Proximity Communication Interface Implementation Specifications

Version 2.0

MARCH 2004

New Media Development Association

Foreword

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

Specifically, since the year 1998, with consideration to the progress of standardization work regarding contactless IC cards (ISO/IEC 14443) within international standardization bodies, NMDA proceeded with developing a "New Generation IC Card Common System" (in accordance with the third supplementary budget of the 1998 fiscal year) based upon an innovative architecture which foundation lays in feature rich highly secure contactless IC cards that are expected to become popular in the future, and as a result published the the first version of this document as "Proximity Communication Interface Implementation Specification Version 1.0" on December of the year 2000.

Within this Implementation Specification, where it is difficult to ensure compatibility by only complying with International Standards, we have categorized International Standards in progress of standardization as "Basic Specifications", and to ensure compatibility, added specifications reflecting results of verification experiments as "Extended Specifications" and "Informative" specifications, so that this Specification will serve its purpose as an implementation specification.

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. This project went to install 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, performed verification experiments of various services that reflect regional attributes, and ensuring interoperability and compatibility among the different combinations of products from various vendors was an important verification factor. This lead to the decision of revising the Implementation Specification, adding specifications such as those for Open type PCDs which are capable of operating by placing card on the device or holding it near the device. The revised edition was published as "Proximity Communication Interface Implementation Specification Version 1.1" on July of the year 2001.

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

This Specification is a revised version of the previous version 1.1. The following factors were taken into consideration in the production of this revised edition.

– Although Version 1.1 was produced on the basis of the latest documents available relating to ISO/IEC 14443 as of February 2001, since that time, work at ISO and standardization as JIS have progressed, and it became necessary to comply with those standards.

– After the public release of Version 1.1 of the specification, ensuring compatibility of IC cards that use contactless interfaces, such as those used for resident basic register cards, has become increasingly important, which made it necessary to produce an even more precise Implementation Specification.

– Based on these background necessities, enhancements and additions they may affect compatibility, such as updating specifying to accommodate the latest standards, revising according to the amendments to the domestic Radio Law, addition of specifications regarding noise and antenna coupling levels, addition of specifications regarding resonance frequency, addition of retry methods and number of retries, addition of compatibility test methods, and addition of references to high-speed specifications under discussion at international standardization bodies, have been made to the provisions to eliminate ambiguity and to provide notes of consideration.

– The format and contents of this specification have been revised significantly so that the Basic Specifications portion will refer to JIS and ISO by quoting their provisions, and with focus on "Compatibility Improvement Specifications" to ensure compatibility and "Operation Diversification Specifications" to accommodate diversification in operation of proximity IC cards, areas of caution and consideration have been noted, and background information leading to these provisions have been added.

We hope that this specification will assist in the future proliferation of IC cards and IC card systems.

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 "Compatibility WG" (located within the NMDA) for its numerous contributions and constructive discussions, and to those persons at the Ministry of Economics, Trade and Industry for their generous support of those efforts pertaining to the revision 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 covers the areas shown in **Figure 1.1** regarding communication features of Proximity IC Cards (PICCs) and Proximity Coupling Devices (PDCs).

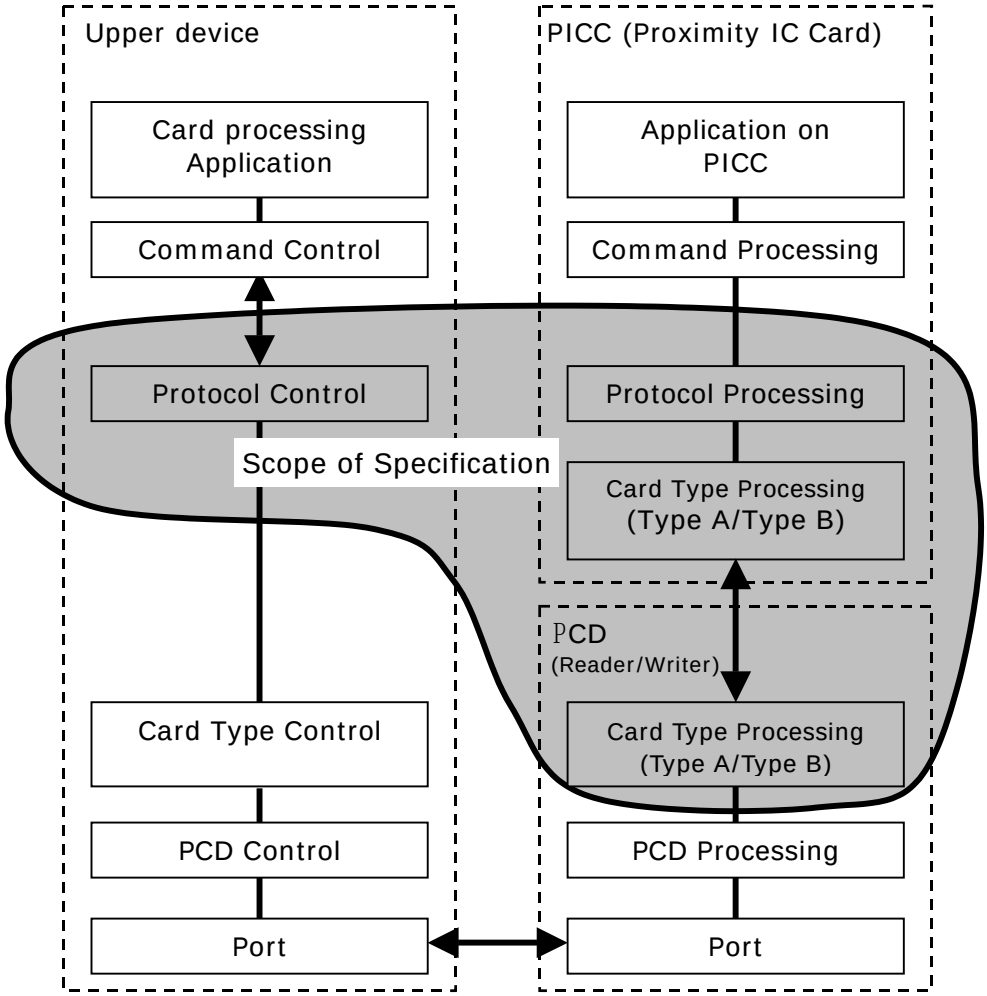


Figure 1.1 – Scope of the Proximity Communication Interface Implementation Specifications

The subject PICC and PCD of this Implementation Specification are PICC with RF signal interfaces of Type A and Type B as specified in the ISO/IEC 14443-2 (JIS X 6322-2) Specification and PCDs that are capable of driving both types of PICCs.

The relationship between the subject area of this Implementation Specification and the Standard Specifications are shown in **Table 1.1**. Standard Specifications as referred to in this Implementation Specification are the JIS and ISO/IEC standards specified in **Table 1.1**.

Table 1.1 – Scope of the Proximity Communication Interface Implementation Specifications

Subject Area	Associated Standard Specification	
	JIS	ISO/IEC
Physical characteristics of PICC	JIS X 6322-1	ISO/IEC 14443-1
Electrical characteristics of the PICC and PCD	JIS X 6322-2, 6322-3, 6322-4	ISO/IEC 14443-2, 14443-3, 14443-4
Verification test methods of the PICC and PCD	JIS X 6305-6	ISO/IEC 10373-6 ISO/IEC 10373-6/AM2
Interface between PCD and upper device	No applicable standard	
Cross test methods of the PICC and PCD	No applicable standard	

1.2 Assumed PICC and PCD

This Implementation Specification assumes PICCs with enhanced security features enabling them to be used for a wide variety of purposes. The following are considered.

(1) PICCs with encryption coprocessors

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 (ex. RSA signature generation) require encryption processors for processing, and consume more power (assuming approximately 50 mW).

This Implementation Specification specifically assumes PICCs with encryption coprocessors enabling them to be used for a wide variety of purposes.

(2) Single Card Operations and Double Card Operations

Along with operations using a combination of a single PCD and a single PICC (single card operations), operations using multiple PICCs could also be assumed as a general way of using the cards. This specification mainly addresses operations using two PICCs (double card operations) which are especially in demand.

– Single card operations

Operation using 1 PICC on 1 PCD at any one time.

This operation mode is used for systems that assume specific application processing, such as auto-feeding slot-in type PCDs and gate processing with special purpose PICCs.

– Double card operations

Of operations that process and communicate with multiple PICCs simultaneously, this type of operation assumes that a maximum of two PICCs are involved in the operation.

This assumption has been decided on the basis that, of the operations that use multiple PICCs,

operations using two PICCs are in higher demand, for example in cases where one PICC would be used for applications while the other will be used for settling payments.

While the Standard Specifications assume single card operation, caution is required in that, depending on which of these operation forms is assumed, the resonance frequency of the PICC and other design conditions vary.

Although a PICCs premised on double card operations can also be used for single card operations enabling it to cover both forms of operations, since a system with the longest communication distance as possible may be implemented on the premise of single card operations, this Implementation Specification considers and describes both PICCs premised on single card operations and PICCs premised on two card operation.

(3) PCD types

This specification addresses Open type PCDs and Insertion type PCDs.

– Open type PCDs

These are PCDs that communicate by being touched with the PICC or by bringing the PICC into close proximity of the PCD operating range. Other than "touch-and-go" type PCDs that are used in gate applications, there are types that are operated by placing the PICC appressed on top.

– Insertion type PCDs

These are PCDs that communicate by having the PICC inserted into a designated slot of the PCD. There are PCDs that require manual insertion and extraction as well as those that feed PCDs automatically.

(4) Touch operations and appressed operations

There are two types of PICC operations depending on the system.

– Touch operations

This is an operation type where activation and communication are performed during the approaching and touching of the PICC on the surface of the PCD.

Major application areas are ticket gate admittance processing for gate passing (touch-and-go) and admittance certification processing for room entry management. In these cases, a situation where a PICCs gradually approach a field generated by the PCD will occur.

The communication distance assumed is 0 mm to over 20 mm, and a displacement diameter of over 20 mm.

– Appressed operations

This is an operation type where communication is performed when the PICC is appressed against the surface of a PCD.

Major applications include update of important date such as financial settlements, card issuing, and downloading. In this case, the distance between the PICC and PCD is very near making the coupling level between the antennae high, which may have effect on the power and data transmit between the PICC and PCD.

The communication distance assumed is 0 mm to approximately 5mm, and a displacement diameter of approximately 5 mm.

The Standard Specification assumes touch operations and gives low consideration to ensuring compatibility of appressed operation situations. This Implementation Specification addresses and stipulates provisions for improving compatibility specific to both operation modes described above.

1.3 Characteristics of this Implementation Specification

This Implementation Specification attempts to ensure interoperability and compatibility of various types of PICCs 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 PICCs and PCDs.

(1) Improving Compatibility of PICCs and PCDs

This Implementation Specification stipulates provisions for improving compatibilities of PICCs 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 PICCs and PCDs. It should therefore be noted that this implementation specification does not unequivocally guarantee the compatibility of PICCs and PCDs.

In order to guarantee compatibility, users of this Implementation Specification are expected to perform the PICC and PCD unit tests indicated in Chapters 9, along with the operation tests (cross tests) of PICCs and PCDs which will actually be used in the IC card system to be applied. The details of the methods for cross tests are specified in Chapter 11.

(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 touch operations. 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 PICCs 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 PICCs, requiring caution to be exercised.

(3) Interface to Upper Applications

The application interface (API) is described in terms of revised content, based on the "Research Project on Cities Equipped with Information Technologies – Proximity Coupling Device Common Interface Specification Version 1.1" which has actually been adopted by municipalities.

(4) 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.

PICC Detail Specifications (Antenna shape, resonance frequency)
Unit verification test methods of PICCs (Power transfer interference, dynamic tests, etc.)
Unit verfication test methods of PCDs (Tests using reference PICC-S/M/L, etc.)
PCD upper interface (informative)
Cross test methods of the PICC and PCD (informative)

1.4 Description Convetion of this Implementation Specification

Within this Implementation Specification, provisions specified by the Standard Specifications are only referred to by quotation, while matters that are necessary to be added, such as considerations to diverse implementation methods and operation modes, are described based on the following four perspectives.

Compatibility Improvement Specifications:

Provisions considered as necessary to improve interoperability and compatibility of PICCs and PCDs.

Operation Diversification Specifications:

Provisions considered as necessary when assuming diverse operation modes.

Specifically, provisions pertaining to each of the single card operations/double card operations, Open type PCDs/Insertion type PCDs, touch operation modes/appressed operation modes.

Considerations:

While not being provisions of this Implementation Specification, matters of consideration to further improve interoperability and compatibility of PICCs 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 "Operation Diversification Specifications," "Compatibility Improvement Specifications," "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 1.2**.

Table 1.2 – Structure of this Implementation Specification

Chpt.	Subject Area	Description	Associated Standard Specification
4	Physical characteristics	Stipulates physical specifications and operating temperature of PICCs and PCDs, and specifies some considerations.	JIS X 6322-1 ISO/IEC 14443-1
5	Electrical characteristics	Stipulates antenna shape and strength of operating/generated magnetic field of PICCs and PCDs, and specifies some considerations for operational noise.	JIS X 6322-2 ISO/IEC 14443-2
6	Signal transmission	Stipulates initial communication and signal interfaces. In addition, describes informative provisions for high-speed communication.	JIS X 6322-2 ISO/IEC 14443-2 ISO/IEC 14443-2/ FPDAM2
7	Initialization and anticollision	Stipulates initial communication and signal interfaces. In addition, describes informative provisions for high-speed communication.	JIS X 6322-3 ISO/IEC 14443-3 ISO/IEC 14443-3/ FPDAM1
8	Transmission protocol	Stipulates the communication sequence.	JIS X 6322-4 ISO/IEC 14443-4
9	Unit tests	Stipulates unit test methods for the PICCs and PCDs specified in this Implementation Specification.	JIS X 6305-6 ISO/IEC 10373-6 ISO/IEC 10373-6/ FPDAM1 ISO/IEC 10373-6/AM2
10	External communication protocol	Stipulates informative interface specifications of the PCD control API.	
11	Cross tests	Stipulates test methods for evaluating interoperability and compatibility of a PICCs and PCDs.	

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.

JIS X 6305-6:2001 Test Methods for Identification Cards – Part 6: IC Cards Without External Terminals – Proximity Cards

JIS X 6322-1:2001 IC Cards Without External Terminals – Part 1: Physical Characteristics

JIS X 6322-2:2001 IC Cards Without External Terminals – Part 2: Power Transfer and Signal Interface

JIS X 6322-3:2001 IC Cards Without External Terminals – Part 3: Initialization and Anticollision

JIS X 6322-4:2002 IC Cards Without External Terminals – Part 4: Transmission Protocol

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 14443-3:2001

Identification cards – Contactless integrated circuit(s) cards – Proximity cards – Part 3: Initialization and anticollision

ISO/IEC 14443-4:2001

Identification cards – Contactless integrated circuit(s) cards – Proximity cards – Part 4: Transmission protocol

Explanatory Notes:

While **ISO/IEC 10373-6/AM2:2003** is already published (approved as International Standard) at the time of the stipulation of this Implementation Standard, it is not yet approved as a Japanese Industry Standard.

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 10373-6:2001/FPDAM1 (Date: 2003-07-03)

Identification cards - Test methods – Part6: Proximity cards

Amendment 1: Protocol test methods for proximity cards

ISO/IEC 14443-2:2001/FPDAM2 (Date: 2003-07-22)

Identification cards – Contactless integrated circuit(s) cards – Proximity cards – Part 2: Radio frequency power and signal interface

Amendment 2: Bit rates of fc/64, fc/32 and fc/16

ISO/IEC 14443-3:2001/FPDAM1 (Date: 2003-07-18)

Identification cards – Contactless integrated circuit(s) cards – Proximity cards – Part 3: Initialization and anticollision

Amendment 1: 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.

Proximity Coupling Device (PCD)

Generally referred to as reader/writer devices, PCDs use inductive coupling to provide power to PICCs and also to control the data exchange with PICCs.

Coupling Degree between Antennae

The degree of coupling between the PICC antenna and the PCD antenna when electromagnetic induction is performed.

Single Card Operations

Operation using 1 PICC on 1 PCD at any one time.

Double Card Operations

Of operations that process and communicate with multiple PICCs simultaneously, this type of operation assumes that a maximum of two PICCs are involved in the operation.

Open Type PCD

PCDs that communicate by touching or bringing the PICC into close proximity of the PCD operating range.

Insertion Type PCD

PCDs that communicate by inserting the PICC into a designated slot of the PCD.

Touch Operation

An operation type where activation and communication are performed during the approaching and touching of the PICC on the surface of the PCD.

Appressed Operation

An operation type where communication is performed when the PICC is appressed against the surface of a PCD.

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 etu = 128 / (D × fc), 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 /fc

Where *fc* is the carrier frequency as defined in **JIS X 6322-2**.

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 PICCs use standard frames defined as Type A PICCs and Type B PICCs use standard frames defined as Type B PICCs.

TR0

Guard time beginning at the end of transmission by a PCD and ending when generation of subcarrier begins by a PICC.

TR1

Synchronization time beginning at the time the subcarrier is generated by a PICC and ending when the PICC begins modulation.

TR2

Time beginning at the time when a PICC begins sending EOF and ending when a PCD begins SOF.

Operating field

The range of magnetic field strength where a PICC is capable of conducting normal operations.

Polling

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

Collision

Transmission by two or more PICCs 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 PICC 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 PICCs from the multiple PICCs within the same operating field of a PCD that have answered to a Request command, and establishing communication between the PICC and PCD.

Load modulation

To generate modulation signals by putting load on and off a PICC.

Request command

A command requesting an answer from a corresponding type of PICC when the PICC 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 PICCs. Stipulated in the Standard Specification.

Test PCD-S

A PCD stipulated for the purpose of this Implementation Specification. Used for tests assuming appressed operations.

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 of 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.

Dummy PICC

A PICC stipulated for the purpose of this Implementation Specification. Used for temperature rise tests.

3.2 Symbols and Abbreviated Terms

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

AFI	Application Family Indentifier 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
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
I-Blocks	Information blocks
LSB	Least Significant Bit

MAX	Index to define a MAXimum value
MIN	Index to define a MINimum value
MSB	Most Significant Bit
NRZ-L	Non-Return to Zero (L for Level)
OOK	On/Off Keying
PCD	Proximity Coupling Device
PICC	Proximity IC Card
PCB	Protocol Control Byte
PUPI	Pseudo-Unique PICC Identifier
R-Blocks	Receive ready blocks
R(ACK)	R-Block containing a positive acknowledge
R(NAK)	R-block containing a negative acknowledge
RATS	Request for Answer To Select
REQA	Request command, Type A
REQB	Request command, Type B
RF	Radio Frequency
RFU	Reserved for Future ISO/IEC Use
S-Blocks	Supervisory blocks
S	Start of communication, Type A
SAK	Select AcKnowledge, Type A
SEL	SELect code, Type A
SELECT	SELECT command, Type A
Slot_MARKER	Slot marker command, Type B
SOF	Start Of Frame, Type B
UID	Unique Identifier, Type A
Uid n	Byte number n of Unique Identifier where n >= 0
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

Shall comply with the "**Physical characteristics**" of **ISO/IEC 14443-1 (JIS X 6322-1)** and shall add the following provisions.

4.1 PICC

Operation Diversification Specifications:

Allow for thickness below dimensions specified for ID-1.

Explanatory Notes:

The operating temperature of a PICC is stipulated as shown below.

– PICCs should operate normally within the temperature range of 0°C to 50°C.

4.2 PCD

Considertations:

For Insertion type PCDs, under a room temperature environment, the area where the PICC will be placed shall be under 50°C for at least 5 minutes after becoming capable of communicating, without consideration to temperature rise due to the PICC's heat generation.

5 Electrical Charactristics

Shall comply with the "**Power transfer**" and "**PICC minimal coupling zone**" of **ISO/IEC 14443-2 (JIS X 6322-2)** and shall add the following provisions.

5.1 PICC

5.1.1 Antenna Shape

Compatibility Improvement Specifications:

In order to operate the PICC in four direction (fore-side, back-side, front approach, rear approach), the selected antenna mounting position shall be capable of ensuring the minimum coupling range with respect to all directions. The antenna positioning range is shown with diagonal lines in **Figure 5.1**.

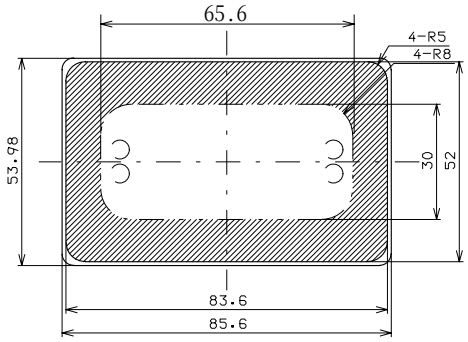


Figure 5.1 – Antenna Implementation Zone

5.1.2 Operating Noise

Considertations:

The PICC should suppress the following load fluctuation while processing commands:

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

The following load fluctuation should be suppressed as much as possible while the PICC 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:

For PICCs assuming single card operations, the resonance frequency shall be equal to or greater than 13.56 MHz. However, consideration shall be given to situations when coming into close proximity of PCDs.

Operation Diversification Specifications (Informative):

For PICCs assuming double card operations, the resonance frequency shall be equal to or greater than 13.56 MHz in situations where they are placed on top of the other.

5.1.4 Operating Field

Compatibility Improvement Specifications:

The minimum non-modulated operating field of a PICC shall be Hmin which value is 4 A/m (rms).

5.2 PCD

5.2.1 Antenna Shape

Compatibility Improvement Specifications:

Although there are no particular specifications for antenna position, antenna position shall be decided so as to satisfy communication performance independent of the operating direction (front, back, up, down) of the PICC within the communication range or the coil position. In addition, the antenna shall be aligned in a direction such that the antenna of the PCD and the antenna of the PICC face each other in parallel.

An example of an antenna position of a PCD where the center of the antenna is aligned with the center of the PICC is shown in **Figure 5.2**.

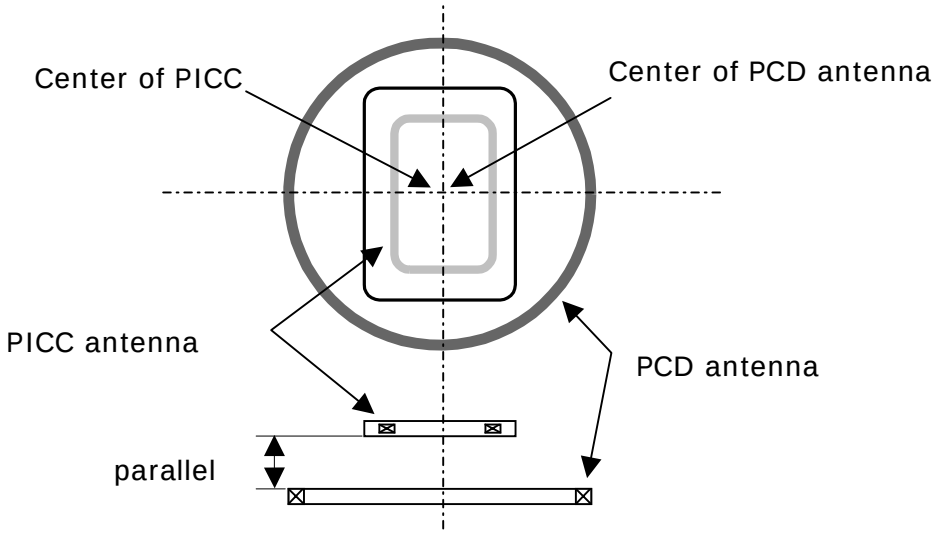


Figure 5.2 – Antenna Position

Considerations:

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 PICC is not largely affected by the operation direction and communication position.

