Proximity Communication Interface Implementation Specifications For e-Passports

– Draft Proposal –

Version 1.2

MARCH 2006

New Media Development Association

Version History

Date	Version	Notes
March 2004	1.0	Formulation.
March 2006	1.2	Changes with regard to revisions to the ISO/IEC and other standards.

Foreword

The New Media Development Association (NMDA) has been involved in the effort of disseminating IC cards for many years.

Specifically, in the field of contactless IC cards, NMDA, with consideration to the progress of discussions concerning the ISO/IEC 14443 standard within international standardization bodies, developed a "New Generation IC Card Common System" (in accordance with the third supplementary budget of the 1998 fiscal year). At end of the 2000 fiscal year, evolving from the fruits of the "New Generation IC Card Common System," the "Research Project on Cities Equipped with Information Technologies through Dissemination of IC Cards" (in accordance with the third supplementary budget of the 2000 fiscal year) was started assuming a role as forerunning issuer of basic resident register cards, installing 120 million contactless IC cards and 8,000 proximity coupling devices (PCD. i.e. IC card reader/writers) in 21 regions nation-wide (54 municipalities) and in each region, performing verification experiments of various services that reflect regional attributes.

In order to improve interoperability and compatibility between IC cards and PCDs from various vendors, NMDA established the "Proximity Communication Interface Implementation Specifications" in compliance with the ISO/IEC 14443 standard, performed compatibility verification tests, and installed the equipment in the regions.

From August 25th, 2003, municipalities began issuing basic resident register cards according to applications from its residents. The methods for preparing the procurement of the IC cards and PCDs by the local government and ensuring their compatibility reflected the outcome of the project.

This "Proximity Communication Interface Implementation Specifications for e-Passports" is a revision to the 1.0 version which was edited and published by NMDA in March 2004 for the purpose of achieving compatibility between e-Passport readers and ID-3 sized e-Passports that have (ISO/IEC 14443 complying) contactless IC chips embedded and that use biometric and other information through contactless interfaces, which are being discussed at ICAO and SC 17.

This revision includes the following changes.

- Accommodation with regard to the latest standards considering progress of discussion of international standards.
- Revision to interoperability test methods based on results from the "Tsukuba e-Passport International Interoperability Test Session" held at Tsukuba City in Japan from March 8th to March 10th of 2005.
- Addition of reference description of the e-Passport interface specification specified by ICAO.

We hope that this Implementation Specification will assist in improving compatibility and the promoting future proliferation of e-Passports.

Furthermore, be aware of the following when referring to or using this Implementation Specification.

The functions, testing methods and so forth specified in this Implementation Specification is subject to addition, revision, or deletion during the course of the efforts scheduled to be conducted in the future by this association.

This association is not responsible in any way for the contents of this Implementation Specification or the results of their use, including industrial property rights and so forth.

In conclusion, the association would like to express its deep appreciation to the members of the e-Passport Interoperability working group (located within the NMDA) for its numerous contributions and constructive discussions, and to those persons at the Ministry of Foreign Affairs and the Ministry of Economics, Trade and Industry for their generous support of those efforts pertaining to the production of this Implementation Specification.

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New Media Development Association

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1 Scope and Characteristics of this Implementation Specification

1.1 Scope

This Implementation Specification assumes that communication interfaces of ID-1 sized contactless IC cards (PICC: Proximity IC Card) will be implemented and used on ID-3 sized e-Passports (hereunder referred to as e-MRPs [Electronic Machine Readable Passports]) and covers the areas shown in **Figure 1** of the communication features between e-MRPs and reader/writers (hereunder referred to as PCD [Proximity Coupling Devices]).

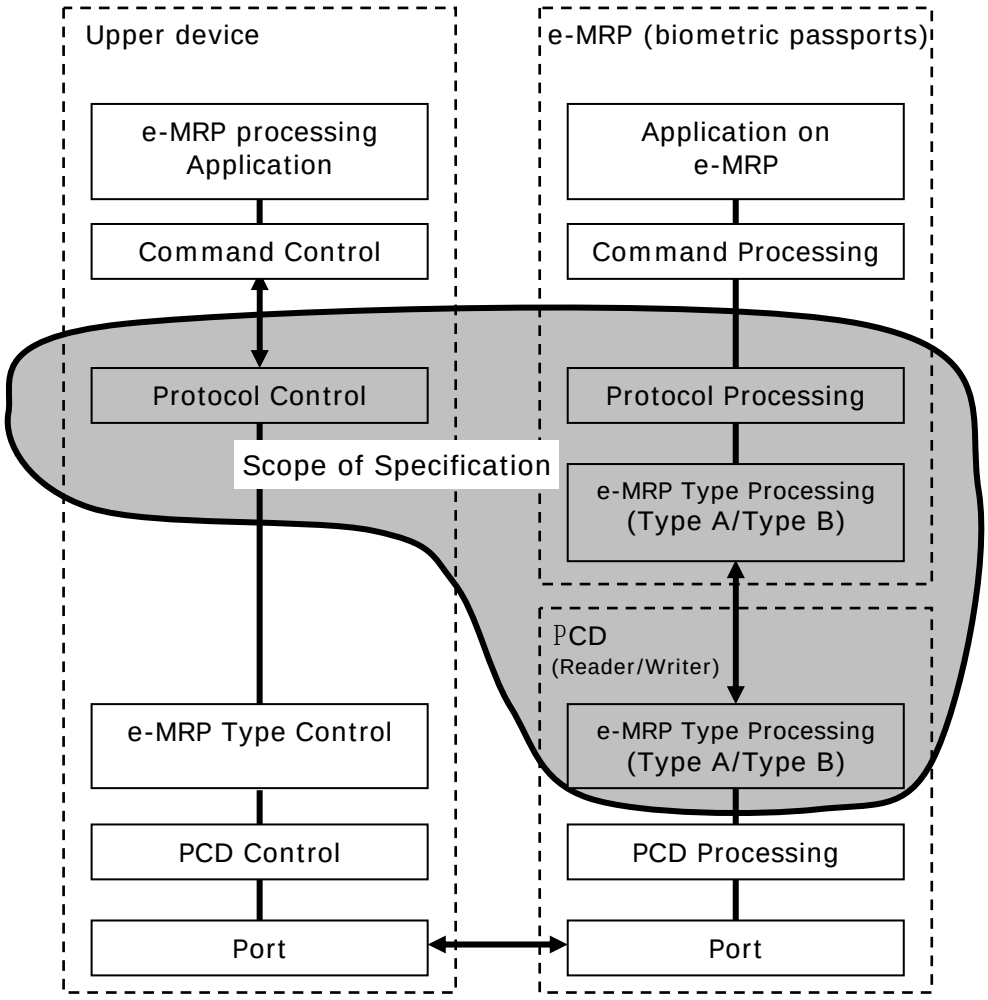


Figure 1 – Scope of the Proximity Communication Interface Implementation Specifications

The subject e-MRP and PCD of this Implementation Specification are e-MRPs with RF signal interfaces of Type A and Type B as specified in the **ISO/IEC 14443-2** Specification and PCDs that are capable of driving both types of e-MRPs.

The relationship between the subject area of this Implementation Specification and the Standard Specifications are shown in **Table 1**. Standard Specifications as referred to in this Implementation Specification are the ISO/IEC standards specified in **Table 1**.

Table 1 – Scope of the Proximity Communication Interface Implementation Specifications

Subject Area	Associated ISO/IEC Standard Specification
Physical characteristics of the e-MRP	ISO/IEC 14443-1
Electrical characteristics of the e-MRP and PCD	ISO/IEC 14443-2, 14443-3, 14443-4
Verification test methods of the e-MRP and PCD	ISO/IEC 10373-6 ISO/IEC 10373-6/AM2

1.2 Assumed e-MRP and PCD

This Implementation Specification considers the interoperability and compatibility of e-MRPs based on the following assumptions.

(1) e-MRP

The PICC assumed by the Standard Specification targets a communication distance of approximately 10 cm and its control circuits are configured with wired logic and other components, having a low electric power consumption (assuming approximately 5 mW). On the other hand, PICCs that perform highly sophisticated encryption (e.g. RSA signature generation) require encryption processors for processing, and consume more power (assuming approximately 50 mW).

The e-MRP assumed in this Implementation Specification will, in anticipation of continued use in the future, allow for rich featured PICCs that may consume much power

(2) Number of Cards

Common usage will assume 1 card on 1 PCD at any one time. However, since we cannot deny the possibility of multiple e-MRPs coming in within communication range of a PCD, anticollision procedures are mandatory.

(3) PCD

This Implementation Specification assumes an Open type PCD capable of generating a magnetic field sufficient enough for high power consuming e-MRPs.

The communication distance assumed between the e-MRP and PCD is 0 mm to around 20 mm, and a displacement diameter of up to 20 mm.

(4) Operation Mode

An e-MRP shall be activated by being brought near the surface of an operating PCD and shall continue its communication while being left in near contact or complete contact with the PCD.

In operation mode, a situation where an e-MRP will gradually approach a generated magnetic field will occur, and since the e-MRP and PCD will be in complete contact, the degree of coupling between the antennae will be high, affecting the power transfer and data transmission between the e-MRP and PCD.

The Standard Specification assumes communication at a distance and gives low consideration to ensuring compatibility of complete contact situations. This Implementation Specification addresses and stipulates provisions for improving compatibility specific to the operation mode described above.

1.3 Characteristics of this Implementation Specification

This Implementation Specification attempts to ensure interoperability and compatibility of various types of e-MRPs and PCDs of numerous manufacturers by serving to standardize antenna characteristics, resonance characteristics and various other parameters at the production level not defined by the Standard Specification in order to improve compatibility of e-MRPs and PCDs.

(1) Improving Compatibility of e-MRPs and PCDs

This Implementation Specification stipulates provisions for improving compatibilities of e-MRPs and PCDs assumed in section 1.2 of this specification. However, considerations have also been given to allow a certain degree of freedom in the design of e-MRPs and PCDs. It should therefore be noted that this implementation specification does not unequivocally guarantee the compatibility of e-MRPs and PCDs.

(2) The Necessity for Provisions not Stipulated in Standard Specifications

The Standard Specifications specify specifications oriented toward maintaining higher levels of extendibility (or diversity).

Furthermore, the specifications assume communications at a distance. As such, for example, the operating field of a PICC is defined to "operate as intended continuously between Hmin (1,5 A/m) and Hmax (7,5 A/m)," and the diameter of a Test PC Antenna is 15 cm, which is large compared to commonly used PCDs.

Thus, the tests assume that the PICCs and PCDs are calibrated at a distance where they will not affect each other, and assume a uniform magnetic field will be generated.

However, when the e-MRPs and PCDs come in physically close contact where the distance is such that it will affect the physical and electrical characteristics of each other's antennae, the magnetic field sensed by the measurement equipment with a uniform magnetic field will be different from what is sensed by actual e-MRPs, requiring caution to be exercised.

(3) Required Specifications other than the Standard Specification

It is necessary to add the matters indicated below not described in the Standard Specification for the reasons described in the previous section. In other words, these are the important points of this Implementation Specification.

- **– e-MRP Detail Specifications (Antenna shape, resonance frequency)**
- **– Unit verification test methods of e-MRPs (Tests with PCD-S, etc.)**
- **– Unit verification test methods of PCDs (Tests with reference PICC-S/M/L, etc.)**

1.4 Description Convention of this Implementation Specification

Within this Implementation Specification, provisions specified by the Standard Specifications are only referred to by quotation, while matters that necessary to be added are described based on the following three perspectives.

Compatibility Improvement Specifications:

Provisions considered as necessary to improve interoperability and compatibility.

Considerations:

While not being provisions of this Implementation Specification, matters of consideration to further improve interoperability and compatibility of t e-MRPs and PCDs.

Explanatory Notes:

Explanatory notes to deepen common understanding regarding provisions of the Standard Specifications.

While the matters added are explicitly categorized and tagged as "Compatibility Improvement Specification," "Considerations," or "Explanatory Notes," if there are provisions not explicitly categorized, those shall be considered as "Compatibility Improvement Specifications."

Furthermore, for major added provisions, the reasons for the additions may also be explicitly noted in the "Explanatory Notes."

1.5 Structure

Based on the assumptions, characteristics and description conventions as provided above, this Implementation Specification stipulates matters of features regarding contactless communication, as specified in **Table 2**.

Table 2 – Structure of this Implementation Specification

Chpt.	Subject Area	Description	Associated Standard Specification
4	Physical characteristics	Stipulates physical specifications and operating temperature of e-MRPs and PCDs, and specifies some considerations.	ISO/IEC 7501-1 ISO/IEC 7810 ISO/IEC 14443-1
5	Electrical characteristics	Stipulates antenna shape and strength of operating/generated magnetic field of e-MRPs and PCDs, and specifies some considerations for operational noise.	ISO/IEC 14443-2
6	Signal transmission	Stipulates initial communication and signal interfaces. In addition, describes provisions for high-speed communication.	ISO/IEC 14443-2 ISO/IEC 14443-2/AM1
7	Initialization and anticollision	Stipulates initial communication and signal interfaces. In addition, describes provisions for high-speed communication.	ISO/IEC 14443-3 ISO/IEC 14443-3/AM1 ISO/IEC 14443-3/FPDAM3
8	Transmission protocol	Stipulates the communication sequence.	ISO/IEC 14443-4 ISO/IEC 14443-4/FPDAM1
9	Unit tests	Stipulates unit test methods for the e-MRPs and PCDs specified in this Implementation Specification.	ISO/IEC 10373-6 ISO/IEC 10373-6/FPDAM1 ISO/IEC 10373-6/AM2 ISO/IEC 10373-6/FPDAM3 ISO/IEC 10373-6/FPDAM4 ISO/IEC 10373-6/FPDAM5

2 Normative References

The following normative documents contain provisions referenced in this text. While the following normative documents are the most recent at the time of the stipulation of this Implementation Specification, parties are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below.

ISO/IEC 7501-1:1997,

Identification cards - Machine readable travel documents - Part 1: Machine readable passport

ISO/IEC 7810:2003,

Identification cards - Physical characteristics

ISO/IEC 10373-6:2001,
Identification cards - Test methods - Part6: Proximity cards

ISO/IEC 10373-6/AM2:2003,
Identification cards - Test methods - Part6: Proximity cards, Amendment 2: Improved RF test methods

ISO/IEC 14443-1:2000,
Identification cards - Contactless integrated circuit(s) cards - Proximity cards - Part1: Physical characteristics

ISO/IEC 14443-2:2001,
Identification cards - Contactless integrated circuit(s) cards - Proximity cards - Part 2: Radio frequency power and signal interface

ISO/IEC 14443-2/AM1:2005,
Bit rate of fc/64, fc/32, fc/16

ISO/IEC 14443-3:2001,
Identification cards - Contactless integrated circuit(s) cards - Proximity cards - Part 3: Initialization and anticollision

ISO/IEC 14443-3/AM1:2005,
Bit rate of fc/64, fc/32, fc/16

ISO/IEC 14443-4:2001,
*Identification cards - Contactless integrated circuit(s) cards - Proximity cards - Part 4: Transmiss*ion protocol

ICAO "ANNEX K of ICAO NTWG BIOMETRICS DEPLOYMENT TECHNICAL REPORT",
Version 2 (Date: July 6, 2005)

Considerations:

While the following documents are not yet approved as an International Standard at the time of the stipulation of this Implementation Standard, certain portions have been referenced within this Implementation Standard. Note that these may be revised since they are still under discussion.

ISO/IEC 14443-3:2001/FPDAM3 (Date: November 2, 2004), Identification cards - Contactless integrated circuit(s) cards - Proximity cards - Part 3: Initialization and anticollision, Amendment 3: Handling of reserved fields and values

ISO/IEC 14443-4:2001/FPDAM1 (Date: November 2, 2004), Identification cards - Contactless integrated circuit(s) cards - Proximity cards - Part 4: Transmission protocol, Amendment 1: Handling of reserved fields and values

ISO/IEC 10373-6:2001/FPDAM1 (Date: May 5, 2005), Identification cards - Test methods - Part6: Proximity cards, Amendment 1: Protocol test methods for proximity cards

ISO/IEC 10373-6:2001/FPDAM3 (Date: December 9, 2004), Identification cards - Test methods - Part6: Proximity cards, Amendment 3: Protocol test methods for proximity coupling devices

ISO/IEC 10373-6:2001/FPDAM4 (Date: April 7, 2005), Identification cards - Test methods - Part6: Proximity cards, Amendment 4: Additional test methods for PCD RF interface and PICC alternating field exposure

ISO/IEC 10373-6:2001/FPDAM5 (Date: April 21, 2005), Identification cards - Test methods - Part6: Proximity cards, Amendment 5: Bit rates of fc/64, fc/32, and fc/16

3 Terms and Definitions, Symbols and Abbreviated Terms

3.1 Terms

Definitions for major terms used in this Implementation Specification are as follows.

Proximity IC Card (PICC)
A terminal-less IC card that communicates by coupling in a proximity magnetic field of a coupling device.

e-MRP (Electronic Machine Readable Passport)
A passport with PICC features which is capable of electronically reading stored biometric information through the use of the PICC's communication interface.

Proximity Coupling Device (PCD)
Generally referred to as reader/writer devices, PCDs use inductive coupling to provide power to the e-MRP and also to control the data exchange with the e-MRP.

Coupling Degree between Antennae
The degree of coupling between the e-MRP antenna and the PCD antenna when electromagnetic induction is performed.

Byte
A byte consists of 8 bits of data which are designated as b1 through b8. b8 is the most significant bit (MSB) while b1 is the least significant bit (LSB).

Bit duration
Time for a single bit to determine its logical state. The bit length unit (time) is defined by "etu" where etu is calculated according to the following formula.

$$1 \text{ etu} = 128 / (D \times fc), \text{ where D is either 1,2,4, or 8}$$

Since the initial value of divisor D is 1, the initial value of etu is as shown below.

1etu = 128 f/c

Where *fc* is the carrier frequency as defined in **ISO/IEC 14443-2**.

Modulation Index

If the modulated signal peak amplitude is "a" and minimum amplitude is "b", the modulation index is as follows.

Modulation index = (a - b)/(a + b)

Modulation index is normally expressed in percentage.

Binary phase shift keying

Phase modulation method to associate two phase state possibilities 180° apart with a logical value.

NRZ-L

A method of bit coding whereby a logical state of a signal during a bit duration is represented by one of the two defined physical states of a carrier frequency (fc).

Subcarrier

A frequency (fs) which modulates a carrier frequency (fc).

Frame

A frame is a series of data bits and optional error detection bits, with frame delimiters at start and end.

> **Note**: Type A e-MRPs use standard frames defined as Type A e-MRPs and Type B e-MRPs use standard frames defined as Type B e-MRPs.

TR0

Guard time beginning at the end of transmission by a PCD and ending when generation of subcarrier is done by an e-MRP.

TR1

Synchronization time beginning at the time the subcarrier is generated by an e-MRP and ending when the e-MRP begins modulation.

TR2

Time beginning at the time when an e-MRP begins sending EOF and ending when a PCD begins SOF.

Operating field

The range of magnetic field strength where an e-MRP is capable of conducting normal operations.

Polling

The operation of a PCD to repetitively emit Request commands in order to sense e-MRPs within the operating field.

Collision

Transmission by two or more e-MRPs that are within the same operating field of a PCD during the same time period, such that the PCD is unable to distinguish from which e-MRP the data originated.

Anticollision

The process of avoiding transmission at the same time by two or more PICCs that are within the same operating field of a PCD.

Anticollision sequence

The procedure to select one or more e-MRPs from the multiple e-MRPs within the same operating field of a PCD that have answered to a Request command, and establishing communication between the e-MRP and PCD.

Load modulation

To generate modulation signals by putting load on and off an e-MRP.

Request command

A command requesting an answer from a corresponding type of e-MRP when the e-MRP is capable of initializing.

Block

A special form of frame that includes a valid protocol data format.

Note: A valid protocol data format includes I-Blocks, R-Blocks or S-Blocks.

Test PCD

A device for testing e-MRPs. Stipulated in the Standard Specification.

Test PCD-S

A PCD stipulated for the purpose of this Implementation Specification. Used for tests assuming close contact.

Calibration Coil

A device for testing PCDs. Stipulated in the Standard Specification.

Reference PICC

A device for testing PCDs. Stipulated in the Standard Specification.

Reference PICC-S/M/L

A generic designation the three types of reference PICCs stipulated for the purpose of this Implementation Specification which are the reference PICC-S, reference PICC-M, and reference PICC-L.

3.2 Symbols and Abbreviated Terms

The following symbols and abbreviated terms shall be used in this Implementation Specification.

AFI	Application Family Identifier Card
	pre-selection criteria by application, Type B
ANTICOLLISION	anticollision command, Type A
ASK	Amplitude Shift Keying
ATS	Answer To Select
ATTRIB	PICC selection command, Type B
ATQA	Answer To Request, Type A
ATQB	Answer To Request, Type B
BPSK	Binary Phase Shift Keying
CID	Card Identifier
CLn	Cascade Level n, Type A
CT	Cascade Tag, Type A
D	Divisor
DUT	Device Under Test
etu	elementary time unit
E	End of communication, Type A
EGT	Extra Guard Time, Type B
EOF	End Of Frame, Type B
FDT	Frame Delay Time, Type A
fc	frequency of operating field (carrier frequency)
fs	frequency of sub-carrier modulation
FWI	Frame Waiting time Integer
FWT	Frame Waiting Time
FWT_{TEMP}	temporary Frame Waiting Time
HLTA	Halt command, Type A
HLTB	Halt command, Type B
Hmax	Maximum field strength of the PCD antenna field
Hmin	Minimum field strength of the PCD antenna field
NRZ-L	Non-Return to Zero, (L for level)
OOK	On/Off Keying
PCD	Proximity Coupling Device
PICC	Proximity IC Card
PUPI	Pseudo-Unique PICC Identifier
REQA	Request command, Type A
REQB	Request command, Type B
RFU	Reserved for Future ISO/IEC Use
S	Start of communication, Type A

Slot_MARKER	Slot marker command, Type B
WTX	Waiting Time eXtension
WTXM	Waiting Time eXtension Multiplier
WUPA	Wake Up command, Type A
WUPB	Wake Up command, Type B

For the purpose of the Implementation Specification, the following notation applies:

b“xxxx xxxx”	Data bit representation
“XX”	Hexadecimal

4 Physical Characteristics

The size and shape of the e-MRP shall comply with the provisions of **ISO/IEC 7501-1**. Additionally, other physical characteristics shall comply with the provisions of **ISO/IEC 14443-1**.

5 Electrical Characteristics

Shall comply with the "**Power transfer**" and "**PICC minimal coupling zone**" of **ISO/IEC 14443-2** and shall add the following provisions.

5.1 e-MRP

5.1.1 Antenna Shape

Compatibility Improvement Specifications:

The implementation zone of a ID-1 size as shown in **Figure 2** shall be applied as the implementation zone of the antenna of an e-MRP which center shall be concentric with the center of the ID-3 sized booklet as stipulated in **ISO/IEC 7501-1** and the center of the ID-1 size as stipulated in **ISO/IEC 7810** when the short (or long) side of one is parallel with the other.

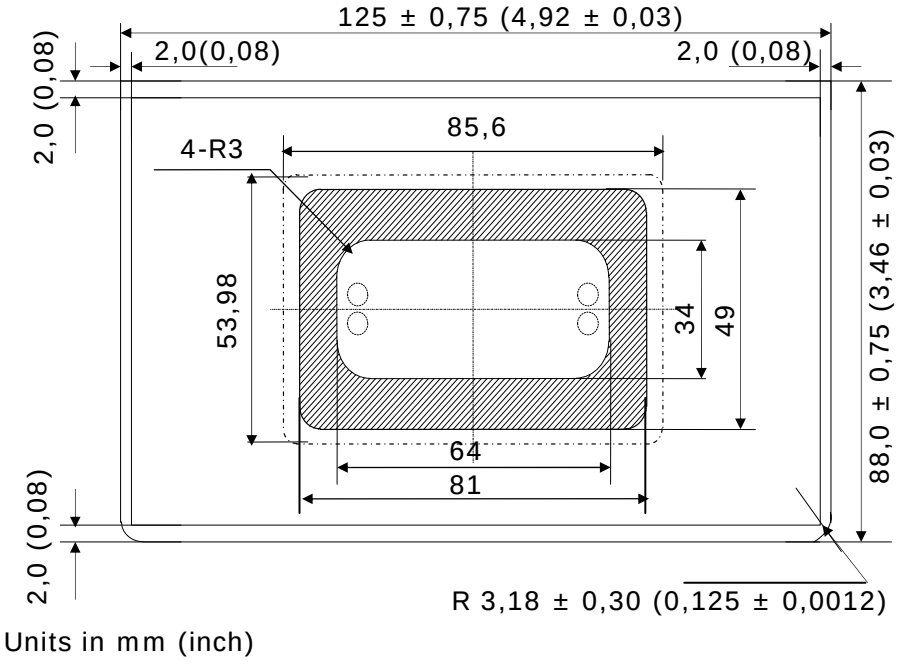


Figure 2 – Antenna Implementation Zone

5.1.2 Operational Noise

Considerations:

The e-MRP should suppress the following load fluctuation while processing commands:

– Continuous load fluctuation with a cycle near preamble.
– Load fluctuation other than load modulation during e-MRP response processing.
– Large load fluctuation that cannot be ignored when compared with load modulation during response.
– Load fluctuation immediately before e-MRP response activity.
– Load fluctuation occurring during low or excess power supplied to e-MRP.

The following load fluctuation should be suppressed as much as possible while the e-MRP is processing the following commands:

– Load fluctuation occurring during processing of Resend Request of protocol.
– Load fluctuation during processing of initial response between the time the request was made until the time the processing of the protocol begins.

