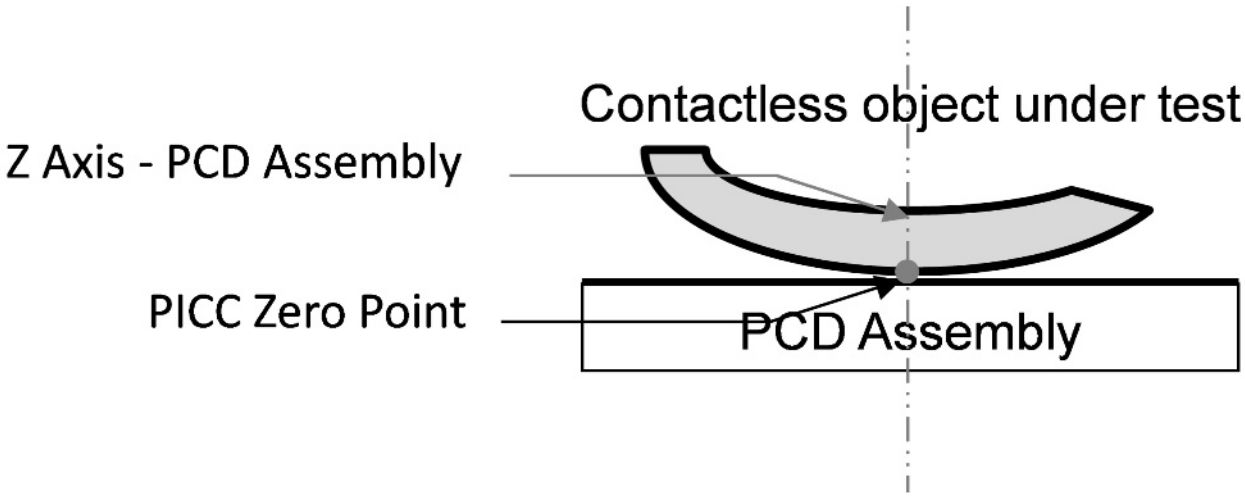


Figure 11 — Positioning for non-flat-surfaced contactless object under test

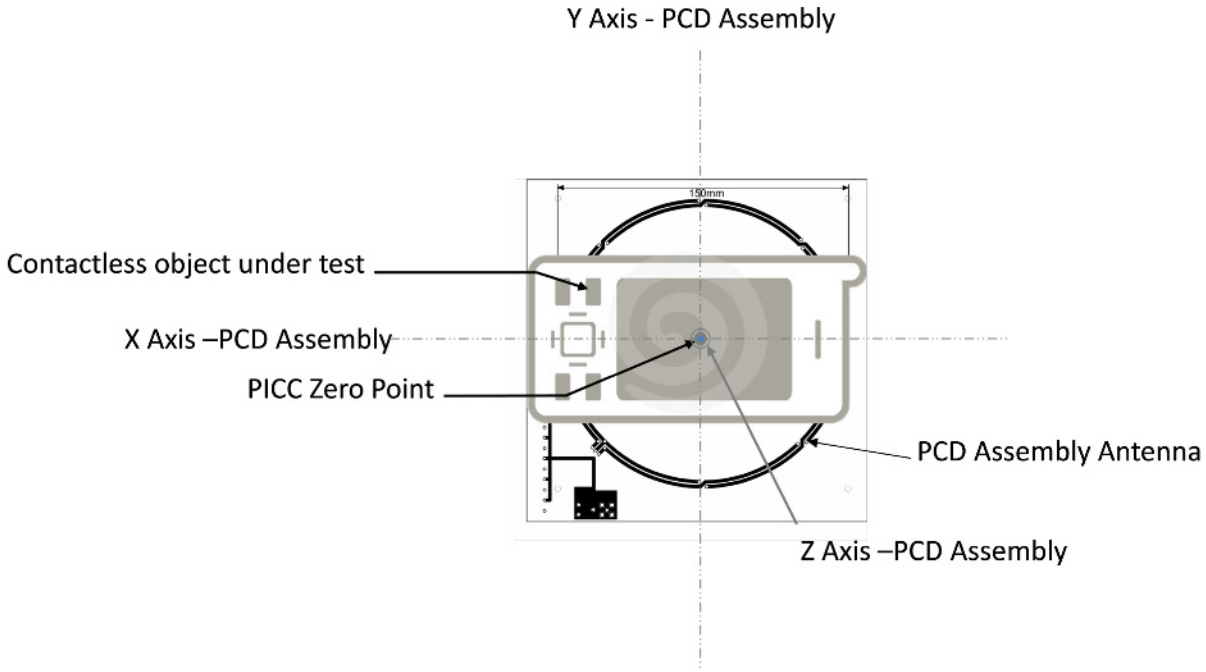


Figure 12 — Positioning for contactless object under test — overhead view

9.2.5 Battery-powered contactless object

Battery-powered contactless object (e.g. NFC-enabled smartphones) shall be tested in two modalities:

— in nominal mode, with the battery fully charged;

— in "battery low" mode (see 3.1).

The applicable tests under each of these modes are detailed in the CEN/TS 16794-2.

9.2.6 Test mode for contactless readers

The contactless reader under test shall propose a "test mode" offering the following functionalities:

a) Nominal operation: places the sample under nominal PCD mode, polling activated;

b) Control over the various test modes:

   1) Possibility of activating the field continuously, without polling

   2) Type A polling sequence only

   3) Type B polling sequence only

c) Possibility of sending each of the following predefined APDU sequences:

   1) UT_TEST_COMMAND1 followed by UT_TEST_COMMAND1

   2) UT_TEST_COMMAND2

d) Visual display of the transaction events log (for the contactless reader sensitivity test).

UT_TEST_COMMAND1 and UT_TEST_COMMAND2 shall be indicated in the PCD ICS.

9.2.7 Test application for contactless object

All tests involving contactless object shall be performed with a mobile ticketing application downloaded onto the contactless object under test.

If the contactless object under test does not come with the test application, then the contactless object supplier shall provide the tools needed to download it.

TEST_COMMAND1 to TEST_COMMAND3 shall be indicated in the PICC ICS.

Annex A
(informative)

Examples of PICC polling scenarios

A.1 Examples of generic polling scenarios

A.1.1 Without shut-off of the operational field

A.1.1.1 General

Below are two generic examples of PICC polling without field shut-off:

A.1.1.2 Straight polling

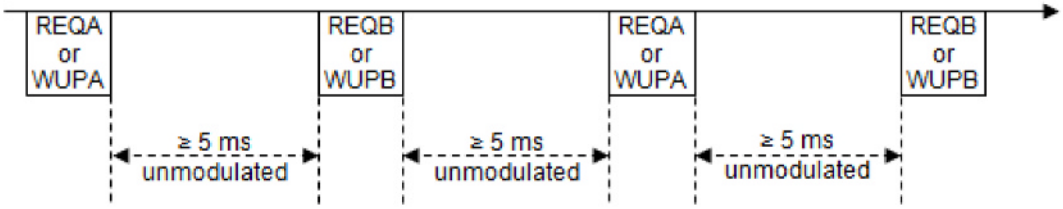


Figure A.1

A.1.1.3 Polling with additional non ISO/IEC 14443-3 polling commands included

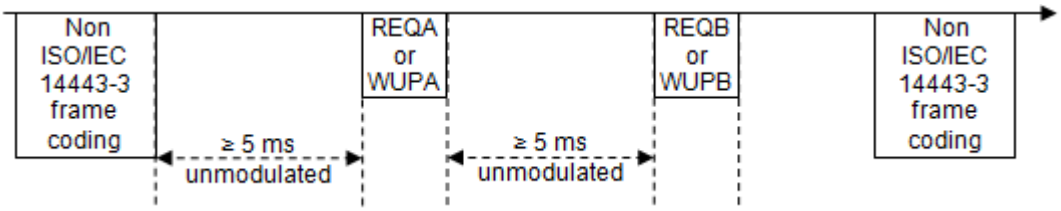


Figure A.2

or

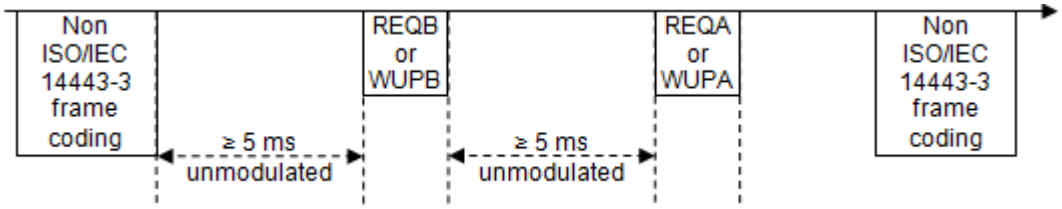


Figure A.3

A.1.2 With shut-off of the operational field

The generic examples given below describe PICC polling with field shut-off. The figures illustrate examples of A-then-B and B-then-A polling subsequences with field shut-off during this subsequence.

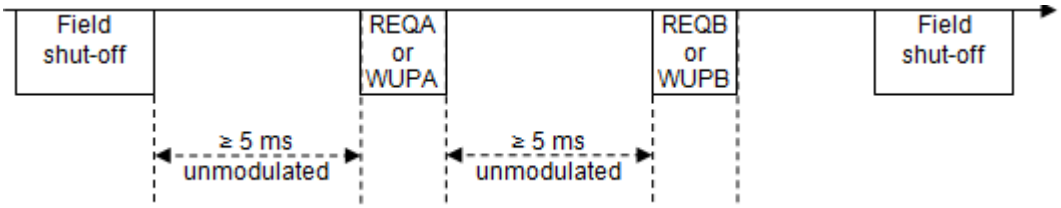


Figure A.4

or

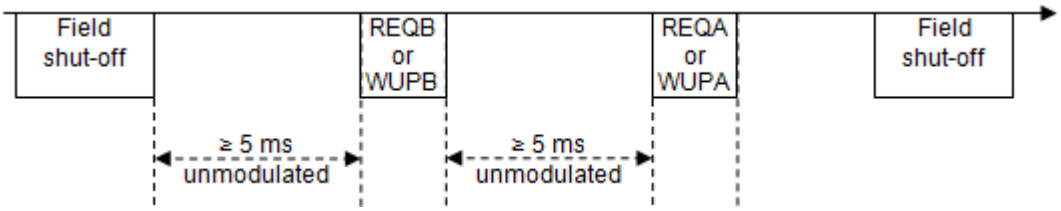


Figure A.5

NOTE Field shut-offs may become a necessity in order, for example, to minimize PCD power demand.

A.2 Examples of specific polling scenarios

A.2.1 General

This subclause gives, for information purposes only, several examples, guidelines and specific scenario possibilities for PICC polling in PCD fields.

Staying in line with ISO/IEC 14443 standard, two variants are outlined below.

A.2.2 Treating the first of all the objects detected

This scenario consists in polling for a Type A or Type B (and potentially even other proprietary types) contactless object and then, for example, treating this first-in object as soon as it is detected, regardless of whether it is Type A or Type B (giving a polling plus decision-step time of around 10 ms, not including additional polling times which may be needed by proprietary types).

A.2.3 Treating one contactless object identified from many after completion of the polling sequence

This scenario, which is designed to select a given PICC from a shortlist of several, consists in polling the PCD antenna field for one contactless PICC from the potentially many contactless objects of different types (Type A or Type B, or possibly even other proprietary types) and then treating the contactless object-of-interest once the polling sequence has completed its cycle (giving a polling plus decision-step time of around 20 ms, not including additional polling times which may be needed by proprietary types).

One criterion could be the presence of a valid transport application carried by the contactless object, and this criterion could be used to select the ‘correct’ object from among all those detected, regardless of their type.

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