Examples of PCD antenna shapes are shown in **Figure 5.3**.

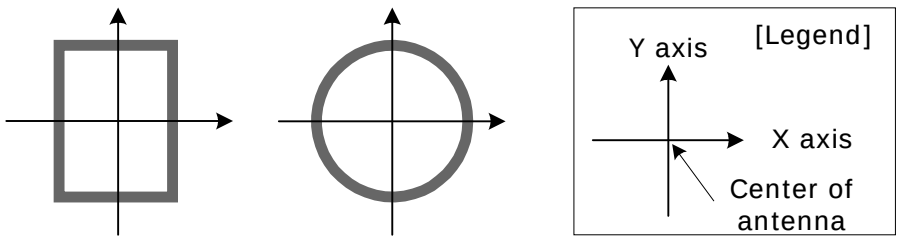


Figure 5.3 – Antenna Shape

5.2.2 Operating Noise

Considerations:

The design of the PCD should reflect consideration to the operating noise emitted from the PICC 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 Antennea

Considertations:

(1) The coupling degree between the antennae will increase when a PICC comes into close proximity of a PCD. Especially with Open type PCDs, PICCs may come into closer proximity than expected, resulting in excess coupling degree between the antennae.
(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 which value is 4 A/m (rms).

6 Signal Transmission

Based on **ISO/IEC 14443-2 (JIS X 6322-2)**, the modulation method, modulation waveform and coding scheme of the signal transmission from PCD to PICC and vice versa shall be stipulated herein. Type A and Type B communication formats are specified.

6.1 Initial Communication of the PICC

Shall comply with "**Initial dialogue for proximity cards**" of **ISO/IEC 14443-2 (JIS X 6322-2)**.

6.2 Signal Interface

Shall comply with the "**Signal Interface**" of **ISO/IEC 14443-2 (JIS X 6322-2)** and shall add the following provisions.

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-2/FPDAM2>

Figure 6.1 shows a summary of the two types of communication methods for fc/128 (approximately 106 kbit/s), fc/64 (approximately 212 kbit/s), fc/32 (approximately 424 kbit/s), and fc/16 (approximately 847 kbit/s).

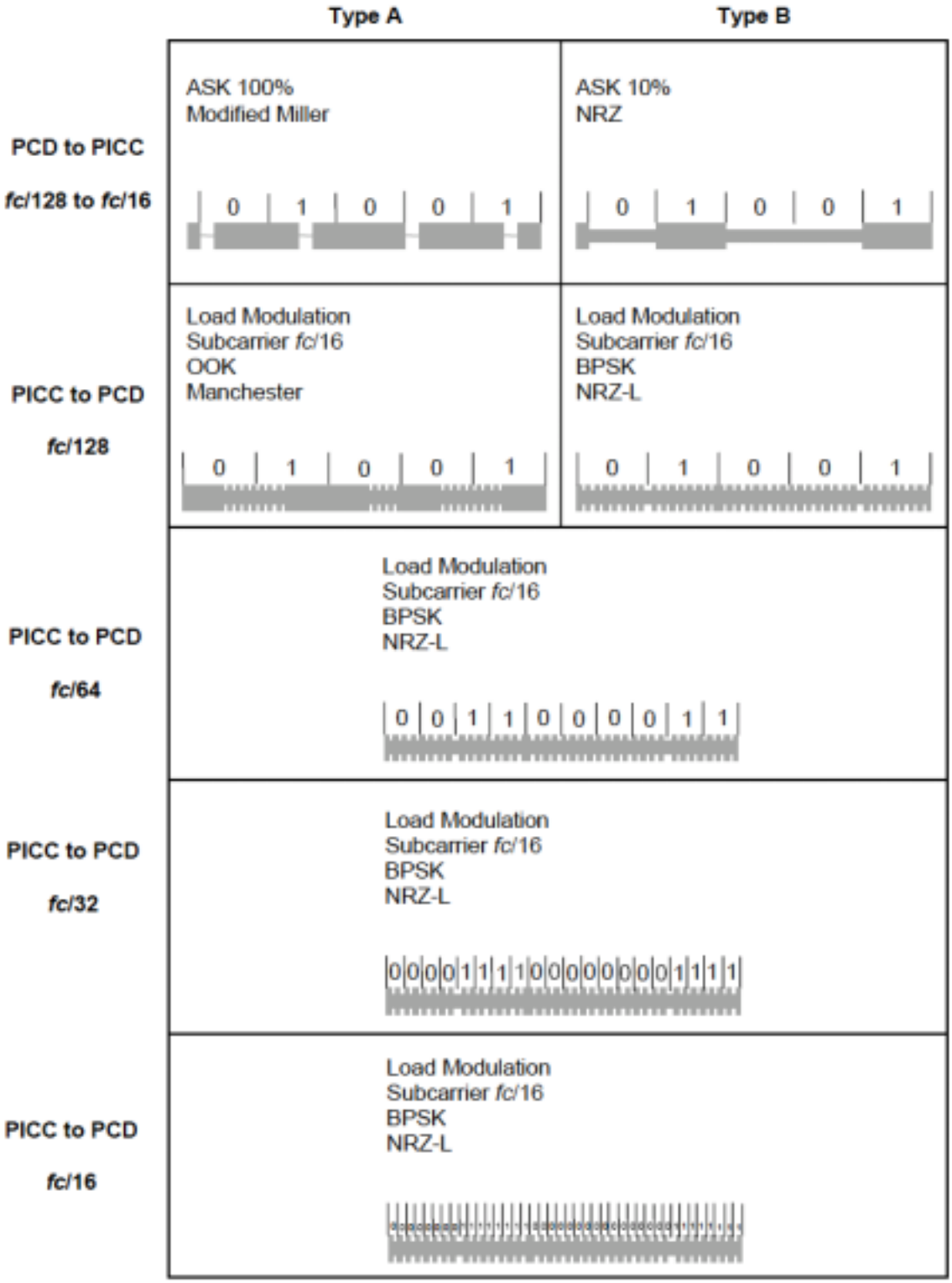


Figure 6.1 – Communication Examples of Type A and Type B

6.3 Communication Signal Interface Type A

Shall comply with the "**Communication Signal Interface Type A**" of **ISO/IEC 14443-2 (JIS X 6322-2)** and shall add the following provisions.

Explanatory Notes:

The following are stipulated in **ISO/IEC 14443-2 (JIS X 6322-2)**.

– 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 Method
- Bit Representation and Coding

6.3.1 Signal transmission from PCD to PICC

6.3.1.1 Bit Rate

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-2/FPDAM2>

The bit rate for initialization and anticollision shall be one of the following.

– fc/128 (approximately 106 kbit/s)
– fc/64 (approximately 212 kbit/s)
– fc/32 (approximately 424 kbit/s)
– fc/16 (approximately 847 kbit/s)

6.3.1.2 Modulation

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-2/FPDAM2>

Communication between PCD to PICC at bit rates fc/64, fc/32, fc/16 takes place using the modulation principle of ASK modulation of the RF operating field to create a "pause" as shown in **Figure 6.2**.

The envelope of the PCD field shall decrease monotonically to less than 60 % of its initial value $H_{INITIAL}$ as shown in **Figure 6.2**.

Overshoots shall remain within ±0,1 × (1-a) of $H_{INITIAL}$.

Parameter a of **Figure 6.2** shall be less than 0,6 for bit rates fc/64, fc/32, fc/16.

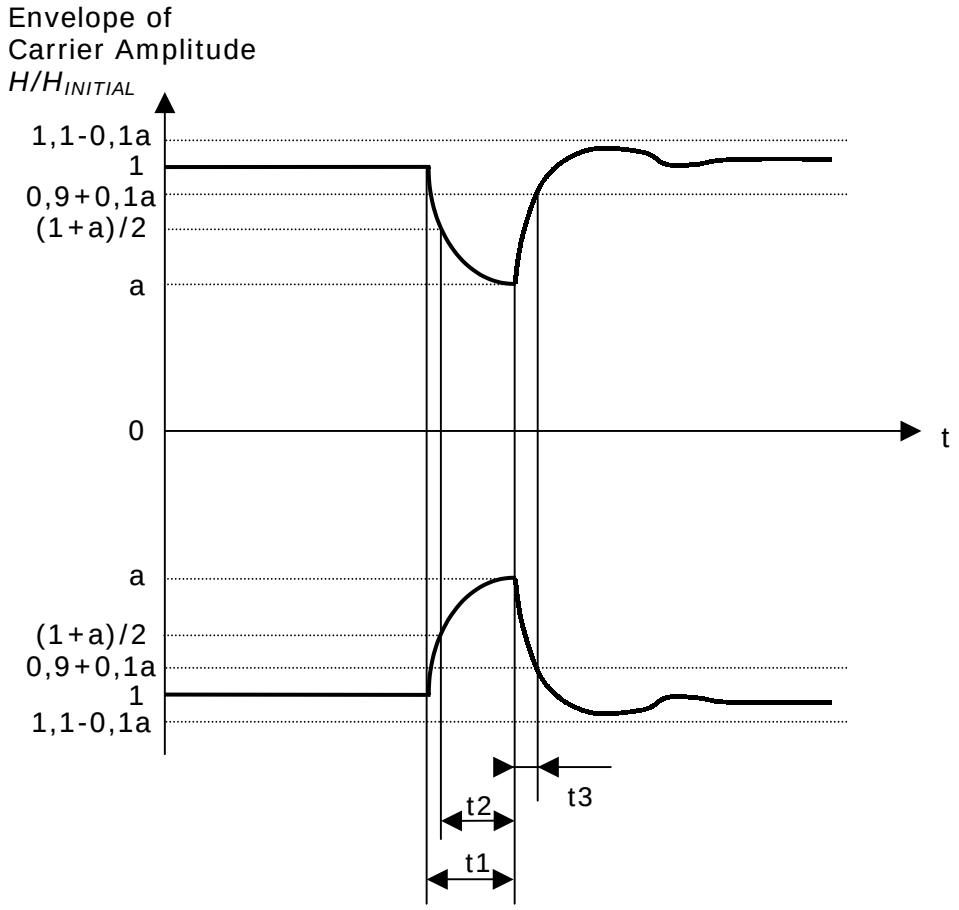


Figure 6.2 – "Pause" waveform at bit rate of fc/64, fc/32, fc/16

Table 6.1 – Modulation Timing

Timing Parameter	fc/64		fc/32		fc/16	
	Min	Max	Min	Max	Min	Max
t1	17/fc	21/fc	10/fc	12/fc	6/fc	7/fc
t2	5/fc	t1	4/fc	t1	3/fc	t1
t3	0	10/fc	0	9/fc	0	8/fc

6.3.2 Signal transmission from PICC to PCD

6.3.2.1 Bit Rate

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-2/FPDAM2>

The bit rate for initialization and anticollision shall be one of the following.

– fc/128 (approximately 106 kbit/s)
– fc/64 (approximately 212 kbit/s)
– fc/32 (approximately 424 kbit/s)
– fc/16 (approximately 847 kbit/s)

6.3.2.2 Subcarrier Modulation Method

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-2/FPDAM2>

At bit rates fc/64, fc/32, fc/16, the subcarrier shall be BPSK modulated as described in **6.3.2.3**.

6.3.2.3 Bit Representation and Coding

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-2/FPDAM2>

At bit rates fc/64, fc/32, fc/16, bit coding shall be NRZ-L as stipulated below.

Logical "1":	The carrier is modulated with the subcarrier for one bit duration.
Logical "0":	The carrier is modulated with the inverse of the subcarrier for one bit duration.
Start of communication:	After the 32 periods of subcarrier (phase of logical "1"), the inverse of the subcarrier (phase of logical "0") shall continue for one bit duration.
End of communication:	The carrier is not modulated with the subcarrier for one bit duration.
No information:	The carrier is not modulated with the subcarrier.

6.4 Communication Signal Interface Type B

Shall comply with the "**Communication Signal Interface Type B**" of **ISO/IEC 14443-2 (JIS X 6322-2)** and shall add the following provisions.

Explanatory Notes:

The following are stipulated in **ISO/IEC 14443-2 (JIS X 6322-2)**.

– 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 Method
- Bit Representation and Coding

6.4.1 Signal transmission from PCD to PICC

6.4.1.1 Bit Rate

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-2/FPDAM2>

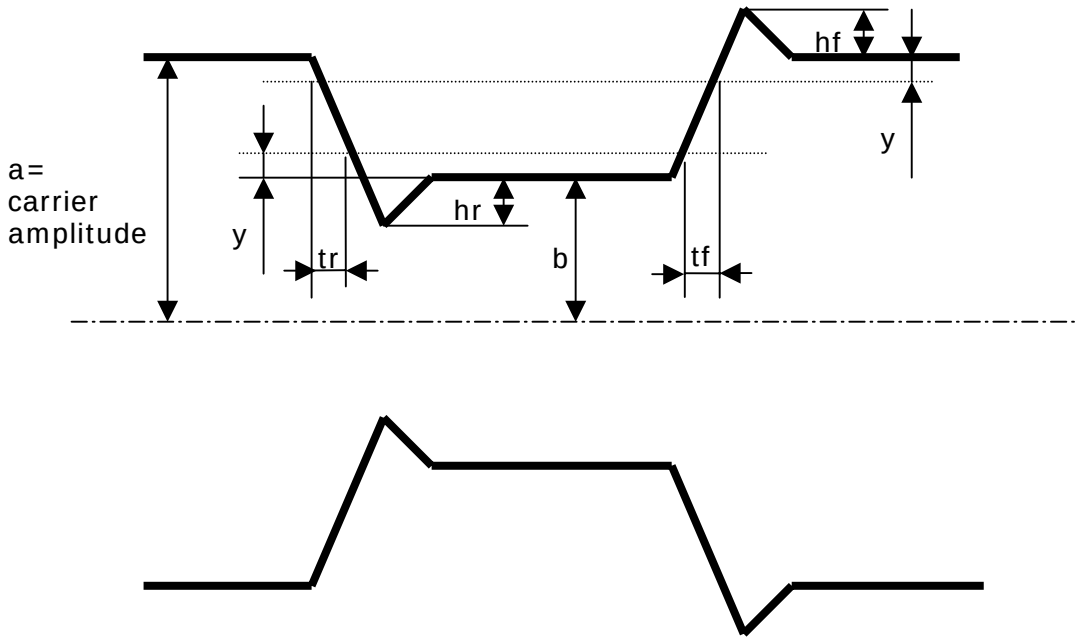
The bit rate for initialization and anticollision shall be one of the following.

– fc/128 (approximately 106 kbit/s)
– fc/64 (approximately 212 kbit/s)
– fc/32 (approximately 424 kbit/s)
– fc/16 (approximately 847 kbit/s)

6.4.1.2 Modulation

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-2/FPDAM2>

The modulation waveform for each bit rate shall comply with **Figure 6.3**.



Parameter	Bit Rate			
	fc/128	fc/64	fc/32	fc/16
1 etu (approx)	9,44 µs	4,72 µs	2,36 µs	1,18 µs
t_f max	2 µs	2 µs	1 µs	0,8 µs
t_r max	2 µs	2 µs	1 µs	0,8 µs
y	0,1 (a-b)	0,1 (a-b)	0,1 (a-b)	0,1 (a-b)
h_f, max h_r max	0,1 (a-b)	0,1 (a-b)	0,1 (a-b)	0,1 (a-b)

Figure 6.3 – Modulation Waveform for Type B

6.4.2 Signal transmission from PICC to PCD

6.4.2.1 Bit Rate

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-2/FPDAM2>

The bit rate for initialization and anticollision shall be one of the following.

– fc/128 (approximately 106 kbit/s)
– fc/64 (approximately 212 kbit/s)
– fc/32 (approximately 424 kbit/s)
– fc/16 (approximately 847 kbit/s)

6.4.2.2 Subcarrier

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-2/FPDAM2>

The frequency fs of the subcarrier shall be fc/16 (approximately 847 kHz). Consequently, during initialization and anticollision, one bit period is equivalent to 8 periods of the subcarrier.

The periods of the subcarrier after initialization and anticollision shall depend on the bit rate.

6.4.2.3 Subcarrier Modulation Method

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-2/FPDAM2>

The subcarrier shall be BPSK modulated, as seen in the example in **Figure 6.4**.

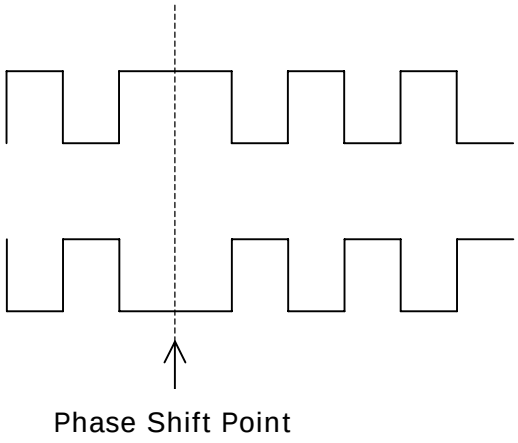


Figure 6.4 – Phase Shift Point

7 Initialization and Anticollision

Shall comply with "**Initialization and anticollision**" of **ISO/IEC 14443-3 (JIS X 6322-3)**.

7.1 Polling

Shall comply with the "**Polling**" of **ISO/IEC 14443-3 (JIS X 6322-3)** and shall add the following provisions.

Compatibility Improvement Specifications:

After disappearance of the operating field, the PICC shall enter POWER-OFF state within 10 ms. After that, the PICC shall perform the operations stipulated in this section when it enters an operating field.

Considerations:

A PICC 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 PICC 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 PICC to begin accepting requests (5 ms).

Explanatory Notes:

When a PICC 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 minimum level shall include cases ranging from slow rising time to fast rising time as shown in **Figure 7.1**. If the operating field is modulated upon attuning minimum

operational level, the PICC shall be able to accept a Request command within 5 ms after the operating field becomes non-modulated above the minimum operational level.

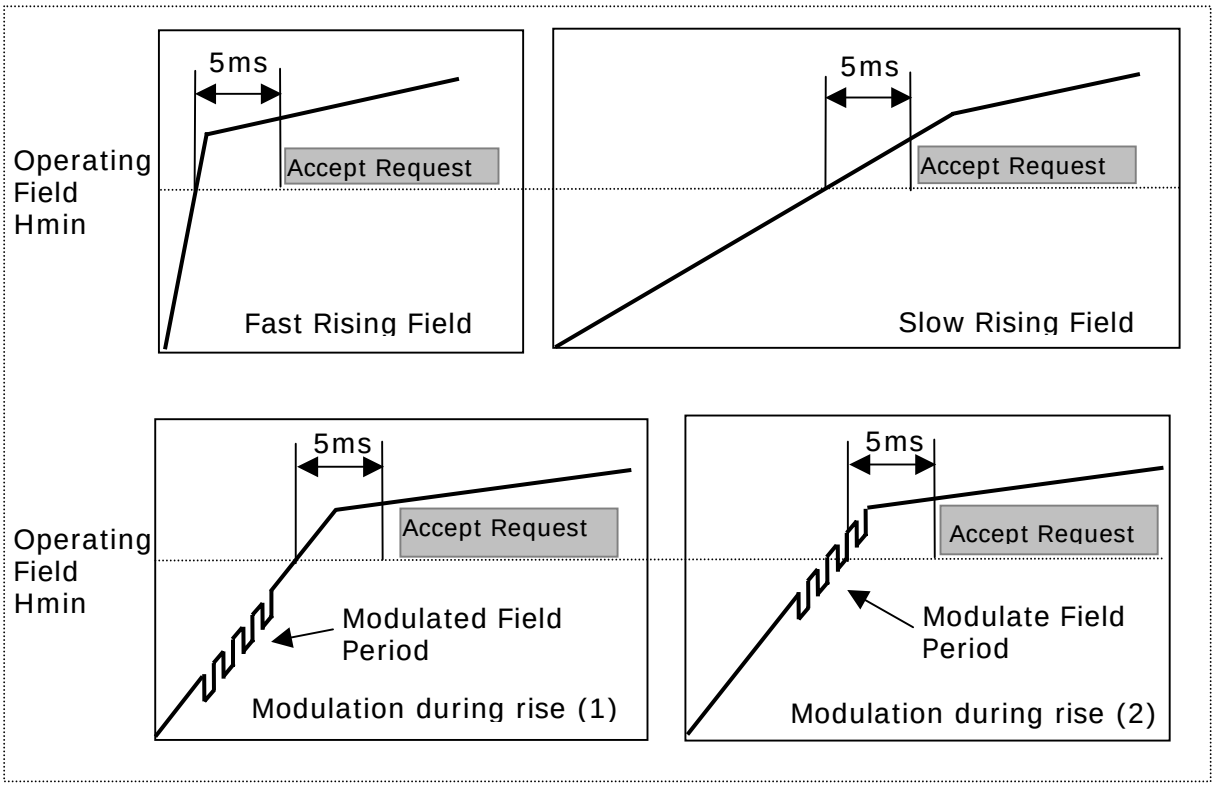


Figure 7.1 – Variations of Operating Field Rising Forms

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-3/FPDAM1>

(1) When a PICC of Type A is exposed to a non-modulated operating field it shall be able to accept a REQA within 5 ms.
When a PICC of Type A receives a Type B command, it shall enter IDLE state in order to receive a REQA, or shall retain the current state capable of communication.

(2) When a PICC of Type B is exposed to a non-modulated operating field it shall be able to accept a REQB within 5 ms.
When a PICC of Type B receives a Type A command, it shall enter IDLE state in order to receive a REQB, or shall retain the current state capable of communication.

After disappearance of the operating field, the PICC shall enter POWER-OFF state within 100 ms. After that, the PICC shall perform the operations stipulated in this section when it enters an operating field.

Explanatory Notes:

It should be noted that the reset time (100 ms) of the PICC is currently under discussion and is subject to change.

7.2 Initialization and Anticollision of PICC Type A

Shall comply with the "**Type A – Initialization and Anticollision**" of **ISO/IEC 14443-3 (JIS X 6322-3)** and shall add the following provisions.

Explanatory Notes:

The following are stipulated in **ISO/IEC 14443-3 (JIS X 6322-3)**.

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

7.2.1 Bit Rate

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-3/FPDAM1>

Four bit rates shown in **Table 7.1** shall be stipulated for the bit rate between the PCD and PICC. Bit rates fc/64, fc/32, and fc/16 are optional.

Table 7.1 – Bit Rates

Divisor D	etu	Bit rate
1	128/fc (~9,4 µs)	fc/128 (~106 kbit/s)
2 (optional)	128/(2fc) (~4,7 µs)	fc/64 (~212 kbit/s)
4 (optional)	128/(4fc) (~2,4 µs)	fc/32 (~424 kbit/s)
8 (optional)	128/(8fc) (~1,2 µs)	fc/16 (~847 kbit/s)

NOTE fc/128 is the initial bit rate and shall be used for all initialization and anticollision procedures.

7.2.2 Frame Format and Timing

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-3/FPDAM1>

The time between the end of the last pause transmitted by the PCD and the first modulation edge within the start bit transmitted by the PICC shall respect the timing defined in **Figure 7.2**.