5.1.3 Resonance Frequency

Compatibility Improvement Specifications:

The resonance frequency of an e-MRP shall be over 13,56 MHz. However, consideration shall be given to situations when coming into close proximity of PCDs.

5.1.4 Operating Field

Compatibility Improvement Specifications:

The minimum non-modulated operating field of an e-MRP shall be Hmin and has a value of 4 A/m (rms).

5.2 PCD

5.2.1 Antenna Shape

Compatibility Improvement Specifications:

Antenna position will no be stipulated. However, the chosen antenna position shall able to suffice communication requirements without regard to the operation direction (fore-side, back-side, front approach, rear approach) and coil position.

Furthermore, the PCD antenna and e-MRP antenna shall be positioned in a parallel opposed position.

An example of an antenna position of a PCD where the center of the antenna is aligned with the center of the e-MRP is shown in **Figure 3**.

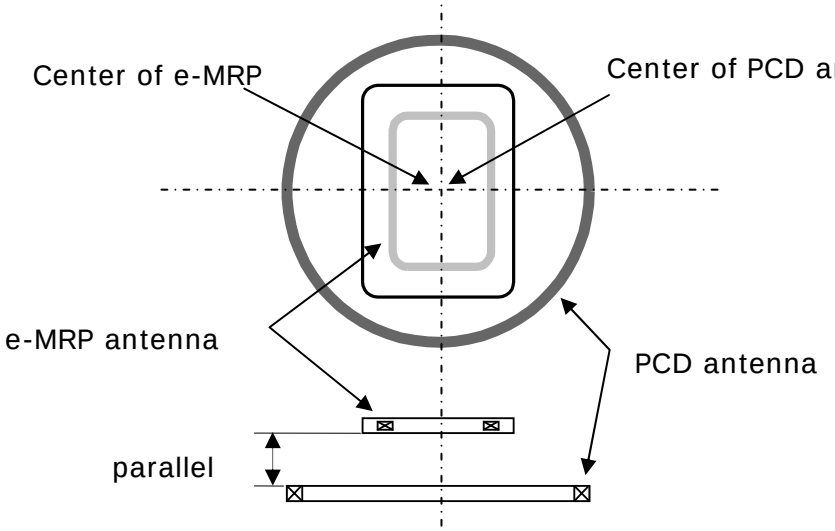


Figure 3 – Antenna Position

Considerations:

(1) Considering the actual operational procedures, the antenna size of the PCD should be larger than the antenna size of the e-MRP.

(2) The shape of the PCD antenna should be symmetric on the X and Y axis with their origin at the center of the antenna so that the communication zone of the e-MRP is not largely affected by the operation direction and communication position.

Examples of PCD antenna shapes are shown in **Figure 4**.

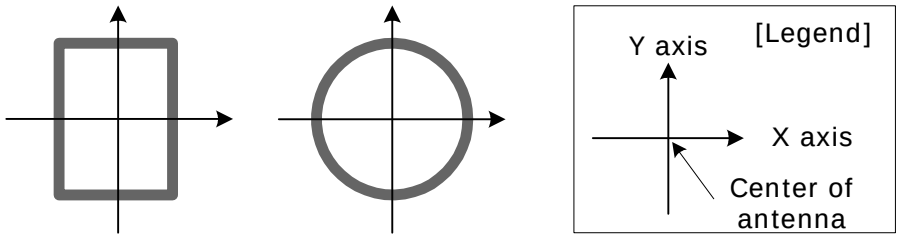


Figure 4 – Antenna Shape

5.2.2 Operational Noise

Considerations:

The design of the PCD should reflect consideration to the operational noise emitted from the e-MRP so that it will not erroneously receive noise which are not communication signals. Furthermore, PCDs shall give consideration to avoid noise getting into carriers.

5.2.3 Coupling Degree between Antennae

Considerations:

(1) The coupling degree between the antennae will increase when an e-MRP comes into close proximity of a PCD.

(2) Since the operational point of a PCD will alter largely when the coupling degree between the antennae is in excess, the operating range of a PCD shall be considered with the following in mind.

– The generated magnetic field might become too strong.
  Thus, consideration shall be given to characteristics of maximum magnetic field generated.
– A situation where field or power becomes too weak might occur.
  Thus, consideration shall be given to characteristics of minimum magnetic field generated and power transmission.
– The modulation index might change.
  Thus, consideration shall be given to the modulation waveform.

5.2.4 Generated Magnetic Field

Compatibility Improvement Specifications:

The minimum non-modulated operating field of a PCD shall be Hmin and has a value of 4 A/m (rms).

6 Signal Transmissions

Based on **ISO/IEC 14443-2** and **ISO/IEC 14443-2/AM1**, the modulation method, modulation waveform and coding scheme of the signal transmission from a PCD to an e-MRP and vice versa shall be stipulated herein. Type A and Type B communication formats are specified.

Considerations:

Since the specification for high-speed communication (**ISO/IEC 14443-2/FPDAM2**) exceeding fc/64 (approximately 212 kbit/s) was not approved yet as an International Standard at the time when version 1.0 of this Implementation Specification was formulated (March 2004), the provisions regarding this matter within the Implementation Specifications was designated as "**Compatibility Improvement Specification (Informative)**". However, since the specification is now approved as an International Standard **ISO/IEC 14443-2/AM1**, the specification is noted as references.

Note that certain parts referenced in the 1.0 version of this Implementation Specification have been revised in accordance with the International Standardization of the specification of high-speed communication.

6.1 Initial Communication of the e-MRP

Shall comply with the "Initial dialogue for proximity cards" of **ISO/IEC 14443-2**.

6.2 Signal Interface

Shall comply with the "Signal Interface" of **ISO/IEC 14443-2** and with **ISO/IEC 14443-2/AM1**.

6.3 Communication Signal Interface Type A

Shall comply with the "Communication Signal Interface Type A" of **ISO/IEC 14443-2** and with **ISO/IEC 14443-2/AM1**.

Explanatory Notes:

The following are stipulated in **ISO/IEC 14443-2**.

– Signal transmission from PCD to PICC

- Bit Rate
- Modulation
- Bit Representation and Coding

– Signal transmission from PICC to PCD

- Bit Rate
- Load Modulation
- Subcarrier
- Subcarrier Modulation
- Bit Representation and Coding

6.3.1 Signal transmission from PCD to e-MRP

6.3.1.1 Bit Rate

Shall comply with the "Data rate" of **ISO/IEC 14443-2** and with **ISO/IEC 14443-2/AM1**.

6.3.1.2 Modulation

Shall comply with the "Modulation" of **ISO/IEC 14443-2** and with **ISO/IEC 14443-2/AM1**.

Considerations:

Note that the values in **Table 3**, "Modulation Timing" of the 1.0 version of this Implementation Specification which had been based on reference to **ISO/IEC 14443-2/FPDAM2**, have been revised as follows in accordance with the International Standardization of the specification.

Table 3 – Modulation Timing

Timing Parameter	Bit Rate					
	fc/64		fc/32		fc/16	
	Min	Max	Min	Max	Min	Max
t1	15/fc	20/fc	8/fc	10/fc	4/fc	5/fc
t2	8/fc	T1	4/fc	T1	2/fc	t1
t3	0	12/fc	0	10/fc	0	8/fc

6.3.2 Signal transmission from e-MRP to PCD

6.3.2.1 Bit Rate

Shall comply with the "Data rate" of **ISO/IEC 14443-2** and with **ISO/IEC 14443-2/AM1**.

6.3.2.2 Subcarrier Modulation

Shall comply with the "Subcarrier modulation" of **ISO/IEC 14443-2** and with **ISO/IEC 14443-2/AM1**.

6.3.2.3 Bit Representation and Coding

Shall comply with the "Bit representation and coding" of **ISO/IEC 14443-2** and with **ISO/IEC 14443-2/AM1**.

6.4 Communication Signal Interface Type B

Shall comply with the "Communication Signal Interface Type B" and with **ISO/IEC 14443-2/AM1**.

Explanatory Notes:

The following are stipulated in **ISO/IEC 14443-2**.

– Signal transmission from PCD to PICC

- Bit Rate
- Modulation
- Bit Representation and Coding

– Signal transmission from PICC to PCD

- Bit Rate
- Load Modulation
- Subcarrier
- Subcarrier Modulation
- Bit Representation and Coding

6.4.1 Signal transmission from PCD to e-MRP

6.4.1.1 Bit Rate

Shall comply with the "Data rate" of **ISO/IEC 14443-2** and with **ISO/IEC 14443-2/AM1**.

6.4.1.2 Modulation

Shall comply with the "Modulation" of **ISO/IEC 14443-2** and with **ISO/IEC 14443-2/AM1**.

6.4.2 Signal transmission from e-MRP to PCD

6.4.2.1 Bit Rate

Shall comply with the "Data rate" of **ISO/IEC 14443-2** and with **ISO/IEC 14443-2/AM1**.

6.4.2.2 Subcarrier

Shall comply with the "Subcarrier" of **ISO/IEC 14443-2** and with **ISO/IEC 14443-2/AM1**.

6.4.2.3 Subcarrier Modulation

Shall comply with the "Subcarrier modulation" of **ISO/IEC 14443-2** and with **ISO/IEC 14443-2/AM1**.

7 Initialization and Anticollision

Shall comply with "Initialization and anticollision" of **ISO/IEC 14443-3**.

7.1 Polling

Shall comply with the "**Polling**" of **ISO/IEC 14443-3** and with the **ISO/IEC 14443-2/AM1**, and shall add the following provisions.

Considerations:

An e-MRP that will operate with an Open type PCD shall consider cases ranging from slow rising time to fast rising time for the operating field to attain minimum operational level. The e-MRP shall also consider the case where the operating field is modulated upon attaining minimum operational level. Both 100%ASK (Type A) and 10%ASK (Type B) are possible for the modulated operating field.

Furthermore, if the Open type PCD will repetitively send Request commands, the interval time for sending out commands shall be longer than the time it takes for the e-MRP to begin accepting requests (5 ms).

Explanatory Notes:

When an e-MRP is exposed to a non-modulated operating field it shall be able to accept a Request command within 5 ms.

The duration until the operating field attains the minimum level shall include cases ranging from slow rising time to fast rising time as shown in **Figure 5**. If the operating field is modulated upon attaining minimum operational level, the e-MRP shall be able to accept a Request command within 5 ms after the operating field becomes non-modulated above the minimum operational level.

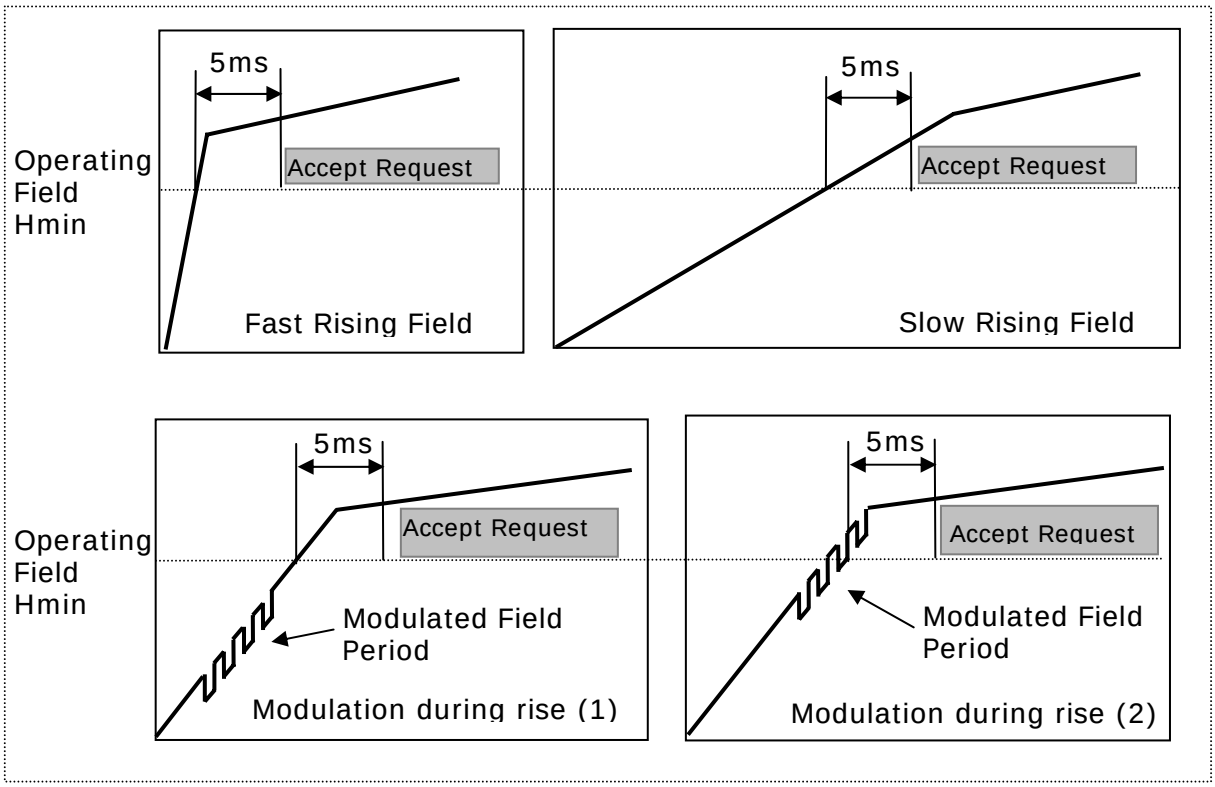


Figure 5 – Variations of Operating Field Rising Forms

7.2 Initialization and Anticollision of e-MRP Type A

Shall comply with the "**Type A – Initialization and Anticollision**" of **ISO/IEC 14443-3** and shall add the following provisions.

Explanatory Notes:

The following are stipulated in **ISO/IEC 14443-3**.

– Frame Format and Timing
– PICC States Description
– Command Set
– Select Sequence

7.2.1 Bit Rate

Shall comply with **ISO/IEC 14443-3/AM1**.

7.2.2 Frame Format and Timing

Shall comply with **ISO/IEC 14443-3/AM1**.

7.2.3 e-MRP States

Shall comply with **ISO/IEC 14443-3/AM1**.

7.2.4 Select Sequence

Shall comply with **ISO/IEC 14443-3/AM1**.

Considerations:

Since the definition of b9 – b11 ATQA high bit rate indicators and higher bit rate selection procedure using the SEL command have been removed from **ISO/IEC 14443-3/AM1**, they are not stipulated in this Specification.

7.3 Initialization and Anticollision of e-MRP Type B

Shall comply with the "**Type B – Initialization and Anticollision**" of **ISO/IEC 14443-3** and shall add the following provisions.

Explanatory Notes:

The following are stipulated in **ISO/IEC 14443-3**.

– Character, Frame Format and Timing
– Anticollision Sequence
– PICC States Description
– Command Set
– Anticollision Command Format
– REQB/WUPB Command
– Slot_MARKER Command
– Answer to Request (ATQB)
– ATTRIB Command
– Answer to ATTRIB Command
– HLTB Command and Answer

7.3.1 Character, Frame Format and Timing

Shall comply with **ISO/IEC 14443-3/AM1**.

7.3.2 REQB/WUPB Command

7.3.2.1 Coding of AFI

Compatibility Improvement Specifications:

The AFI set for the e-MRP shall be "00".

In addition, the PCD shall set AFI to "00" and send a REQB/WUPB command.

7.3.2.2 Coding of PARAM

Considerations:

The PCD should set N to 1 and send a REQB/WUPB command.

7.3.3 Answer to Request (ATQB)

7.3.3.1 Pseudo-Unique e-MRP Identifier (PUPI)

Considerations:

The PUPI used for the initial anticollision after entering the IDLE state from a POWER-OFF state of an e-MRP which had been in an ACTIVE state should have a different value from the value of the PUPI used in the previous anticollision procedure.

7.3.3.2 Application Data

Compatibility Improvement Specifications:

(1) AFI (1 byte)
The AFI set for the e-MRP shall be "00".

(2) CRC_B (AID) (2 bytes)
Shall be any value.

(3) Application count (1 byte)
Shall be any value.

7.3.3.3 Protocol Info

Compatibility Improvement Specifications:

(1) Bit rate capability (8 bits)
e-MRP shall support at least fc/32 (approximately 424 kbit/s).

(2) Maximum frame size (4 bits)
e-MRP shall be capable of receiving a maximum frame size of 256 bytes.

(3) Protocol type (4 bits)
Shall support **ISO/IEC 14443-4**.

(4) FWI (4 bits)
Shall be less than or equal to 12 (FWT approx. 1,24s).

(5) Application data coding (2 bits)
The value of application data coding (ADC) shall be b"00". However, the value for the AFI of "**7.3.3.2 Application Data**" shall be set to the specified value ("00").

(6) Frame option (2 bits)
With e-MRP, support for CID shall be mandatory and NAD shall not be supported.

7.3.4 ATTRIB Command

7.3.4.1 Coding of Param 1

Shall comply with **ISO/IEC 14443-3/AM1**.

Considerations:

(1) Minimum value of TR0
Should use the default value (64/fs).

(2) Minimum value of TR1
Should use the default value (80/fs).

(3) EOF/SOF
The PCD should request EOF/SOF to the e-MRP to ensure compatibility.

7.3.4.2 Coding of Param 2

Compatibility Improvement Specifications:

PCD shall be capable of receiving a maximum frame size of 256 bytes.

PCD shall support at least fc/32 (approximately 424 kbit/s).

7.3.4.3 Coding of Param 3

Compatibility Improvement Specifications:

Shall support **ISO/IEC 14443-4**.

7.3.4.4 High Layer INF

Compatibility Improvement Specifications:

High Layer INF shall not be used.

7.3.5 Answer to ATTRIB Command

Considerations:

Since the minimum memory size of an e-MRP is established, it is not required to output the information regarding maximum internal buffer size using MBLI.

8 Transmission Control Sequence

Communication frames and the basic communication sequence are specified with the transmission protocol of the e-MRP and PCD on the basis of **ISO/IEC 14443-4**. Type A and Type B communication formats are specified.

8.1 Protocol Activation of e-MRP Type A

Shall comply with "Protocol activation of PICC Type A" of **ISO/IEC 14443-4**.

Explanatory Notes:
The following are stipulated in **ISO/IEC 14443-4**.

– Request for Answer To Select (RATS)
– Answer To Select (ATS)
– Protocol and Parameter Selection Request
– Protocol and Parameter Selection Response
– Activation Frame Waiting Time
– Error Detection and Recovery

8.2 Protocol Activation of e-MRP Type B

Shall comply with "Protocol activation of PICC Type B" of **ISO/IEC 14443-4**.

8.3 Half-Duplex Block Transmission Protocol

Shall comply with "Half-Duplex Block Transmission Protocol" of **ISO/IEC 14443-4**.

Explanatory Notes:
The following are stipulated in **ISO/IEC 14443-4**.

– Block Format
– Frame Waiting Time
– Frame Waiting Time Extension
– Power Level Indication
– Protocol Operation

Explanatory Notes 2:
The following is added in **ISO/IEC 14443-4/AM1**.

– The CID bytes b6-b5 shall be '00'. PCDs or e-MRPs that set values other than '00', or those do not generate a protocol error on receiving values other than '00', shall be considered non-conforming. When implementing products, considerations should be given to existence of e-MRPs or PCDs that conform to previous ISO standards with implementations that do not generate this protocol error.

8.3.1 Frame Waiting Time

Compatibility Improvement Specifications:

The Frame Waiting Time (FWT) for e-MRP shall be less than or equal to 1,24 s (FWI = 12).

Explanatory Notes:

FWI shall be less than or equal to 12, in accordance with the requirement described in the ICAO TR (Technical Report) Annex K.

8.3.2 Frame Waiting Time Extension

Compatibility Improvement Specifications:

The temporary FWT (FWT_{TEMP}) that corresponds with the Frame Waiting Time Extension (WTX) of the e-MRP shall be less than or equal to the value stipulated in "**8.3.1 Frame Waiting Time**."

Explanatory Notes:

WTX shall follow the same specification, based on the stipulations for FWI.

Explanatory Notes 2:

The following is added in **ISO/IEC 14443-4/AM1**.

– PCDs shall handle frames received with WTXM = 0, 60-63 as protocol errors. Any PCDs that handle otherwise shall be considered non-conforming. Considerations should be given to existence of PCDs that conform to previous ISO standards which may not generate this protocol error.

8.3.3 Power Level Indication

Compatibility Improvement Specifications:

Power Level Indication shall not be used.

Even if the e-MRP indicates a value other than b"00", the PCD may ignore that indication.

8.4 Protocol Deactivation of e-MRP Type A and Type B

Shall comply with "Protocol Deactivation of PICC Type A and Type B" of **ISO/IEC 14443-4**.

Explanatory Notes:

The following are stipulated in **ISO/IEC 14443-4**.

– Deactivation Frame Waiting Time
– Error Detection and Recovery

8.5 Protocol Scenarios

Shall comply with "Annex B (Informative) Protocol Scenarios" of **ISO/IEC 14443-4**.

8.6 Components of the Blocks and Frames

Shall comply with "Annex C (Informative) Block and Frame Coding Overview" of **ISO/IEC 14443-4**.

8.7 T = CL Transmission Control Matrix of Protocol

The following **Tables 4** and **5** are Transmission Control Matrices to help in understanding the Protocol.

Table 4 – Transmission Control Protocol on the e-MRP Side (Towards Upper Device)

State	Event											
	Receive I block (from PCD)				Receive R block (from PCD)				Receive S block (from PCD)		Receive error	
	A No-Chain Received $I(0)_0$	B No-Chain Received $I(0)_1$	C Chain Received $I(1)_0$	D Chain Received $I(1)_1$	E $R(ACK)_0$ Received	F $R(ACK)_1$ Received	G $R(NAK)_0$ Received	H $R(NAK)_1$ Received	I Response S(WTX) Received	J Request S(DESELECT) Received	K Error (PCB error)	L Error (CRC error, EGT timeout)
0 Protocol start state	$I(0)_0$ -> 1 Rule 10 $I(1)_0$ -> 3 Rule 10 S(WTX) -> 7 Rule 9 [1]		$R(ACK)_0$ -> 5 Rule 2 S(WTX) -> 7 Rule 9 [1]		No operation Return to prev. stat.	No operation Return to prev. stat.	$R(ACK)_1$ -> 6 Rule 12:	No operation Return to prev. stat.	No operation Return to prev. stat.	Response S(DESELECT) -> protocol end Rule 3:	No operation Return to prev. stat.	No operation Return to prev. stat.
1 $I(0)_0$ (Non-Chaining) After send Wait receive	$I(0)_1$ -> 2 Rule 10 $I(1)_1$ -> 4 Rule 10 S(WTX) -> 7 Rule 9 [1]		$R(ACK)_1$ -> 6 Rule 2 S(WTX) -> 7 Rule 9 [1]		Last block $I(0)_0$ Resend -> 1 Rule 11:	No operation Return to prev. stat.	Last block $I(0)_0$ Resend -> 1 Rule 11:	$R(ACK)_0$ -> 5 Rule 12:				
2 $I(0)_1$ (Non-Chaining) After send Wait receive	$I(0)_0$ -> 1 Rule 10 $I(1)_0$ -> 3 Rule 10 S(WTX) -> 7 Rule 9 [1]		$R(ACK)_0$ -> 5 Rule 2 S(WTX) -> 7 Rule 9 [1]		No operation Return to prev. stat.	Last block $I(0)_1$ Resend -> 2 Rule 11:	$R(ACK)_1$ -> 6 Rule 12:	Last block $I(0)_1$ Resend -> 2 Rule 11:				
3 $I(1)_0$ (Chaining) After send Wait receive	No operation Return to prev. stat.		No operation Return to prev. stat.		Last block $I(1)_0$ Resend -> 3 Rule 11:	$I(0)_1$ Send-> 2 $I(1)_1$ Send-> 4 Rule 13: [1]	Last block $I(1)_0$ Resend -> 3 Rule 11:	No operation Return to prev. stat.				
4 $I(1)_1$ (Chaining) After send Wait receive					$I(0)_0$ -> 1 $I(1)_0$ -> 3 Rule 13: [1]	Last block $I(1)_1$ Resend -> 4 Rule 11:	No operation Return to prev. stat.	Last block $I(1)_1$ Resend -> 4 Rule 11:				
5 $R(ACK)_0$ After send Wait receive	$I(0)_1$ -> 2 Rule 10 $I(1)_1$ -> 4 Rule 10 S(WTX) -> 7 Rule 9 [1]		$R(ACK)_1$ -> 6 Rule 2 S(WTX) -> 7 Rule 9 [1]		No operation Return to prev. stat.		Last block $R(ACK)_0$ Resend -> 5 Rule 11:	$R(ACK)_0$ -> 5 Rule 12:				
6 $R(ACK)_1$ After send Wait receive	$I(0)_0$ -> 1 Rule 10 $I(1)_0$ -> 3 Rule 10 S(WTX) -> 7 Rule 9 [1]		$R(ACK)_0$ -> 5 Rule 2 S(WTX) -> 7 Rule 9 [1]				$R(ACK)_1$ -> 6 Rule 12:	Last block $R(ACK)_1$ Resend -> 6 Rule 11:				
7 Request S(WTX) After send Wait receive	No operation Return to prev. stat.		No operation Return to prev. stat.		No operation Return to prev. stat.		Request S(WTX) Resend -> 7		Send what should be sent out before entering this state and then enter the state.			

NOTE "Rule" refers to rules as stipulated in "**Block Numbering Rules**" of **ISO/IEC 14443-4**.

1) e-MRP shall update its internal block number for the block number it will assign to the block that it will send next.