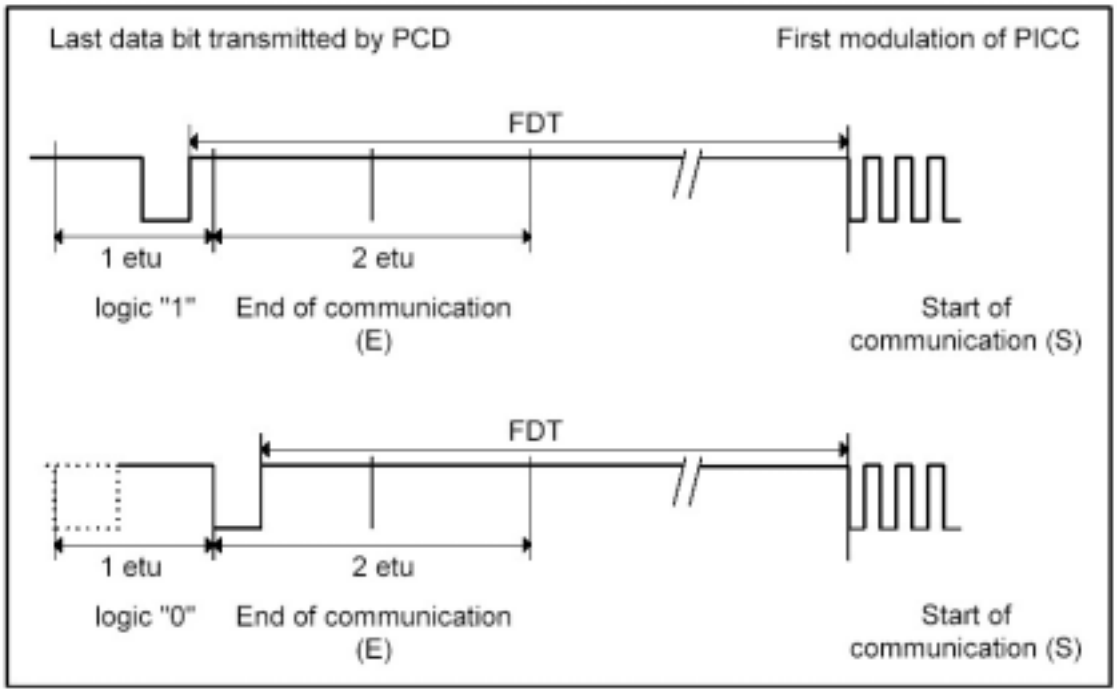


Figure 7.2 – Frame Delay Time from PCD to PICC

Table 7.2 defines the values for n and FDT depending on the command type and the logic state of the last transmitted data bit in the command.

Table 7.2 – Frame Delay Time from PCD to PICC

Command type	n (integer value)	FDT	
		last bit = (1)b	last bit = (0)b
REQA Command WUPA Command ANTICOLLISION Command SELECT Command		1236/fc	1172/fc
All other commands at bit rates PCD –> PICC fc/128 PCD <– PICC fc/128	>=9	(n × 128 + 84) / fc	(n × 128 + 20) / fc
All other commands at bit rates PCD –> PICC fc/64 PCD <– PICC fc/128	>=8	(n × 128 + 138) / fc	(n × 128 + 106) / fc
All other commands at bit rates PCD –> PICC fc/32 PCD <– PICC fc/128	>=8	(n × 128 + 106) / fc	(n × 128 + 90) / fc
All other commands at bit rates PCD –> PICC fc/16 PCD <– PICC fc/128	>=8	(n × 128 + 97) / fc	(n × 128 + 89) / fc
All other commands at bit rates PCD –> PICC fc/128 or fc/64 or fc/32 or fc/16 PCD <– PICC fc/64 or fc/32 or fc/16		>=1113/fc	>=1113/fc

NOTE To prevent collision, all PICCs shall respond in a synchronous way to REQA, WUPA, ANTICOLLISION, and SELECT commands.

For bit rates of fc/64, fc/32 and fc/16, there is an exception where the final parity bit of a PICC standard frame is inverted.

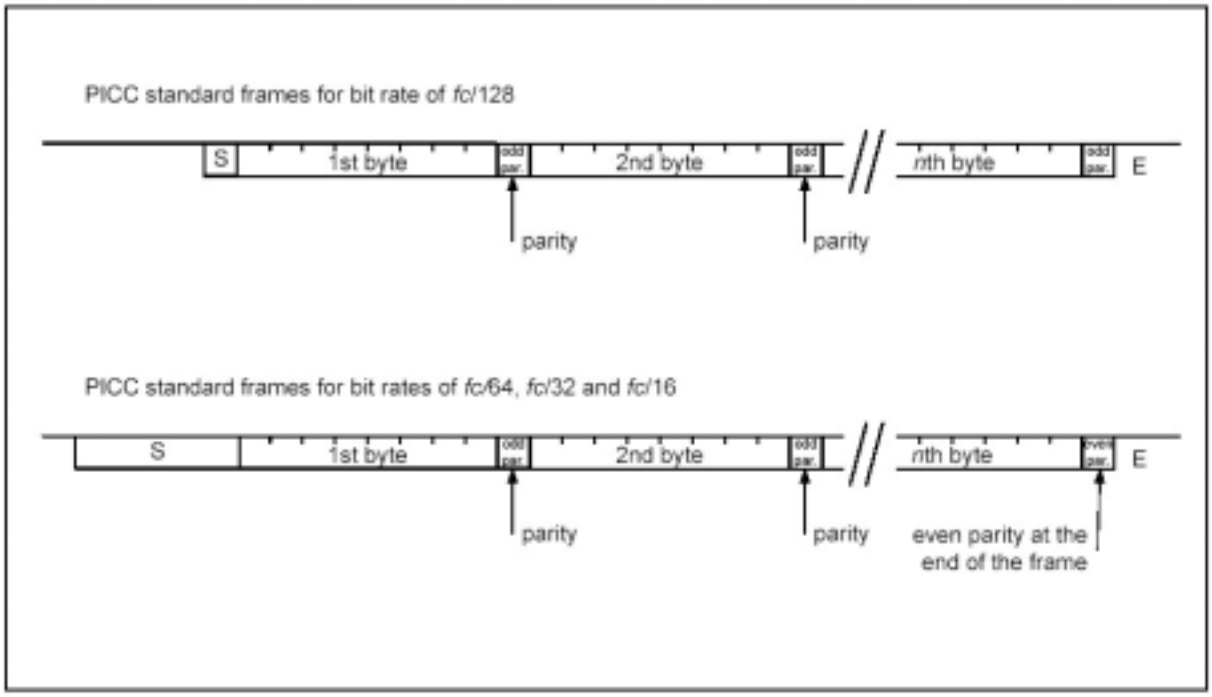


Figure 7.3 – PICC Standard Frame

7.2.3 PICC States Description

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-3/FPDAM1>

Change the designation of "ISO/IEC 14443-4" in the PICC state diagram to "PROTOCOL state".

7.2.4 Select Sequence

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-3/FPDAM1>

The Answer To Request (ATQA) is coded as shown in **Table 7.3**.

Table 7.3 – Coding of Answer To Request (ATQA)

b16	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1
RFU				Proprietary	HB2	HB1	HB0	UID size Bit frame		RFU	Bit frame anticollision				

As shown in **Tables 7.4**, **7.5**, and **7.6**, high speed bit rate factors HB0, HB1, and HB2 describe whether PICC supports option Select Codes.

Table 7.4 – Coding of High Speed Bit Rate Factor HB0

b9	Meaning
0	PICC does not support Select Code “92”
1	PICC supports Select Code “92”

Table 7.5 – Coding of High Speed Bit Rate Factor HB1

b10	Meaning
0	PICC does not support Select Code “94”
1	PICC supports Select Code “94”

Table 7.6 – Coding of High Speed Bit Rate Factor HB2

b11	Meaning
0	PICC does not support Select Code “98”
1	PICC supports Select Code “98”

The coding for SEL (Select Code) shall be one of the values shown in **Table 7.7**.

Table 7.7 – Coding of SEL

b8	b7	b6	b5	b4	b3	b2	b1	Meaning
1	0	0	1	0	0	1	1	“93”: Select cascade level 1
1	0	0	1	0	1	0	1	“95”: Select cascade level 2
1	0	0	1	0	1	1	1	“97”: Select cascade level 3
1	0	0	1	0	0	1	0	Optional “92”: Select cascade level 1 and switch bit rate to fc/64 after receive SAK
1	0	0	1	0	1	0	0	Optional “94”: Select cascade level 2 and switch bit rate to fc/32 after receive SAK
1	0	0	1	0	1	1	0	Optional “98”: Select cascade level 3 and switch bit rate to fc/16 after receive SAK

If the PICC indicates that it supports high speed bit rates using the information specified in **Table 7.3** "Coding of Answer To Request (ATQA)," the PCD shall be able to select a new bit rate by using SEL

values of "92", "94", or "98". After transmitting SAK, the PCD and PICC shall begin transmitting using the new bit rate.

Note: An alternate method of selecting bit rates is stipulated in **ISO/IEC 14443-4 (JIS X 6322-4)**. The selection method allow for the PCD and PICC to select bit rates individually.

Table 7.8 – Single Size UIDs

uid 0	Description
“08”	uid1 to uid3 is a random number which is dynamically generated
"x0" ~ "x7"	Proprietary number
"x9" ~ "xE"'	Proprietary number
"18" ~ "F8"	RFU
"xF"	RFU

The value "88" of the cascade tag CT shall not be used for uid3 in double sized UID.

The usage of cascade levels is shown in **Figure 7.4**.

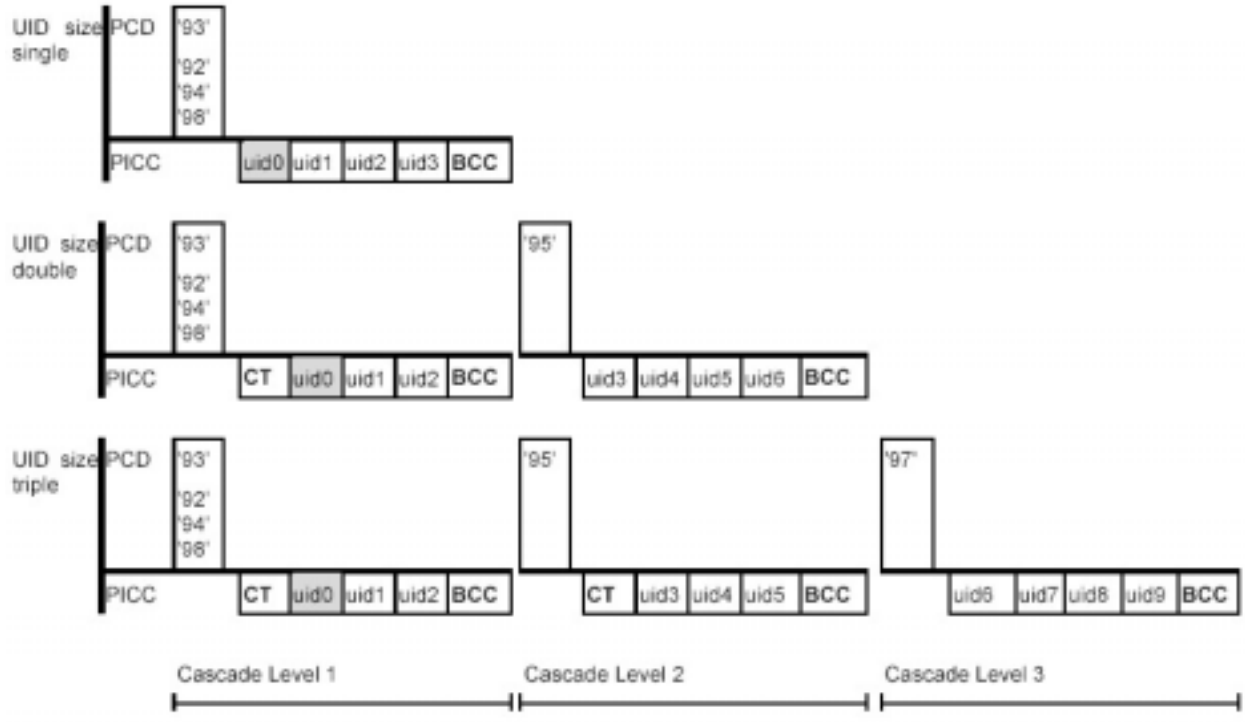


Figure 7.4 – Usage of Cascade Levels

NOTE SEL values "92", "94", and "98" are optional and can be used to switch to fc/64, fc/32, or fc16.

7.3 Initialization and Anticollision of PICC Type B

Shall comply with the "**Type B – Initialization and Anticollision**" of **ISO/IEC 14443-3 (JIS X 6332-3)** and shall add the following provisions.

Explanatory Notes:

The following are stipulated in **ISO/IEC 14443-3 (JIS X 6322-3)**.

– 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

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-3/FPDAM1>

Bit boundaries within a character shall occur between (n - 0,125) etu and (n + 0,125) etu where n is the number of bit boundaries after the start bit falling edge (1 <= n <= 9).

For transmissions from PICCs to PCDs, the bit boundaries within a character shall occur only at the phase shift point of the rising edge or the falling edge of the carrier specified in "**6.4.2.3 Subcarrier Modulation Method**."

Table 7.9 – Bit Boundaries from PCD to PICC

	PICC to PCD bit rate			
	fc/128 (1 etu = 8/fs)	**fc/64 (1 etu = 4/fs)**	**fc/32 (1 etu = 2/fs)**	**fc/16 (1 etu = 1/fs)**
Bit boundaries from PICC to PCD	n etu ± 1/fs	n etu ± 1/(2fs)	n etu	n etu

A character is separated from the next sent one by the extra guard time EGT as follows.

The EGT between two consecutive characters sent by the PCD to the PICC shall be any value between 0 and 6 etu.

The EGT between two consecutive characters sent by the PCD to the PICC shall be any value between 0 and 2 etu.

Note: The EGT is not limited to an integer value of etu.

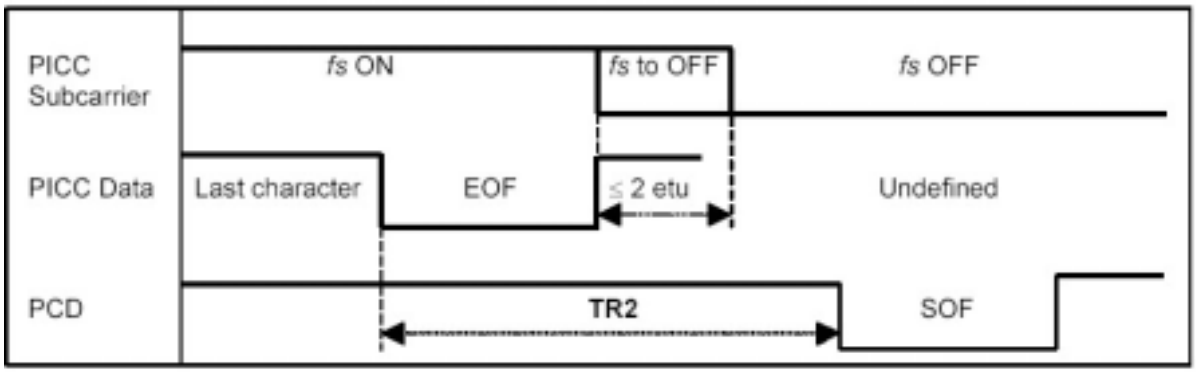


Figure 7.5 – From PICC EOF to PCD SOF

Table 7.10 – Compliance With ISO/IEC 14443

b11	Meaning
1	PICC Compliant with ISO/IEC 14443-4
0	PICC not Compliant with ISO/IEC 14443-4

The minimum value of TR2 shall be coded by the Protocol_Type of Protocol Info within ATQB.

The minimum value of TR2 (the delay between PICC EOF start and PCD SOF start) shall be defined by bits 2 and 3 of Protocol_Type as shown in **Table 7.11**.

Table 7.11 – Coding of Minimum Value of TR2

b3	b2	Minimum TR2 for PICC to PCD			
		fc/128 (1 etu = 8/fs)	fc/64 (1 etu = 4/fs)	fc/32 (1 etu = 2/fs)	fc/16 (1 etu = 1/fs)
0	0	10 etu + 32/fs	10 etu + 32/fs	10 etu + 32/fs	10 etu + 32/fs
0	1	10 etu + 32/fs	10 etu + 32/fs	10 etu + 32/fs	26 etu
1	0	10 etu + 32/fs	18 etu	18 etu	18 etu
1	1	10 etu + 32/fs	14 etu	14 etu	14 etu

7.3.2 REQB/WUPB Command

Considerations:

It is not clear to what value the AFI of a multipurpose PICC Type B should be set, which might lead to confusion. In order to ensure compatibility, this Implementation Specification recommends setting the value of the AFI of PICCs to "00", and for PCDs, setting the value of the AFI to "00" and sending a REQB/WUPB command.

However, for single-purpose PICC Type B, if the AFI can be determined uniquely, the value shall comply with the provisions of "**Initialization and Anticollision**" of **ISO/IEC 14443-3 (JIS X 6322-3)**.

7.3.3 Answer to Request (ATQB)

7.3.3.1 Pseudo-Unique PICC Identifier (PUPI)

Considertations:

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

7.3.4 ATTRIB Command

Compatibility Improvement Specification (Informative): <Refer to ISO/IEC 14443-3/FPDAM1>

After Answer to ATTRIB, the parameters selected by the ATTRIB command shall be applied.

Table 7.12 – Coding of Minimum Value of TR0

b8	b7	Minimum TR0 for PCD to PICC			
		fc/128	fc/64	fc/32	fc/1
0	0	64/fs	64/fs	64/fs	64/fs
0	1	48/fs	32/fs	16/fs	16/fs
1	0	16/fs	8/fs	4/fs	4/fs
1	1	RFU	RFU	RFU	RFU

Table 7.13 – Coding of Minimum Value of TR1

b5	b6	Minimum TR1 for PCD to PICC			
		fc/128	fc/64	fc/32	fc/16
0	0	80/fs	80/fs	80/fs	80/fs
0	1	64/fs	32/fs	32/fs	32/fs
1	0	16/fs	8/fs	8/fs	8/fs
1	1	RFU	RFU	RFU	RFU

8 Transmission Control Sequence

Shall comply with **ISO/IEC 14443-4 (JIS X 6322-4)**.

8.1 Protocol Activation of PICC Type A

Shall comply with "**Protocol activation of PICC Type A**" of **ISO/IEC 14443-4 (JIS X 6322-4)**.

Explanatory Notes:

The following are stipulated in **ISO/IEC 14443-4 (JIS X 6322-4)**.

– 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 PICC Type B

Shall comply with "**Protocol activation of PICC Type B**" of **ISO/IEC 14443-4 (JIS X 6322-4)**.

8.3 Half-Duplex Block Transmission Protocol

Shall comply with "**Half-Duplex Block Transmission Protocol**" of **ISO/IEC 14443-4 (JIS X 6322-4)**.

Explanatory Notes:

The following are stipulated in **ISO/IEC 14443-4 (JIS X 6322-4)**.

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

Considerations:

When considering operations using Open type PCDs or when considering speed up, the values for PICC Frame Wait Time FWI and WTXM (when using WTX) should be decided with consideration to operability.

8.4 Protocol Deactivation of PICC Type A and Type B

Shall comply with "**Protocol Deactivation of PICC Type A and Type B**" of **ISO/IEC 14443-4 (JIS X 6322-4)**.

Explanatory Notes:

The following are stipulated in **ISO/IEC 14443-4 (JIS X 6322-4)**.

– 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 (JIS X 6322-4)**.

8.6 Components of the Blocks and Frames

Shall comply with "**Annex C (Informative) Block and Frame Coding Overview**" of **ISO/IEC 14443-4 (JIS X 6322-4)**.

8.7 １４４４３－４ Transmission Control Matrix of Protocol

The following **Tables 8.1** and **8.2** are Transmission Control Matrices to help in understanding the Protocol.

Table 8.1 – Transmission Control Protocol on the PICC 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 (JIS X 6322-4)**.

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

Table 8.2 – Transmission Control Protocol on the (Upper Device) PCD Side (Towards PICC)

State	Event										
	Receive I block (from PICC)				Receive R block (from PICC)		Receive S block (from PICC)		Receive error		
	A No-Chain $I(0)_0$ Received	B Non-Chain $I(0)_1$ Received	C Chain $I(1)_0$ Received	D Chain $I(1)_1$ Received	E $R(ACK)_0$ Received	F $R(ACK)_1$ Received	G Request S(WTX) Received	H Response S(DESELECT) Received	I Error (PCB error)	J Error (CRC error, EGT timeout)	K FWT Timeout
0 Wait command from upper device	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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 (JIS X 6322-4)**.

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

While the test methods are stipulated in ISO/IEC 10373-6 (JIS X 6305-6), this Implementation Specification adds tests aimed to improve compatibility and accommodate diversification of operation modes (appressed operations, dynamic operations, and double card operations). This Implementation Specification also reflects provisions stipulated in **ISO/IEC 10373-6/AM2**.

9.1 General Requirements

9.1.1 Test Environment

Unless otherwise specified, the test environment as specified in **Table 9.1** shall apply.

Table 9.1 – Test Environment

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

9.1.2 Pre-conditioning

The PICC 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 PICC under test

are shown in **Table 9.2**, and

– Test content for the PCD under test

are shown in **Table 9.3**.

Details of each test content listed in **Tables 9.2** and **9.3** are described from section 9.3 onward.

There are several Compatibility Improvement Specifications and Operation Diversification Specifications designate as "Informative" which tests can be added according to the usage environment of the application.