Table 5 – Transmission Control Protocol on the (Upper Device) PCD Side (Towards e-MRP)

1 $I(0)_0$ (No-Chain) After send Wait receive	Normal termination -> 0 [1]	Block number Violation -> 0	$R(ACK)_1$ -> 6 Rule 2: [1]	Block number Violation -> 0	Protocol Error -> 0		Response S(WTX) Sent Rule 3	Protocol Error -> 0	Format Error -> 0	$R(NAK)_0$ -> 7 Rule 4: [2]	$R(NAK)_0$ -> 7 Rule 4: [2]
2 $I(0)_1$ (No-Chain) After send Wait receive	Block number Violation -> 0	Normal termination -> 0 [1]	Block number Violation -> 0	$R(ACK)_0$ -> 5 Rule 2: [1]						$R(NAK)_1$ -> 8 Rule 4: [2]	$R(NAK)_1$ -> 8 Rule 4: [2]
3 $I(1)_0$ (Chain) After send Wait receive	Protocol Error -> 0				$I(0)_1$ -> 2 $I(1)_1$ -> 4 Rule 7: [1]	Block number Violation -> 0				$R(NAK)_0$ -> 7 Rule 4: [2]	$R(NAK)_0$ -> 7 Rule 4: [2]
4 $I(1)_1$ (Chain) After send Wait receive					Block number Violation -> 0	$I(0)_0$ -> 1 $I(1)_0$ -> 3 Rule 7: [1]				$R(NAK)_1$ -> 8 Rule 4: [2]	$R(NAK)_1$ -> 8 Rule 4: [2]
5 $R(ACK)_0$ After send Wait receive	Normal termination -> 0 [1]	Block number Violation -> 0	$R(ACK)_1$ -> 6 Rule 2: [1]	Block number Violation -> 0	Protocol Error -> 0					$R(ACK)_0$ -> 5 Rule 5: [2]	$R(ACK)_0$ -> 5 Rule 5: [2]
6 $R(ACK)_1$ After send Wait receive	Block number Violation -> 0	Normal termination -> 0 [1]	Block number Violation -> 0	$R(ACK)_0$ -> 5 Rule 2: [1]						$R(ACK)_1$ -> 6 Rule 5: [2]	$R(ACK)_1$ -> 6 Rule 5: [2]
7 $R(NAK)_0$ After send Wait receive	Normal termination -> 0 [1]	Block number Violation -> 0	$R(ACK)_1$ -> 6 Rule 2: [1]	Block number Violation -> 0	$I(0)_1$ -> 2 $I(1)_1$ -> 4 Rule 7: [1]	Last block $I(0)_0$ Resend -> 1 $I(1)_0$ Resend -> 3 Rule 6: [1]				$R(NAK)_0$ -> 7 Rule 4: [2]	$R(NAK)_0$ -> 7 Rule 4: [2]
8 $R(NAK)_1$ After send Wait receive	Block number Violation -> 0	Normal termination -> 0 [1]	Block number Violation -> 0	$R(ACK)_0$ -> 5 Rule 2: [1]	Last block $I(0)_1$ Resend -> 2 $I(1)_1$ Resend -> 4 Rule 6: [3]	$I(0)_0$ -> 1 $I(1)_0$ -> 3 Rule 7: [1]				$R(NAK)_1$ -> 8 Rule 4: [2]	$R(NAK)_1$ -> 8 Rule 4: [2]
9 Request S(DESELECT) After send Wait receive	S(DESELECT) -> 0 Rule 8:							protocol end	S(DESELECT) Resend -> 0 Rule 8:		

NOTE1 "Rule" refers to rules as stipulated in "**Block Numbering Rules**" of **ISO/IEC 14443-4**.

NOTE2 The initial value of the error counter shall be 0. If the error counter equals the maximum value N (can be set to an appropriate value when building system), PCD (upper device) shall end the protocol and return to state 0.

1) PCD shall update its internal block number for the block number it will assign to the block that it will send next, and shall clear the error counter.
2) Increment error counter.
3) Clear error counter

9 Unit Tests

Since the electrical characteristics of an e-MRP are the same as those of the PICC, Unit Tests for the e-MRP shall refer to **ISO/IEC 10373-6** as the "Standard Specification." In order to improve compatibility of e-MRPs and PCDs, this Implementation Specification includes additional tests as "Compatibility Improvement Specifications." This Implementation Specification also reflects provisions stipulated in **ISO/IEC 10373-6/AM2**.

Explanatory Notes:

The following standards specify the corresponding tests

ISO/IEC 10373-6/FPDAM4

– Additional test methods for PCD RF interface and PICC maximum applied magnetic field.

– Alternating current magnetic field tests and electrostatic discharge tests.

– Effects of maximum load Class 1 PICC.

– Magnetic field strength of PCDs that support operation of Class 1 PICC.

ISO/IEC 10373-6/FPDAM5

– Additional protocol test methods for data rates of fc/64, fc/32, and fc/16.

9.1 General Requirements

9.1.1 Test Environment

Unless otherwise specified, the test environment as specified in **Table 6** shall apply.

Table 6 – Test Environment

Subject Area	Condition
Temperature	23±3°C
Humidity	Relative humidity from 40% to 60%

9.1.2 Pre-conditioning

The e-MRP and PCD to be tested shall be conditioned to the test environment that satisfies the provisions of the test environment for a period of 24 h before testing.

9.1.3 Default Tolerance

Unless otherwise specified, a default tolerance of ±5 % shall be applied to the quantity values given to specify the characteristics of the test equipment (e.g. linear dimensions) and the test method procedure (e.g. test equipment adjustments).

9.1.4 Total Measurement Uncertainty

The total measurement uncertainty for each quantity determined by these test method shall be stated in the test report.

Note: Basic information is given in "ISO Guide to the Expression of Uncertainty in Measurement" ISBN 92-67-10188, 1993.

9.2 Test Content

– Test content for the e-MRP under test
  are shown in **Table 7**, and
– Test content for the PCD under test
  are shown in **Table 8**.

Details of each test content listed in **Tables 7** and **8** are described from section 9.3 onward.
There are several Compatibility Improvement Specifications designate as "Informative" which tests can be added according to the usage environment of the application.

Table 7 – Test Content (for e-MRP under test)

Item	Test content	Test Apparatus [Generated Magnetic Field Strength]	Rule	Category	
				Standard Specification	Compatibility Improvement
9.3.1	e-MRP load modulation amplitude test	Test PCD [1,5 A/m]	30/H^1,2 mVp-p or more.	Normative	
		Test PCD [4,0 A/m]			Normative
		Test PCD [7,5 A/m]		Normative	
		Test PCD-S (Informative) [4,0 A/m]	A REQA/REQB response is received.		Informative
		Test PCD-S (Informative) [7,5 A/m]			Informative
9.3.2	Reception test	Test PCD [1,5 A/m]	A REQA/REQB response is received.	Normative	
		Test PCD [4,0 A/m]			Normative
		Test PCD [4,5 A/m]		Normative	1)
		Test PCD [7,5 A/m]		Normative	
9.3.3	Resonance Frequency	Impedance analyzer or LCR meter	No rule.	Informative	
			13,56 MHz or more.		Normative
9.3.4	Maximum Applied Magnetic Field Test	Test PCD [Apply 10 A/m]	The e-MRP shall function normally after applying the magnetic field of 10 A/m.		Normative
9.3.5	Protocol Timing characteristics (Informative)	Test PCD [No rule]	The timing values shall satisfy the rules.		Informative

1) Test PCD [4,5 A/m] shall be omitted from the Compatibility Improvement Specifications.

Table 8 – Test Content (for PCD under test)

Item	Test content	Test Apparatus [Reference PICC Resonance Frequency]	Rule	Category	
				Standard Specification	Compatibility Improvement
9.4.1	Magnetic Field Strength Maximum Generated Magnetic Field	Reference PICC [19 MHz]	3 V (dc) or less (7,5 A/m)	Normative	
		Reference PICC-S [19 MHz]	3 V (dc) or less (7,5 A/m)		Normative
		Reference PICC-M [19 MHz]			
		Reference PICC-L [19 MHz]			
	Magnetic Field Strength Minimum Generated Magnetic Field	Reference PICC [13,56 MHz]	3 V (dc) or more (1,5 A/m)	Normative	
		Reference PICC-S [13,56 MHz]	3 V (dc) or more (4 A/m)		Normative
		Reference PICC-M [13,56 MHz]			
		Reference PICC-L [13,56 MHz]			
9.4.2	Power Transmission Test	Reference PICC [19 MHz]	1,8 kOhm load, 3 V (dc) or more	Normative	
		Reference PICC-S [19 MHz]	910 Ohm load, 6,8 V (dc) or more		Informative
		Reference PICC-M [19 MHz]			
		Reference PICC-L [19 MHz]			
9.4.3	Modulation Waveform	Calibration Coil	The results shall satisfy the rules.	Normative	
		Reference PICC (Annex I) [19 MHz]		Informative	
		Reference PICC-S/M/L [19 MHz]			Normative
9.4.4	Reception ability of load modulation signal (Informative)	Reference PICC [19 MHz]	Shall be able to receive.	Informative	
		Reference PICC-S [19 MHz]			Informative
		Reference PICC-M [19 MHz]			Informative
		Reference PICC-L [19 MHz]			Informative
9.4.5	Protocol Timing Characteristics (Informative)	N/A	Timing value shall satisfy specification.	Informative	

9.3 Test Content for the e-MRP Under Test

Shall comply with "Testing of PICC" of **ISO/IEC 10373-6** and **ISO/IEC 10373-6/AM2**.

9.3.1 e-MRP Load Modulation Amplitude Test

Shall comply with "PICC load modulation amplitude" of **ISO/IEC 10373-6** and **ISO/IEC 10373-6/AM2**.

Compatibility Improvement Specifications:

The minimum operating field Hmin shall be equal to the value as specified in "**5.1.4 Operating Field**."

Compatibility Improvement Specifications (Informative):

Functional test of an e-MRP in close contact is performed by verifying whether the e-MRP satisfies the rules while using a Test PCD-S.

(1) Test procedure

Place the e-MRP on the Test PCD-S and send a REQA or REQB from the Test PCD-S.
Verify the modulated signal received from the e-MRP using an oscilloscope connected to a calibration coil.

(2) Measurements

Check the receipt of modulation signal from the e-MRP when the e-MRP is within the operating range of the test PCD-S.
Operating range of Test PCD-S
Distance: from 0 mm to 5mm.
Displacement: within diameter of 5 mm.

(3) Rule

A modulation signal shall be received from the e-MRP within the operating range of the test PCD-S.

9.3.2 Reception Test

Shall comply with "PICC reception" of **ISO/IEC 10373-6/AM2**.

Compatibility Improvement Specifications:

(1) Test procedure

Adjust the modulation waveform from the Test PCD to satisfy the conditions specified in **Table 9** and **10**.

Verify the response from the e-MRP according to the test method stipulated in **ISO/IEC 10373-6**.

Table 9 – Type A Testing Conditions

Condition	H (A/m)	t1 (μs)	t2 (μs)
1	4,0	3	0,5
2	4,0	2	0,7
3	7,5	3	0,5
4	7,5	2	0,7

Table 10 – Type B Testing Conditions

Condition	H (A/m)	Modulation index (%)	tr (μs)	tf (μs)
1	4,0	8	2	2
2	4,0	14	2	2
3	7,5	8	2	2
4	7,5	14	2	2

(2) Rule

A response shall be emitted from the e-MRP.

Explanatory Notes:

The following is specified in **ISO/IEC 10373-6/FPDAM5**.

– Test conditions for acceleration.

9.3.3 Resonance Frequency

Shall comply with "PICC resonance frequency (informative)" of **ISO/IEC 10373-6/AM2**.

Compatibility Improvement Specifications:

Results shall satisfy the Compatibility Improvement Specifications of "**5.1.3 Resonance Frequency**."

9.3.4 Maximum Field Strength Application Test

The purpose of this test is to verify that the e-MRP under test does not have any anomaly after applying maximum field strength on the e-MRP.

Compatibility Improvement Specifications:

(1) Test procedure

Place an e-MRP into the DUT position on the Test PCD and after applying a field with an average (for the span of 30 seconds) strength of 10 A/m rms at 13,56 MHz, verify the operation of the e-MRP.

(2) Rule

e-MRP shall function normally after applying field.

9.3.5 Protocol Timing Characteristics (Informative)

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 10373-6:2001/FPDAM1>

(1) Test procedure

Refer to **ISO/IEC 10373-6:2001/FPADM1** and measure each protocol timing specified in **Table 11** and **12**.

(2) Rule

The measurements of each protocol timing shall satisfy the values specified in **Table 11** and **12**.

Table 11 – Excerpt from

< ISO/IEC 10373-6:2001/FPDAM1. Table G.33 – Type A Specific Timing Table>

No.	Parameter	ISO Reference	Required Test Value	Measured Value(s)
1	Frame delay time PICC to PCD	ISO/IEC 14443-3:2001, 6.1.3	At least 1172/*fc*	
2	Frame delay time PCD to e-MRP (for REQA,WUPA, ANTICOLLISION,SELECT commands)	ISO/IEC 14443-3:2001, 6.1.2	Last bit (1)b->1236/*fc* Last bit (0)b->1172/*fc*	
3	Frame delay time PCD to e-MRP (for all commands, exclude ones from previous row)	ISO/IEC 14443-3:2001, 6.1.2	Last bit (1)b -> (n × 128 + 84) / fc Last bit (0)b -> (n × 128 + 20) / fc	
4	Deactivation frame waiting Time	ISO/IEC 14443-4:2001, 8.1	See Table G.34 No.12 (same values)	
NOTE All timing values are calculated for carrier frequency *fc* equal 13,56 MHz and bit rate equal to *fc*/128 (~106 kbit/s).				

Table 12 – Excerpt from

< ISO/IEC 10373-6:2001/FPDAM1. Table G.34 – Type B Specific Timing Table>

No.	Name	ISO Reference	Std Min	Std Max	Measured Value(s)
1	SOF low	ISO/IEC 14443-3:2001, 7.1.4	10 etu (~94,40 µs)	11 etu (~103,83 µs)	
2	SOF high	ISO/IEC 14443-3:2001, 7.1.4	2 etu (~18,88 µs)	3 etu (~28,32 µs)	
3	EOF low	ISO/IEC 14443-3:2001, 7.1.5	10 etu (~94,40 µs)	11 etu (~103,38 µs)	
4	Bit boundaries	ISO/IEC 14443-3:2001, 7.1.1	(n - 1/8) etu	(n + 1/8) etu	
5	EGT PICC to PCD	ISO/IEC 14443-3:2001, 7.1.2	0 µs	19 µs	
6	TR0 for ATQB	ISO/IEC 14443-3:2001, 7.1.6	64/fs (~75,52 µs)	256/fs (~302,06 µs)	
7	TR1 for ATQB	ISO/IEC 14443-3:2001, 7.1.6	80/fs (~94,40 µs)	200/fs (~235,99 µs)	
8	TR0 Not ATQB	ISO/IEC 14443-3:2001, 7.1.6 ISO/IEC 14443-3:2001, 7.10.3	64/fs (~75,52 µs) or May be Reduced	(256/fs) × 2FWI - TR1 (~302,06 × 2FWI) - TR1 µs	FWI = Max TR0 =
9	TR1 Not ATQB	ISO/IEC 14443-3:2001, 7.1.6 ISO/IEC 14443-3:2001, 7.10.3	80/fs (~94,40 µs) or May be Reduced	200/fs (~235,99 µs)	
10	Delay from the end of EOF and Subcarrier off	ISO/IEC 14443-3:2001, 7.1.7	0 µs	2 etu	
11	Deactivation frame waiting time	ISO/IEC 14443-4:2001, 8.1	64/fs + 80/fs (~169,92 µs)	65536/fs (~4,8 ms)	

NOTE All timing values are calculated for carrier frequency *fc* equal 13,56 MHz and bit rate equal to *fc*/128 (~106 kbit/s).

9.4 Test Content for the PCD Under Test

9.4.1 Field Strength

Shall comply with the "PCD field strength" of **ISO/IEC 10373-6**.

Compatibility Improvement Specifications:

(1) Test procedure

Using the Reference PICC -S/M/L, measure minimum and maximum field generated. Test procedure and measurements shall be the same as those stipulated in "**PCD field strength**" of **ISO/IEC 10373-6**, and minimum field strength (Hmin) shall be equal to the value stipulated in "**5.2.4 Generated Magnetic Field**."

(2) Rule

a) Maximum field generated
Receive voltage of 3 V (dc) or less within the operating range of the PCD.

b) Minimum field generated
Receive voltage of 3 V (dc) or more within the operating range of the PCD.

9.4.2 Power Transfer Test

Shall comply with the "Power transfer PCD to PICC" of **ISO/IEC 10373-6**.

Compatibility Improvement Specifications (Informative):

(1) Test procedure

Using the Reference PICC -S/M/L for power transfer tests, measure the voltage. Test procedure shall be the same as the procedure stipulated in "**Power transfer PCD to PICC**" of **ISO/IEC 10373-6**.

Connect jumper to resistor R3 of the reference PICC-S/M/L and tune the resonance frequency to 19 MHz. Measure the voltage generated at both ends of R3 with a high input impedance voltmeter. Measurement shall be performed with all reference PICC-S/M/L.

(2) Measurements

Measure the voltage generated at both ends of R3 within the operating range of the PCD.

(3) Rule

Receive voltage of reference PICC shall be 6,8 V (dc) or more

9.4.3 Modulation Waveform

Shall comply with the "Modulation index and waveform" of **ISO/IEC 10373-6**.

Compatibility Improvement Specifications:

The modulation waveform shall be measured with the reference PICC set in place.

(1) Test procedure

Measure the modulation waveform on the calibration coil with the reference PICC placed within the operating range of the PCD.

Using the Reference PICC -S/M/L for modulation waveform tests, measure the specified measurements.

a) Tune the reference PICC so as to synchronize at 19 MHz.

b) Place the calibration coil over the reference PICC-S/M/L coil, place the reference PICC in the operating range of the PCD, and measure the modulation waveform by monitoring the voltage waveform induced on the calibration coil.

(2) Measurements

Measure the modulation waveform in the operating range of the PCD, along with measurement of the modulation index, rise time, fall time, and overshoot.

(3) Rule

The modulation index and modulation waveform shall satisfy the provisions stipulated in "**Modulation**" of **ISO/IEC 14443-2**.

Compatibility Improvement Specifications (Informative): <Refer to ISO/IEC 10373-6:2001/FPDAM4>

The modulation waveform shall be measured with the reference PICC (Annex I) set in place.

(1) Test procedure

Measure the modulation waveform on the pickup coil with the reference PICC (Annex I) for modulation waveform tests placed within the operating range of the PCD.

a) The calibration coil shall be placed above the reference PICC (Annex I) coil and the PCD shall be calibrated to generate maximum generated magnetic field above the calibration coil.

b) The jumper J1 of the reference PICC (Annex I) shall be connected to resistance R1 and adjusted to synchronize at 19 MHz.

c) After the reference PICC (Annex I) is placed within the operating range of PCD, and the jumper J1 is connected to resistance R2, and R2 is adjusted so as to receive 6 V (dc) at capacitor C4, measure the modulation waveform from the voltage waveform induced at the pickup coil.

(2) Measurements

Measure the modulation waveform within the operating range of the PCD, and measure the modulation level, rising and falling time, and other values such as over-shoot.

(3) Rule

Modulation level and waveform shall satisfy "**Modulation**" of **ISO/IEC 14443-2**.

9.4.4 Reception Ability of Load Modulation Signal (Informative)

Shall comply with the "**Load modulation reception (informative only)**" of **ISO/IEC 10373-6**.

Compatibility Improvement Specifications:

(1) Test procedure

Using the Reference PICC -S/M/L for modulation waveform tests, measure the specified measurements.

Other test procedure shall be the same as the procedure stipulated in "**Load modulation reception (informative only)**" of **ISO/IEC 10373-6**.

(2) Measurements

Measure the load modulation signal that can be received by the PCD within the operating range of the PCD.

(3) Rule

The PCD shall be capable of receiving load modulation signal stipulated in "**Load modulation**" of **ISO/IEC 14443-2**.

Explanatory Notes:

The following is specified in **ISO/IEC 10373-6/FPDAM4**.

– Details of test procedures.

9.4.5 Protocol Timing Characteristics (Informative)

Compatibility Improvement Specifications (Informative): <Refer to ISO/IEC 10373-6:2001/FPDAM3>

(1) Test procedure

Refer to **ISO/IEC 10373-6:2001/FPDAM3** and measure each protocol timing specified in **Table 13** and **14**.

(2) Rule

Measurements shall satisfy the protocol values specified in **Table 13** and **14**.

Table 13 – Excerpt from

<ISO/IEC 10373-6:2001/FPDAM3. Table H.4 – Type A Specific Timing Table>

No	Parameter	ISO Reference	Reference Value	Measured Value
1	Frame delay time PICC to PCD (for REQA,WUPA, ANTICOLLISION, SELECT commands)	ISO/IEC14443-3:2001, 6.1.3	at least 1172/fc (~86 µs)	
2	Request Guard Time	ISO/IEC14443-3:2001, 6.1.4	at least 7000/fc (~512 µs)	
3	Deactivation frame waiting time	ISO/IEC14443-4:2001, 8.1	Min 64/fs + 80/fs(~169.92 µs) Max 65536/fc(~4.8 ms)	
NOTE All timing values are calculated for carrier frequency *fc* equal 13,56 MHz and bit rate equal to *fc*/128 (~106 kbit/s).				

Table 14 – Excerpt from

<ISO/IEC 10373-6:2001/FPDAM3. Table H.5 – Type B Specific Timing Table>

No	Parameter	ISO Reference	Minimum	Maximum	Measured Value
SEQ1	SOF low	ISO/IEC14443-3:2001, 7.1.4	10etu (~94.40µs)	11etu (~103.83 µs)	
2	EOF low	ISO/IEC14443-3:2001, 7.1.5	10etu (~94.40µs)	11 etu (~103.83 µs)	
SEQ2	Bit boundaries	ISO/IEC14443-3:2001, 7.1.1	(n - 0.125) etu	(n + 0.125) etu	
SEQ3	EGT PCD to PICC	ISO/IEC14443-3:2001, 7.1.2	0 etu	6 etu	
SEQ4	Minimum delay between the PICC EOF start and PCD SOF start	ISO/IEC14443-3:2001, 7.1.7	10etu + 32/fs	No maximum	
NOTE All timing values are calculated for carrier frequency *fc* equal 13,56 MHz and bit rate equal to *fc*/128 (~106 kbit/s).					

Note: All timing values are calculated for carrier frequency *fc* = 13.56 MHz and bit rate ~106 kbit/s

9.5 Test Apparatus for Unit Tests

9.5.1 Calibration Coil

Shall comply with "Calibration coil" of **ISO/IEC 10373-6** and **ISO/IEC 10373-6/AM2**.

Explanatory Notes:

Note that changes have been applied in accordance with **ISO/IEC 10373-6/AM2**.

Major changes are the following.

- Change in Note: Change of standard inductor value and resistance value.
- Addition of Note: Note of caution related to connection of oscilloscope added.

9.5.2 Test PCD

9.5.2.1 Assembly of Test PCD

Shall comply with "Assembly of test PCD" and Annex of **ISO/IEC 10373-6** and **ISO/IEC 10373-6/AM2**.

Explanatory Notes:

(1) Note that changes have been applied in accordance with **ISO/IEC 10373-6/AM2**.

Major changes are the following.

Changed resistance value in **Figure 6**.

- Note of Annex A Test PCD Antenna: Added note of caution regarding capacitor and resistor ratings.