Table 9.2 – Test Content (for PICC under test)

Item	Test content	Test Apparatus [Generated Magnetic Field Strength]	Paired use conditions	Rule	Category			
					Standard	Compatibility Improvement	Diversification	
							single	double
9.3.1	PICC load modulation amplitude test	Test PCD [1,5 A/m]	Single (not paired)	30/H^1,2 mVp-p or more.	Normative			
		Test PCD [4,0 A/m]	Single (not paired)			Normative		
			Paired PICC					Normative
			Reference PICC-S/M/L					Normative
		Test PCD [7,5 A/m]	Single (not paired)		Normative			
			Paired PICC					Normative
			Reference PICC-S/M/L					Normative
		Test PCD-S (Informative) [4,0 A/m]	Single (not paired)	A REQA/REQB response is received.			Informative	
			Paired PICC					Informative
			Reference PICC-S/M/L					Informative
		Test PCD-S (Informative) [7,5 A/m]	Single (not paired)				Informative	
			Paired PICC					Informative
			Reference PICC-S/M/L					Informative
9.3.2	Reception test	Test PCD [1,5 A/m]	Single (not paired)	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	Single (not paired)	No rule.	Informative			
			Single (not paired)	13,56 MHz or more.		Normative		
			Paired PICC	13 MHz or more.				Informative
9.3.4	Maximum Applied Magnetic Field Test	Test PCD [Apply 10 A/m]	Single (not paired)	The PICC shall function normally after applying the magnetic field of 10 A/m.		Normative		
			Paired PICC					Normative
			Reference PICC-S/M/L					Normative
9.3.5	Power transmit interference test for double card operations	Test PCD	Reference PICC-S/M/L	Receive voltage of (6,8) V or more at load of 910 Ohm				Normative
9.3.6	PICC dynamic test (informative)	Test PCD [No rule]	Single (not paired)	A REQA/REQB response is received.			Informative	
9.3.7	Protocol Timing Characteristics (Informative)	Test PCD [No rule]	Single (not paired)	The timing values shall satisfy the rules.		Informative		

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

Table 9.3 – Test Content (for PCD under test)

Item	Test content	Test Apparatus [Reference PICC Resonance Frequency]	Paired use conditions	Rule	Category			
					Standard	Compatibility Improvement	Diversification	
							single	double
9.4.1	Magnetic Field Strength Maximum Generated Magnetic Field	Reference PICC [19 M]	Single (not paired)	3 V or less (7,5 A/m)	Normative			
		Reference PICC-S [19 M]		3 V or less (7,5 A/m)		Normative		
		Reference PICC-M [19 M]						
		Reference PICC-L [19 M]						
	Magnetic Field Strength Minimum Generated Magnetic Field	Reference PICC [13,56 M]	Single (not paired)	3 V or more (1,5 A/m)	Normative			
		Reference PICC-S [13,56 M]		3 V or more (4 A/m)		Normative		
		Reference PICC-M [13,56 M]						
		Reference PICC-L [13,56 M]						
9.4.2	Power Transmission Test	Reference PICC [19 M]	Single (not paired)	1,8 kOhm load, 3 V or more	Normative			
		Reference PICC-S [19 M]		910 Ohm load, 6,8 V or more		Informative		
		Reference PICC-M [19 M]						
		Reference PICC-L [19 M]						
		Reference PICC-S/M/L[19 M]pair	Reference PICC pair S-S / S-M / S-L M-S / M-M / M-L L-S / L-M / L-L	910 Ohm load, 6,8 V or more				Informative
9.4.3	Modulation Waveform	Calibration Coil	Single calibration coil (not paired)	The results shall satisfy the rules.	Normative			
			Reference PICC-S/M/L [19 M]			Normative		
			Reference PICC-S/M/L [19 M] pair S-S / S-M / S-L M-S / M-M / M-L L-S / L-M / L-L					Normative
9.4.4	Reception ability of load modulation signal (Informative)	Reference PICC [19 M]	Single (not paired)	Shall be able to receive.	Informative			
		Reference PICC-S [19 M]				Informative		
		Reference PICC-M [19 M]				Informative		
		Reference PICC-L [19 M]				Informative		
9.4.5	Temperature rise test (Informative)	Dummy PICC	None	Target: Insertion Type PCD Surrounding temperature of dummy PICC is 50°C or lower			Informative	

9.3 Test content for the PICC under test

Shall comply with "**Testing of PICC**" of **ISO/IEC 10373-6** and **ISO/IEC 10373-6/AM2 (JIS X 6305-6)**.

Explanatory Notes:

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

Major changes are the following.

– Clarification of test content: The content of "Test of PICC" has become "PICC load modulation amplitude test."

– Clarification of test method: The procedures of "Test of PICC" has become "PICC load modulation amplitude test" have been stipulated in detail.

– Addition of test content: The following tests have been added.

PICC reception test
PICC Resonance Frequency (informative)

9.3.1 PICC Load Modulation Amplitude Test

Shall comply with "**PICC load modulation amplitude**" of **ISO/IEC 10373-6** and **ISO/IEC 10373-6/AM2 (JIS X 6305-6)**.

Compatibility Improvement Specifications:

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

Operation Diversification Specifications:

These test items only apply to PICCs premised on double card operation.

(1) Test Method

Testing is performed using two test target PICCs, placing one PICC on top of the other.

Perform test under minimum operating field Hmin and maximum operating field Hmax. Hmin shall be equal to the value specified in "**5.1.4 Operating Field**" and Hmax shall be equal to the value specified in the Standard Specification.

a) Case of Pairing two PICCs

Place the paired PICCs on the Test PCD and send a REQA or REQB from the Test PCD. Verify the modulated signal received from the PICC using an oscilloscope connected to a calibration coil. If the response from the two PICCs result in a collision, perform anticollision procedures to perform the test under a condition where no collisions occur.

b) Case of Pairing a PICC with a Reference PICC

Place the PICC paired with a reference PICC-S/M/L for power transmit testing on the Test PCD and send a REQA or REQB from the Test PCD. Verify the modulated signal received from the PICC using an oscilloscope connected to a calibration coil.

(2) Measurements

Measure the amplitude values of the upper and lower band frequencies of (fc + fS) and (fc - fS) of the response signal generated by the PICC.

Considerations:

Keep in mind that characteristics will change depending on the order within the combination of the PICC under test and the reference PICC.

Operation Diversification Specifications (Informative):

Functional test of a PICC for appressed operations is performed by verifying whether the PICC satisfies the rules while using a Test PCD-S.

(1) Test Method

Place the PICC in the Test PCD-S and send a REQA or REQB from the Test PCD-S. Verify the modulated signal received from the PICC using an oscilloscope connected to a calibration coil. Perform tests using a single PICC and using paired PICCs. When performing tests using paired PICCs, test with the combination of two PICCs under test as well as the combination of a PICC under test and a reference PICC-S/M/L.

(2) Measurements

Check the receipt of modulation signal from the PICC when the PICC 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 PICC within the operating range of the test PCD-S.

Considerations:

Keep in mind that characteristics will change depending on the order within the combination of the PICC under test and the reference PICC.

9.3.2 Reception Test

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

Explanatory Notes:

The method for measuring reception characteristics was added by **ISO/IEC 10373-6/AM2**. The changes are summarized below.

Specify multiple test conditions within the range of the modulation waveform stipulated in **ISO/IEC 14443-2 (JIS X 6322-2)**. Then, verify responses to REQA/REQB for each condition.

Compatibility Improvement Specifications:

(1) Test Method

Adjust the modulation waveform from the Test PCD to satisfy the conditions specified in **Table 9.4** and **9.5**.

Verify the response from the PICC according to the test method stipulated in **ISO/IEC 10373-6 (JIS X 6305-6)**.

Table 9.4 – 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 9.5 – 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 PICC.

9.3.3 Resonance Frequency

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

Explanatory Notes:

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

The resonance frequency of a PICC is measured using an impedance analyzer connected to a calibration coil, or an LCR-meter. The coil of the PICC shall as close as possible to the calibration coil with their center axis being concentric. The resonance frequency is the frequency where the resistant component of the impedance is at its maximum.

Compatibility Improvement Specifications:

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

Operation Diversification Specifications (Informative):

Results shall satisfy the Operation Diversification 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 PICC under test does not have any anomaly after applying maximum field strength on the PICC.

Compatibility Improvement Specifications:

(1) Test procedure

Place a PICC 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 PICC.

(2) Rule

PICC must function normally after applying magnetic field

Operation Diversification Specifications:

These test items only apply to PICCs premised on double card operation.

(1) Test procedure

a) Case of pairing two PICCs

Place the paired PICCs 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 PICCs.

b) Case of Pairing a PICC with a Reference PICC

Place the PICC under test paired with a reference PICC-S/M/L 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 PICCs.

(2) Rule

PICC must function normally after applying magnetic field

Considerations:

Keep in mind that characteristics will change depending on the order within the combination of the PICC under test and the reference PICC.

9.3.5 Power Transmit Interference Test for Double Card Operations

Operation Diversification Specifications:

These test items only apply to PICCs premised on double card operation. The tests measure the effect of the PICC on the Reference PICC -S/M/L.

(1) Test Method

Connect jumper J1 to resistor R3 of the power transmission testing reference PICC, then pair the same type of power transmission testing reference PICC and place them on the DUT position of the test PCD, and adjust the output of the test PCD so that the voltage at both ends of R3 of the power transmission testing reference PICC is 6,8 V.

Next, pair a PICC with a single power transmission testing reference PICC and place them on the DUT position of the test PCD, and measure power received by the power transmission testing reference PICC.

(2) Rule

The received voltage of the reference PICC-S/M/L shall be 6,8 V or more.

9.3.6 PICC Dynamic Test (Informative)

This test is for PICCs used in systems utilizing Open type PCDs.

The test measures whether the PICC is activated successfully depending on the change in field strength received by the PICC when the PICC is dynamically approaching the communicating range of the PCD.

Operation Diversification Specifications (Informative):

(1) Test Method

Based on the test method specified in "9.3.1 Load Modulation Amplitude Test," the PICC shall maintain a parallel position with regard to the test PCD antenna while dynamically approaching the test PCD antenna, and after 5 ms has passed since receiving the minimum operating field, the PICC shall receive REQA or REQB generated by the test PCD as specified in "7.1 Polling" from the test PCD antenna. After that, connect the output of the test PCD to an oscilloscope to verify the load modulation signal emitted by the PICC.

Note that the approaching speed of the PICC depends on the usage and operation of each system. As such, the speed shall be determined depending on the individual systems.

(2) Rule

A response shall be emitted from the PICC.

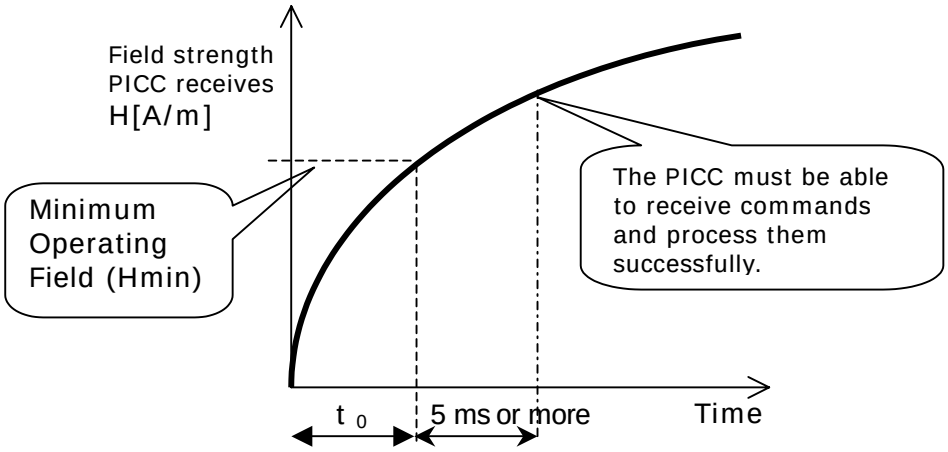


Figure 9.1 – Verification on PICC Activation

Considerations:

– Case using Open type PCDs

(PCD and upper system)

Considering performing communication while moving the PICC within the polling field, the behavior f the PICC may become unstable when the PICC is approaching the PCD and the operating field is below minimum, or when after entering the stipulated field, the operating field becomes lower than the stipulated strength due to the PICC moving away. Thus, anticipating situations where the PICC does not respond during communication, it is desirable to prepare a mechanism that will reset the PICC by switching the carrier OFF and ON at the system side including the PCD and then retry communicating.

(PICC)

The PICC shall operate successfully within the range of Hmin and Hmax

9.3.7 Protocol Timing Characteristics (Informative)

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

(1) Test Method

Refer to ISO/IEC 10373-6:2001/FPADM1 and measure each protocol timing specified in **Table 9.6** and **9.7**.

(2) Rule

The measurements of each protocol timing shall satisfy the values specified in **Table 9.6** and **9.7**.

Table 9.6 – Excerpt from

< ISO/IEC 10373-6:2001/FPDAM1. Table G.4 – Type A Specific Timing Table>

No	Name	ISO Reference (ISO/IEC14443-3:2001)	Required Test Value	Measured Value(s)
1	Frame delay time PCD to PICC (for REQA,WUPA, ANTICOLLISION,SELECT commands)	Clause 6.1.2	Last bit (1)b-> 1 236/*fc* Last bit (0)b-> 1 172/*fc*	
2	Frame delay time PCD to PICC (for all commands, exclude ones from previous row)	Clause 6.1.2	Last bit (1)b -> (n × 128 + 84) / fc Last bit (0)b -> (n × 128 + 20) / fc	
3	Request Guard Time	Clause 6.1.4	Min. 7 000/*fc*	
4	Deactivation frame waiting time	Clause 8.1	See Table G. 5 No.12 (same values)	

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

Table 9.7 – Excerpt from

<ISO/IEC 10373-6:2001/FPDAM1. Table G0.5 – Type A Specific Timing Table>

No	Name	ISO Reference (ISO/IEC14443-3:2001)	Std Min	Std Max	Measured Value(s)
1	SOF low	Clause 7.1.4	10 etu (~ 94,40 µs)	11 etu (~103,83 µs)	
2	SOF high	Clause 7.1.4	2 etu (~ 18,88 µs)	3 etu (~28,32 µs)	
3	EOF low	Clause 7.1.5	10 etu (~ 94,40 µs)	11 etu (~103,38 µs)	
4	Bit boundaries	Clause 7.1.1	(n -1/8) etu	(n + 1/8) etu	
5	Bit rate		fc/128 (~106 kbit/s)		
6	EGT PICC to PCD	Clause 7.1.2	0 µs	19 µs	
7	TR0 for ATQB	Clause 7.1.6	64/fs (~ 75,52 µs)	256/fs (~302,06 µs)	
8	TR1 for ATQB	Clause 7.1.6	80/fs (~ 94,40 µs)	200/fs (~235,99 µs)	
9	TR0 Not ATQB	Clause 7.1.6 Clause 7.10.3	64/fs (~ 75,52 µs) or May be Reduced	(256/fs) × 2FWI - TR1 (~302,06 × 2FWI) - TR1 µs	FWI = Max TR0 =
10	TR1 Not ATQB	Clause 7.1.6 Clause 7.10.3	80/fs (~ 94,40 µs) or May be Reduced	200/fs (~235,99 µs)	
11	Delay from the end of EOF and Subcarrier off	Clause 7.1.7	0 µs	2 etu	
12	Deactivation frame waiting time	Clause 8.1	64/fs + 80/fs (~ 169,92 µs)	65 536/fs (~4,8 ms)	

NOTE All timing values are calculated for carrier frequency *fc* equal 13,56 MHz and bit rate equal *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 (JIS X 6305-6)**.

Compatibility Improvement Specifications:

(1) Test Method

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 (JIS X 6305-6)**, and minimum field strength (Hmin) shall be equal to the value stipulated in "**5.2.4 Generated Magnetic Field**."

(2) Rule

a) Maximum generated field

Receive voltage of 3 V or less within the operating range of the PCD.

b) Minimum generated field

Receive voltage of 3 V or more within the operating range of the PCD.

9.4.2 Power Transfer Test

Shall comply with the "**Power transfer PCD to PIC**" of **ISO/IEC 10373-6 (JIS X 6305-6)**.

Compatibility Improvement Specifications (Informative):

(1) Test Method

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 PIC**" of **ISO/IEC 10373-6 (JIS X 6305-6)**.

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 or more

Operation Diversification Specifications (Informative):

These test items only apply to PCDs premised on double card operation.

(1) Test Method

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 PIC**" of **ISO/IEC 10373-6 (JIS X 6305-6)**.

Connect jumper to resistor R3 of the reference PICC-S/M/L and tune the resonance frequency to 19 MHz. (Tuning shall be done against the two reference PICCs used in the test) Place the paired reference PICCs in the operating range of the PCD and measure the voltage generated at both ends of R3 with a high input impedance voltmeter. Check for all combinations of reference PICCs.

(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 or more

9.4.3 Modulation Waveform

Shall comply with the "**Modulation index and waveform**" of **ISO/IEC 10373-6 (JIS X 6305-6)**.

Compatibility Improvement Specifications:

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

(1) Test Method

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.

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

ii) 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 (JIS X 6322-2)**.

Operation Diversification Specifications:

These test items only apply to PCDs premised on double card operation.

Using all combinations of Reference PICC -S/M/L for modulation waveform tests, measure the modulation waveform by placing the paired PICCs in position.

(1) Test Method

i) Adjust the reference PICC so as to synchronize at 19 MHz. (Adjust for the two reference PICCs used in testing.)

ii) Place the paired reference PICCs so that one is on the other, and measure the modulation waveform from 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 (JIS X 6322-2)**.

9.4.4 Reception Ability of Load Modulation Signal (Informative)

Shall comply with the "**Load modulation reception (informative only)**" of **ISO/IEC 10373-6 (JIS X 6305-6)**.

Compatibility Improvement Specifications:

(1) Test Method

Using the Reference PICC -S/M/L for power modulation tests, measure the voltage.

Other test procedure shall be the same as the procedure stipulated in "**Load modulation reception (informative only)**" of **ISO/IEC 10373-6 (JIS X 6305-6)**.

(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 able to receive the load modulation signal stipulated in "**Load modulation**" of **ISO/IEC 14443-2 (JIS X 6322-2)**.

9.4.5 Temperature Rise Test (Informative)

This test only applies to Insertion type PCDs.

Verify that the temperature surrounding the PICC inserted into the Insertion type PCD does not exceed the guaranteed maximum operating temperature of the PICC.

(1) Test parameters

On performing this test, the parameters below shall be determined according to the actual use environment.

a) Surrounding temperature of the PCD

b) Interval between PCD carrier ON to the moment the temperature within the PCD is measured

(2) Test Method

The test shall be conducted as follows.

a) Turn ON the PCD and wait 30 minutes in a carrier OFF state.

b) Insert the dummy PICC into the PICC and switch the carrier state to ON.

c) After the specified time has passed, measure the surrounding temperature of the dummy PICC within the PCD.

Explanatory Notes:

– The dummy PICC shall be the same shape as the actual PICC to be used and shall not emit heat.

(Usually, a plastic card, etc. without an embedded IC chip is used.)

– Temperature measurement devices are not specifically stipulated.

(3) Rule

The surrounding temperature of the dummy PICC shall be 50°C or lower.

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 (JIS X 6305-6)**.

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 (JIS X 6305-6)**.

Explanatory Notes:

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

Major changes are the following.

– Changed resistance value in **Figure 9.2**.

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

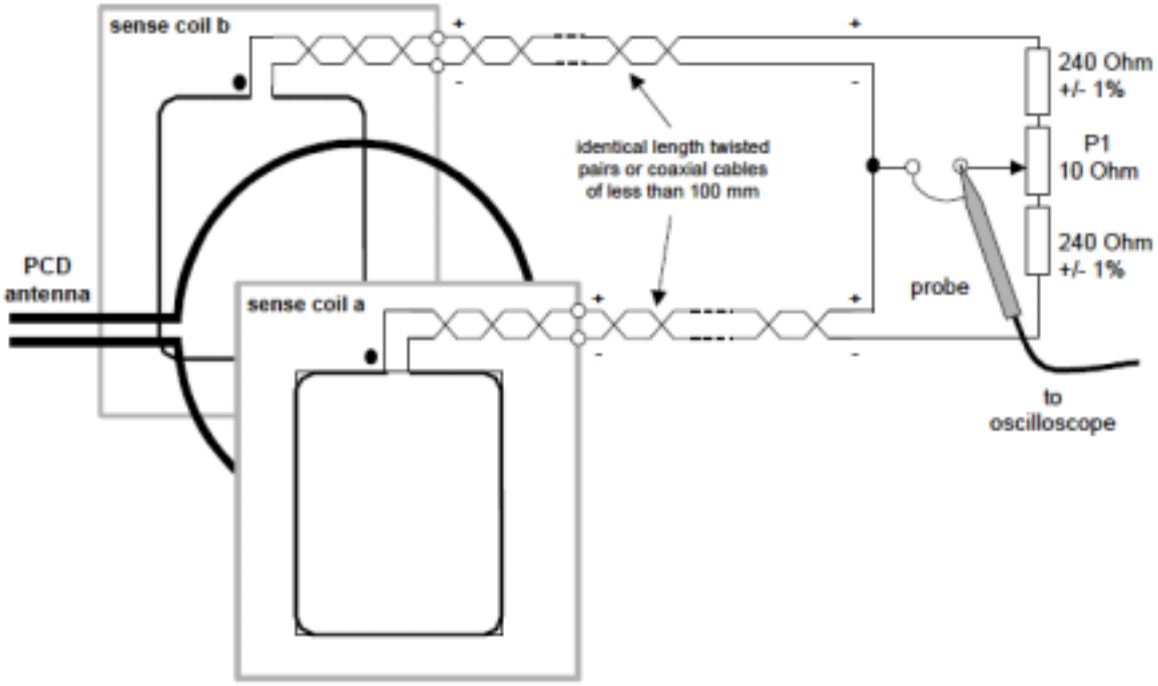


Figure 9.2 – Initial Settings of Test PCD

9.5.2.2 Settings of Test PCD

Shall compy with Annex of **ISO/IEC 10373-6** and **ISO/IEC 10373-6/AM2 (JIS X 6305-6)**.

9.5.3 Test PCD-S

9.5.3.1 Assembly of Test PCD-S

Table 9.8 shows the antenna specifications of the PCD-S.

Table 9.8 – 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 9.3 shows the Test PCD-S circuit and **Figure 9.4** 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 9.4**.

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.