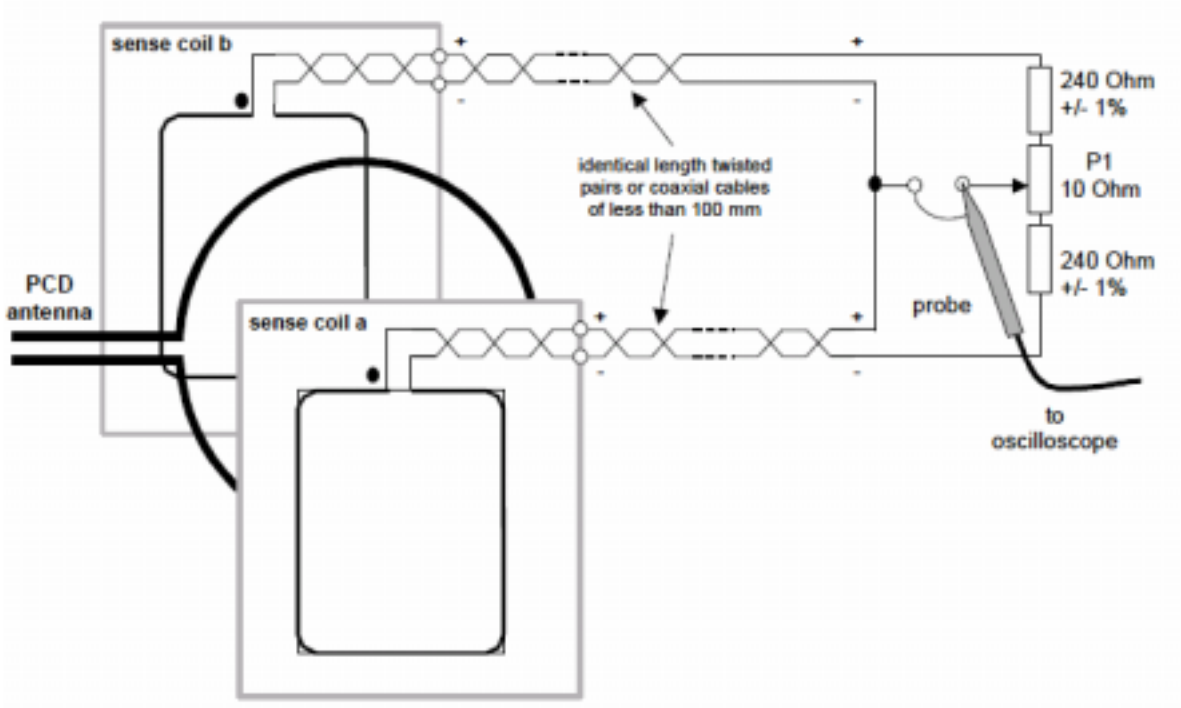
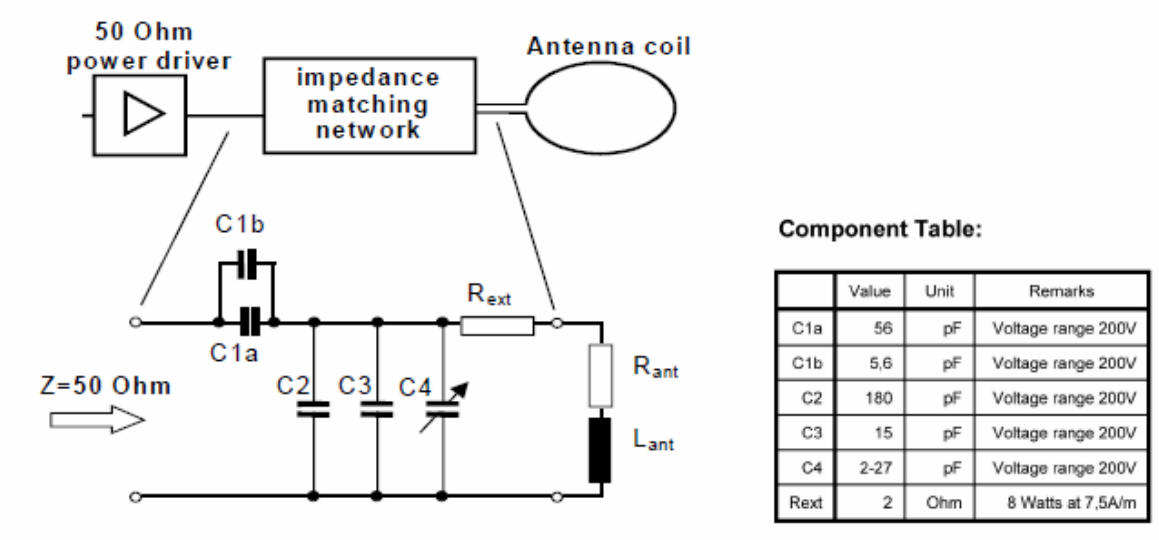


Figure 6 – Initial Settings of Test PCD

(2) Be aware that certain parts have been revised in accordance with **ISO/IEC 10373-6/FPDAM5**.

Major changes are the following.

- Annex A: Impedance matching network added for cases where bit data rate are fc/64, fc/32, or fc/16.



Component Table:

	Value	Unit	Remarks
C1a	56	pF	Voltage range 200V
C1b	5,6	pF	Voltage range 200V
C2	180	pF	Voltage range 200V
C3	15	pF	Voltage range 200V
C4	2-27	pF	Voltage range 200V
Rext	2	Ohm	8 Watts at 7,5A/m

Figure 7 – Impedance Matching Network for Data Rates of fc/64, fc/32, and fc/16

9.5.2.2 Settings of Test PCD

Shall comply with Annex of **ISO/IEC 10373-6** and **ISO/IEC 10373-6/AM2**.

9.5.3 Test PCD-S

9.5.3.1 Assembly of Test PCD-S

Table 15 shows the antenna specifications of the PCD-S.

Table 15 – Antenna Specification of Test PCD-S

Name	Description	
Antenna coil	Coil outer diameter	(38 ± 0,2) mm
	Pattern width	0,5 mm
	Pattern interval	0,5 mm
	Pattern thickness	35 µm
	No. of turns	3 turns
	Structure	The coil shall be made as a printed coil on PCB plated with copper.
Antenna board	Size	120 mm × 100 mm
	Thickness	1,6 mm
	Material	FR4
Impedance matching network	Impedance is matched between the antenna coil and output circuit at 50 Ohm.	

Figure 8 shows the Test PCD-S circuit and **Figure 9** shows the structure of the Test PCD-S.

The calibration coil and test PCD-S antenna shall be arranged in parallel so that the central axis of the calibration coil and test PCD-S antenna coil are concentric. At this time, the test PCD-S shall be assembled so that the distance between the effective conductor surfaces is 15 mm as shown in **Figure 9**.

In addition, a 5 mm spacer shall be arranged between the Test PCD-S and measured PICC, and the spacer surface shall be defined as the reference surface (distance: 0 mm) of the Test PCD-S, while the antenna center of the Test PCD-S shall be defined as the central position.

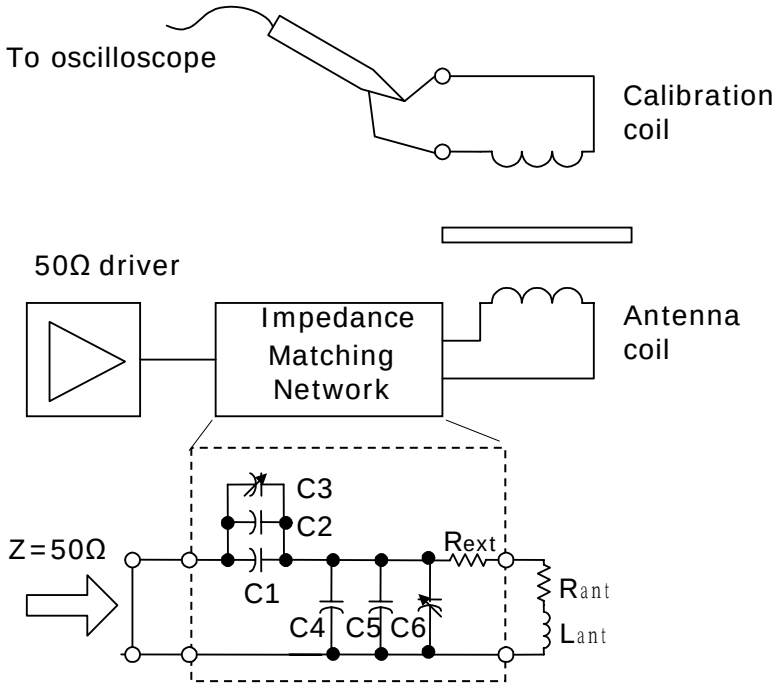


Figure 8– Test PCD-S Circuit

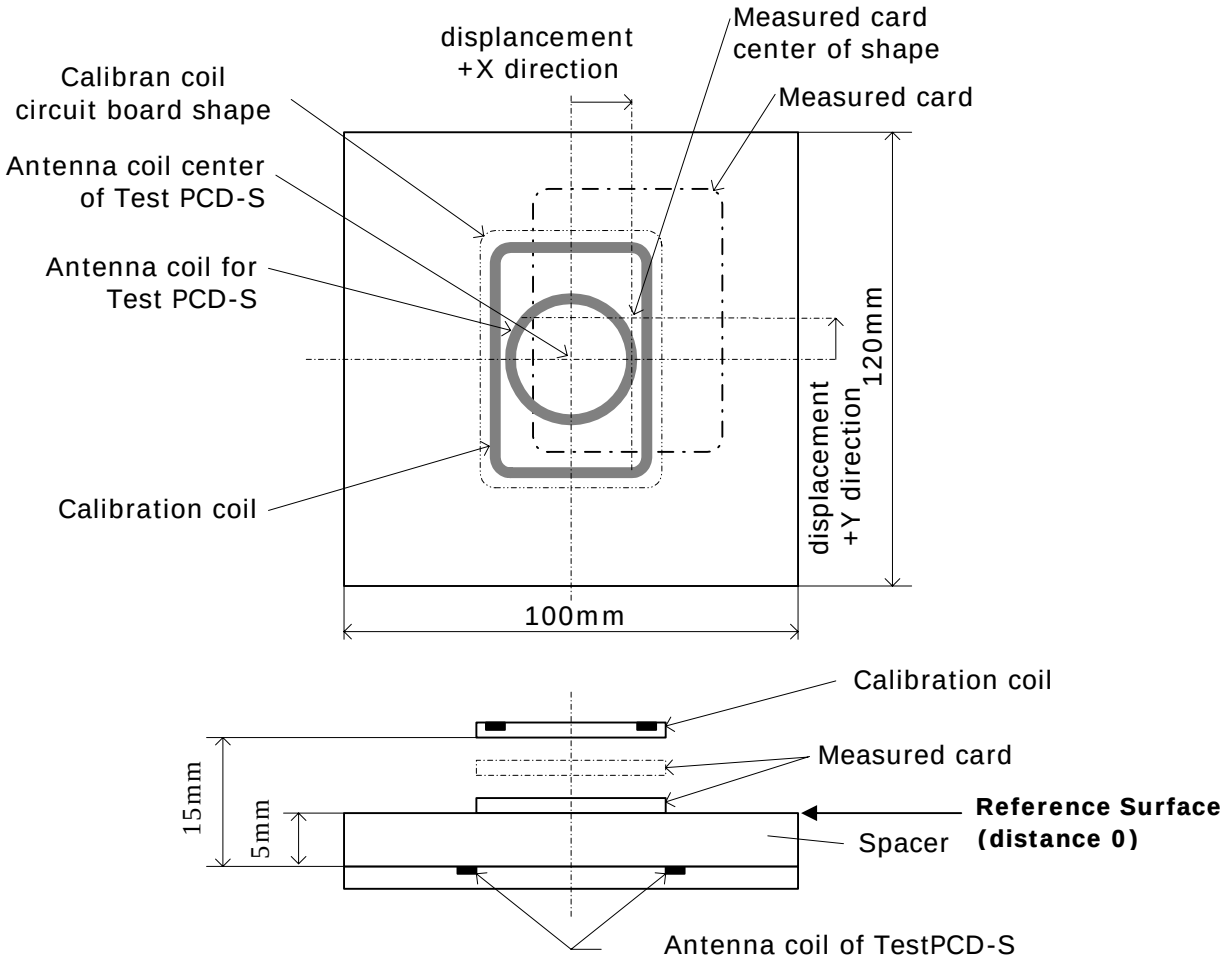


Figure 9 – Test PCD-S Structure

9.5.3.2 Settings of Test PCD-S

9.5.3.2.1 Calibration of Generated Field

Compatibility Improvement Specifications:

Using the reference PICC-S and reference PICC-L, the field strength H of the Test PCD-S shall be calibrated to the maximum generated field and minimum generated field as specified in the Compatibility Improvement Specifications of **9.4.1**.

The center of the reference PICC shall be concentric with the center of the Test PCD-S antenna at a distance of 0 mm (reference surface) with no disposition.

(1) Calibration of maximum generated field

On the Test PCD, the output voltage of the reference PICC-S shall be tuned to measure 3 V (dc) under a field strength of 7,5 A/m. After placing this reference PICC-S in the DUT position of the PCD-S, the Test PCD-S shall be tuned so that the output voltage of the reference PICC-S measures 3 V (dc).

(2) Calibration of minimum generated field

On the Test PCD, the output voltage of the reference PICC-L shall be tuned to measure 3 V (dc) under

a field strength of 4,0 A/m. After placing this reference PICC-L in the DUT position of the PCD-S, the Test PCD-S shall be tuned so that the output voltage of the reference PICC-L measures 3 V (dc).

9.5.3.2.2 Modulation Waveform

By measuring the modulation waveform at the calibration coil, the modulation waveform shall be calibrated so that the modulation waveform matches the stipulated waveform. The center of the calibration coil shall be concentric with the center of the Test PCD-S antenna at a distance of 0 mm (reference surface) with no disposition.

9.5.4 Reference PICC

Shall comply with the "**Reference PICCs**" of **SO/IEC 10373-6** and **ISO/IEC 10373-6/AM2** and shall add the following provisions.

Explanatory Notes:

Note that changes have been applied to relevant areas in accordance with **ISO/IEC 10373-6/AM2**.

Major changes are the following.

– Field strength as well as the adjustment range of R2 within the circuit of the reference PICC for measuring voltage was changed.

– The adjustment method of the resonance frequency of the reference PICC was changed.

Compatibility Improvement Specifications:

(1) Size, thickness and material of the reference PICC-S/M/L
Size, thickness and material of the reference PICC-S/M/L shall be the same as the reference PICC.

(2) Coil Characteristics

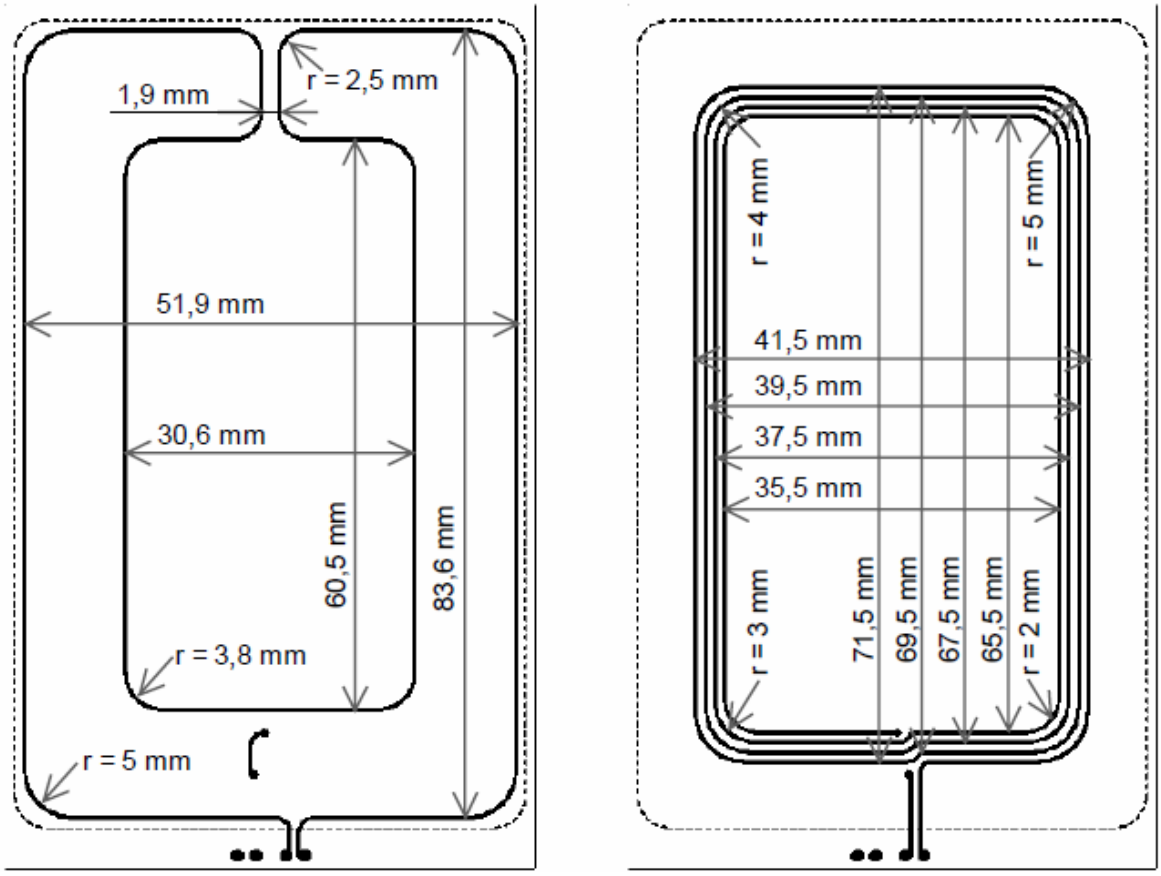
Table 16 shows the size and other characteristics of the reference PICC-S/M/L.

Table 16 – Characteristics of Reference PICC-S/M/L

Subject Area	Description		
	Reference PICC-S	**Reference PICC-M**	**Reference PICC-L**
Coil dimensions	Coil inner diameter: (66,6 ± 2%) mm × (31 ± 2%) mm	Coil outer diameter: (72 ± 2%) mm × (42 ± 2%) mm	Coil outer diameter: (83,6 ± 2%) mm × (52 ± 2%) mm
	Corner radius: (8,5 ± 2%) mm	Corner radius: (5 ± 2%) mm	Corner radius: (5 ± 2%) mm
No. of turns	4		
Pattern width	(0,5 ± 20%) mm		
Pattern interval	(0,5 ± 20%) mm		
Pattern material	Copper plated.		
Pattern thickness	35 µm		
NOTE The coil characteristics of the reference PICC-M is the same as those of the reference PICC of the Standard Specification.			

Compatibility Improvement Specifications (Informative): <Refer to ISO/IEC 10373-6/PFADM4>

The antenna layout, circuit layout, and component table of the reference PICC (Annex I) for modulation level tests and modulation waveform tests are shown in **Figure 10**, **Figure 11**, and **Table 17**, respectively.



Front Face: Pickup Coil **Back Face: Main Coil**

Figure 10 – Antenna Layout

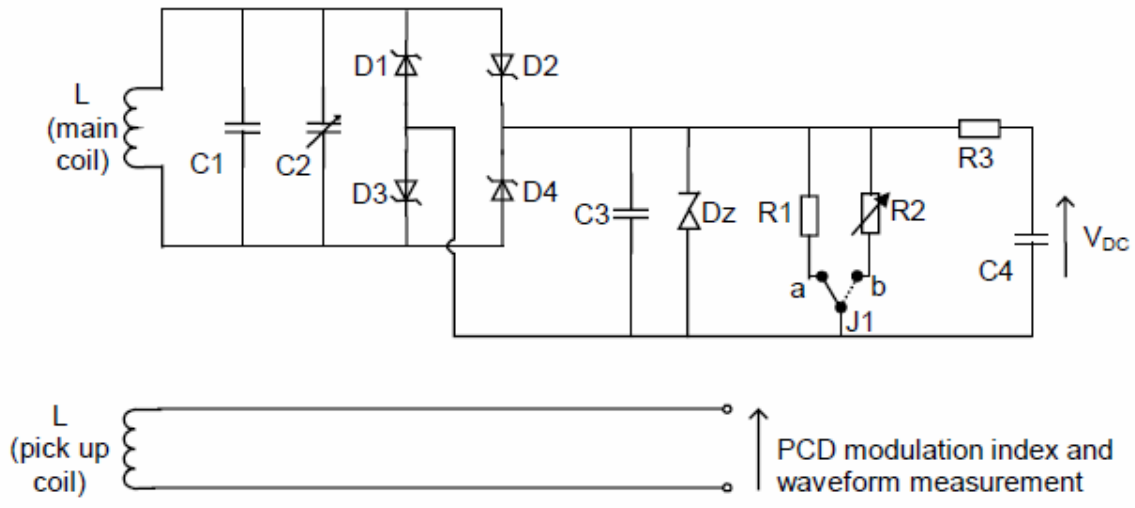


Figure 11 – Circuit Diagram of Reference PICC (Annex I) for Modulation Level Tests and Module Waveform Tests

Table 17 – Characteristics of Reference PICC-S/M/L

Component	Value
L (main coil)	See **Figure 10**.
L (pickup coil)	See **Figure 10**.
C1	Stray capacitance < 5 pF
C2	Variable capacitance (ex. From 3 pF to 20 pF)
D1, D2, D3, D4	See characteristics in **Table 19** (BAR43 or equivalent)
C3	1 nF
R1	1.8 kOhm
R2	From 0 to 200 Ohm
Dz	Zener diode 15 V (BZX84C15 or equivalent)
R3	10 kOhm
C4	1 nF

9.5.4.1 Reference PICC-S/M/L for Power Transfer Tests

9.5.4.1.1 Assembly of PICC-S/M/L

Figure 12 shows the circuit, and **Table 18** shows the components of the reference PICC-S/M/L for power transfer tests.

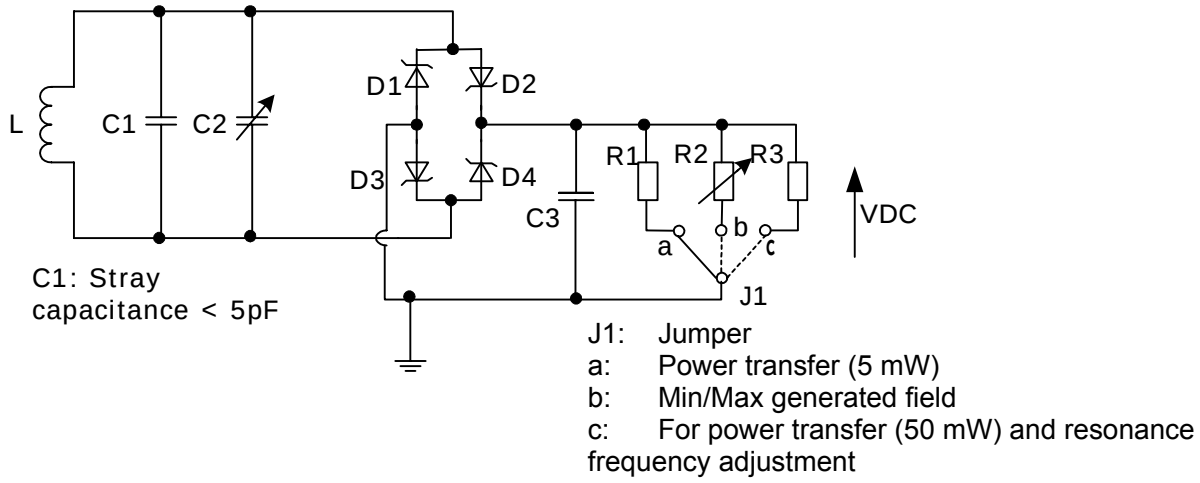


Figure 12 – Circuit of Reference PICC-S/M/L for Power Transfer Tests

Table 18 – Components

Component	Value	Comparison with Standard Specification
L (coil)	See **Table 16**	Reference PICC-S/M/L is defined.
C1	Stray capacitance < 5 pF	Same.
C2	From 6 pF to 60 pF	
C3	10 nF	
D1, D2, D3, D4	See **Table 19** (BAR43 or equivalent)	
R1	1.8 kOhm (5 mW)	
R2	From 0 to 1 kOhm [1)]	
R3	910 Ohm	Newly added.
1) Changed according to **ISO/IEC 10373-6/AM2**		

Table 19 – Basic Characteristics of Diode D1, D2,D3, and D4

Subject Area	Test condition (Tj = 23°C)	Standard	Maximum	Unit
V_F	I_F = 2 mA		0,33	V
C	V_R = 1 V F = 1 MHz	7		pF
trr	I_F = 10 mA I_R = 1 mA Irr = 1 mA		5	ns

V_F	Forward voltage drop
V_R	Reverse voltage
I_F	Forward current
I_R	Reverse current
t_{rr}	Recovery time
I_{rr}	Recovery current
Tj	Juncture temperature
F	Frequency
C	Juncture capacity

9.5.4.1.2 Resonance Frequency Setting of PICC-S/M/L

The resonance frequency shall be set based on the method for setting the resonance frequency of the reference PICC as stipulated in "**PCD field strength**" and "**Power transfer PCD to PICC**" of **ISO/IEC 10373-6/AM2**, with modifications as stipulated below in the Compatibility Improvement Specifications.

Explanatory Notes:

The method for setting resonance frequency was changed by **ISO/IEC 10373-6/AM2**. The changes are summarized below.

Drive the calibration coil directly from the signal generator using the frequency to set, set the jumper to a, and tune C2 so that the voltage at both ends of the resistance (1,8 kOhm) becomes largest. Here, the signal generator output and C2 shall be tuned so that the maximum voltage at both ends of resistance R1 is 3 V (dc).

Compatibility Improvement Specifications:

Drive the calibration coil directly from the signal generator using the frequency to set, set the jumper to c, and tune C2 so that the voltage at both ends of the resistance R3 (910 kOhm) becomes largest. Here, the signal generator output and C2 shall be tuned so that the maximum voltage at both ends of resistance R3 is 3 V (dc).

9.5.4.1.3 Setting Resistor R2 of PICC-S/M/L

Shall comply with the method of setting resistor R2 of the reference PICC stipulated in "**PCD field strength**" of **ISO/IEC 10373-6/AM2**.

Explanatory Notes:

Resistance R2 shall be set as follows.

(1) Calibrate the field generated by the test PCD using a calibration coil.

(2) Set the resonance frequency.

(3) Place the reference PICC in the DUT position on the test PCD and connect jumper to resistor R2. Measure the voltage at both ends of R2 with a high input impedance voltmeter, and adjust the voltage to 3 V (dc).
Observe the state of the operating field by monitoring the voltage generated on the calibration coil.

9.5.4.2 Reference PICC-S/M/L for Load Modulation Tests

9.5.4.2.1 Assembly of PICC-S/M/L

Figure 13 shows the circuit, and **Table 20** shows the components of the reference PICC-S/M/L for load modulation tests.