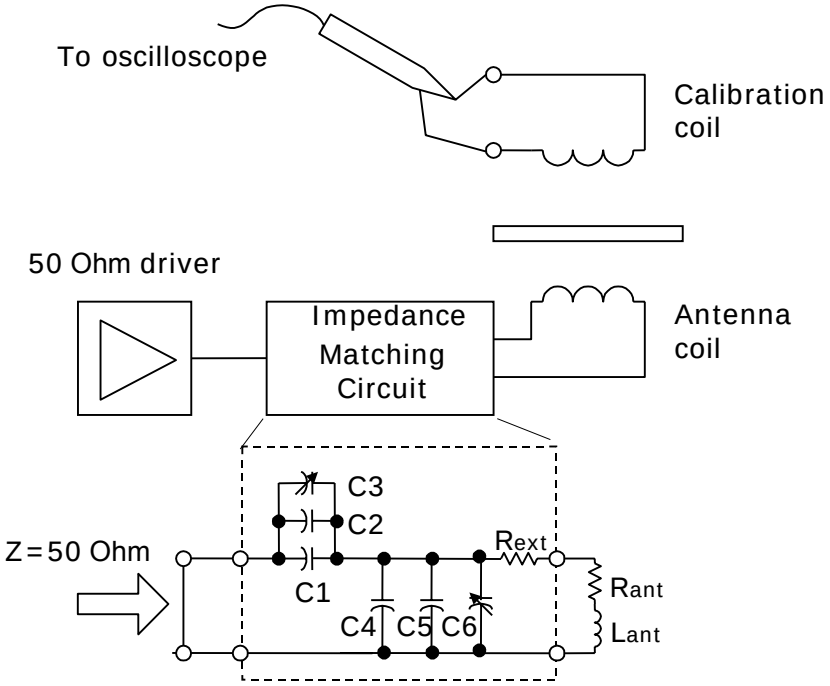


Figure 9.3 – Test PCD-S Circuit

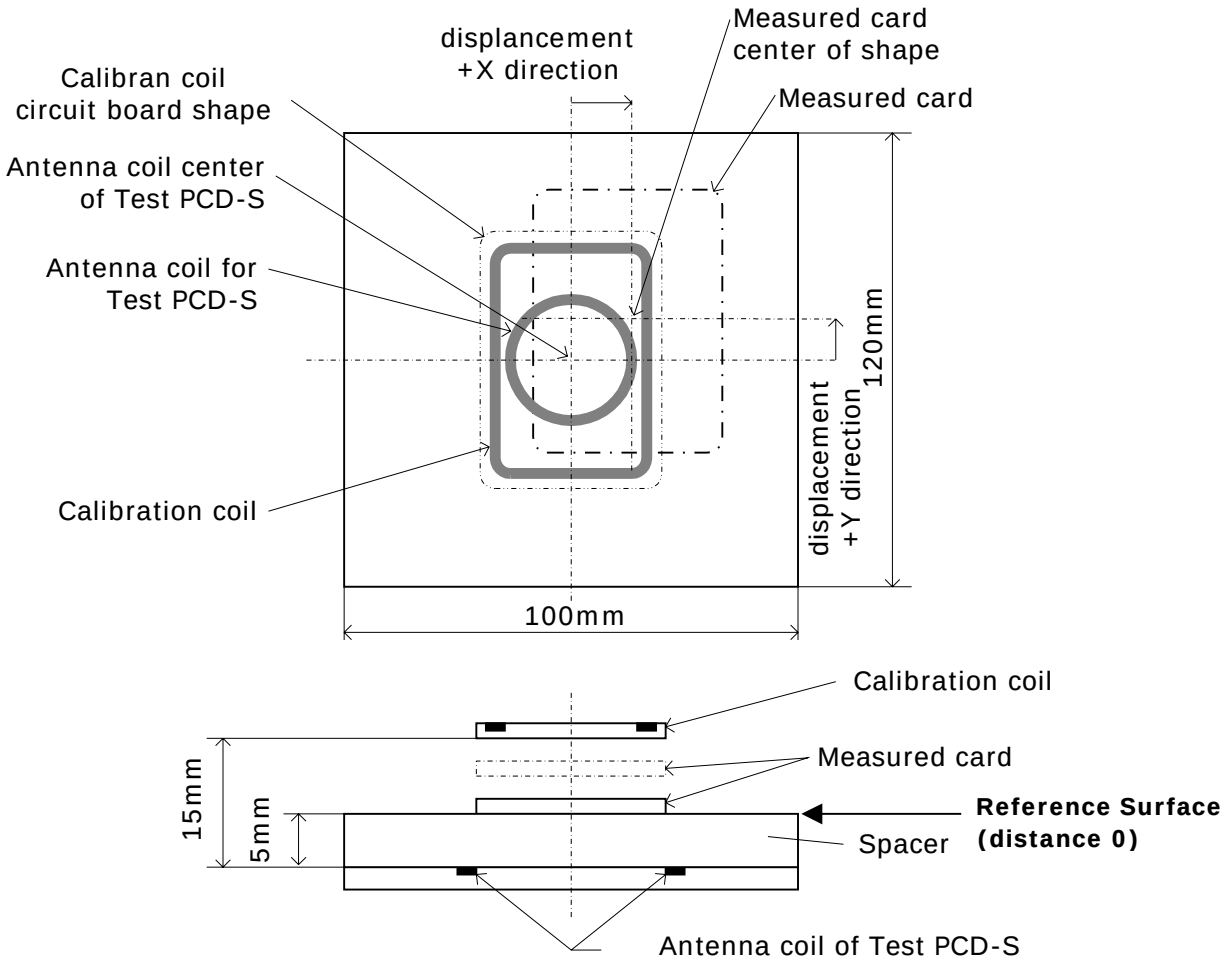


Figure 9.4 – Test PCD-S Structure

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 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.

(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 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.

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 (JIS X 6305-6)** 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 9.9 shows the size and other charecteristics of the reference PICC-S/M/L.

Table 9.9 – 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 the reference PICC of the Standard Specification.

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 9.5 shows the circuit, and **Table 9.10** shows the components of the reference PICC-S/M/L for power transfer tests.

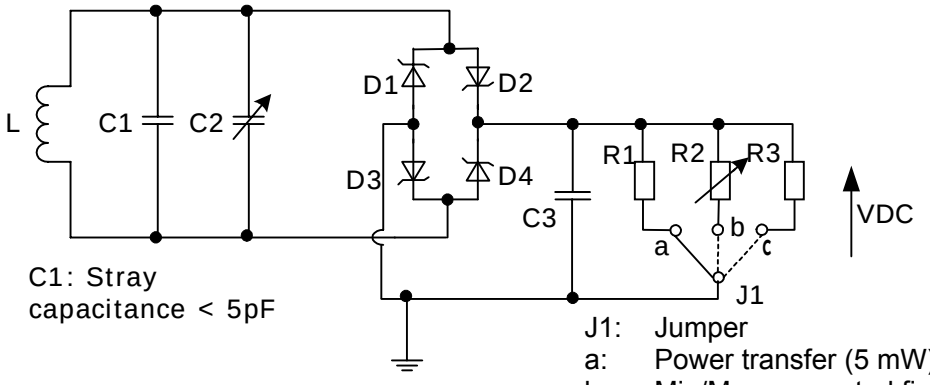


Figure 9.5 – Circuit of Reference PICC-S/M/L for Power Transfer Tests

Table 9.10 – Components

Component	Value	Comparison with Standard Specification
L (coil)	See **Table 9.9**	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 9.11** (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 9.11 – Basic Characteristics of Diode D1, D2,D3, and D4

Subject Area	Test condition (Tj = 25°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.

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.

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 9.6 shows the circuit, and **Table 9.12** shows the components of the reference PICC-S/M/L for modulation waveform tests.

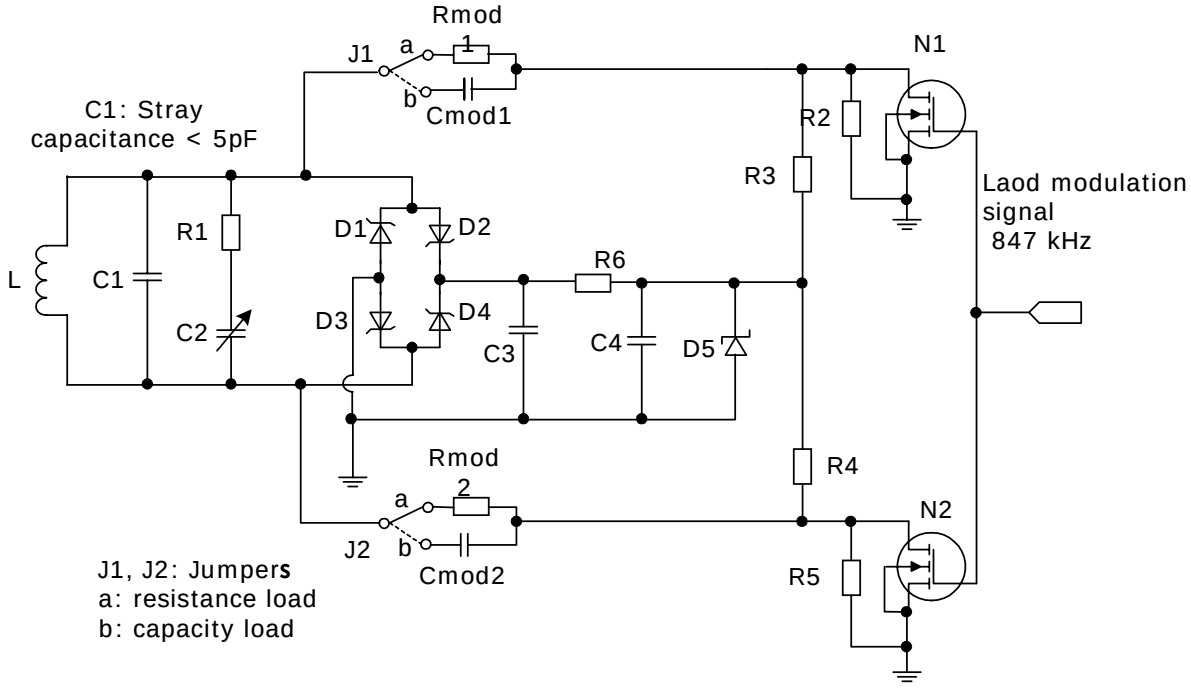


Figure 9.6 – Circuit of Reference PICC-S/M/L for Load Modulation Tests

Table 9.12 – 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 9.11** (BAR43 or equivalent)	
L	See **Table 9.9**	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 (JIS X 6322-6)**.

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 9.7 shows the circuit, and **Table 9.13** shows the components of the reference PICC-S/M/L for modulation waveform tests.

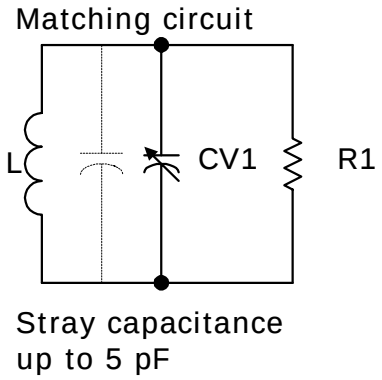


Figure 9.7 – Circuit of Reference PICC-S/M/L for Modulation Waveform Tests

Table 9.13 – Components

Component	Value	Comparison with Standard Specification
L (coil)	See **Table 9.9**	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.

10 External Communication Protocol (Informative)

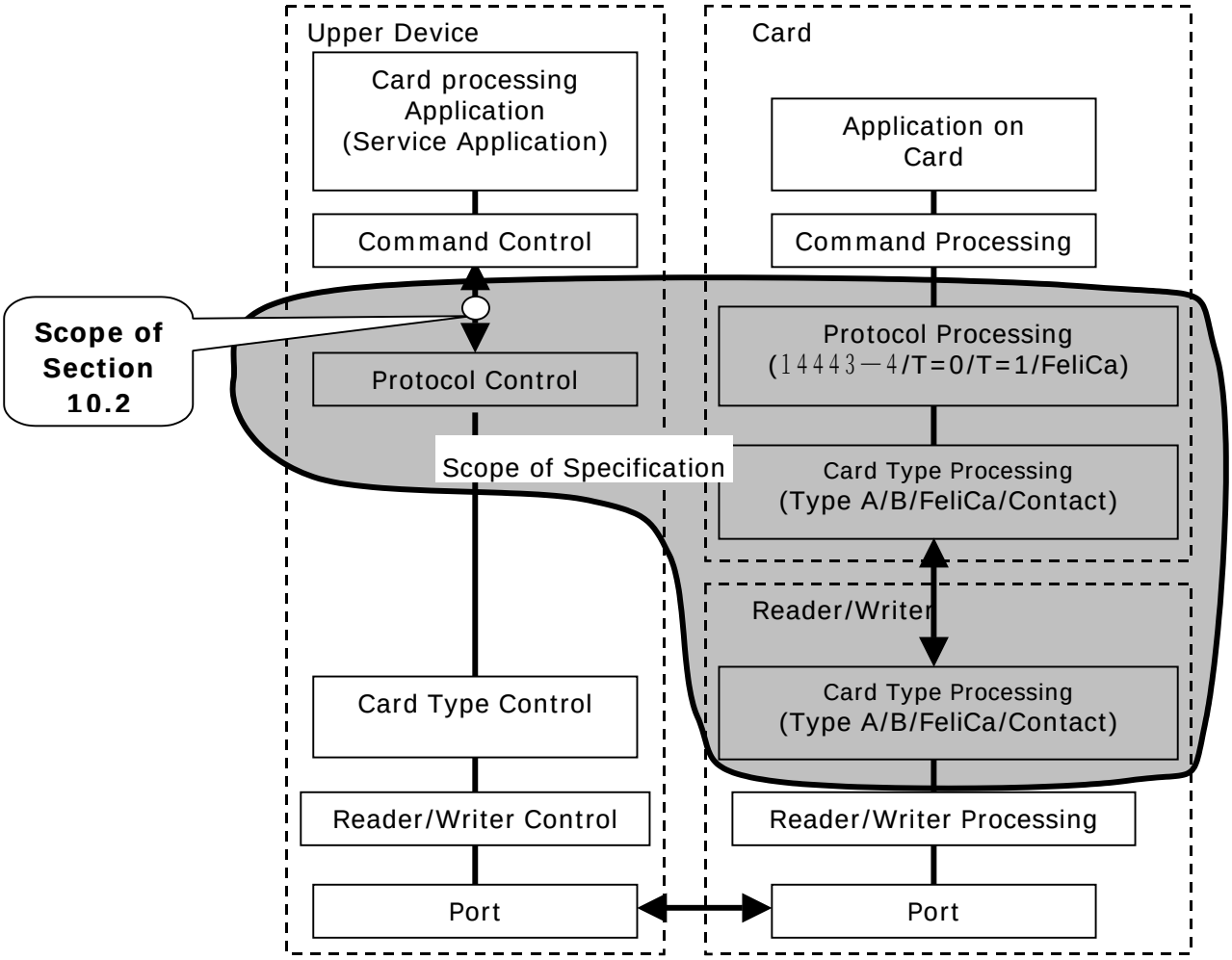
10.1 Scope

Section 10.2 of this chapter "10 External Communication Protocol," stipulates API functions required to implement the proximity communication interface for the communication protocol between the reader/writer device and external device (upper device). Also Section 10.3 describes command based communication sequences between the upper device and the reader/writer device and card.

The scope of the provisions in this chapter includes contact-type cards reader/writer devices. Thus, in order not to limit the provisions to contactless-type cards, the terms "card" and "reader/writer device" shall be used.

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.

Figure 10.1 shows the scope of the specification described in Section 10.2.



Note: FeliCa is a technology method for contactless IC cards developed by Sony Corporation, and is a registered trademark of Sony Corporation.

Figure 10.1 – Scope of the Interface Specification of the Reader/Writer Device Control API

10.2 Interface Specification of the Reader/Writer Device Control API

The descriptions herein stipulate the specification of the reader/writer device common interface (API functions) as seen from the upper device and will not specify interface specifications particular to reader/writer devices.

Note that service applications of upper devices shall use particular interfaces when using reader/writer device specific features.

A summary of the common interface is described below.

10.2.1 Overview of the Common Interface

A summary of the common interface is described below.

(1) Purpose of the Common Interface

To absorb differences in reader/writer devices and to provide common interface functions to service applications.

To simplify procedures for controlling reader/writer devices and card communication.

(2) Form of the Common Interface

Dynamic Link Library (DLL)

(3) Common Interface Driver Name

ITRWDRIVER.DLL

10.2.2 List of Major Interface Functions

Table 10.1 shows a list of major functions supported by the common interface, and **Table 10.2** shows a list of error codes.

Table 10.1 – List of Major Interface Functions

№	Function name	Description
1	RW_Open	Open communication port of reader/writer device.
2	RW_Close	Close communication port of reader/writer device.
3	RW_Insert	Allow insertion of card.
4	RW_Eject	Eject card.
5	RW_Sense	Detect card.
6	RW_Activate	Set card to ACTIVE state.
7	RW_Transmit	Perform data transmission between card.
8	RW_Deactivate	Set card to inactive state.

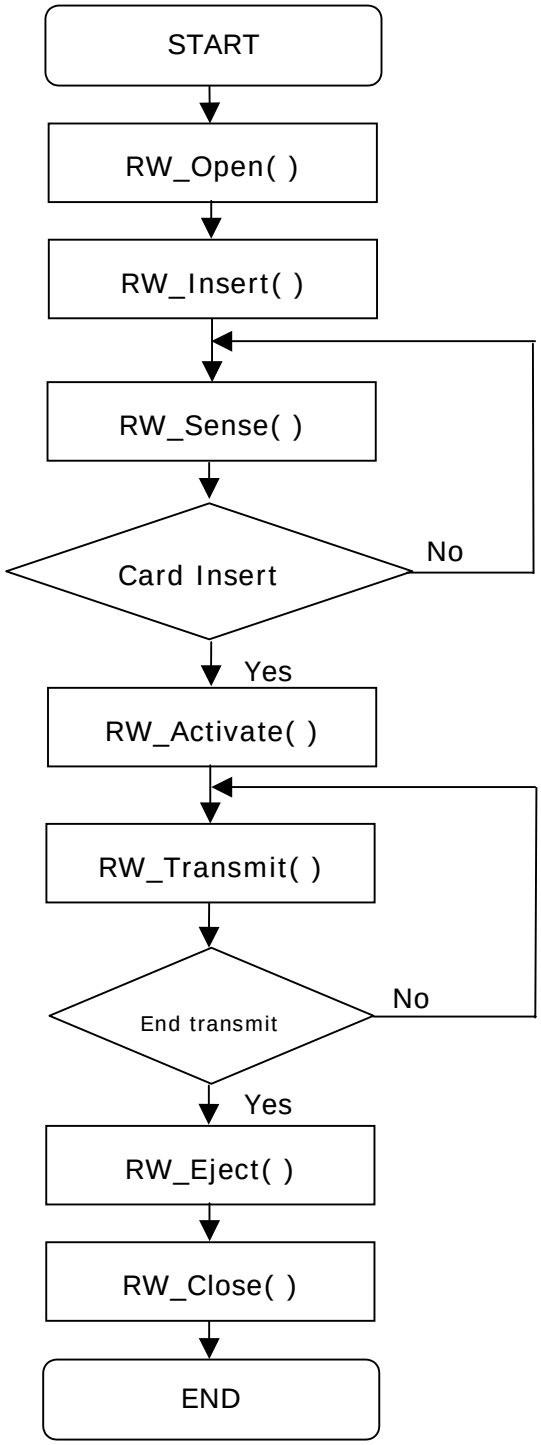
Table 10.2 – Common Error Code List

№	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 reader/writer device.
6	0x0000A102	Error occurred during transmission from reader/writer device.
7	0x0000A201	Error occurred during transmission to card.
8	0x0000A202	Error occurred during transmission from card.
9	0x0000A203	Timeout occurred during transmission from card.
10	0x0000A301	Number error (other than 1 or 2) of specified slot
11	0x0000A302	Specified communication speed not supported by reader/writer.
12	0x0000A303	Specified communication speed not supported by card.
13	0x0000A304	Specified communication speed not supported by reader/writer.
14	0x0000A305	Specified operation mode not supported by reader/writer device.
15	0x0000A306	Cannot initialize card with specified operation mode.
16	0x0000A901	Specified port already open.
17	0x0000A902	Specified port already closed.
18	0x0000A903	INSERT command already received.
19	0x0000AE01	Card not inserted.
20	0x0000AE02	Card not initialized.
21	0x0000AE03	Card is jammed.

NOTE Error codes for reader/writer device specific interface code shall be defined avoiding the range from 0x0000A000 to 0x0000AFFF.

10.2.3 Procedures of Using the Common Interface

Figure 10.2 shows the usage procedure of the common interface functions during basic operations of a card.



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

Figure 10.2 – Usage of Function During Basic Operations

10.2.4 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 reader/writer device to open a connected communication port.
When using a COM port, the communication speed between the upper device (PC) and the card should be set to the maximum communication speed the reader/writer device 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 reader/writer device 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

Allow insertion of card into slot of designated reader/writer device.

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 (1 or 2).

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 reader/writer device.
0x0000A102: Error occurred during transmission from reader/writer device.
0x0000A301: Slot Number (other than 1 or 2) error of specified port.
0x0000A302: Specified slot number not supported.
0x0000A902: INSERT command already executed.

NOTE:

Reader/writer devices that do not support the allow card insertion command shall return a normal termination value if there are no errors in the arguments passed to it.

The allow card insertion state shall be reset by issuing the RW_Eject function.

(4) Function Name: RW_Eject

Description

Allow ejection of card from slot of designated reader/writer device.

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 (1 or 2).

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 reader/writer device.
0x0000A102: Error occurred during transmission from reader/witer device.
0x0000A301: Slot Number (other than 1 or 2) error of specified port.
0x0000A302: Specified slot number not supported.
0x0000AE02: Card is jammed.

NOTE:

For contact-type cards, cards shall be ejected only after inactivating them.

For contactless cards, cards shall be ejected only after turning their carrier OFF.

For manual insertion-type reader/writer devices, perform the above operation to prepare for card extraction.

If there are no errors in the arguments passed, reset the allow card insertion state.

(5) Function Name: RW_Sense

Description

Detects whether a card is inserted in the slot of the reader/writer device and detects the operating status of the card.

Synopsis

DWORD WINAPI RW_Sense(BYTE bPortNumber,BYTE bSlotNumber,LPLONG IccStatus1,
LPLONG IccStatus2)

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 (1 or 2).

IccStatus1: The storage buffer for the insertion state and operating state of card number 1.

IccStatus2: The storage buffer for the insertion state and operating state of card number 2.

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 reader/writer device.
0x0000A102: Error occurred during transmission from reader/writer device.

NOTE:

The insertion state and operating state of card (IccStatus1, IccStatus2 [1)])

******** *******1 ******** ********B: card insertion state: card jammed

******** *******0 ******** ********B: card insertion state: card not jammed

******** ******** 0******* ********B: card insertion state: not inserted

******** ******** 1******* ********B: card insertion state: inserted

******** ******** *000**** ********B: card type: contactless Type B

******** ******** *001**** ********B: card type: contactless Type A

******** ******** *010**** ********B: card type: FeliCa technology method

******** ******** *100**** ********B: card type: Contact type (T=0)

******** ******** *101**** ********B: card type: Contact type (T=1)

******** ******** *111**** ********B: card type: unknown

******** ******** ****0000 ********B: card state: IDLE

******** ******** ****0001 ********B: card state: READY

******** ******** ****0010 ********B: card state: ACTIVE

******** ******** ****1000 ********B: card state: HALT

******** ******** ******** ******00B: Communication speed: reader/writer to card 1× speed (106 kbit/s)

******** ******** ******** ******01B: Communication speed: reader/writer to card 2× speed (212 kbit/s)

******** ******** ******** ******10B: Communication speed: reader/writer to card 4× speed (424 kbit/s)

******** ******** ******** ******11B: Communication speed: reader/writer to card 8× speed (847 kbit/s)

******** ******** ******** ****00**B: Communication speed: card to reader/writer 1× speed (106 kbit/s)

******** ******** ******** ****01**B: Communication speed: card to reader/writer 2× speed (212 kbit/s)

******** ******** ******** ****10**B: Communication speed: card to reader/writer 4× speed (424 kbit/s)

******** ******** ******** ****11**B: Communication speed: card to reader/writer 8× speed (847 kbit/s)

The communication speed of contact-type cards shall be 9 600 bit/s for 1× speed, 19 200 bit/s for 2× speed, 38 400 bit/s for 4× speed, and 76 800 bit/s for 8× speed.

For single card operations, the value of argument IccStatus2 shall be set to 0.

1) Code of IccStatus1 and IccStatus2 may differ depending on the particular reader/writer device.

(6) Function Name: RW_Activate

Description

Initializes the card inserted into the slot of the reader/writer device to the specified operation mode and communication speed, and sets the card 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 (1 or 2).

bCardNumber: Card number (1 or 2).

IccMode: The operation mode to specify.
Contactless Type B (0x00), Contactless Type A (0x01),
Felica technology type (0x02), Contact type (0x10)

IccSpeed: The communication speed between the reader/writer device and card to set.
1× communication speed (0x00), 2× communication speed (0x01), 4× communication speed (0x02), 8× communication speed (0x03).
Autoset communication speed (0x80. Set the communication speed to the maximum speed both reader/writer device and card 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 reader/writer device.
0x0000A102: Error occurred during transmission from reader/writer device.
0x0000A201: Error occurred during transmission to card.
0x0000A202: Error occurred during transmission from card.
0x0000A203: Timeout occurred during transmission from card.
0x0000A301: Slot Number (other than 1 or 2) error of specified port.
0x0000A302: Specified slot number not supported.
0x0000A303: Specified communication speed not supported by card.
0x0000A304: Specified communication speed not supported by reader/writer device.

0x0000A305: Specified operation mode not supported by reader/writer device.
0x0000A306: Cannot initialize card with specified operation mode.
0x0000AE01: Card not inserted.

NOTE:

The initialization of the card 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 card, and set the the operating state of the card to ACTIVE state.

(7) Function Name: RW_Transmit

Description

Process the protocol in accordance with the operating mode of the card inserted in the slot of the specified reader/writer device and transmit to and from the card.

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 (1 or 2).

bCardNumber: card number (1 or 2).

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 reader/writer device.
0x0000A102: Error occurred during transmission from reader/writer device.
0x0000A201: Error occurred during transmission to card.
0x0000A202: Error occurred during transmission from card.
0x0000A203: Timeout occurred during transmission from card.
0x0000A301: Slot Number (other than 1 or 2) error of specified port.

0x0000A302: Specified slot number not supported.
0x0000AE01: Card not inserted.
0x0000AE03: card not in ACTIVE state.

NOTE:

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

(8) Function Name: RW_Deactivate

Description

Deactivate card inserted in the slot of designated reader/writer device.

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 (1 or 2).
bCardNumber: card number (1 or 2).

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 reader/writer device.
0x0000A102: Error occurred during transmission from reader/writer device.
0x0000A301: Slot Number (other than 1 or 2) error of specified port.
0x0000A302: Specified slot number not supported.

NOTE:

The behavior of this API function depends upon the particular reader/writer device.

The reader/writer device may halt transferring power to the card. Thus when operating with two cards in a single slot, caution must be exercised on calling this function.

10.3 Communication Sequence

Command based communication sequences between the upper device and the reader/writer device and card are described herein.

10.3.1 Normal Sequence Examples

Examples of normal communication sequences are shown below.

(1) Reader/Writer Device Initialization

Figure 10.3 shows the sequence from initialization of the reader/writer device to enabling communication with the card.

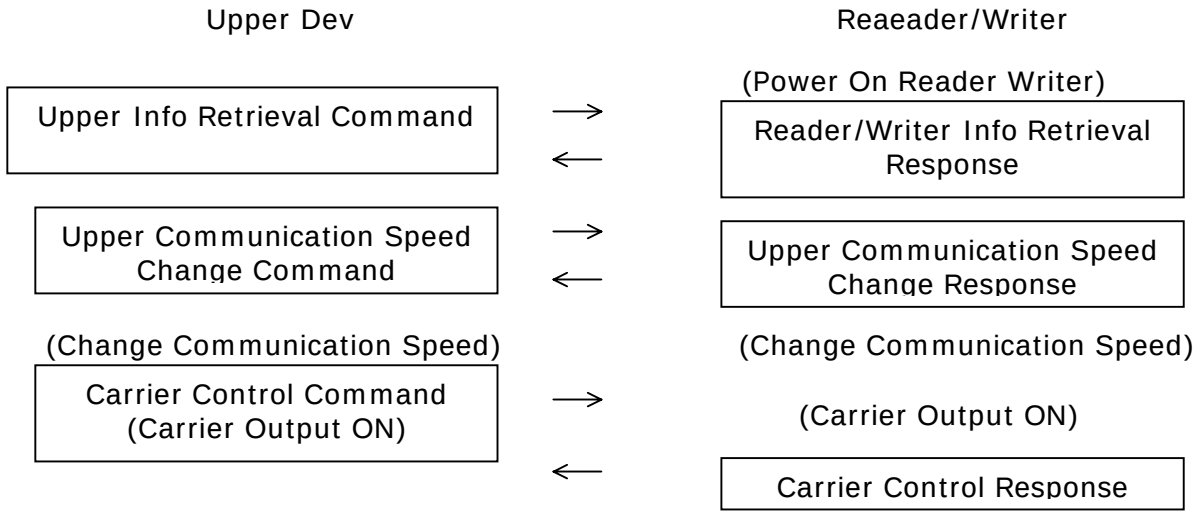
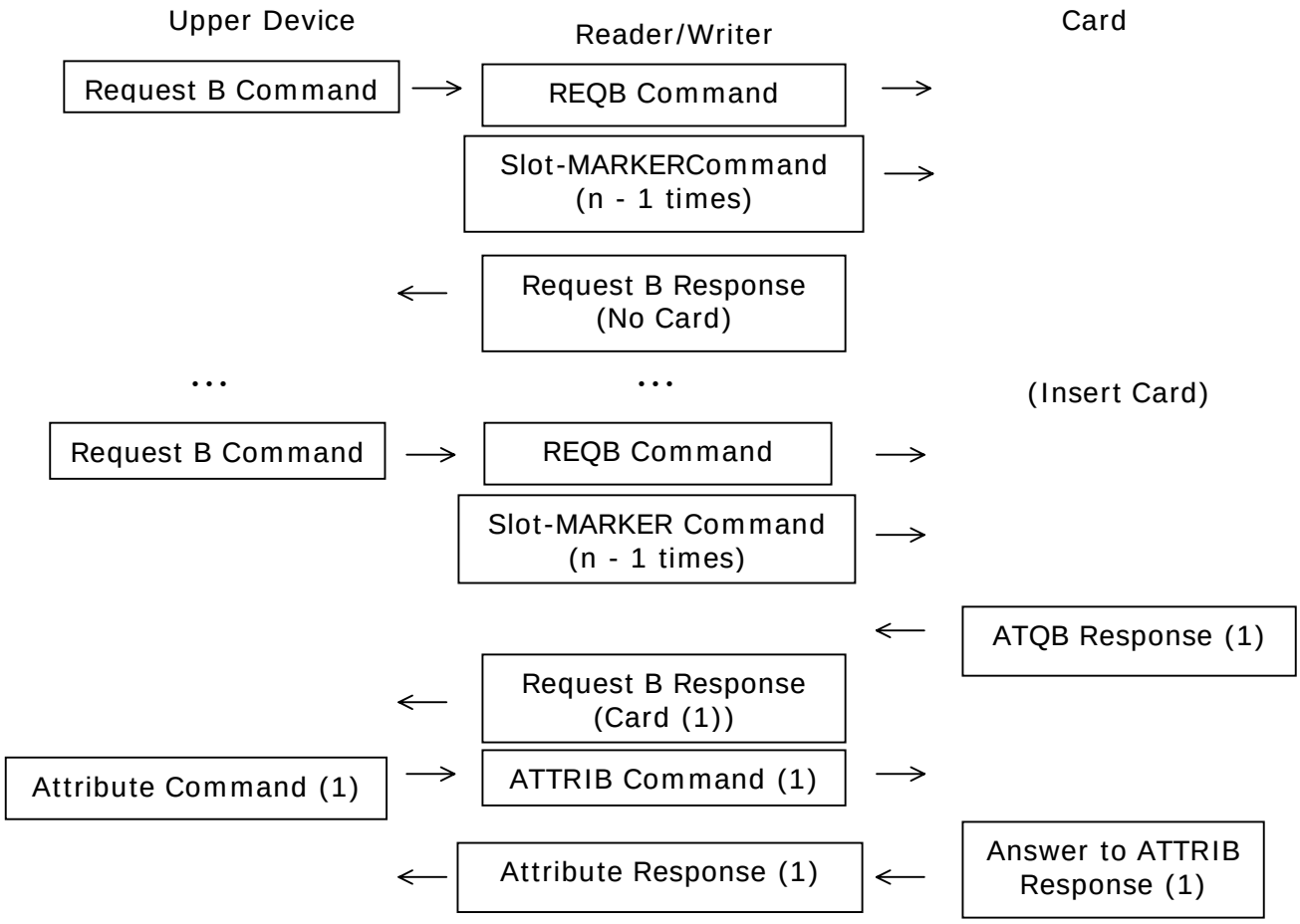


Figure 10.3 – Initialization Sequence

(2) Type B Card Detection (One Card)

Figure 10.4 shows the sequence to detect a card Type B after initialization of the reader/writer device is completed. (Case of single card)

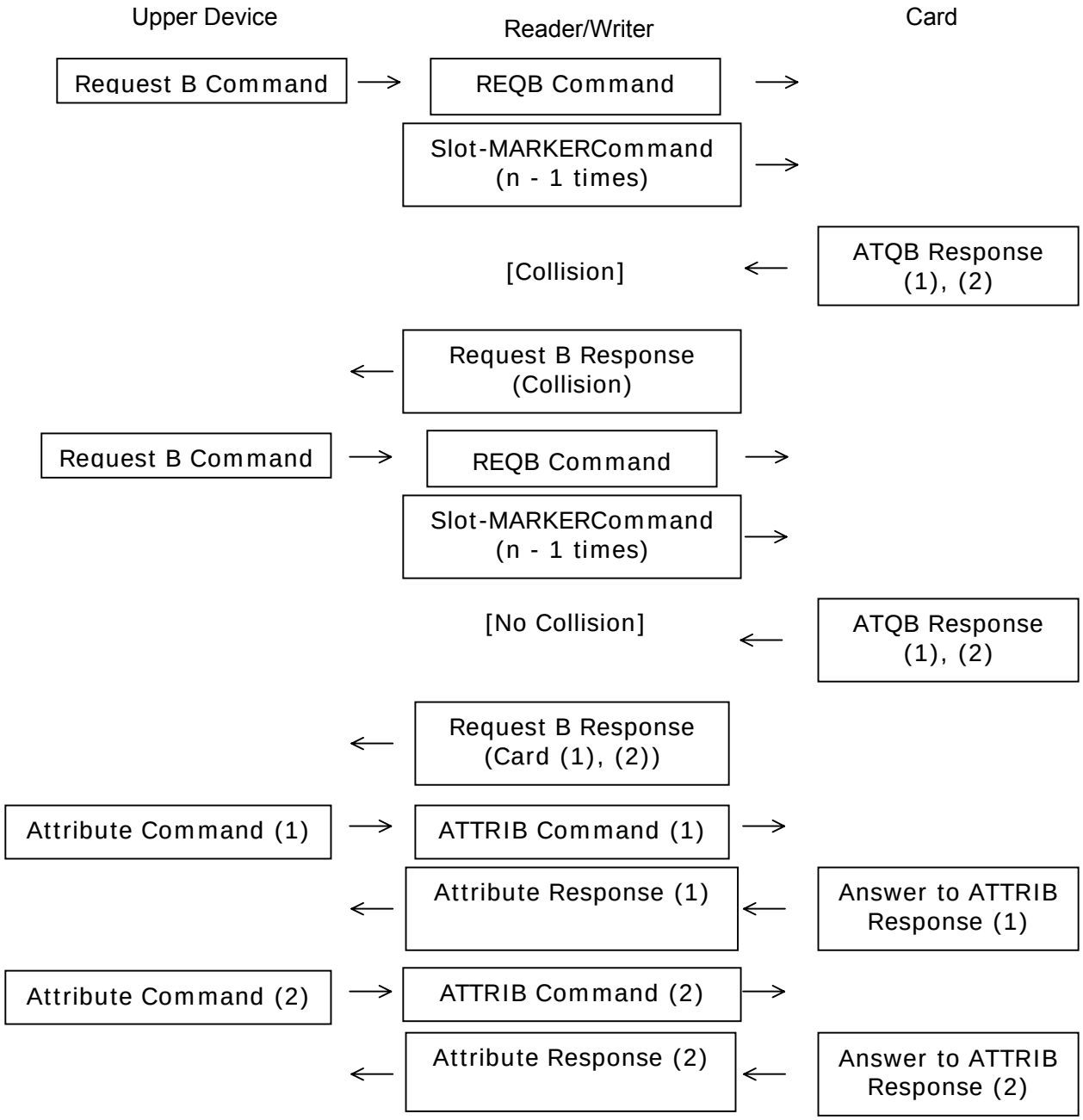


The numbers in parentheses are the number of the card for the sake of convenience, and indicate that the information of the corresponding card is sent.

Figure 10.4 – Card Type B Detection Sequence

(3) Type B Card Detection (Multiple Cards)

Figure 10.5 shows the sequence to detect a card Type B after initialization of the reader/writer device is completed. (Case of two cards)

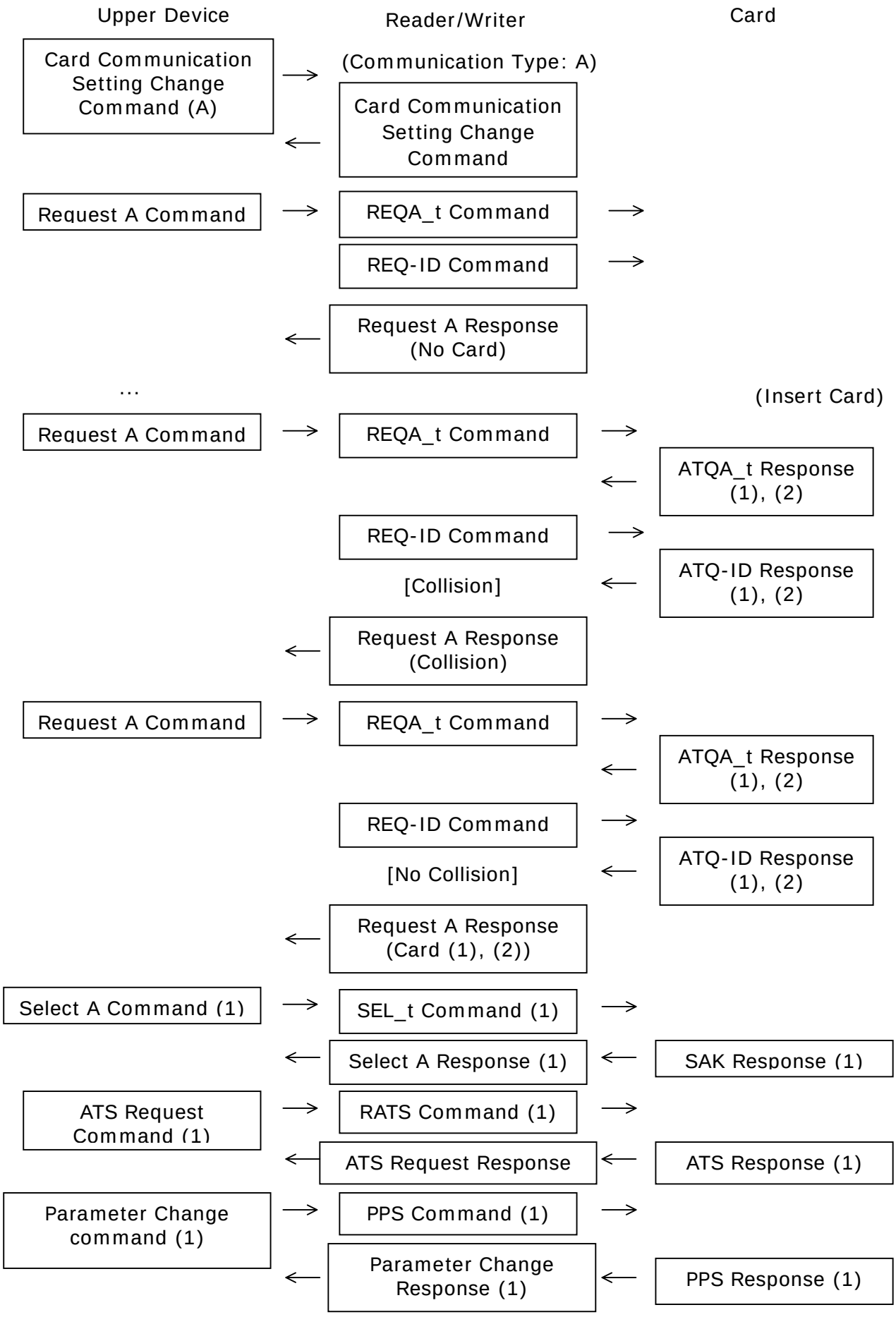


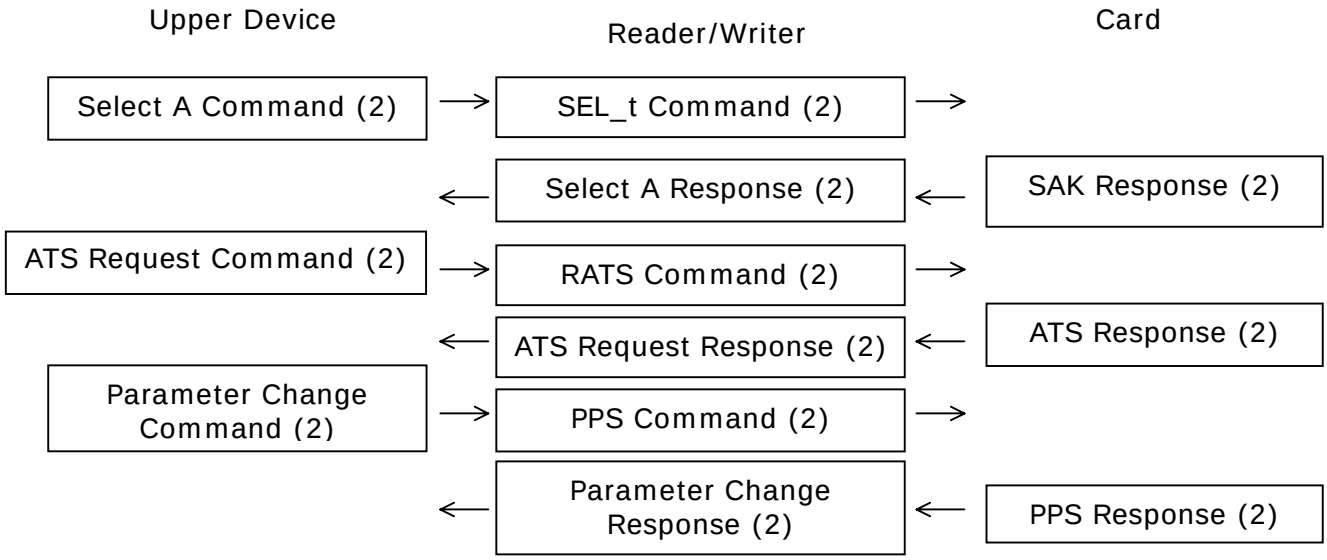
Note: The numbers in parentheses are the number of the card for the sake of convenience, and indicate that the information of the corresponding card is sent.

Figure 10.5 – Card Type B Detection Sequence 2

(4) Type A Card Detection (Multiple Cards)

Figure 10.6 shows the sequence to detect a card Type A after initialization of the reader/writer device is completed. (Case of two cards)


Upper Device
Reader/Writer
Card
Card Communication Setting Change Command (A)
(Communication Type: A)
Card Communication Setting Change Command
Request A Command
REQA_t Command
REQ-ID Command
Request A Response (No Card)
...
(Insert Card)
Request A Command
REQA_t Command
ATQA_t Response (1), (2)
REQ-ID Command
[Collision]
ATQ-ID Response (1), (2)
Request A Response (Collision)
Request A Command
REQA_t Command
ATQA_t Response (1), (2)
REQ-ID Command
[No Collision]
ATQ-ID Response (1), (2)
Request A Response (Card (1), (2))
Select A Command (1)
SEL_t Command (1)
Select A Response (1)
SAK Response (1)
ATS Request Command (1)
RATS Command (1)
ATS Request Response
ATS Response (1)
Parameter Change command (1)
PPS Command (1)
Parameter Change Response (1)
PPS Response (1)



Note: The numbers in parentheses are the number of the card for the sake of convenience, and indicate that the information of the corresponding card is sent.

Figure 10.6 – Card Type A Detection Sequence

(5) 10.3.1.5 Card Deactivation

Figure 10.7 shows the sequence to deactivate a card after detection of the card is completed.

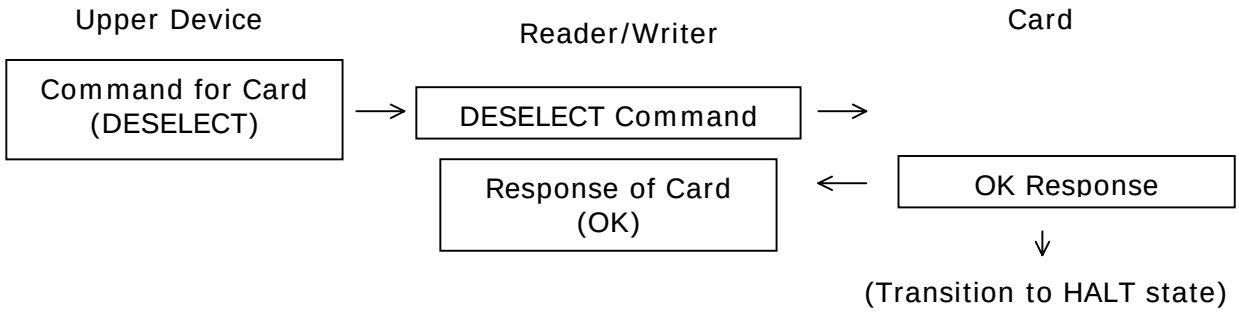


Figure 10.7 – Card Deactivation Sequence

10.3.2 Abnormal Sequence Examples

The following indicates communication sequences on event of an error.

(1) Reader/Writer Device Receive Error

Figure 10.8 show the processing sequence when the reader/writer device has judged that a command received from an upper device was a receive error.

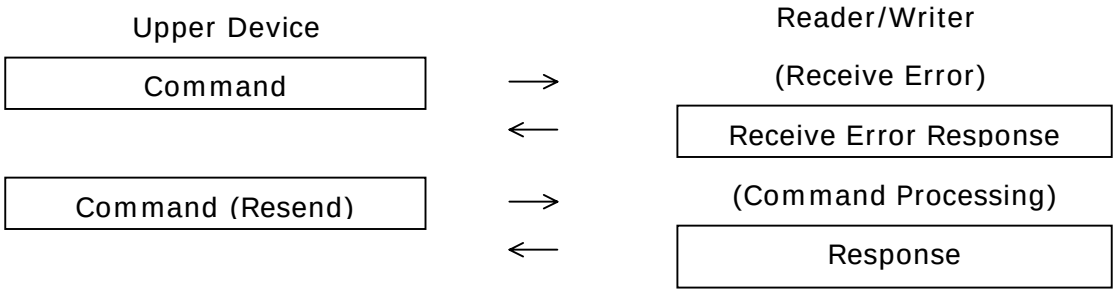


Figure 10.8 – Reader/Writer Device Receive Error Sequence

(2) Upper Device Receive Error

Figure 10.9 show the processing sequence when the upper device has judged that a response received from a reader/writer device was a receive error.

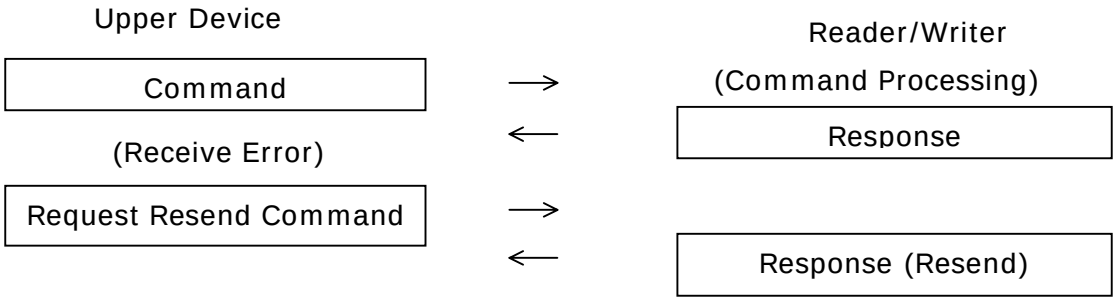


Figure 10.9 – Upper Device Receive Error Sequence

(3) Upper Communication Speed Change Error 1

Figure 10.10 shows the processing sequence when the upper device has judged that a response received from a reader/writer device was a receive error when performing an upper communication speed change command.