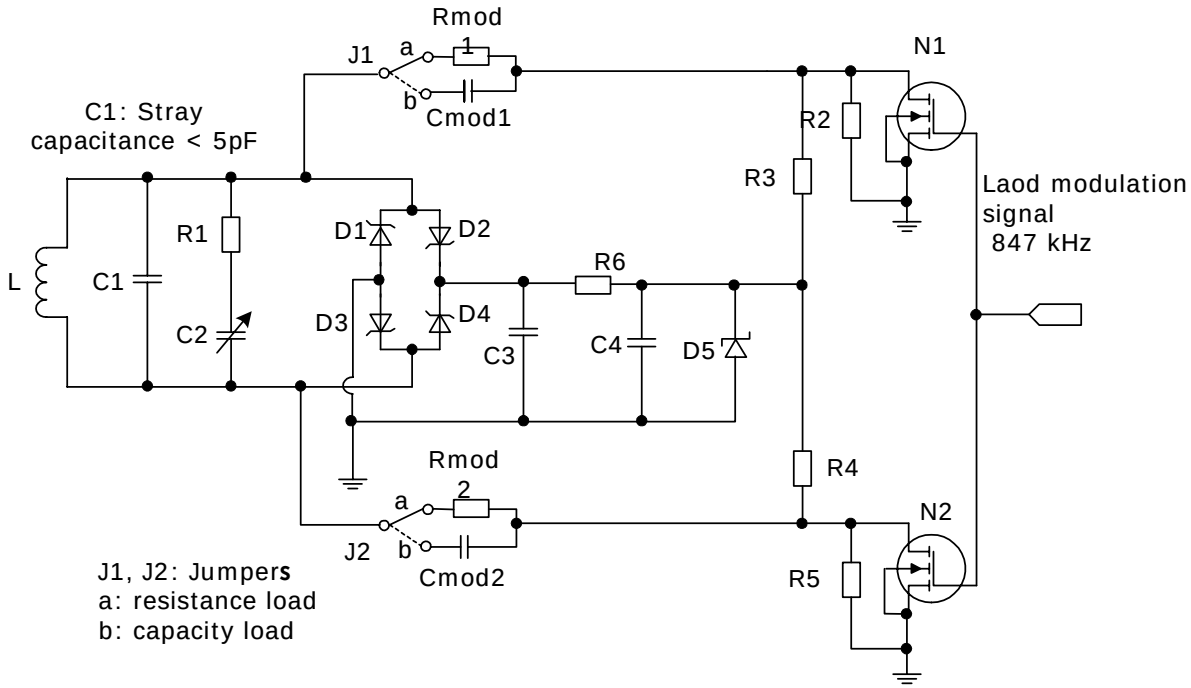


Figure 13 – Circuit of Reference PICC-S/M/L for Load Modulation Tests

Table 20 – Components

Adjustment Components

Component	Function	Value	Comparison with Standard Specification
R1	adjust Q	0 Ohm	Within range of ISO (from 0 Ohm to 10 Ohm)
C2	Requires adjustments.	Value that makes the resonance frequency 19 MHz.	Same.
Cmod1, Cmod2	Capacitor modulation	0 pF (None)	Remove since it is performed with resistive modulation.
Rmod1, Rmod2	Resistive modulation	From 400 Ohm to 12 kOhm	Same.
R6	Shunt resistance	100 Ohm	Within range of ISO (from 10 Ohm to 5 kOhm)
D5	Adjusts shunt voltage.	5,1 V	Within range of ISO (from 2,7 V to 15 V)

Fixed Components

Component	Value	Comparison with Standard Specification
R2, R3, R4, R5	1 MOhm	Same.
D1, D2, D3, D4	See **Table 19** (BAR43 or equivalent)	
L	See **Table 16**	Reference PICC-S/M/L is defined.
C1	Stray capacitance < 5 pF	Same.
C2	From 6 pF to 60 pF	
C3	100 pF	
C4	10 nF	
N1, N2	N-MOS transistor with earth capacitance of 10 pF or less	

9.5.4.2.2 Resonance Frequency Setting of PICC-S/M/L

Use the same method as stipulated in **9.5.4.1.2**.

Explanatory Notes:

Resonance frequency is not stipulated in **ISO/IEC 10373-6**.

9.5.4.3 Reference PICC-S/M/L for Modulation Waveform Tests

9.5.4.3.1 Assembly of PICC-S/M/L

Figure 14 shows the circuit, and **Table 21** shows the components of the reference PICC-S/M/L for modulation waveform tests.

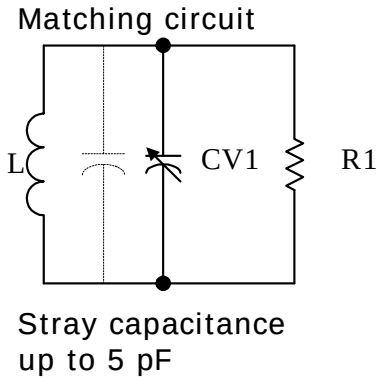


Figure 14 – Circuit of Reference PICC-S/M/L for Modulation Waveform Tests

Table 21 – Components

Component	Value	Comparison with Standard Specification
L (coil)	See **Table 16**	Newly added.
CV1	From 6 pF to 60 pF	
R1	910 Ohm	

9.5.4.3.2 Resonance Frequency Setting of PICC-S/M/L

CV1 shall be tuned using the same measurement method as for the resonance frequency of PICC.

Explanations

This explanation describes contents stipulated or written in the main and Annex portions as wells as related information, and does not constitute part of the Implementation Specification.

Purpose of Stipulation

This Implementation Specification titled "Proximity Communication Interface Implementation Specification for e-Passports," is a compilation of a communication interface that will be required to ensure compatibility of biometric passports (e-Passports or e-MRP) and proximity coupling devices (PCD) while complying with International Standards, and is based on the "Proximity Communication Interface Implementation Specification Version 2.0" which was established as an implementation specification complementing the Standard Specification in order to ensure compatibility between contactless IC cards.

It is expected that this Implementation Specification will be respected by the e-MRP, PCD and vendors of systems that use these devices when considering interoperability.

Issues that were raised during discussion

Antenna size and antenna position of e-MRP

An issue that the compatibility with a PCD will be largely affected by the size of the antenna implemented on an ID-3 sized e-MRP was raised.

If an ID-3 sized antenna is allowed to be implemented on an e-MRP, redefinition of the field strength, and with that, a new effort for establishing an International Standard will be required, and considering the fact that ID-1 sized contactless ID cards have proven track record of compatibility, it was decided that e-MRPs shall implement Class-1 sized antennae.

Furthermore, while the antenna size to be implemented on an e-MRP shall be Class-1 sized, the implementation location will affect compatibility, which led to the decision that the antenna position of the e-MRP shall be concentric with the center of a booklet.

Range of e-MRP operating field

The operating field of the e-MRP shall be in the proven range (from 4,0 A/m to 7,5 A/m) of the contactless IC card, anticipating adaptation to advanced demands (authentication features using coprocessors) expected in the future.

Initial response parameters of e-MRP

In **ISO/IEC 14443-3:2001/FPADM3**, the AFI value of an e-MRP Type B was specified as 'E1'. However, since e-MRPs issued before this specification was defined are likely to exist, it was decided to require that PCDs should set the value of AFI to "00" and send a REQB/WUPB command.

Issues that were raised when establishing the "Proximity Communication Interface Implementation Specification Version 2.0"

Measurement of Field Using Calibration Coil

In version 1.1 of the implementation specification, the description for calibrating the generated field of a test PCD-S and for measuring the strength of the generated field included specifications to measure the open-circuit voltage using a calibration coil and calculating the field strength using a conversion factor.

However, while fields generated by large antennae (uniform field) such as those used in test PCDs, and the fields at proximity of relatively small sized antennae (non-uniform field) such as those used in general PCDs and test PCD-Ss might have same measurement values, the fact that fields that a PICC senses are not necessarily the same became an issue.

Thus, the intended use of calibration coils was organized as follows to exclude measurement using the calibration coil.

The intended use of the calibration coil is to calibrate the measurement test environment (test PCD, reference PICC, etc.) for the purpose of calculation of field strength at a distance of 37,5 mm from the test PCD antenna. Direct measurement of fields of PCDs and test PCD-Ss with other antenna sizes and at other distances are not considered as the intended use of the calibration coil in this Implementation Specification.

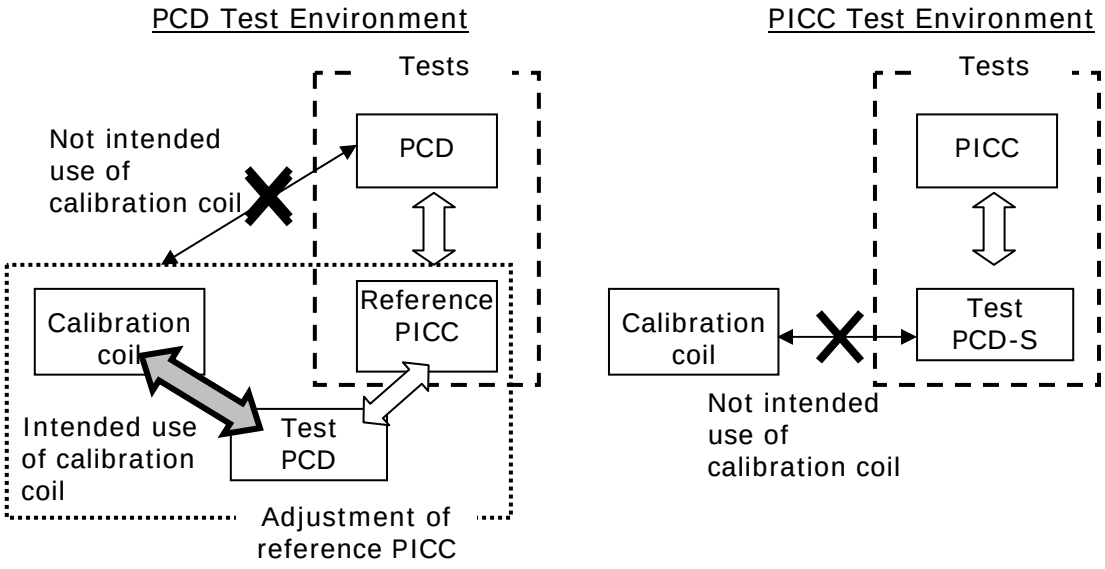


Figure 15 – Intended Use of Calibration Coil

Compatibility of Open Type PCDs and PICCs

Methods on how to ensure compatibility of a situation where a PICC gradually approaches an open type PCD were discussed.

Basic concept was organized and the following tests were added.

– Behavior when card approaches: Test for PICC characteristics (functional test) invocation
– Communication after card begins operation: Static cross test of open type PCDs

Calibration of Test PCD-S

When calibrating the generated field in accordance with Compatibility Improvement Specifications of **Subclause 9.4.1**, the maximum generated field of the test PCD-S is determined by the reference PICC-S, and the minimum generated field is determined by the reference PICC-L. Thus, it was decided that the setting for the generated field of the test PCD-S shall be performed using the reference PICC-S and reference PICC-L.

Reasons for stipulating individual provisions

Subject area: PICC operation noise

This was specified in anticipation of establishing stable operation during high-speed communication which is expected to become popular in the future.

Load fluctuation during operation of an IC on a PICC will be considered as load fluctuation of the PICC itself, which will be received by the PCD as operational noise similar to load modulation. This may affect communication quality.

Since the margin of communication quality for high-speed communication is small than slower-speed communication, this noise may become an issue.

Therefore, in order to evoke caution at design time, areas that may be affected by load fluctuation were listed and a guideline to enable reprocessing by the system was introduced as one method to evade disturbance pertaining to load fluctuation.

Note that since methods for measuring noise are currently not established, no numbers are specified.

Annex A

External Communication Protocol (Informative)

This informative document describes the communication protocol between PCDs and external equipment (upper devices).

Communication protocol between PCDs and upper devices are stipulated in the specifications for each nation's upper device.

Table of Contents

A.1 Scope

The external communication protocol described herein is informative since it is not specified in the Standard Specification and will depend on the application using it. Thus implementing the interface described in this document on a PCD is not a requirement. However, in order to accommodate the differences between PCD vendors and to standardize service application software at the upper device level, PCD vendors should provide driver software that implement the common interface specification described in chapter 2, or PC/SC driver described in chapter 3.

A.2 Common Interface Specification of the PCD Control API

This chapter describes the specification of the PCD common interface (API functions) as seen from the upper device and will not specify interface specifications particular to PCDs.

Note that service applications of upper devices shall use particular interfaces when using PCD specific features.

Figure A.1 shows the scope of the specification described in Chapter 2.

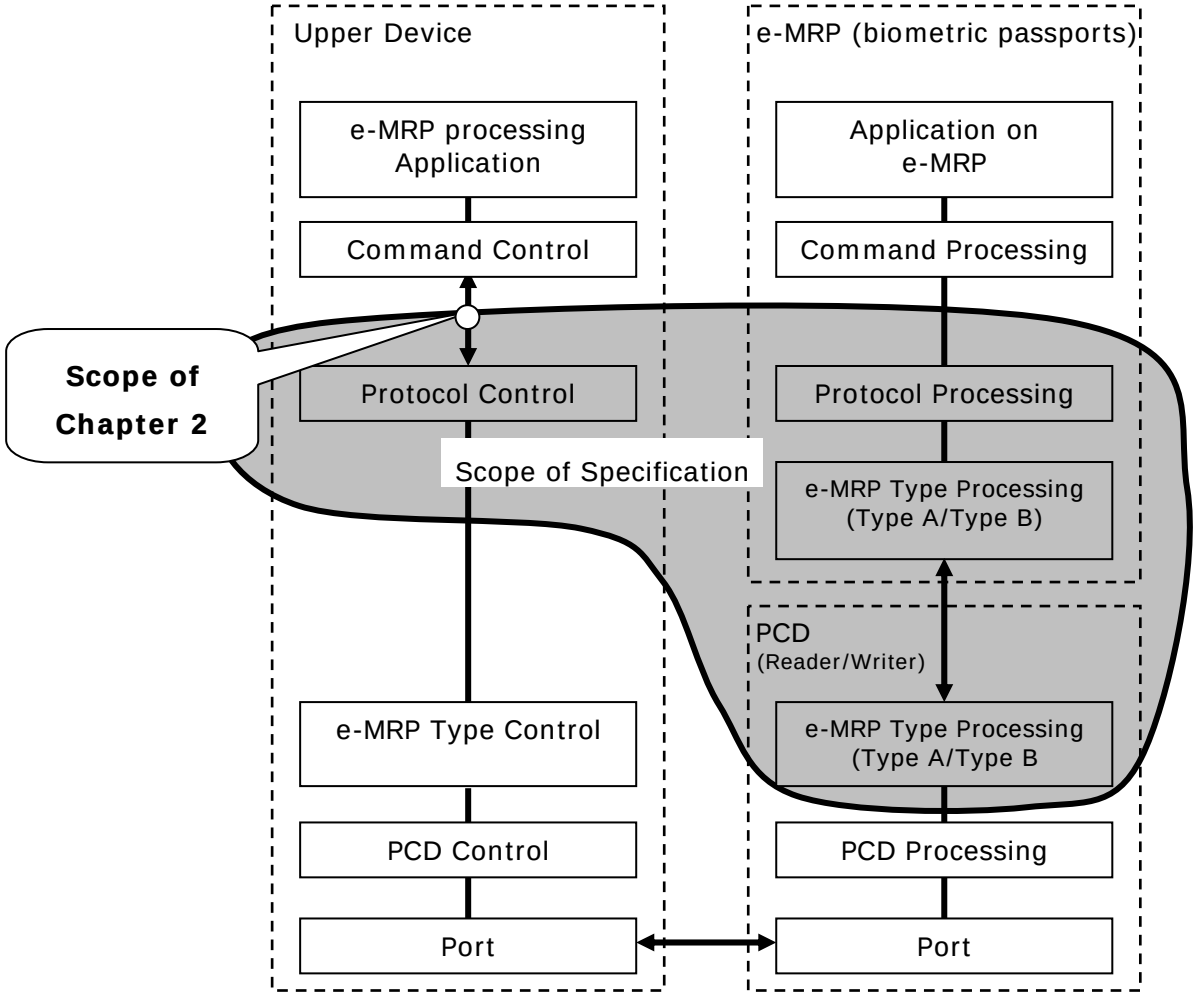


Figure A.1 – Scope of the Interface Specification of the PCD Control API

A.2.1 Overview of the Common Interface

A summary of the common interface is described below.

(1) Purpose of the Common Interface

To absorb differences in PCDs and to provide common interface functions to service applications.

To simplify procedures for controlling PCDs and e-MRP communication.

(2) Form of the Common Interface

Dynamic Link Library (DLL)

(3) Common Interface Driver Name

EMRPPCDDRV.DLL

A.2.2 List of Major Interface Functions

Table A.1 shows a list of major functions supported by the common interface, and **Table A.2** shows a list of error codes.

Table A.1 – List of Major Interface Functions

№	Function name	Description
1	RW_Open	Open communication port of PCD.
2	RW_Close	Close communication port of PCD.
3	RW_Insert	Enable detection of e-MRP by PCD.
4	RW_Eject	Disable detection of e-MRP by PCD.
5	RW_Sense	Detect e-MRP.
6	RW_Activate	Set e-MRP to ACTIVE state.
7	RW_Transmit	Perform data transmission between e-MRP.
8	RW_Deactivate	Set e-MRP to inactive state.

Table A.2 – Common Error Code List

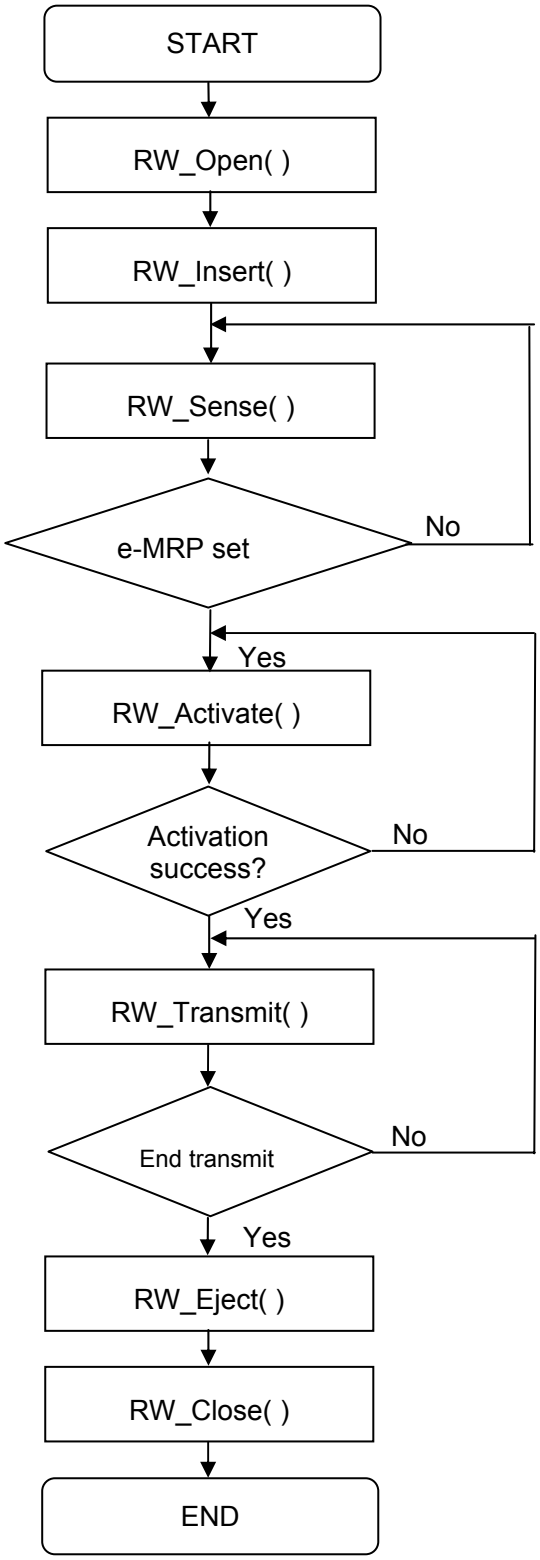
№	Error code	Description
1	0x0000A001	Number error of specified port.
2	0x0000A002	Open failure on specified port.
3	0x0000A003	Close failure on specified port.
4	0x0000A004	Specified port not open.
5	0x0000A101	Error occurred during transmission to PCD.
6	0x0000A102	Error occurred during transmission from PCD.
7	0x0000A201	Error occurred during transmission to e-MRP.
8	0x0000A202	Error occurred during transmission from e-MRP.
9	0x0000A203	Timeout occurred during transmission from e-MRP.
10	0x0000A301	Number error (other than 1) of specified slot [1)]
11	0x0000A302	Specified communication speed not supported by PCD.
12	0x0000A303	Specified communication speed not supported by e-MRP.
13	0x0000A304	Specified communication speed not supported by PCD.
14	0x0000A305	Specified operation mode not supported by PCD.
15	0x0000A306	Cannot initialize e-MRP with specified operation mode.
16	0x0000A901	Specified port already open.
17	0x0000A902	Specified port already closed.
18	0x0000A903	INSERT command already received.
19	0x0000AE01	e-MRP is not set in the detectable range of PCD.
20	0x0000AE02	e-MRP no activated.
21	0x0000AE03	Preserved for future use.

NOTE Error codes values for PCD specific interface code shall be defined avoiding the range from 0x0000A000 to 0x0000AFFF.

1) In this document "slot" refers to e-MRP detectable range of PCD.

A.2.3 Procedures of Using the Common Interface

Figure A.2 shows the usage procedure of the common interface functions during basic operations of an e-MRP.



NOTE The procedure shows basic operations only and does not show all procedures.

Figure A.2 – Usage of Function During Basic Operations

A.2.4 Function Details

Details of the common interface functions are described herein. Note that the operating environment of the examples of functions shown below assumes a device that run a Windows environment.

Note: Windows is a trademark or registered trademark of Microsoft Corporation in the United States of America and other countries.

(1) Function Name: RW_Open

Description

Directs a PCD to open a connected communication port.

When using a COM port, the communication speed between the upper device (PC) and the e-MRP should be set to the maximum communication speed the PCD supports.

Synopsis

DWORD WINAPI RW_Open(BYTE bPortNumber)

Arguments

bPortNumber : The port to open.

COM port : 1 though 9 (COM1 through COM9)

USB port : 101 through 109

Note: Ports other than the above are vendor specific.

Return value

0 : Normal termination.

Non 0 : Error occurred.

0x0000A001 : Number error of specified port.

0x0000A901 : Specified port already open.

0x0000A002 : Open failure on specified port.

(2) Function Name: RW_Close

Description

Directs a PCD to close a connected communication port.

Synopsis

DWORD WINAPI RW_Close(BYTE bPortNumber)

Arguments

bPortNumber : The port to close.

COM port : 1 though 9 (COM1 through COM9)

USB port : 101 through 109

Note: Ports other than the above are vendor specific.

Return value

0 : Normal termination.

Non 0 : Error occurred.

0x0000A001 : Number error of specified port.

0x0000A902 : Specified port already closed.

0x0000A003 : Close failure on specified port.

(3) Function Name: RW_Insert

Description

Enables detection of e-MRP by PCD.

Synopsis

DWORD WINAPI RW_Insert(BYTE bPortNumber,BYTE bSlotNumber)

Arguments

bPortNumber : Communication Port.

COM port : 1 though 9 (COM1 through COM9)

USB port : 101 through 109

Note: Ports other than the above are vendor specific.

bSlotNumber : Slot number (fixed to 1).

Return value

0 : Normal termination.

Non 0 : Error occurred.

0x0000A001 : Number error of specified port.

0x0000A004 : Specified port not open.

0x0000A101 : Error occurred during transmission to PCD.

0x0000A102 : Error occurred during transmission from PCD.

0x0000A301 : Slot Number (other than 1) error of specified port.

0x0000A302 : Specified slot number not supported.

0x0000A902 : INSERT command already executed.

NOTE:

PCDs that do not support the enable e-MRP detection command shall return a normal termination value if there are no errors in the arguments passed to it.

The enable e-MRP detection state shall be reset by issuing the RW_Eject function.

(4) Function Name: RW_Eject

Description

Disables detection of e-MRP by PCD.

Synopsis

DWORD WINAPI RW_Eject(BYTE bPortNumber, BYTE bSlotNumber)

Arguments

bPortNumber : Communication Port.

COM port : 1 though 9 (COM1 through COM9)

USB port : 101 through 109

Note: Ports other than the above are vendor specific.

bSlotNumber : Slot number (fixed to 1).

Return value

0 : Normal termination.

Non 0 : Error occurred.

0x0000A001 : Number error of specified port.

0x0000A004 : Specified port not open.

0x0000A101 : Error occurred during transmission to PCD.

0x0000A102 : Error occurred during transmission from PCD.

0x0000A301 : Slot Number (other than 1) error of specified port.

0x0000A302 : Specified slot number not supported.

NOTE:

Disables detection of e-MRP by PCD after turning carrier off.

If there are no errors in the arguments passed, reset the enable e-MRP detection state.

(5) Function Name: RW_Sense

Description

Detects whether an e-MRP is set within the detectable range of the PCD and detects the operating status of the e-MRP.

Synopsis

DWORD WINAPI RW_Sense(BYTE bPortNumber,BYTE bSlotNumber,LPLONG lccStatus1,
LPLONG lccStatus2)

Arguments

bPortNumber : Communication Port.

COM port : 1 though 9 (COM1 through COM9)

USB port : 101 through 109

Note: Ports other than the above are vendor specific.

bSlotNumber : Slot number (fixed to 1).

lccStatus1 : The storage buffer for the set state and operating state of e-MRP number 1.

lccStatus2 : Ignore value since it is currently not used with e-MRP operations.

Return value

0 : Normal termination.

Non 0 : Error occurred.

0x0000A001 : Number error of specified port.

0x0000A004 : Specified port not open.

0x0000A101 : Error occurred during transmission to PCD.

0x0000A102 : Error occurred during transmission from PCD.