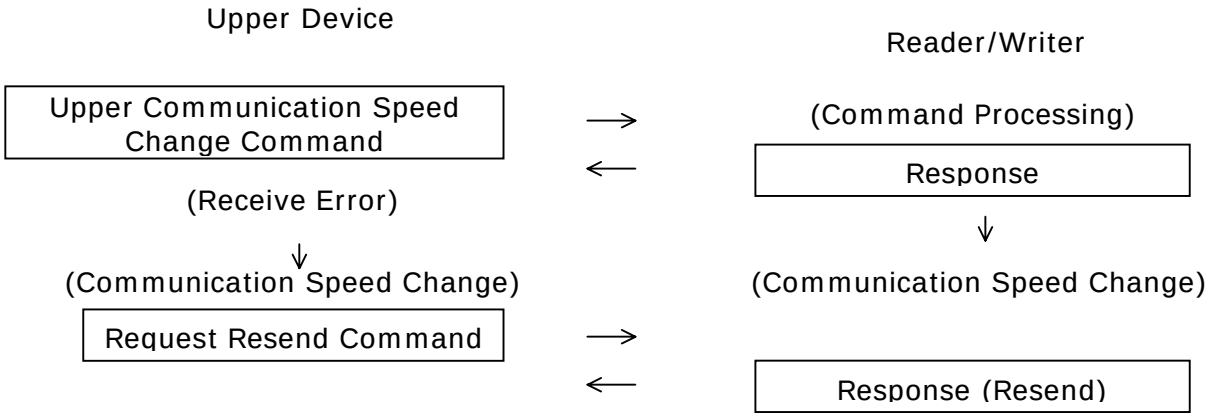


Figure 10.10 – Upper Communication Speed Change Error Sequence 1

If the upper device receives any response, it considers the reader/writer device has performed processing normally and changes the communication speed.

(4) Upper Communication Speed Change Error 2

Figure 10.11 shows the processing sequence when the reader/writer device has judged that a command received from an upper device was a receive error when performing an upper communication speed change command, and the upper device has judged that a response received from the reader/writer device was a receive error.

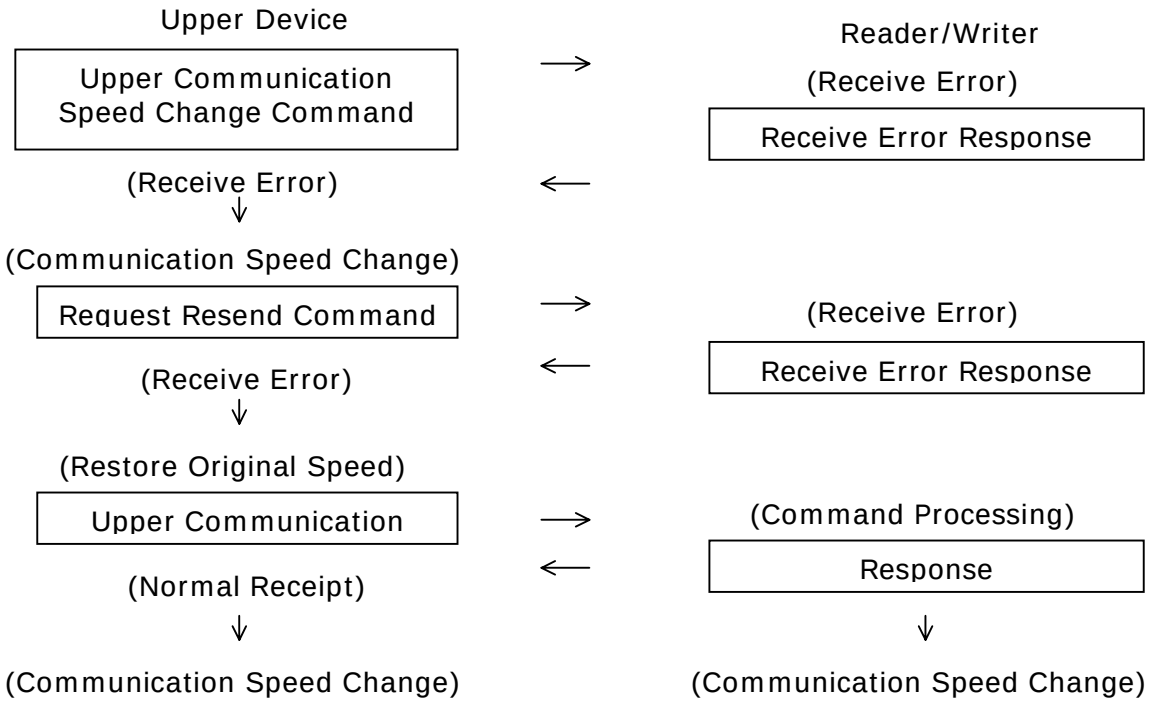


Figure 10.11 – Upper Communication Speed Change Error Sequence 2

If the upper device receives any response, it considers the reader/writer device has performed processing normally and changes the communication speed. If a receive error occurs again when sending a request in response to the resend command, the communication speed returns to its original speed.

(5) Card Communication Error 1

Figure 10.12 show the processing sequence when the reader/writer device has judged that a response received from a card was a receive error when performing a command upon the card.

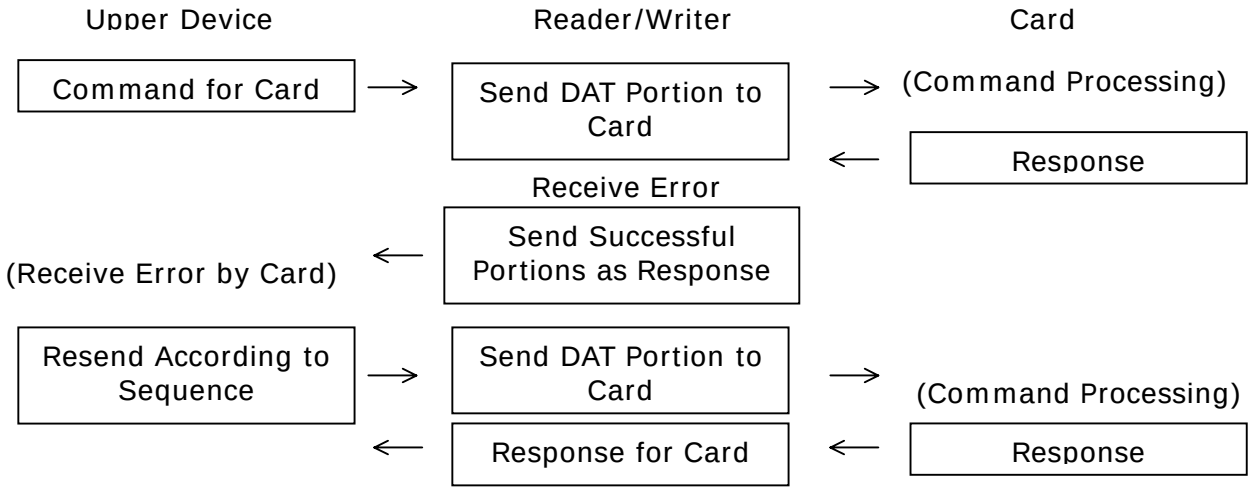


Figure 10.12 – Card Communication Error Sequence 1

If the upper device has judged that there was a receive error from the card, the command is resent according to the transmission sequence of the card.

(6) Card Communication Error 2

Figure 10.13 shows the processing sequence when the reader/writer device has judged that a response from an upper device timed-out (due to a card receive error) when performing a command upon the card.

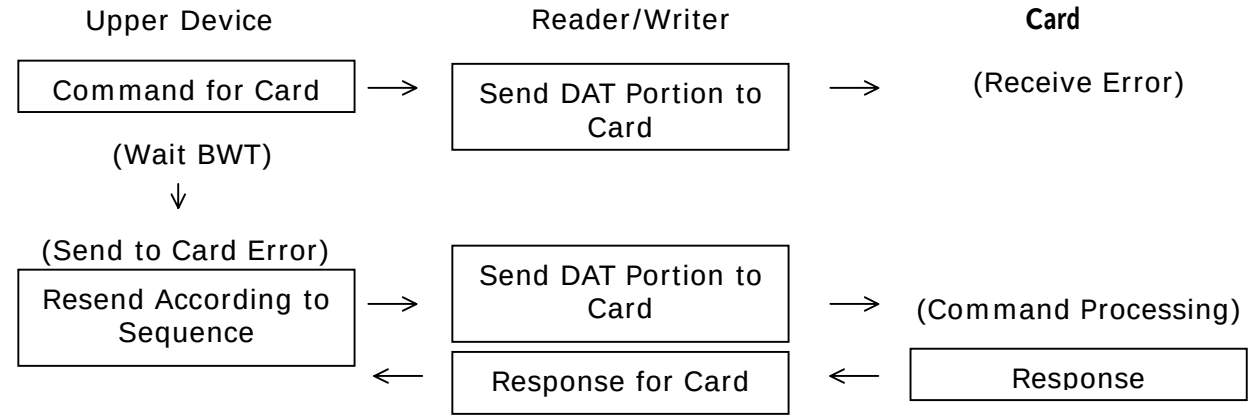


Figure 10.13 – Card Communication Error Sequence 2

If the upper device has judged that there was no response from the card, the command is resent according to the transmission sequence of the card.

(7) Card Communication Error 3

Figure 10.14 shows the processing sequence when the reader/writer device has judged that a response from an upper device timed-out (due to absence of the card) when performing a command upon the card.

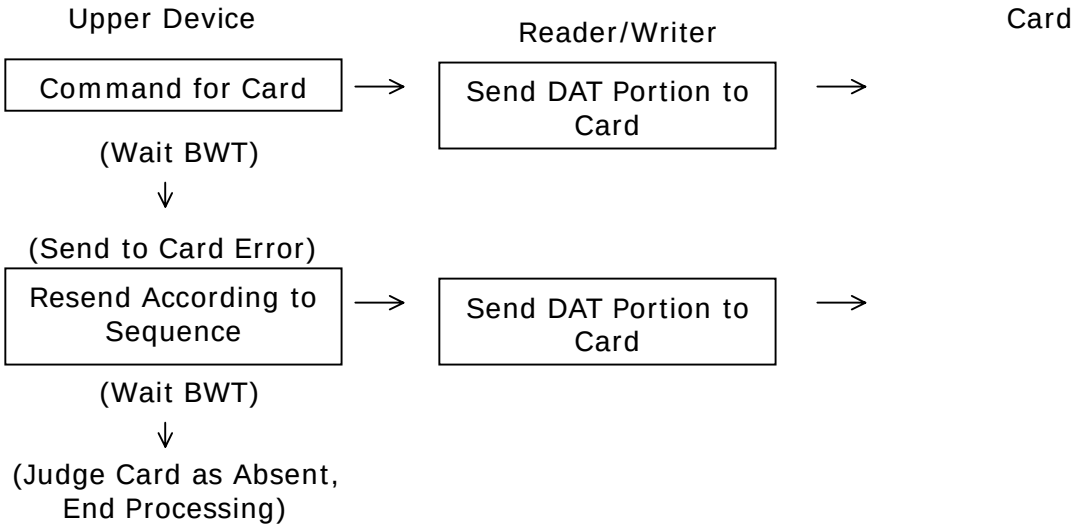


Figure 10.14 – Card Communication Error Sequence 3

If the upper device judges there is no response from the card and there is no response even after resending, according to the transmission sequence of the card, it is judged that the card is absent.

10.3.3 Notes on Communication Sequence

When requesting resend (NAK) or waiting for response from the card, several communication sequences between the upper device (application), reader/writer device and card can be possible. In such case, documentation such as operation manuals accompanying the reader/writer device or reader/writer device driver should specify the communication sequences implemented by the reader/writer device so that users can understand the sequences used.

Examples of how to describe communication sequences are shown below.

(1) Communication Sequence Description Example 1

Figure 10.15 shows an example of a communication sequence of an upper device (application) requesting a resend.

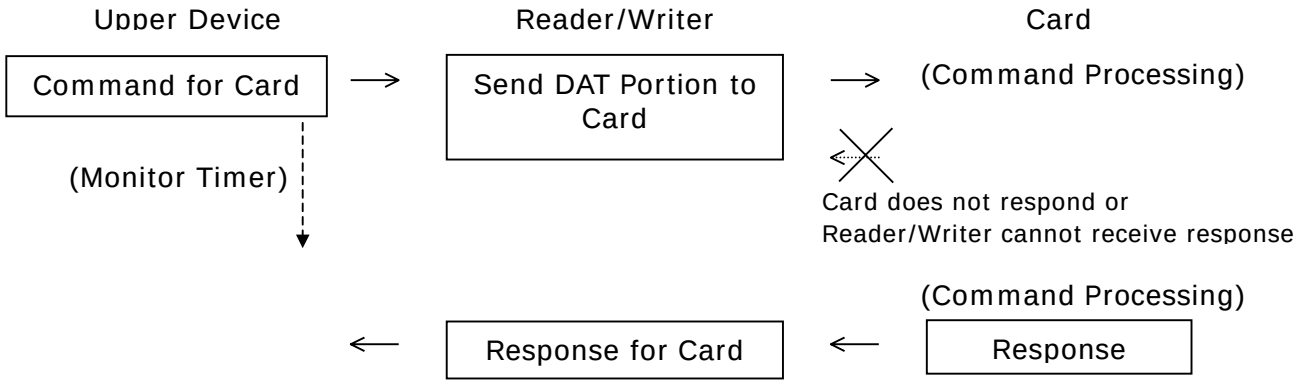


Figure 10.15 – An Example of a Communication Sequence of an Upper Device (Application) Requesting a Resend

(2) Communication Sequence Description Example 2

Figure 10.16 shows an example of a communication sequence of a reader/writer device driver requesting a resend.

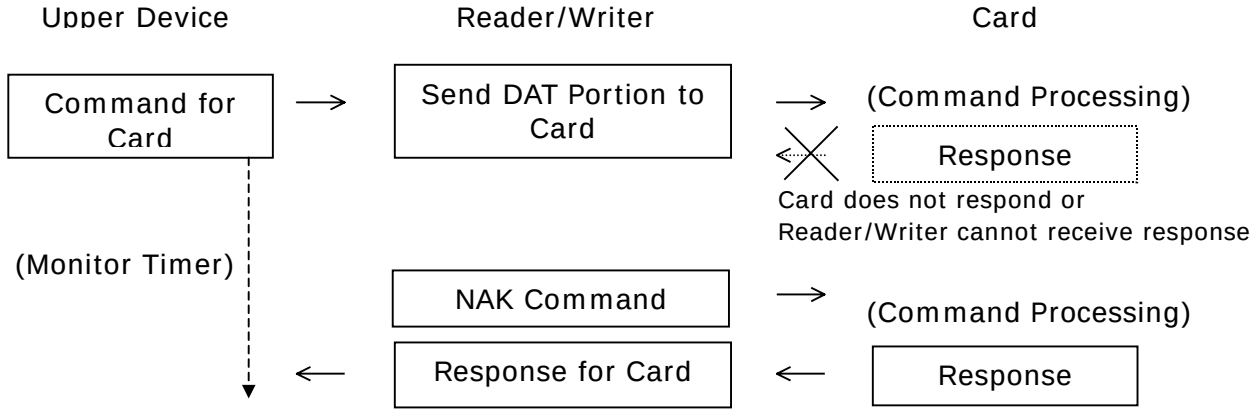


Figure 10.16 – An Example of a Communication Sequence of a Reader/Writer Device Driver Requesting a Resend

11 Cross Tests (Informative)

The operating compatibility PICCs and PCDs shall be verified by performing functional cross tests using PICCs and PCDs that will actually be used with the applied IC card system.

The cross tests described herein are informative since they are not specified in the Standard Specification and will depend on the application using it.

11.1 Common Testing Conditions

11.1.1 Selection of Test Method

The test method shall be selected according to the operation mode (single card operation or double card operation) and the type of PCD (Open type, Insertion type). (See table below.)

Table 11.1 – List of Applied Test Methods

Operating mode	PCD type	Test method to apply
Single Card Operations	Insertion Type	11.2 Compatibility Test of Single Card Operations with Insertion Type PCDs
	Open Type	11.3 Compatibility Test of Single Card Operations with Open Type PCDs
Double Card Operations	Insertion Type	11.4 Compatibility Test for Double Card Operations
	Open Type	

11.1.2 Test Environment

The temperature and humidity of the test environment shall be determined considering the actual operating environment of the applied IC card system.

11.1.3 Pre-test Considerations

The following shall be decided before performing the tests.

– The number of PCDs for each type of PCD and the number of PICCs for each type of PICC

  It is recommended to use multiple PCDs and multiple PICCs.

– The interval between powering on the PCD and beginning the test

  Specify the time required to avoid the instability that may occur immediately after powering on the PCD.

– The types of card commands to use for the tests

  For the purpose of verifying compatibility, tests shall be performed using as many commands as possible.

Commands that entail maximum current and commands that emit strong noise shall be included in the commands selected.

– The number of retries of the ISO/IEC 14443-4 transmission protocol

– Communication speed between the PCD and PICC

– The direction of PICC (especially, for PICCs with no terminals and no printing, determine according to the location of the IC chip, etc.)

– The direction of PCD (for Open type PCDs)

– The test poin on the PCD (for Open type PCDs)

– Other parameters that will affect the tests

11.1.4 Pass-Fail Decisions

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

11.2 Compatibility Test of Single Card Operations with Insertion Type PCDs

11.2.1 List of Tests

Table 11.2 lists the tests to perform.

Table 11.2 – List of Tests

No.	Test name	Test description	Notes
T1	Activation test	After inserting the PICC into a PCD, verify whether the PICC can enter the activated state.	
T2	Command send/receive test	Verify that card commands operate correctly.	

11.2.2 Test Combinations

– Cross tests using all PCD types and all PICC types shall be performed.

– For each PCD, perform the test using each PICC sequentially.

Table 11.3 shows the combinations of the PCD and PICC for each test.

Table 11.3 – Combinations

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

11.2.3 PICC Insertion Direction

Perform insertion tests on PCDs from 4 directions.

– The 4 insertion directions

Forward and backward directions with front surface faced up and the same with back surface faced up.

11.2.4 Test Contents and Pass-Fail Criteria

(1) T1 Tests

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

– For each PICC, perform 10 times for 1 direction totaling 40 times with all 4 directions.

Table 11.4 shows the pass-fail criteria of the tests.

Table 11.4 – T1 Tests Pass-Fail Criteria

Evaluation	Criteria	Notes
Pass	More than 9 out of 10 attempts are successful for all test points of all combinations.	
Fail	All other cases.	

(2) T2 Tests

– Verify that card commands are sent and received correctly.

– For each PICC, perform 10 times for 1 direction totaling 40 times with all 4 directions.

Table 11.5 shows the pass-fail criteria of the tests.

Table 11.5 – T2 Tests Pass-Fail Criteria

Evaluation	Criteria	Notes
Pass	More than 9 out of 10 attempts are successful for all commands of all combinations.	
Fail	All other cases.	

11.2.5 Processing Flow

(1) Basic Processing Flow

Figure 11.1 shows the basic test processing flow.