NOTE:

The set state and operating state of e-MRP (lccStatus1 [1]))

******** ******** 0******* ********B: e-MRP set state: not set

******** ******** 1******* ********B: e-MRP set state: already set

******** ******** *000**** ********B: e-MRP type: contactless Type B

******** ******** *001**** ********B: e-MRP type: contactless Type A

******** ******** *111**** ********B: e-MRP type: unknown

******** ******** ****0000 ********B: e-MRP state: IDLE

******** ******** ****0001 ********B: e-MRP state: READY

******** ******** ****0010 ********B: e-MRP state: ACTIVE

******** ******** ****1000 ********B: e-MRP state: HALT

******** ******** ******** ******00B: Communication speed: PCD to e-MRP 1× speed (106 kbit/s)

******** ******** ******** ******01B: Communication speed: PCD to e-MRP 2× speed (212 kbit/s)

******** ******** ******** ******10B: Communication speed: PCD to e-MRP 4× speed (424 kbit/s)

******** ******** ******** ******11B: Communication speed: PCD to e-MRP 8× speed (847 kbit/s)

******** ******** ******** ****00**B: Communication speed: e-MRP to PCD 1× speed (106 kbit/s)

******** ******** ******** ****01**B: Communication speed: e-MRP to PCD 2× speed (212 kbit/s)

******** ******** ******** ****10**B: Communication speed: e-MRP to PCD 4× speed (424 kbit/s)

******** ******** ******** ****11**B: Communication speed: e-MRP to PCD 8× speed (847 kbit/s)

1) Code of IccStatus1 may differ depending on the particular PCD.

Communication speed shows the speed state at that particular moment and is not the speed specification (ability) supported by the PCD or e-MRP. If the e-MRP type is unknown, the communication speed information is invalid.

(6) Function Name: RW_Activate

Description

Initializes the e-MRP set on the PCD to the specified operation mode and communication speed, and sets the e-MRP to ACTIVE state.

Synopsis

DWORD WINAPI RW_Activate(BYTE bPortNumber, BYTE bSlotNumber,
BYTE bCardNumber, BYTE IccMode, BYTE IccSpeed)

Arguments

bPortNumber : Communication Port.
COM port : 1 though 9 (COM1 through COM9)
USB port : 101 through 109
Note: Ports other than the above are vendor specific.
bSlotNumber : Slot number (fixed to 1).
bCardNumber : e-MRP number (fixed to 1).
IccMode : The operation mode to specify.
Contactless Type B (0x00), Contactless Type A (0x01)
IccSpeed : The communication speed between the PCD and e-MRP to set.
1× communication speed (0x00), 2× communication speed (0x01),
4× communication speed (0x02), 8× communication speed (0x03).
Auto set communication speed (0x80. Set the communication speed to the maximum speed both PCD and e-MRP support).

Return value

0 : Normal termination.
Non 0 : Error occurred.
0x0000A001 : Number error of specified port.
0x0000A004 : Specified port not open.
0x0000A101 : Error occurred during transmission to PCD.
0x0000A102 : Error occurred during transmission from PCD.
0x0000A201 : Error occurred during transmission to e-MRP.

0x0000A202 : Error occurred during transmission from e-MRP.

0x0000A203 : Timeout occurred during transmission from e-MRP.

0x0000A301 : Slot Number (other than 1) error of specified port.

0x0000A302 : Specified slot number not supported.

0x0000A303 : Specified communication speed not supported by e-MRP.

0x0000A304 : Specified communication speed not supported by PCD.

0x0000A305 : Specified operation mode not supported by PCD.

0x0000A306 : Cannot initialize e-MRP with specified operation mode.

0x0000AE01 : e-MRP not set.

NOTE:

The initialization of the e-MRP shall follow the procedures stipulated in the appropriate specification in accordance with the specified operating mode.

Example: In Type B operating mode, following the procedures specified in the **ISO/IEC 14443** standard, send the REQB command and then the ATTRIB commando to the e-MRP, and set the operating state of the e-MRP to ACTIVE state.

If the e-MRP type retrieved using the RW_Sense command specified in item (5) is unknown, for IccMode, an RW_Activate command shall be issued for contactless type A and contactless type B. And for IccSpeed, when errors occur, the RW_Activate command shall be issued with varying parameters until successful.

(7) Function Name: RW_Transmit

Description

Process the protocol in accordance with the operating mode of the e-MRP set in the specified PCD and transmit to and from the e-MRP.

Synopsis

```
DWORD WINAPI RW_Transmit(BYTE bPortNumber, BYTE bSlotNumber,
        BYTE bCardNumber, DWORD dwLenSend, LPBYTE lpbSendBuf,
        LPDWORD lpdwLenRecv, LPBYTE lpbRecvBuf)
```

Arguments

bPortNumber : Communication Port.

COM port : 1 though 9 (COM1 through COM9)

USB port : 101 through 109

Note: Ports other than the above are vendor specific.

bSlotNumber : Slot number (fixed to 1).

bCardNumber : e-MRP number (fixed to 1).

dwLenSend : Number of bytes in send data (1 or more bytes).

lpbSendBuf : Buffer to store send data.

lpdwLenRecv : Buffer to store received number of data bytes.

lpbRecvBuf : Buffer to store received data.

Return value

0 : Normal termination.

Non 0 : Error occurred.

0x0000A001 : Number error of specified port.

0x0000A004 : Specified port not open.

0x0000A101 : Error occurred during transmission to PCD.

0x0000A102 : Error occurred during transmission from PCD.

0x0000A201 : Error occurred during transmission to e-MRP.

0x0000A202 : Error occurred during transmission from e-MRP.

0x0000A203 : Timeout occurred during transmission from e-MRP.

0x0000A301 : Slot Number (other than 1) error of specified port.

0x0000A302 : Specified slot number not supported.

0x0000AE01 : e-MRP not set.

0x0000AE03 : e-MRP not in ACTIVE state.

NOTE:

Response data from the e-MRP including those is SW1 and SW2 shall be stored in the received data buffer.

(8) Function Name: RW_Deactivate

Description

Sets e-MRP placed in the PCD to inactive state.

Synopsis

DWORD WINAPI RW_Deactivate(BYTE bPortNumber, BYTE bSlotNumber,
BYTE bCardNumber)

Arguments

bPortNumber : Communication Port.

COM port : 1 though 9 (COM1 through COM9)

USB port : 101 through 109

Note: Ports other than the above are vendor specific.

bSlotNumber : Slot number (fixed to 1).

bCardNumber : e-MRP number (fixed to 1).

Return value

0 : Normal termination.

Non 0 : Error occurred.

0x0000A001 : Number error of specified port.

0x0000A004 : Specified port not open.

0x0000A101 : Error occurred during transmission to PCD.

0x0000A102 : Error occurred during transmission from PCD.

0x0000A301 : Slot Number (other than 1) error of specified port.

0x0000A302 : Specified slot number not supported.

NOTE:

The behavior of this API function depends upon the particular PCD.

The PCD may halt transferring power to the e-MRP.

A.3 The PC/SC Specification

PC/SC is an acronym of Personal Computer/Smart Card, and specifies the standards for using IC cards on a PC.

The PC/SC Specification is published at the PC/SC Workgroup web page (http://www.pcscworkgroup.com/). The 1.0 version of this specification for IC cards with contact terminals was published in December 1997, and the 2.01 version which added contactless IC cards as its target was published June 2005. The version to apply needs to be selected depending on the support for the operating system of the upper device. When applying version 1.0, a contact terminal equipped IC card shall be simulated to support the version.

Figure A-3 depicts the components of PC/SC version 2.01. The differences of the reader/writers (IFD) shall be accommodated through IFD Handlers (driver software) that are provided by each reader/writer vendor.

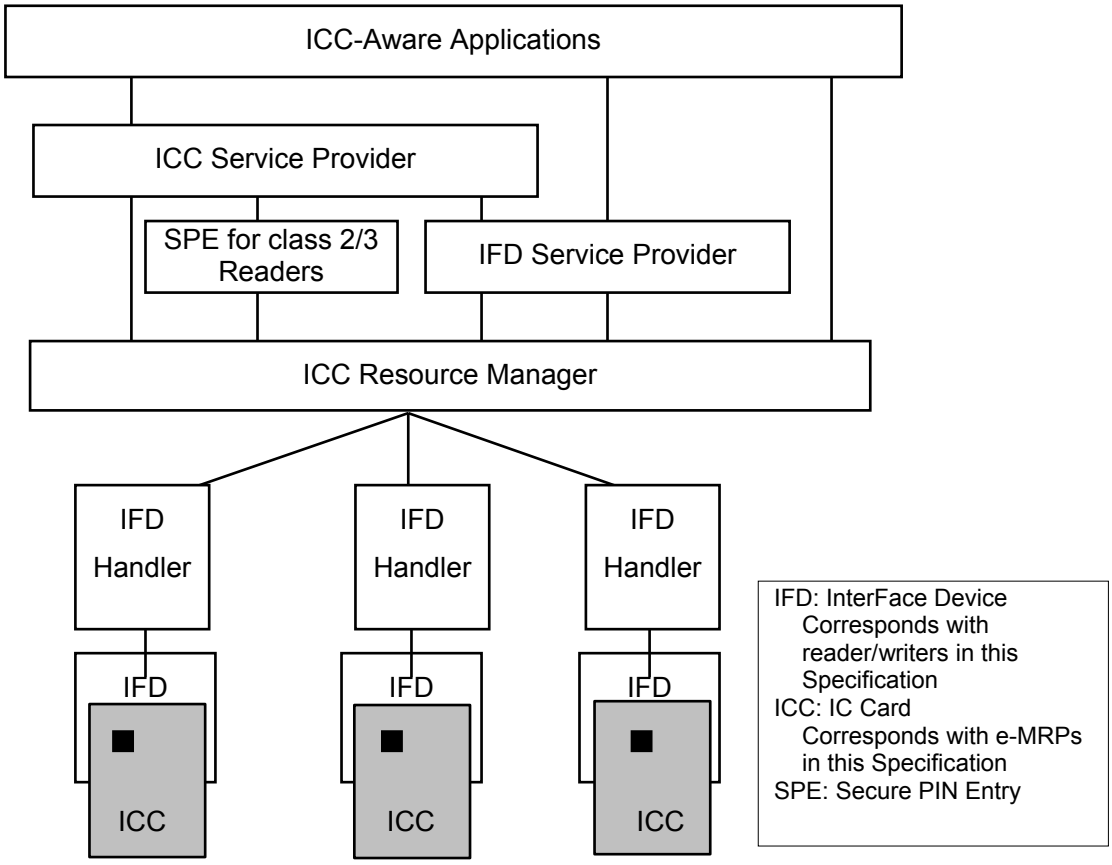


Figure A.3 – Components of the PC/SC Specification

Note that, for details of the PC/SC interface, certain reference material should also be consulted. For example, when using Windows platform PCs, consult the following materials.

– Microsoft Windows Software Development Kit (SDK)
– Microsoft Windows Driver Development Kit (DDK)

Annex B

Compatibility Testing Specifications (Informative)

Table of Contents

B.1 Introduction

This Annex specifies methods to verify compatibility by performing operation tests using e-MRPs and PCDs that will actually be used on biometric (e-MRP) systems.

While performing cross-tests using actual e-MRPs and PCDs would be the most reliable method to ensure interoperability, the fact that e-MRPs are developed and deployed by various nations world-wide makes it difficult if not impossible to bring together all of the various types of devices developed in each nations to one place and perform cross-tests. Nevertheless, since it is desirable and anticipated that a single nation or several agreeing nations would perform cross-tests, test methods that should be applied in such cases are specified hereunder. Furthermore, in anticipation of performing global interoperability tests in the future, a guideline is provided for interoperability tests using reference devices as an alternative to cross-tests.

B.2 Scope

The interoperability test methods described herein shall be applied to the scope defined in **ISO/IEC 14443-3** and **ISO/IEC 14443-4**. Furthermore, in order to verify compliance with 14443-4, a minimum command send and receive test shall be performed.

B.3 Testing Conditions

B.3.1 Selection of Test Method

For e-MRP both Type A and Type B shall be tested.

PCD shall be an open type capable of handling both Type A and Type B.

B.3.2 Test Environment

Testing shall take place in an environment of temperature 25°C ± 3°C and of relative humidity (50 ± 20) %. However, since it is anticipated that the actual operating environments will exceed this range, the devices' guaranteed range of operation shall be decided with consideration to the actual operating environment.

B.3.3 Pre-test Considerations

The following shall be decided before performing the tests. Value specifications designated as "standard" are recommended values or assumed specification values. These can be changed according to system requirements.

- Number of PCDs for each type of PCD and number of e-MRPs for each type of e-MRP
  Multiple PCDs and multiple e-MRPs should be used. The standard number of PCDs and e-MRPs to use is 2 and 3 respectively.

- The time from turning on the power of the PCD to time the test is started
  A time shall be decided to avoid unstable behavior that may occur immediately after turning on the power of the PCD.
- Communication speed from PCD to e-MRP
  During the period from insertion of e-MRP into PCD until activation, the communication speed shall be 106 kbit/s. Communication speed for sending and receiving commands shall be set to the maximum speed supported. The standard speed is 424 kbit/s.
- The direction of e-MRP
- The direction of PCD
- The test point on the PCD
- Number of test iteration and pass/fail decision criteria
- Other parameters that will affect the tests

B.3.4 Pass-Fail Decisions

When a failure occurs for a certain combination, the e-MRP or PCD that caused the failure shall be determined carefully after thoroughly investigating the situation and performing analysis.

B.4 Compatibility Testing Methods Using PCD

B.4.1 List of Tests

Table B.1 lists the tests to perform.

Table B.1 – List of Tests

No.	Test name	Test description	Notes
T1	Activation test	After placing the e-MRP on a PCD, verify whether the e-MRP can enter the activated state.	
T2	Command send/receive test	Verify that commands operate correctly.	The SELECT FILE (DF) command shall be used.

B.4.2 Combination of Tests

- Cross tests using all PCD types and all e-MRP types shall be performed.
- For each PCD, perform the test using each e-MRP sequentially.

Table B.2 shows the combinations of the PCD and e-MRP for each test.

Table B.2 – Combinations

No.	Test name	Combination of PCD and e-MRP to perform test	Notes
T1	Activation test	Perform tests using combinations of all PCDs and all e-MRPs	
T2	Command send/receive test	Perform tests using all combinations that have passed the T1 test.	

B.4.3 Testing Point and Direction of e-MRP

(1) Testing Point

The testing point shall be determined with consideration to the operating conditions of the applied e-MRP system.

Examples of testing points are shown below.

Considering a cylinder with its center axis concentric with the center of the PCD at "o", a total of 10 test points (shown with a black filled circle) shall be selected at the center points and at each intersection point of the X axis and Y axis with the surface of the cylinder. The center point, X axis, Y axis, and Z axis positions shall be determined at test time. However, the standard Z axis test position shall be 20 mm.

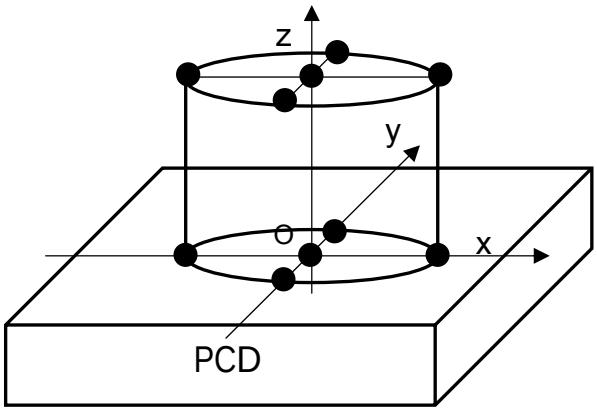


Figure B.1 – Testing Points (Example)

(2) Direction of e-MRP

The standard direction of e-MRP shall be the position that the PCD vendor specifies. Otherwise, refer to the following.

When viewing the PCD from directly above, the long edge of the e-MRP shall be parallel with the X axis.

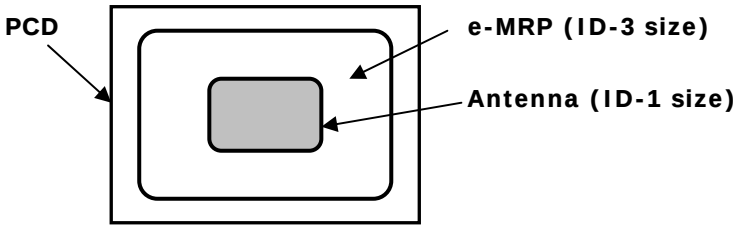


Figure B.2 – Direction of e-MRP (Example)

B.4.4 Test Contents and Pass-Fail Criteria

(1) T1 Tests

– Verify that transition from REQ command to activation is performed correctly complying with **ISO/IEC 14443-3**.

– For each e-MRP, the standard shall be to perform the test multiple times for each direction on each test position for all specified directions on all test points. The number of times shall be specified independently at each test occasion (three times or more is desirable).

– The pass criteria would be to pass every test. If results are unstable, review and fix the problematic area, and then aim to pass the tests multiple times.

(2) T2 Tests

– Verify that e-MRP test commands are sent and received correctly.

– For each e-MRP, the standard shall be to perform the test multiple times for each direction on each test position for all specified directions on all test points. The number of times shall be specified independently at each test occasion (three times or more is desirable).

– The pass criteria would be to pass every test. If results are unstable, review and fix the problematic area, and then aim to pass the tests multiple times.

B.4.5 Processing Flow

(1) Basic Processing Flow

Figure B.3 shows the basic test processing flow.

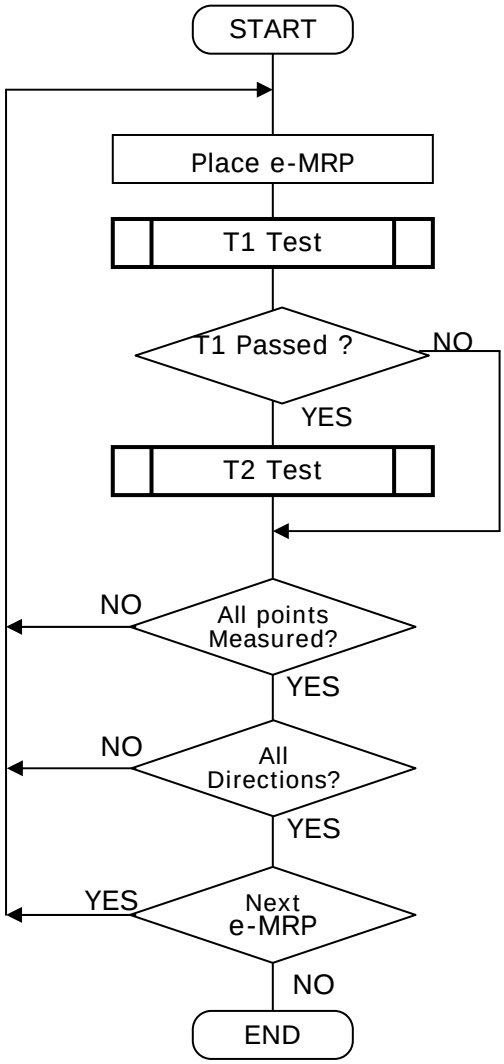
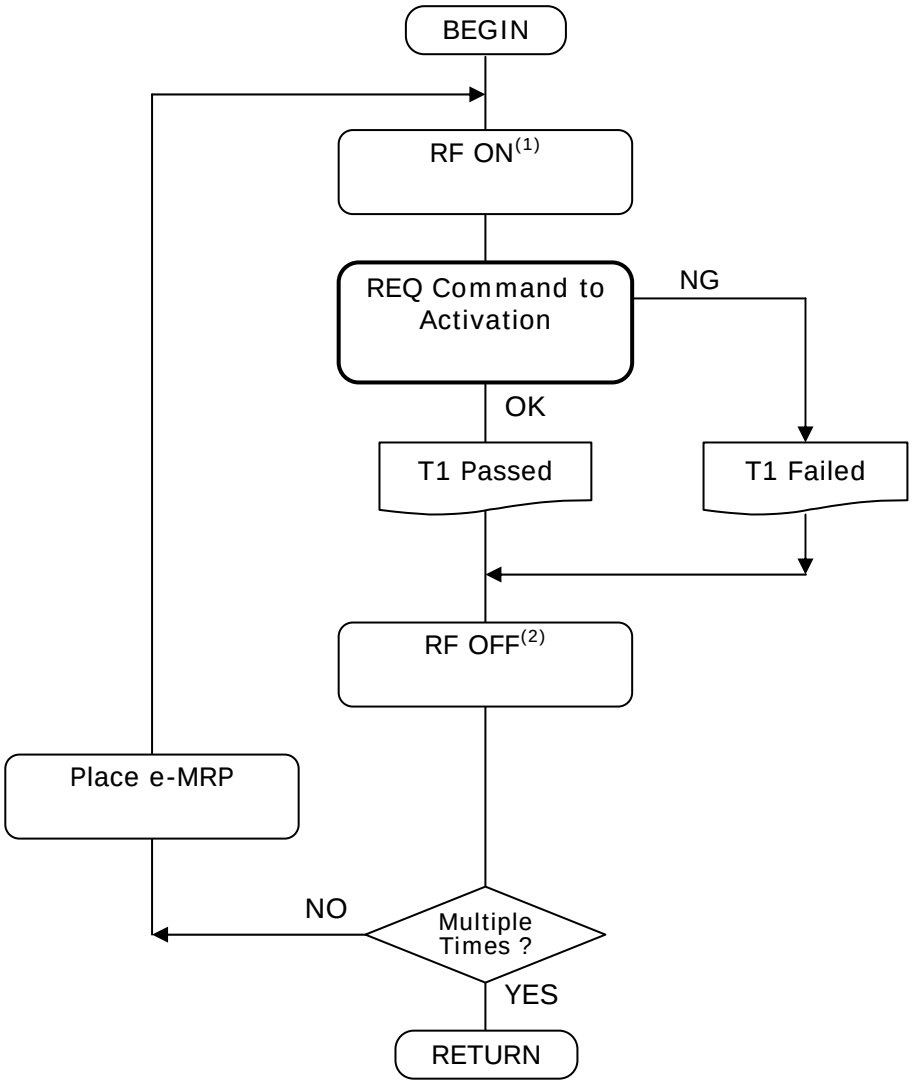


Figure B.3 – Basic Test Processing Flow

(2) T1 Test Processing Flow

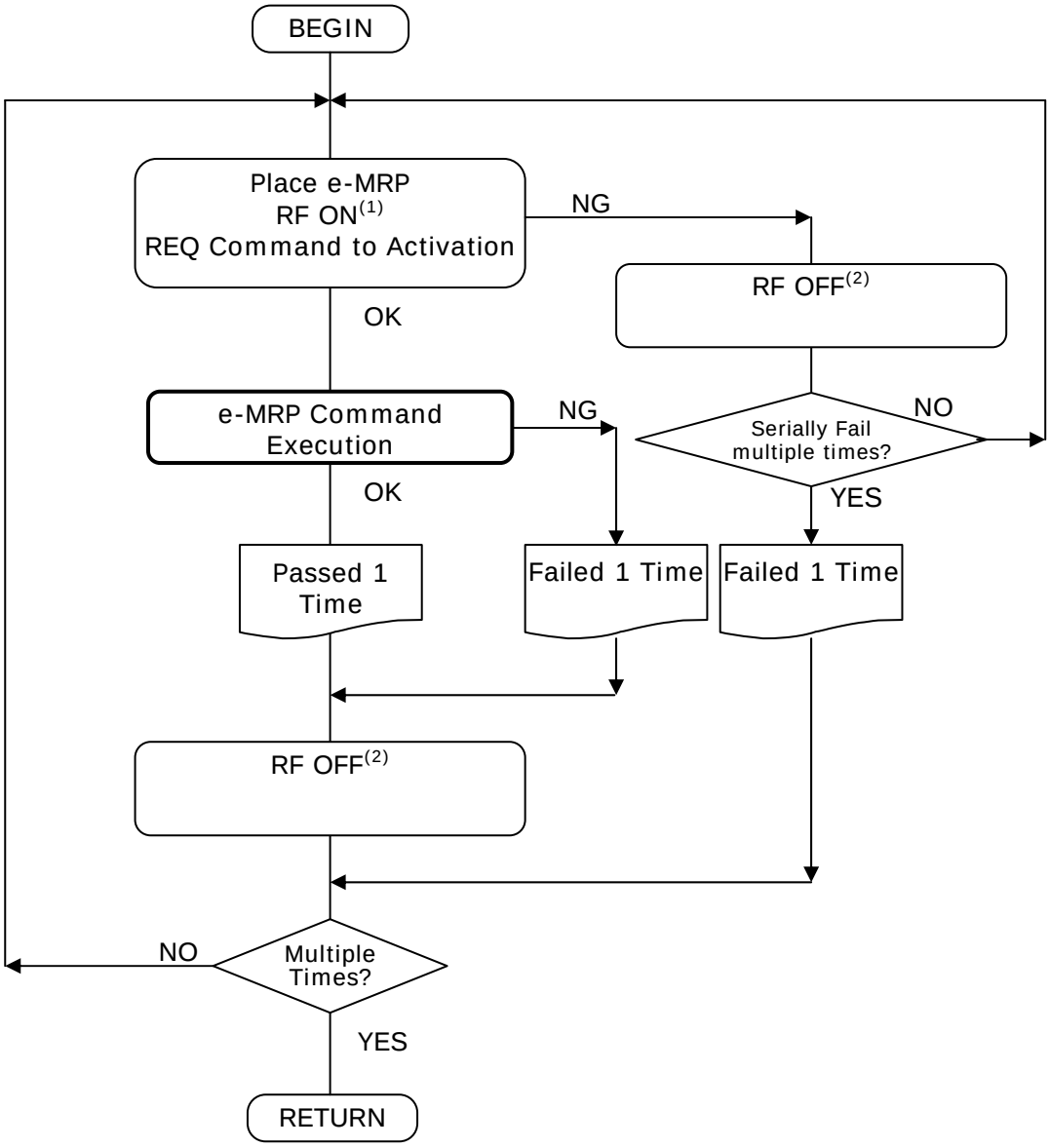


(1) If the PCD not controllable through commands, this may be achieved by moving the e-MRP to a position where the PCD and e-MRP can communicate with each other.

(2) If the PCD not controllable through commands, this may be achieved by moving the e-MRP to a position where the PCD and e-MRP cannot communicate with each other.

Figure B.4 – T1 Test Processing Flow

(3) T2 Test Processing Flow



(1) If the PCD not controllable through commands, this may be achieved by moving the e-MRP to a position where the PCD and e-MRP can communicate with each other.

(2) If the PCD not controllable through commands, this may be achieved by moving the e-MRP to a position where the PCD and e-MRP cannot communicate with each other.

Figure B.5 – T2 Test Processing Flow

B.5 Compatibility Test With Reference Devices (Guideline)

Perform compatibility tests of target device with a reference e-MRP and a reference PCD as an alternative to performing cross tests with other target e-MRPs and PCDs.

B.5.1 Reference Device

Prepare a reference PCD and a reference e-MRP that satisfy the following specifications. Note that a single reference device may not necessarily provide all features.

- The device shall be capable of setting parameters complying with **ISO/IEC 14443-2**, **ISO/IEC 14443-3**, and **ISO/IEC 1444-4**.
- Commands can be sent and received against the parameters mentioned above.

B.5.2 Test Methods

Perform tests in accordance with the following test specifications.

- e-MRP shall be tested against the reference PCD.
- PCD shall be tested against the reference e-MRP.
- Decide on the parameter values to set and the combination of parameter values to use. To decide the values, information such as results from cross tests shall be used.
- For each combination of parameter values, perform tests by applying the test methods for the e-MRP compatibility tests that use open type PCDs.

Devices that passed the test for all combinations of the specified parameters shall be considered as devices that passed the compatibility test.

Annex C

e-MRP Command Interface (Informative)

The e-MRP command interface is described in "Logical Data Structure (LDS) version 1.7, PKI for Machine Readable Travel Documents offering ICC read only access V1.1, Supplement to Doc9303-epassports Ver2005-4V3.0". This informative document describes topics such as examples of recommended command sequences, items that were raised as issues during past ICAO interoperability tests, and considerations for improving interoperability.

Table of Contents

Referenced Standards:

[1] ICAO "MACHINE READABLE TRAVEL DOCUMENT
DEVELOPMENT OF A LOGICAL DATA STRUCTURE For OPTIONAL CAPACITY EXPANSION TECHNOLOGIES" Ver1.7 (May 18, 2004)

[2] ICAO "MACHINE READABLE TRAVEL DOCUMENT
PKI for Machine Readable Travel Documents offering ICC Read-Only Access" Ver1.1 (October 1, 2004)

[3] ICAO "MACHINE READABLE TRAVEL DOCUMENT
Supplement to Doc9303-epassports" Ver2005-4 V3.0 (2005.6.12)

C.1 Scope

This informative document describes the application level command interface within the communication function between the e-MRP and upper device.

Figure C.1 shows the scope of this document

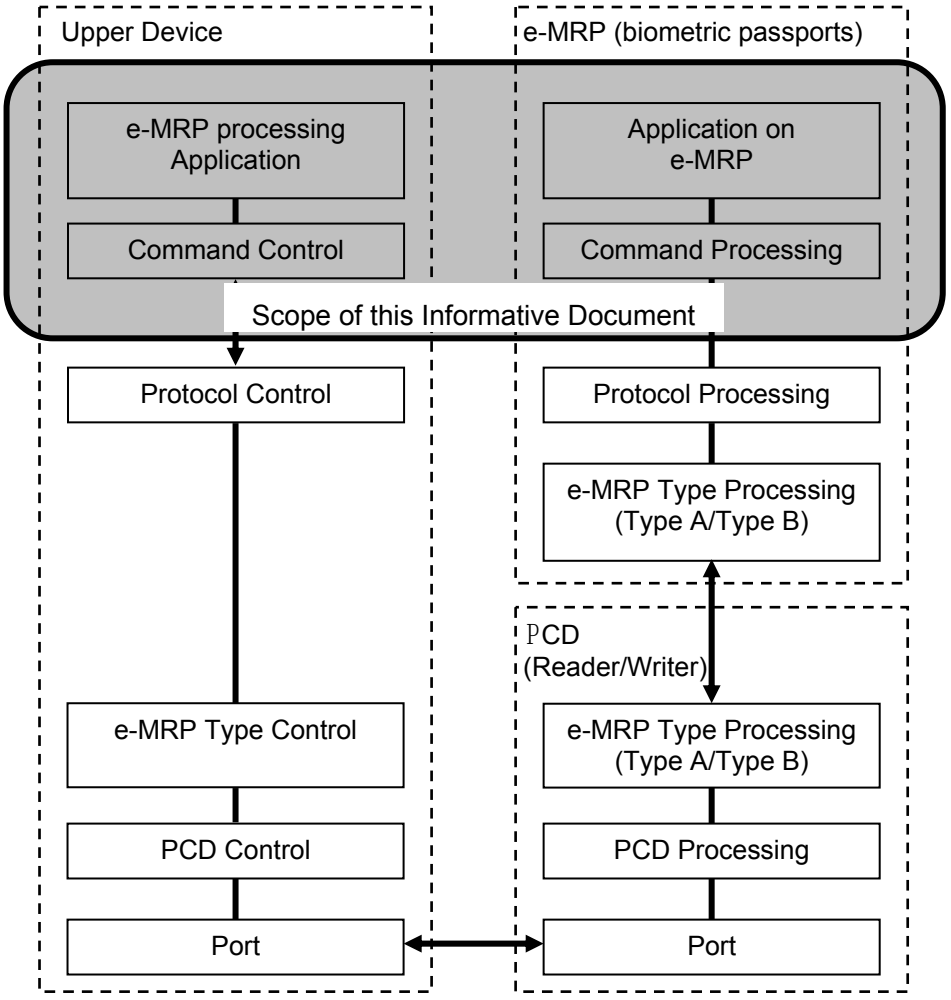


Figure C.1 – Scope of this Informative Document

C.2 Examples of Command Sequences

This chapter describes examples of recommend command sequences for the e-MRP command interface as well as considerations regarding compatibility.

C.2.1 Select File and Read Binary

The e-MRP command interface complies with "Logical Data Structure (LDS) version 1.7".

Compatibility Improvement Specifications:
The e-MRP shall support SFI to ensure compatibility.

Considerations:
It should be noted that transmission efficiency of the upper device will decline if the Le in the Read Binary command is set to "00" within the Data-Group reading sequence.

Le should be set to an optimal data size that will prevent the transmission efficiency to decline.

Explanatory Notes:
While the receive buffer size of PICCs (e-MRPs) and PCDs defined in **ISO/IEC 14443** include the six (6) bytes comprised of PCB, CID, SW1, SW2 and CRC, the data size defined in **ISO/IEC 7816-4** does not include these bytes.

Therefore, when Le is set to "00" when issuing read command to retrieve 256 bytes, and e-MRP will, in accordance with the **ISO/IEC 14443** specification, divide the data using the chaining function and send them as response data.

Table C.1 shows the responses when the data size is set to 256 bytes using Short Le (Le = 1 byte) under the condition where buffer size = 256 bytes, CID exists, and NAD does not. In this case, the 256 bytes of data would require 2 frames thus reducing the efficiency of the data transmission.

Table C.1 – Read Binary Response (when Le set to "00')

1st Response by READ BINARY command

PCB	CID	DATA	CRC
1	1	252	2

2nd Response by 'next' of PCB (Command Chaining)

PCB	CID	DATA	SW1	SW2	CRC
1	1	4	1	1	2

* For a single Read Binary command, this block will be sent until the last byte of the data is read.

Compared to the above, when Le is set to a data size that does not cause chaining (250 bytes), the 250 byte data can be sent in a single frame as shown in **Table C.2** thus improving efficiency of the data transmission.

Table C.2 – Read Binary Response (when Le set to "FA')

1st Response by READ BINARY command

PCB	CID	DATA	SW1	SW2	CRC
1	1	250	1	1	2

2nd Response by 'next' of PCB (Command Chaining)

PCB	CID	DATA	SW1	SW2	CRC
1	1	250	1	1	2

Table C.3 and **C.4** shows examples of read command sequences for Data-Group2 considering transmission efficiency.

Table C.3 – Example Command Sequence When Using FID

CLA	INS	P1	P2	Lc	Data	Le	Notes
"00"	"A4"	"04"	"0C"	"07"	"A0 00 00 02 47 10 01"	-	Select DF
"00"	"A4"	"02"	"0C"	"02"	"01 02"	-	Select DG2
"00"	"B0"	"00"	"00"	-	-	"FA"	Read first 250 byte
"00"	"B0"	"00"	"FA"	-	-	"FA"	Read next 250 byte
"00"	"B0"	"01"	"F4"	-	-	"FA"	Read next 250 byte
"00"	"B0"	"02"	"EE"	-	-	"FA"	:

Table C.4 – Example Command Sequence When Using SFI

CLA	INS	P1	P2	Lc	Data	Le	Notes
"00"	"A4"	"04"	"0C"	"07"	"A0 00 00 02 47 10 01"	-	Select DF
"00"	"B0"	"82"	"00"	-	-	"FA"	Direct Read of 250 byte
"00"	"B0"	"00"	"FA"	-	-	"FA"	Read next 250 byte
"00"	"B0"	"01"	"F4"	-	-	"FA"	Read next 250 byte
"00"	"B0"	"02"	"EE"	-	-	"FA"	:

C.2.2 Basic Access Control and Secure Messaging

The command sequence complies with "Logical Data Structure (LDS) version 1.7" and "PKI for Machine Readable Travel Documents offering ICC read only access V1.1".

Compatibility Improvement Specifications:

The e-MRP shall support SFI to ensure compatibility.

Considerations:

It should be noted that compatibility of the upper device will be affected depending on the data size that is set to the Le in the Read Data Group command for Secure Messaging.

Explanatory Notes:

When instructing to read with Short Le (Le = 1 byte) to perform Read Data-Group for Secure Messaging, the data size accepted by the upper device for Le is restricted according to **ISO/IEC 7816-4**.

Under the condition where buffer size = 256 bytes, CID exists, and NAD does not, the data transmission is most efficient when Le is set to the data size of 231 bytes. **Table C.5** shows the response when Le is set to the data size of 231 bytes.

However, when a data size equal to or larger than 231 bytes is set to Le, depending on the interpretation of **ISO/IEC 7816-4**, the expected response may vary in multiple ways.

Therefore, upper devices should set a value less than 231 bytes for Le.

Table C.5 – Read Binary Response (when Le set to "E7')

1st Response by READ BINARY command

PCB(1)	CID(1)	TCG(1) LCG(2) PI(1)	VCG Encrypted Data(232)	TSW(1) LSW(1) VSW(2)	TCC(1) LCC(1) VCC(8)	SW1(1) SW2(1)	CRC(2)
1	1	4	232	4	10	2	2

2nd Response by READ BINARY command

PCB(1)	CID(1)	TCG(1) LCG(2) PI(1)	VCG Encrypted Data(232)	TSW(1) LSW(1) VSW(2)	TCC(1) LCC(1) VCC(8)	SW1(1) SW2(1)	CRC(2)
1	1	4	232	4	10	2	2

* Encrypted Data consist of the specified DATA (231) and an additional Padding (1), and is encrypted.

* Padding consist of a single byte that must be added to the DATA and has the value of "80" plus additional "00" bytes so that the sum of the number of bytes are a multiple of 8. (If DATA is a multiple of 8, "80 00 00 00 00 00 00 00" [8 bytes] would be added).

* LCG is 2 bytes if Encrypted Data exceeds 127 bytes, and 3 bytes if it exceeds 255 bytes.

On the other hand, when using Extended Le, there are no restrictions like the above, a single frame can transmit 252 bytes of data, transmission efficiency improves.

Table C.6 shows the responses when the data size is set to 256 bytes or more using Extended Le under the condition where buffer size = 256 bytes, CID exists, and NAD does not.

Table C.6 – Read Binary Response (when Le set to "E7')

1st Response by READ BINARY command

PCB(1)	CID(1)	TCG(1) LCG(3) PI(1)	VCG Encrypted Data(247)	CRC(2)
1	1	5	247	2

2nd Response by 'next' of PCB (Command Chaining)

PCB(1)	CID(1)	VCG Encrypted Data(252)	CRC(2)
1	1	252	2

* The above block is returned as response until the last byte of the Data is read.

Last Response by READ BINARY command (Command Chaining)

PCB(1)	CID(1)	VCG Encrypted Data(xxx)	TSW(1) LSW(1) VSW(2)	TCC(1) LCC(1) VCC(8)	SW1(1) SW2(1)	CRC(2)
1	1	xxx	4	10	2	2

C.2.3 Odd INS (B1) Read Binary

The command specification of Odd INS (B1) Read Binary complies with "Logical Data Structure (LDS) version 1.7" and "Supplement to Doc9303-epassports Ver2005-4V3.0".

Considerations:

From past ICAO interoperability test results, it was found that three different interpretations in the implementation of Read Binary with Odd INS Byte exist. Therefore, it is desirable for upper devices to support the following three types.

1) The Le byte includes only V

2) The Le byte includes TL and V (where L is coding by Simple-TLV)

3) The Le byte includes an extended TL and V (where L is coding by BER-TLV)

C.3 Examples of Basic Access Control Availability Assessment Sequences

C.3.1 Example of BAC Support Availability Assessment Sequence

The sequence to determine whether or not BAC is supported by an e-MRP complies with "Supplement to Doc9303-epassports Ver2005-4V3.0".

C.3.2 Example of Extended Le Support Availability Assessment Sequence

Explanatory Notes:
The upper device should be capable of determining whether or not BAC is supported by the e-MRPs from the various nations, as well as determining whether or not Extended Le is supported.

Actually, it is possible to determine whether or not Extended Le is supported by an e-MRP by reading the first two bytes of the DATA stored in EF.COM.

An example of an assessment sequence is shown below.

1) Perform BAC processing.

2) With Extended Le (Le = "00 00 02"), read the header portion of EF.COM.

3) Depending on the response from the e-MRP, determine as follows:

* If SW = "9000" and the returned response data length is 2 bytes, it can be said that the e-MRP has processed the Extended Le correctly.

* If SW = "9000" and the returned response data length is NOT 2bytes, it can be said that the e-MRP has NOT processed the Extended Le correctly.

* If the response is other than the above two, decide that e-MPR does not support Extended Le and after performing BAC processing again, read the header portion of EF.COM with Short Le (Le = "02").

Figure C.2 presents a process flow diagram of the above.

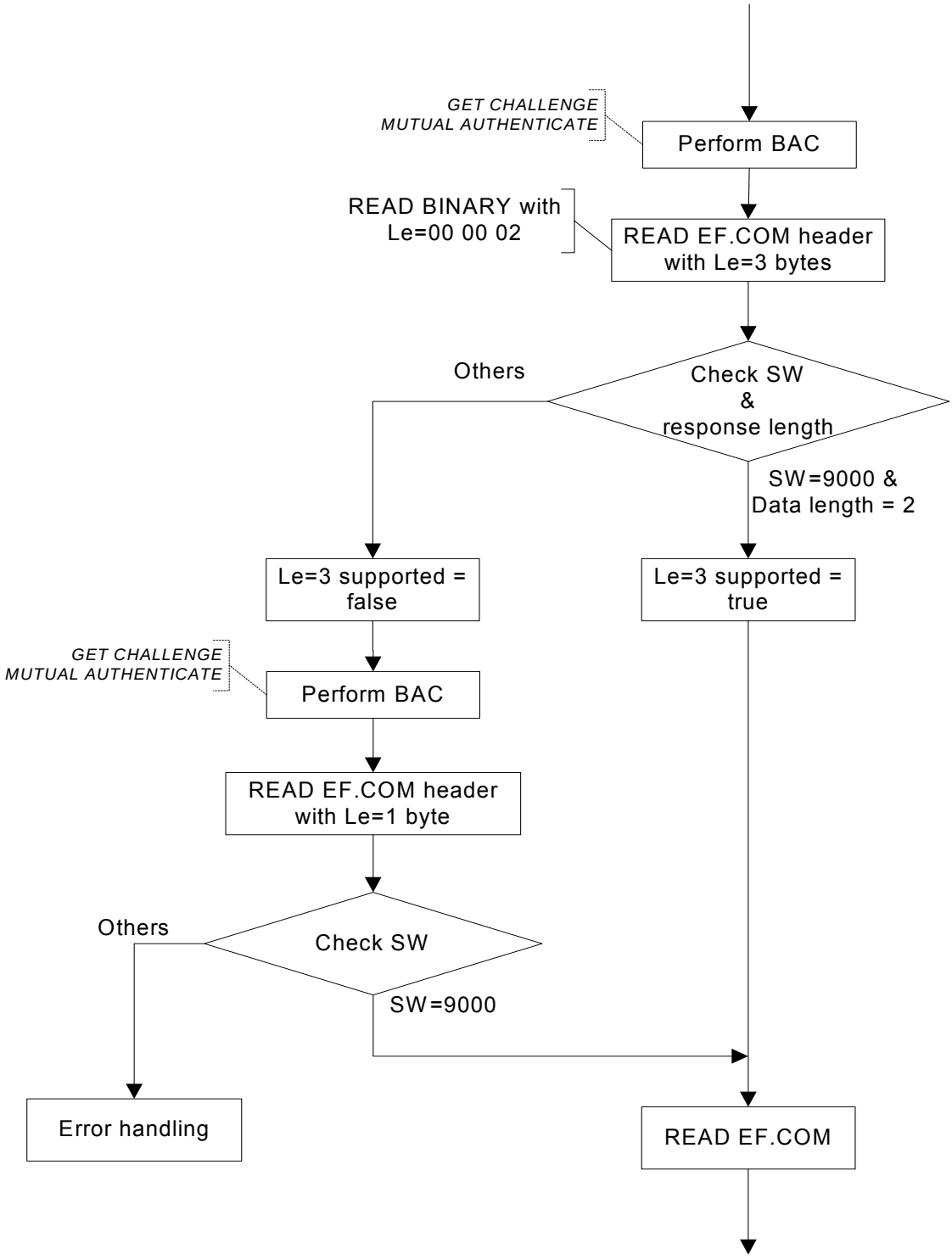


Figure C.2 –Extended Le Assessment Process Flow Diagram

Annex D

e-MRP – PCD Command Interface Compatibility Tests (Informative)

This informative document describes the interoperability test procedures of cross tests between biometric e-Passports (hereunder referred to as "e-MRP") and PCDs to test the e-MRP command interface of an e-MRP system.

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Abbreviations and Symbols

The abbreviations and symbols used in this Specification are as follows.

AA	Active Authentication
BAC	Basic Access Control
SOD	Document Security Object
PA	Passive Authentication
DG1	Data group 1 stored in e-MRP (MRZ information)
DG2	Data group 2 stored in e-MRP (Facial and other image information)
DG15	Data group 15 stored in e-MRP (Public key information for AA)
MRZ (Machine Readable Zone) information	Personal information and passport information of e-MRP owner written on the e-MRP

Referenced Standards:

[1] ICAO "MACHINE READABLE TRAVEL DOCUMENT
DEVELOPMENT OF A LOGICAL DATA STRUCTURE For OPTIONAL CAPACITY EXPANSION TECHNOLOGIES" Ver1.7 (May 18, 2004)

[2] ICAO "MACHINE READABLE TRAVEL DOCUMENT
PKI for Machine Readable Travel Documents offering ICC Read-Only Access"
Ver1.1 (October 1, 2004)

D.1 Test Target e-MRPs and PCDs

The test target e-MRPs and PCDs shall satisfy the common conditions described below.

This test focuses on testing the interoperability of the command interface and is not for the purpose of performance tests (see chapter 9 of this Specification) or initial response compatibility tests (see "T1 Test" of this Specification [Informative]) of individual e-MRPs or PCDs. e-MRPs and PCD that have passed the unit tests and initial response compatibility tests shall selected as test target e-MRPs and PCDs for this Test. (See figure below.)

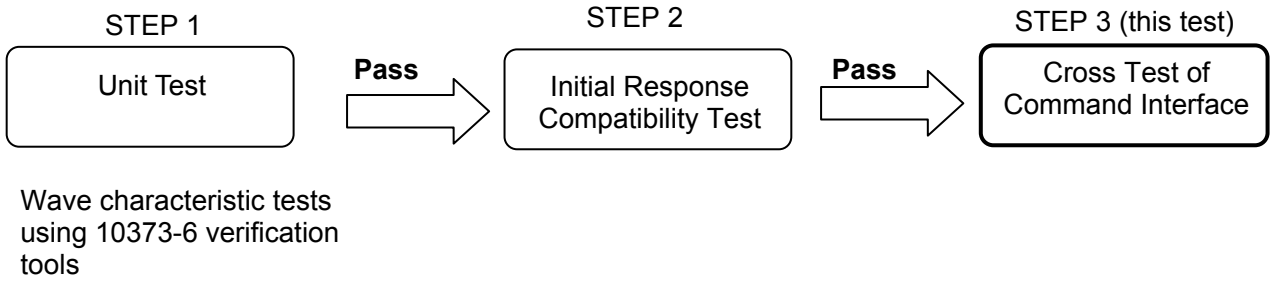


Figure D.1 – Conditions that Test Target e-MRPs and PCDs Must Satisfy

D.1.1 Test Target e-MRP

The e-MRP must comply with this Specification. (Major specifications are shown below.)

– Supports Type A or Type B (complying with **ISO/IEC 14443-1** – **ISO/IEC 14443-4**).

– Supports a quadruple communication speed (424 kbps) from PCD to e-MRP or vice-versa.

– PA (SOD Structure Verification) processing is possible.

– e-MRPs capable of processing BAC can undergo Basic Access Control tests.

– e-MRPs capable of AA can undergo Active Authentication tests.

– Arbitrary data can be stored in an e-MRP. (examples of data sets shall refer to reference standards [1] and [2].)

– Data structure within the test target e-MPR shall refer to reference standards [1] and [2].

The e-MRP shall implement the following commands.

– Initial response command

– SELECT FILE command

– READ BINARY command

– GET CHALLENGE command (for Basic Access Control test targets only)

– Mutual Authenticate (Mutual Auth) command (for Basic Access Control test targets only)

– Internal Authenticate command (for Active Authentication test targets only)

D.1.2 Test Target PCD

The PCD must comply with this Specification. (Major specifications are shown below.)

– Open type PCD.

– Supports Type A or Type B (complying with **ISO/IEC 14443-1** – **ISO/IEC 14443-4**).

– Supports a quadruple communication speed (424 kbps) from PCD to e-MRP or vice-versa.

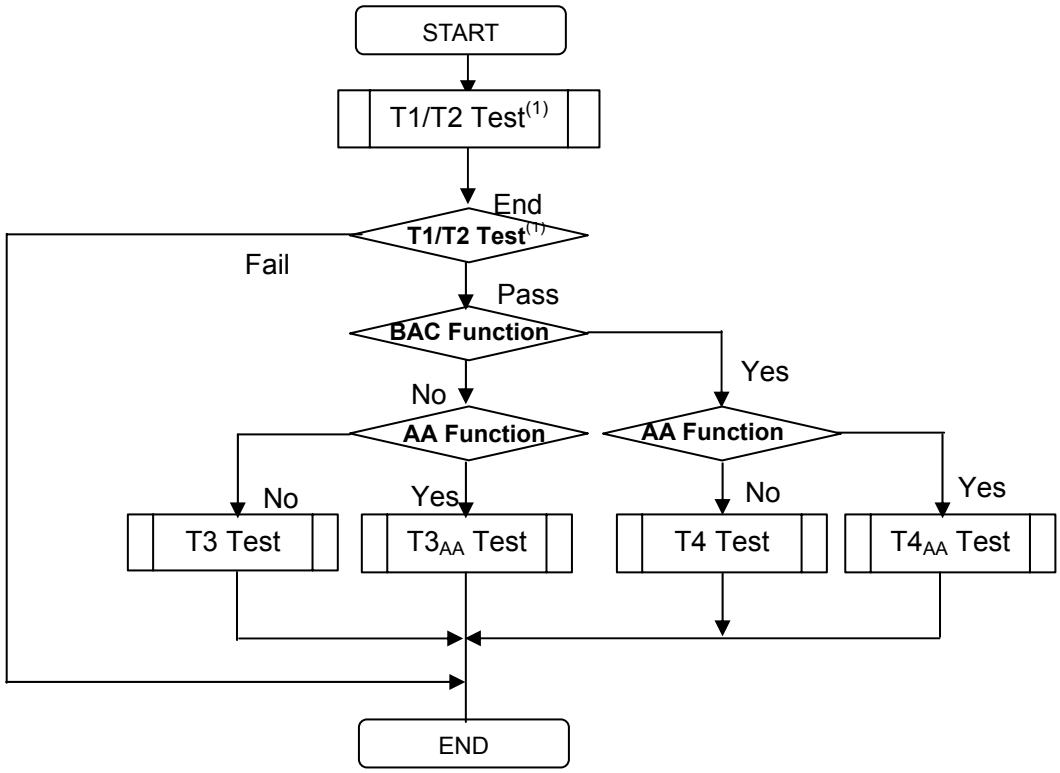
D.2 Compatibility Test Methods

D.2.1 List of Tests

Below is a list of tests to be performed for this test.