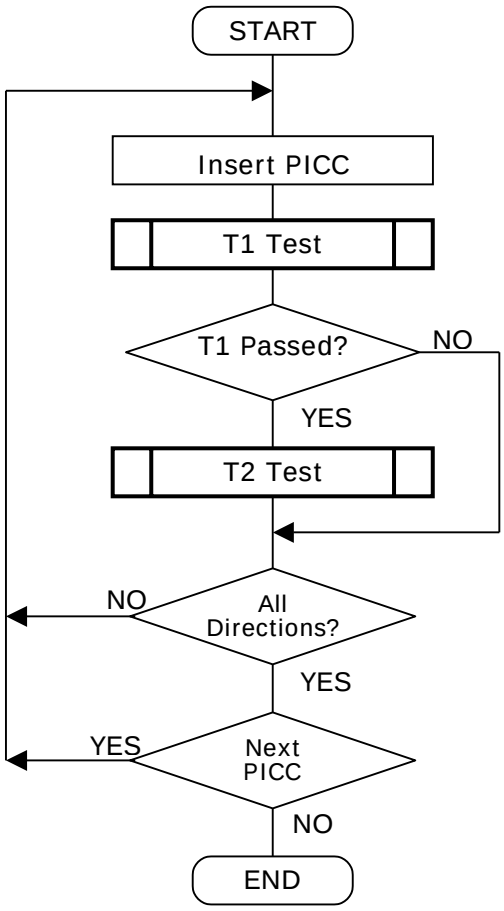


Figure 11.1 – Basic Test Processing Flow

(2) T1 Test Processing Flow

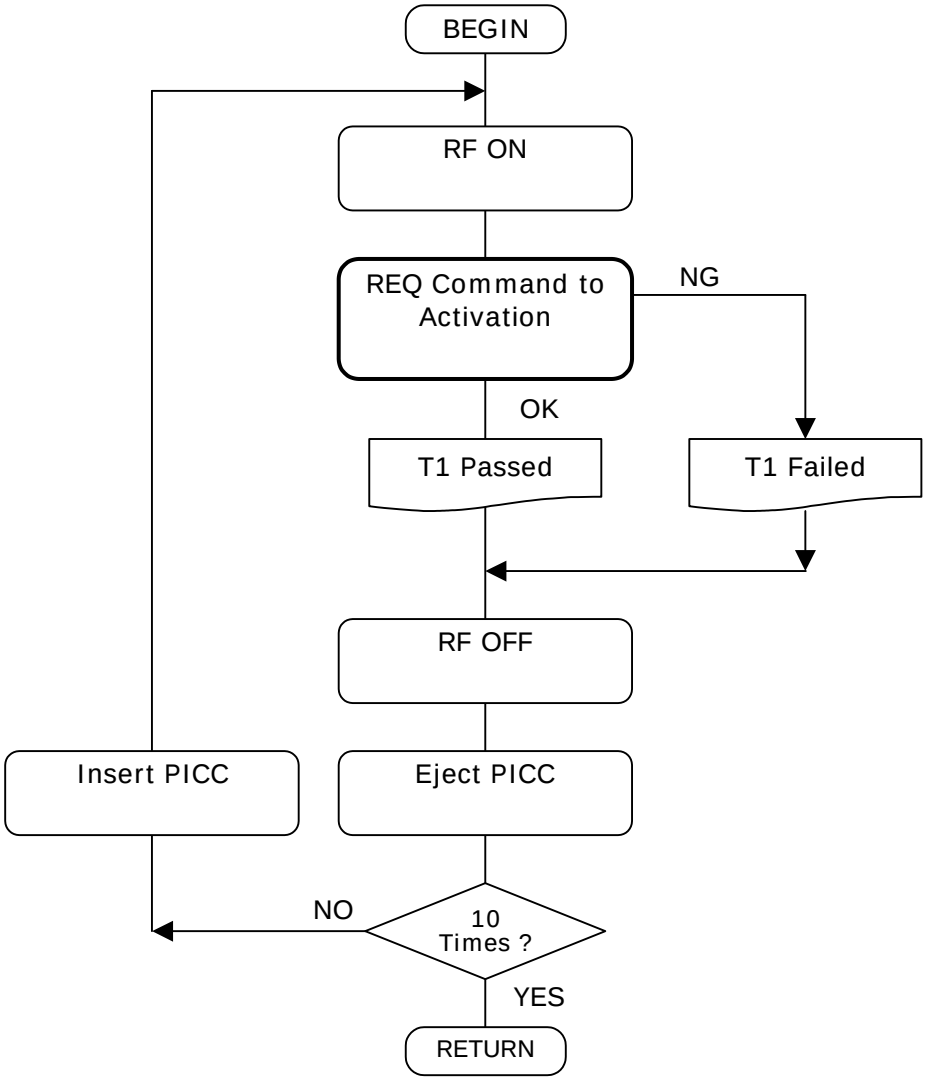


Figure 11.2 – T1 Test Processing Flow

(3) T2 Test Processing Flow

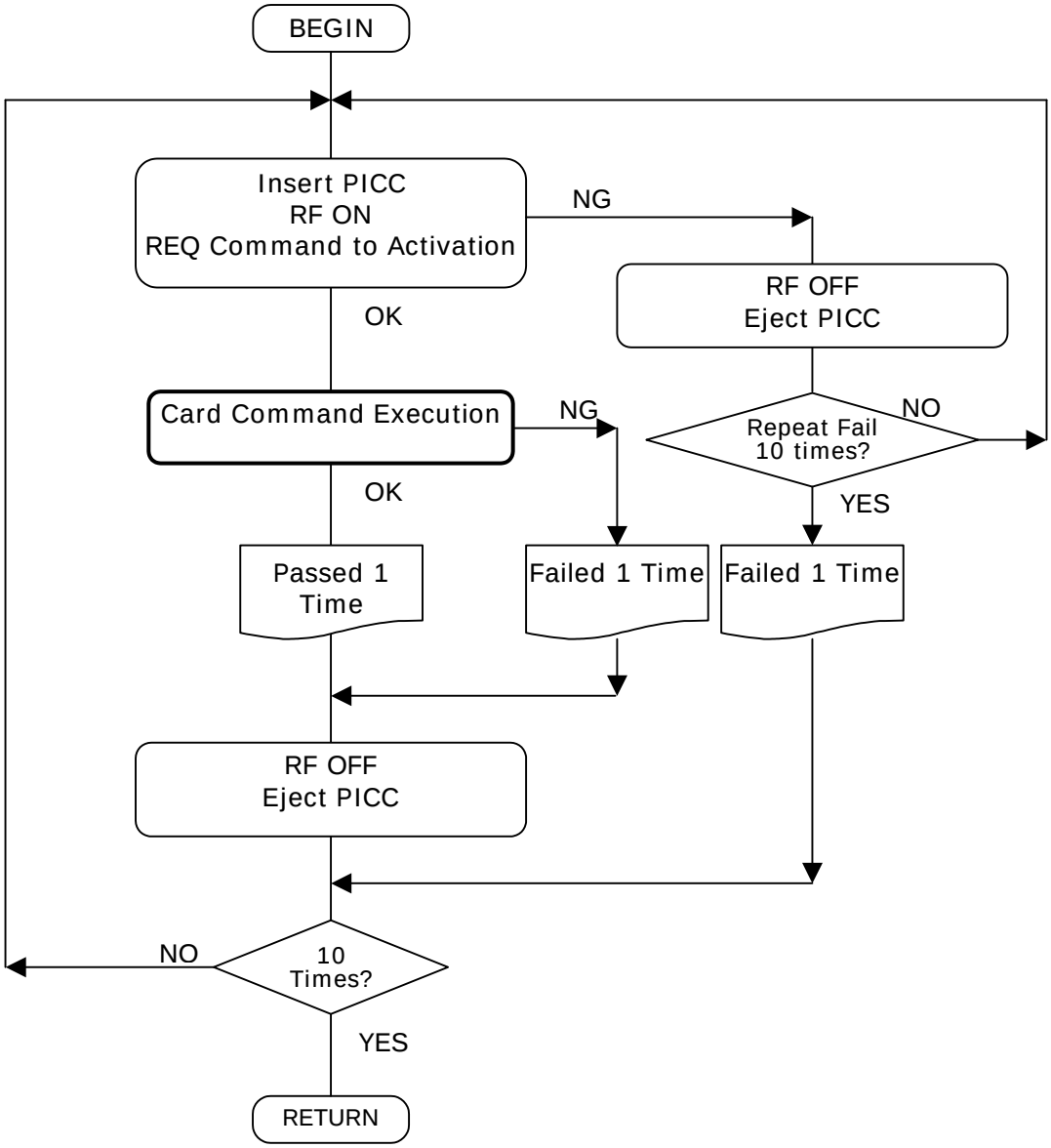


Figure 11.3 – T2 Test Processing Flow

11.3 Compatibility Test of Single Card Operations with Open Type PCDs

11.3.1 List of Tests

Table 11.6 lists the tests to perform.

Table 11.6 – List of Tests

No.	Test name	Test description	Notes
T1	Activation test	After inserting the PICC into a PCD, verify whether the PICC can enter the activated state.	
T2	Command send/receive test	Verify that card commands operate correctly.	

11.3.2 Test Combinations

– Cross tests using all PCD types and all PICC types shall be performed.

– For each PCD, perform the test using each PICC sequentially.

Table 11.7 shows the combinations of the PCD and PICC for each test.

Table 11.7 – Combinations

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

11.3.3 Testing Point and Direction of PICC

Testing points shall be determined with consideration to the operating conditions of the applied IC card system.

Examples of testing points are shown below.

(1) Testing Point

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 positions of center point "o", the X, Y, and Z axes shall be determined separately.)

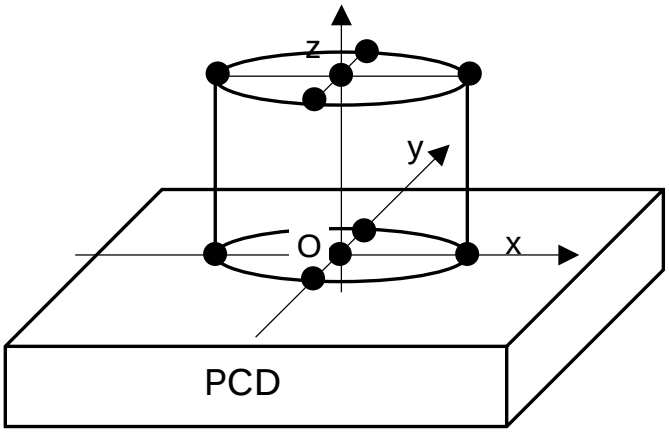


Figure 11.4 – Testing Points (Example)

(2) Direction of PICC

When viewing the PCD from directly above, the long edge of the PICC shall be parallel or orthogonal with the X axis. (See **Figure 11.5** below.)

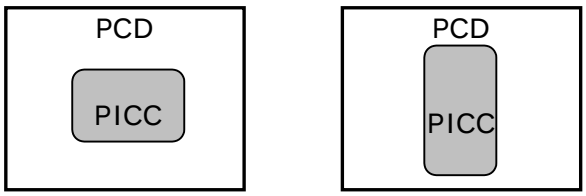


Figure 11.5 – Directions of PICC

11.3.4 Test Contents and Pass-Fail Criteria

(1) T1 Tests

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

– For each PICC, perform test for a total of 20 times for the two directions (10 times for each direction) on each test point for all specified directions on all test points.

Table 11.9 shows the pass-fail criteria of the tests.

Table 11.9 – T1 Tests Pass-Fail Criteria

Evaluation	Criteria	Notes
Pass	More than 9 out of 10 attempts are successful for all test points of all combinations.	
Fail	All other cases.	

(2) T2 Tests

– Verify that card commands are sent and received correctly.

– For each PICC, perform test for a total of 20 times for the two directions (10 times for each direction) on each test point for all specified directions on all test points.

Table 11.10 shows the pass-fail criteria of the tests.

Table 11.10 – T2 Tests Pass-Fail Criteria

Evaluation	Criteria	Notes
Pass	More than 9 out of 10 attempts are successful for all commands of all combinations for all test points.	
Fail	All other cases.	

11.3.5 Processing Flow

(1) Basic Processing Flow

Figure 11.6 shows the basic test processing flow.

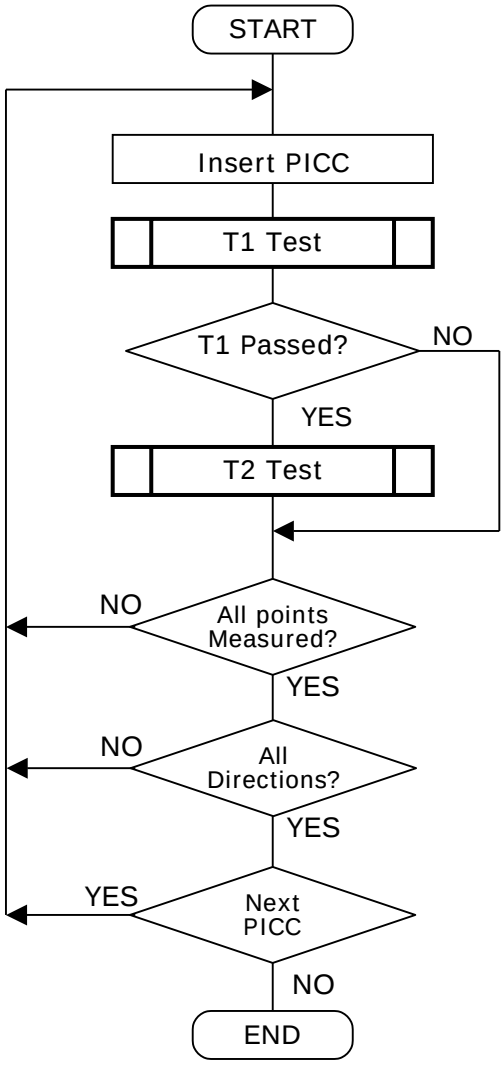


Figure 11.6 – Basic Test Processing Flow

(2) T1 Test Processing Flow

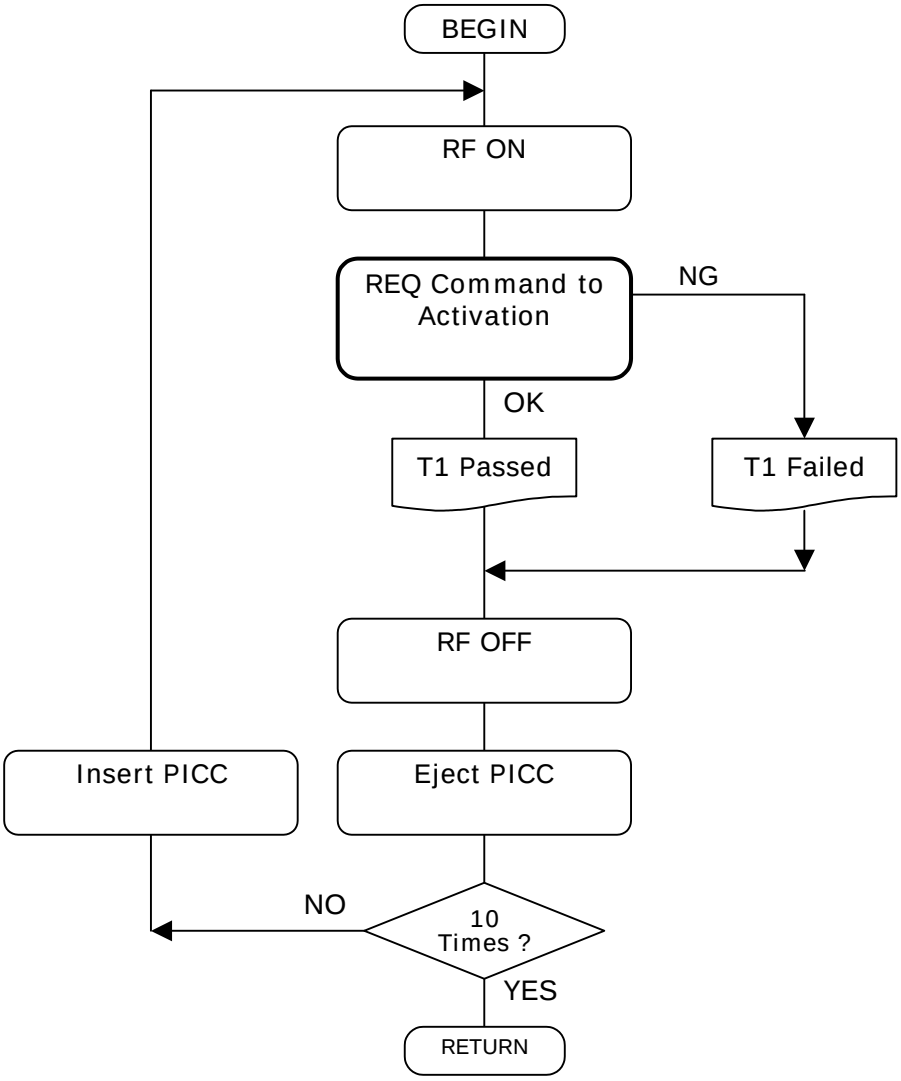


Figure 11.7 – T1 Test Processing Flow

(3) T2 Test Processing Flow

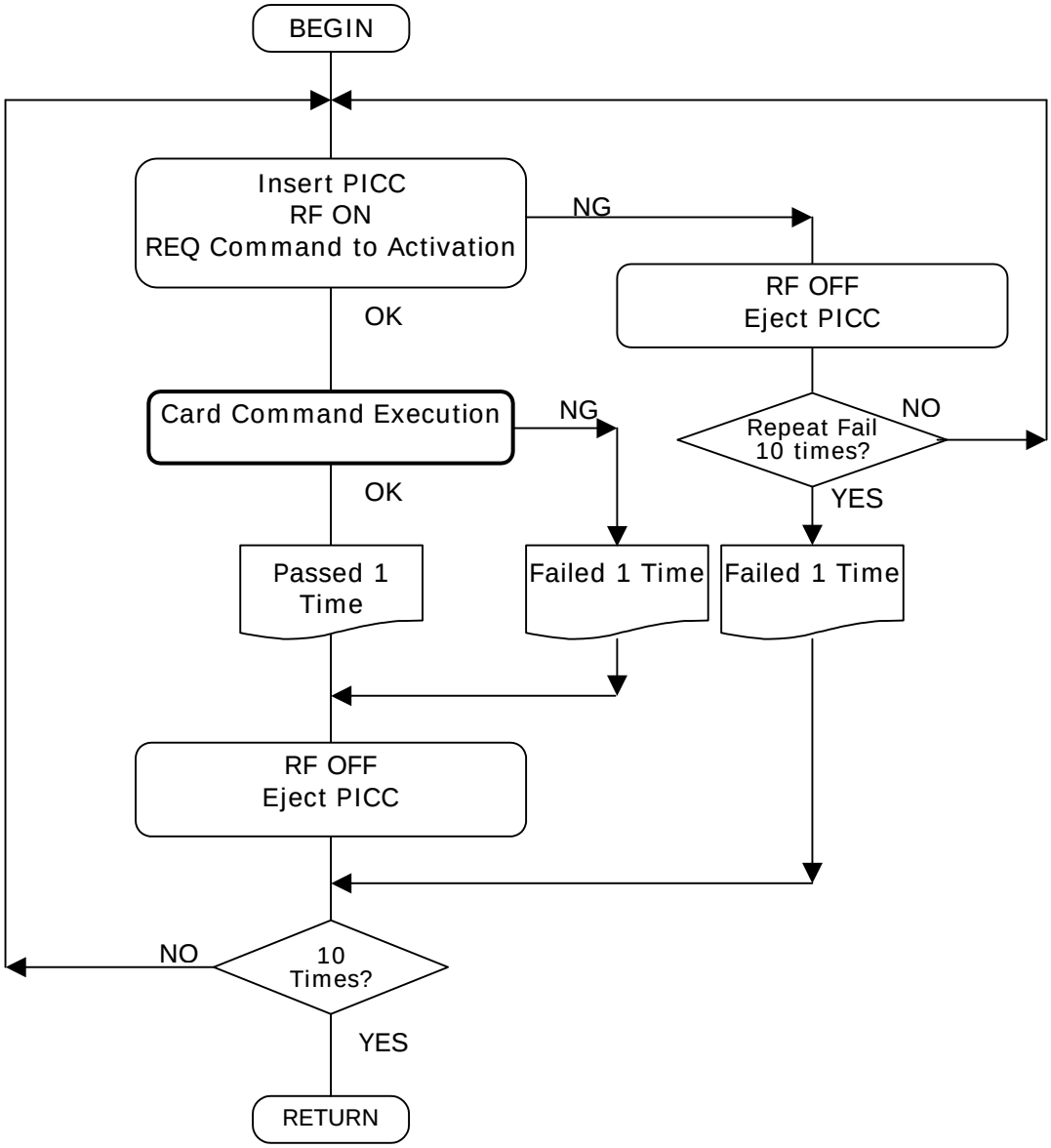


Figure 11.8 – T2 Test Processing Flow

11.4 Compatibility Test for Double Card Operations

Regarding compatibility tests for double card operations, tests using a single card and test using paired cards can be assumed. The following compatibility tests shall be performed.

– For compatibility test of using a single card, apply compatibility tests for single card operations.

– For compatibility test of using two cards, perform the tests for single card operations with the two cards placed on one another.

The following ways of pairing two PICCs can be assumed.

(1) Place one precisely on top of the other with no displacement.

(2) Place one on top of the other with displacement towards each of the X, Y, and Z axes directions.

(3) Rotate the PICC placed on the other to a relative angle.

(4) Exchange the positions of the PICCs so that the one on top is placed at the bottom.

There are numerous ways to place the paired PICCs, especially for Open type PCDs, and the test for each type of placement will increase in proportion to the power of two of the number of placements. Thus consideration is required to determine the placement before performing the tests.

Explanations

This explanation describe 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

Considering the future promotion and dissemination of contactless proximity IC card systems, ensuring the compatibility and interoperability of PICCs and PCDs was most important issue. Since the Standard Specifications is not sufficient to ensure compatibility of contactless interfaces, an Implementation Specification that would complement the Standard Specifications was in need to ensure compatibility.

To fulfill this need, NMDA, based on fruits it had bore from performing investigations for the Implementation Specification in their development projects and verification experiment projects, compiled this "Proximity Communication Interface Implementation Specification."

Purpose of Revision

Purpose of Revision for Version 1.1

– Although Version 1.0 was produced on the basis of the latest documents available relating to ISO/IEC 14443 as of March 2000, since that time, work at ISO have progressed, and with some exceptions, were released in the form of ISO standards, which made it necessary to align with the ISO standards.

– Following the release of Version 1.0, requests were made from various fields asking for implementation specifications for PCDs (Open type PCDs) that were capable of being operated by placing cards on it or holding cards over it. Implementation specifications were therefore added and revised in order to accommodate these needs.

Purpose of Revision for Version 2.0

– Although Version 1.1 was produced on the basis of the latest documents available relating to ISO/IEC 14443 as of February 2001, since that time, work at ISO and standardization as JIS have progressed, and it became necessary to comply with those standard specifications.

– After the publication of Version 1.1, the issuing of the resident basic register card started. Thus, ensuring compatibility has become increasingly important and an even more precise implementation specification was in need.

– Based on such background, this version seeks to update its provisions to comply with Standard Specifications, revise provisions to comply with the revision of the domestic Radio Law, and for areas that were not stipulated or not clear enough, clarify provisions and caution points that are required to ensure compatibility and reduce issues regarding interoperability to further promote dissemination of contactless IC cards.

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

Issues that were raised during discussion

Document Format

When Version 1.1 of the Implementation Specification was published, ISO/IEC standards were still no published. However, currently standardization as ISO/IEC and also as JIS are complete. This led to the issue that there were a lot of duplication of those standards within the document adding up to a lot of pages.

Therefore, it was decided to form the document as a common specification document, and structure it so that provisions will be clear.

Description Regarding Radio Law

There was a description regarding the Radio Law in Version 1.1 of the Implementation Specification. How to handle this description was raised as an issue.

At the time when Version 1.1 of the Implementation Specification was published, it was required to suppress the radiated field intensity of the PCD to a weak level in order to avoid the necessity of applying as wireless radio stations. This was one of the challenges then, and specific explanations were provided.

However, currently at the time of this publication, PCDs are considered as radio frequency equipment due to the revision of the Radio Law, and does not require any installation permission. Thus the need to suppress the radiated field intensity to a weak level is obsolete. Within this Implementation Specification, descriptions pertaining to this aspect are provided as notes.

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 PCD 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.

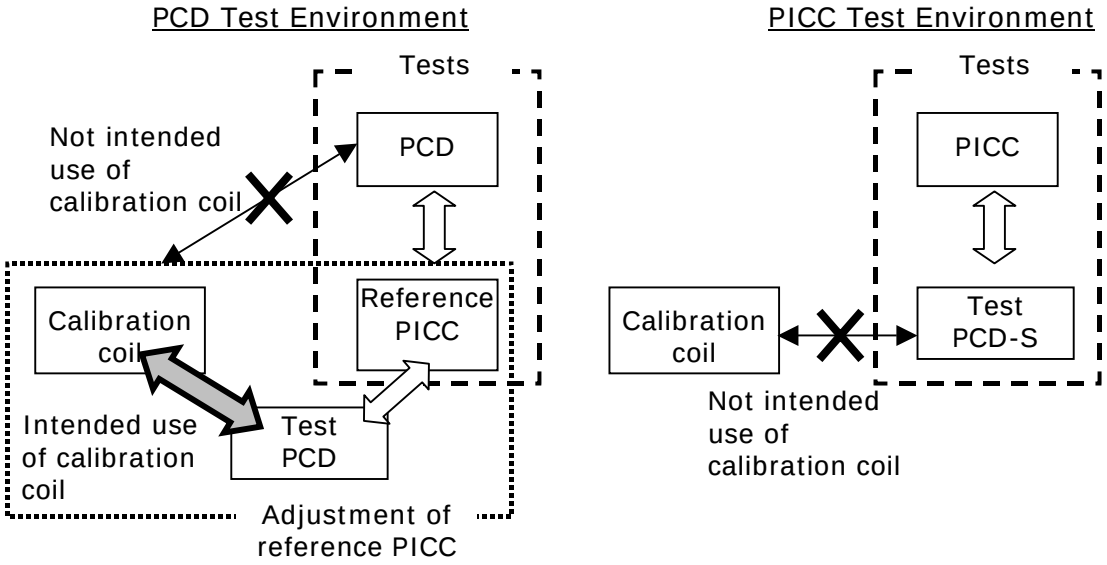


Figure – Intended Use of Calibration Coil

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 concepts were 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 **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.

External Communication Protocol (High Level Interface)

In Version 1.1 of the Implementation Specification, descriptions were provided from the physical level (RS-232C) as informative specifications.

Regarding this, there was discussion over what in fact should be stipulated and the following were decided.

– Details of the physical interface shall not be stipulated. (To allow for all types of expansibility)

– Revise and describe the high level interface based on the "Research Project on Cities Equipped with Information Technologies – Proximity Coupling Device Common Interface Specification Version 1.1" which has actually been adopted by municipalities.

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.