Table D.1 – List of Tests

Test No.	Test Name	Details	Note
T3	SO_D Structure Verification Test	Performs SO_D structure verification processing and verifies that information stored on the e-MRP can be read. Also measure processing time for reference.	Only for e-MRPs without BAC processing features.
T4	BAC + SO_D Structure Verification Test	Perform BAC processing, create session key and share. Using this session key, verify that information stored on the e-MRP can be read by performing SO_D structure verification processing under secure messaging processing. Also measure processing time for reference.	Only for e-MRPs with BAC processing features.
$T3_{AA}$	SO_D Structure Verification Test + AA	In addition to the T3 Test, perform AA processing to verify that the AA processing feature is correctly implemented on the e-MRP.	For e-MRPs without BAC processing features but with AA processing features.
$T4_{AA}$	BAC + SO_D Structure Verification Test + AA	In addition to the T4 Test, perform AA processing to verify that the AA processing feature is correctly implemented on the e-MRP.	For e-MRPs with BAC processing features as well as AA processing features.



(1) T1, T2 Tests: Refer to Chapter 4 of this Specification (Informative).

Figure D.2 – Entire Flow of the Test

D.2.2 Tests Combinations

D.2.2.1 Combinations of e-MRPs and PCDs

– A single test target PCD shall be tested by applying e-MRPs one by one.

– Tests shall be performed on one PCD per PCD type. (Variance among the same type of PCD is not tested.)

– e-MRPs used for the test shall be one piece per e-MRP type. (Variance among the same type of e-MRP is not tested.)

Table D.1 – List of Tests

Test No.	Test Name	Combination of Test Target PCD and e-MRP	Notes
T3	SO_D Structure Verification Test	All combinations that have passed T1/T2 shall be tested.	Only for e-MRPs without BAC processing features.
T4	BAC + SO_D Structure Verification Test	All combinations that have passed T1/T2 shall be tested.	Only for e-MRPs with BAC processing features.
$T3_{AA}$	SO_D Structure Verification Test + AA	All combinations that have passed T1/T2 shall be tested.	For e-MRPs without BAC processing features but with AA processing features.
$T4_{AA}$	BAC + SO_D Structure Verification Test + AA	All combinations that have passed T1/T2 shall be tested.	For e-MRPs with BAC processing features as well as AA processing features.

D.2.3 Testing Points and Direction of e-MRP

D.2.3.1 Testing Point

The testing point shall be determined with consideration to the operating conditions of the applied e-MRP system.

Examples of testing points are shown below.

Considering a cylinder with its center axis concentric with the center of the PCD at "o", a total of 10 testing points (shown with a black filled circle) shall be selected at the center points and at each intersection point of the X axis and Y axis with the surface of the cylinder. The center point, X axis, Y axis, and Z axis positions shall be determined at test time. However, the standard Z axis testing position shall be 20 mm.

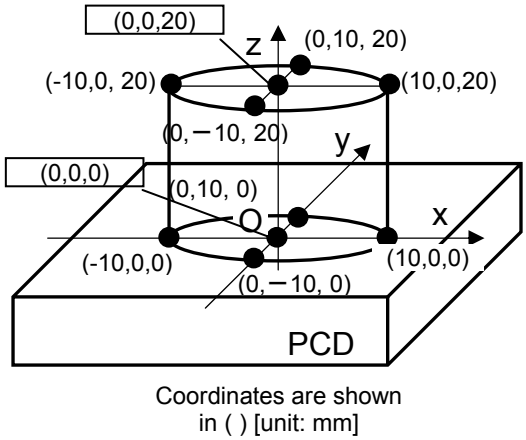


Figure D.3 – Testing Points (Informative)

D.2.3.2 Direction of e-MRP

The position specified by the PCD vendor shall be used as the standard e-MRP direction. Otherwise the directions shall refer to the following:

When viewing the PCD directly from above, the long edge of the e-MRP shall be parallel with the X axis.

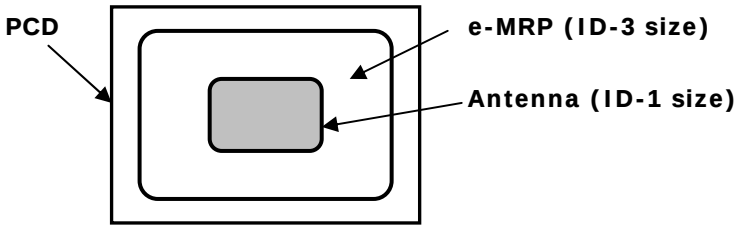


Figure D.4 – Direction of e-MRP (Informative)

D.2.4 Test Contents and Pass-Fail Criteria

D.2.4.1 Test Contents

D.2.4.1.1 T3 Tests

– SO_D read and SO_D verification processing of information stored on the e-MRP, which are part of the PA process of the e-MRP shall be verified.

– Tests shall be performed on e-MRPs that have passed T1/T2 tests and do not have BAC features.

– e-MRPs with AA features shall be tested with the $T3_{AA}$ Test.

– Each test target e-MRP shall store data that is defined for each test.

– In order to estimate the processing time for actual operations, the total processing time shall be measured for reference and the facial data size of DG2 shall be described.

– The commands and internal processing procedures shall comply with the referred standards [1] and [2].

– The standard procedure shall be to test the target e-MRP multiple times for each and all testing points, in all specified directions. The number of times to test shall be determined at each testing occasion (three times or more is desirable). The pass criteria would be to pass every attempt. If results are unstable, review and fix the problematic area, and then aim to pass the tests multiple times.

D.2.4.1.2 T4 Tests

– A session key for secure messaging shall be created according to the BAC procedure. Under secure messaging, SO_D structure verification processing shall be performed in the same manner as T3 Tests, and whether information can be read from the e-MRP shall be verified.

– Test shall be performed on e-MRPs that have passed T1/T2 Tests and have BAC features.

– e-MRPs with AA features shall be tested with the $T4_{AA}$ Test.

– Each test target e-MRP shall store multiple types of data that is defined for each test.

– In order to estimate the processing time for actual operations, the total processing time (of T4 and $T4_{AA}$ Tests) shall be measured for reference and the facial data size of DG2 shall be described.

– The commands and internal processing procedures shall comply with the referred standards [1] and [2].

– The standard procedure shall be to test the target e-MRP multiple times for each and all testing points, in all specified directions. The number of times to test shall be determined at each testing occasion (three times or more is desirable). The pass criteria would be to pass every attempt. If results are unstable, review and fix the problematic area, and then aim to pass the tests multiple times.

D.2.5 Data Set

Data sets are sets of data that shall be written into the internal files of the test target e-MRPs before performing tests and may have anything written in accordance with the referred standards [1] and [2].

D.2.6 Test Processing Flows (Examples)

D.2.6.1 Entire Test Processing Flow

The following shows the entire test processing flow for reference.

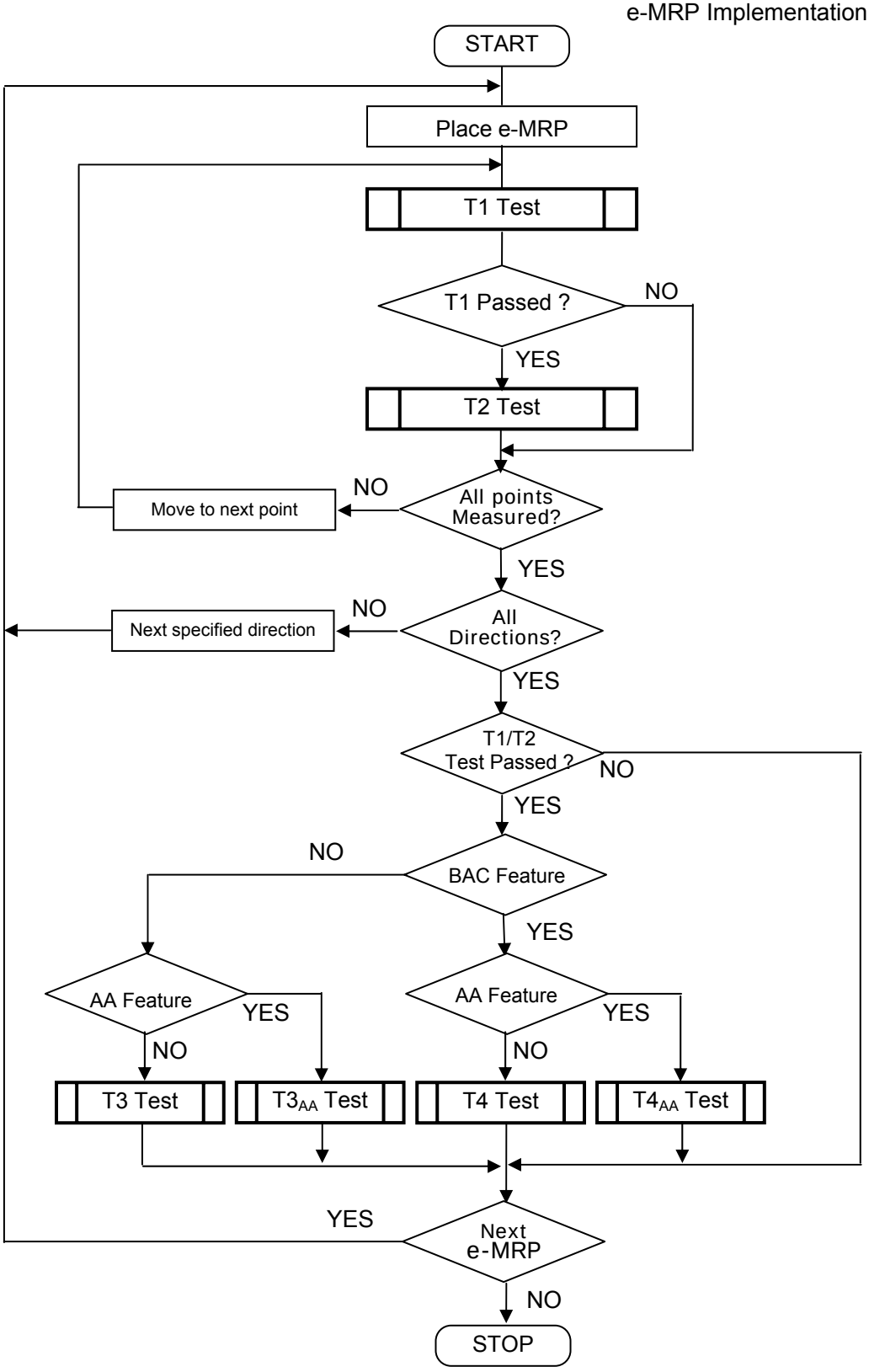


Figure D.5 – Entire Test Processing Flow

D.2.6.2 T3 Test Processing Flow

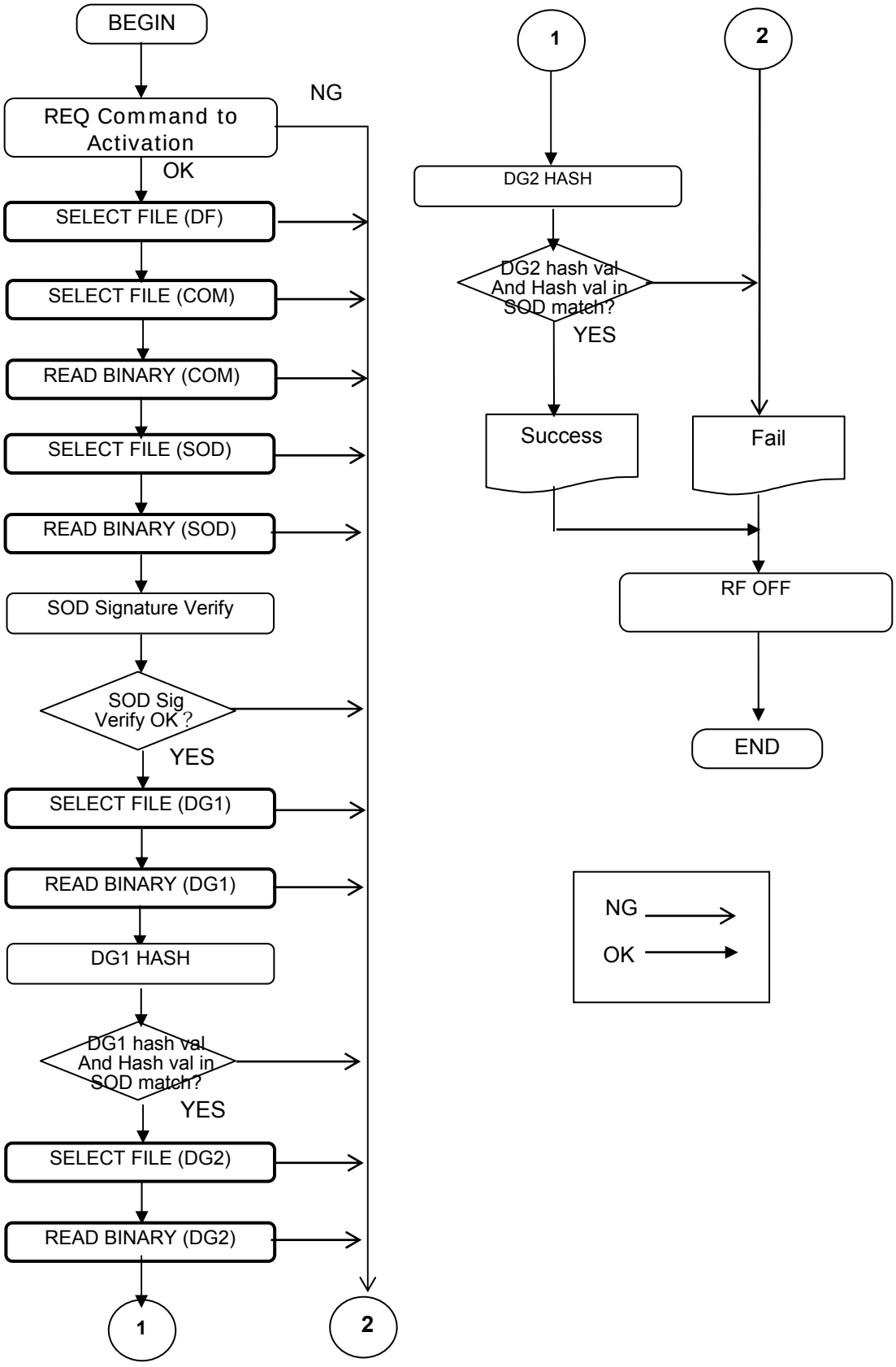


Figure D.6 – T3 Test Processing Flow

D.2.6.3 T4 Test Processing Flow

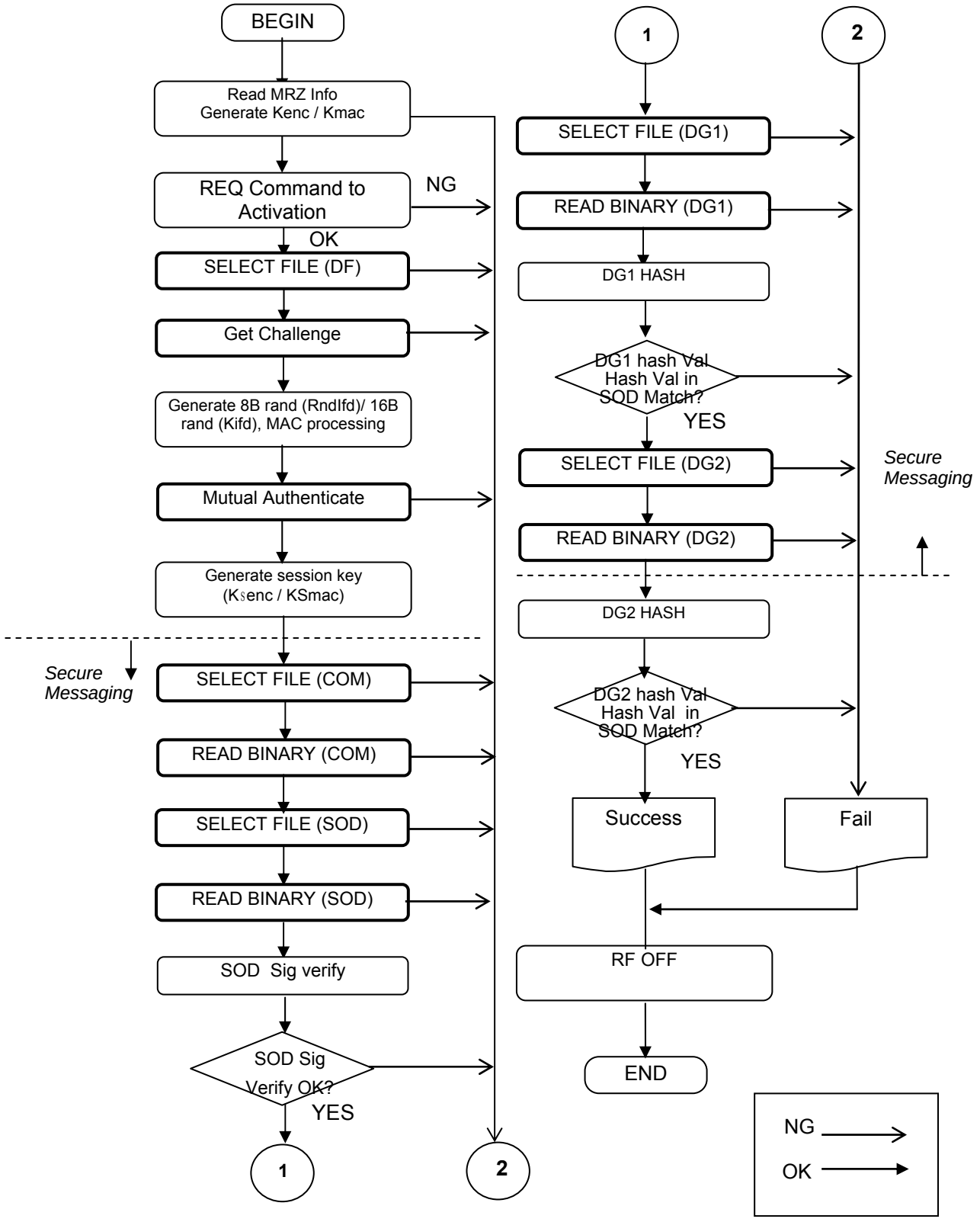


Figure D.7 – T4 Test Processing Flow

D.2.6.4 $T3_{AA}$ Test Processing Flow

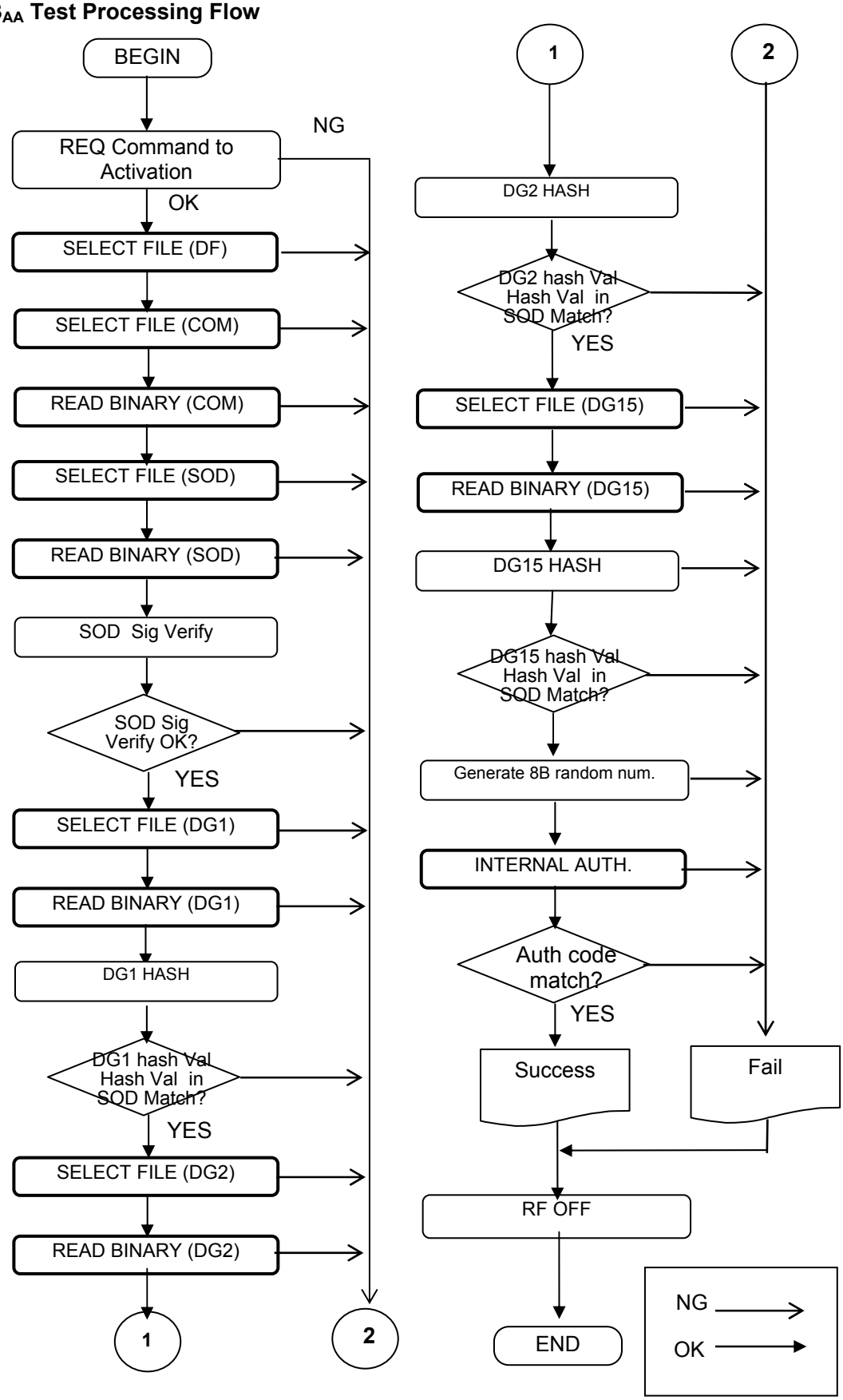


Figure D.8 – $T3_{AA}$ Test Processing Flow

D.2.6.5 $T4_{AA}$ Test Processing Flow

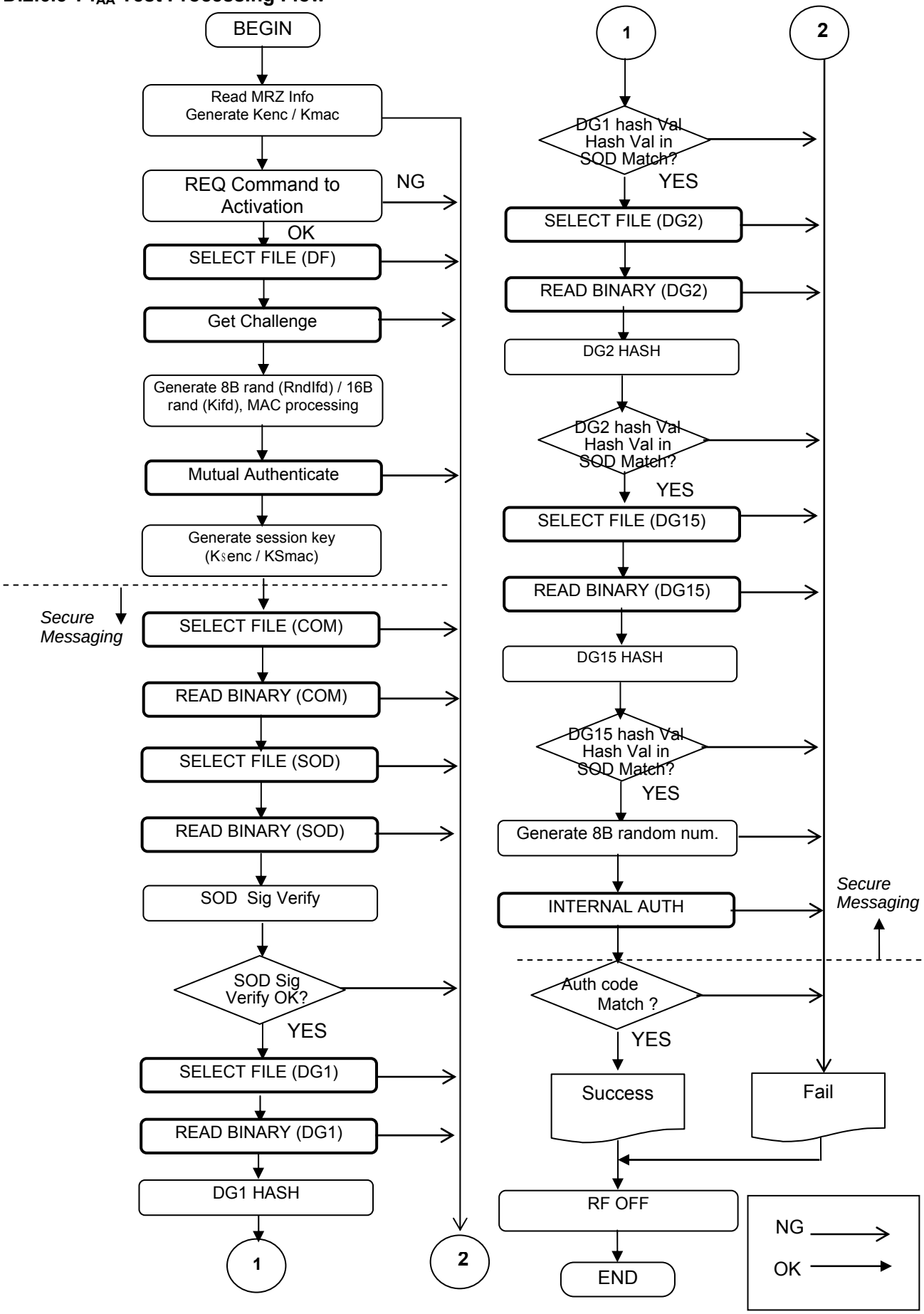


Figure D.9 – $T4_{AA}$ Test Processing Flow