INTERNATIONAL STANDARD

ISO/IEC 14443-2

Third edition
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Identification cards — Contactless integrated circuit cards — Proximity cards —

Part 2: Radio frequency power and signal interface

Cartes d'identification — Cartes à circuit(s) intégré(s) sans contact — Cartes de proximité —

Partie 2: Interface radiofréquence et des signaux de communication

Reference number
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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, Subcommittee SC 17, *Cards and personal identification*.

This third edition cancels and replaces the second edition (ISO/IEC 14443-2:2010), which has been technically revised.

It also incorporates the Amendments ISO/IEC 14443-2:2010/Amd 1:2011, ISO/IEC 14443-2:2010/Amd 2:2012 and ISO/IEC 14443-2:2010/Amd 3:2012.

ISO/IEC 14443 consists of the following parts, under the general title *Identification cards — Contactless integrated circuit cards — Proximity cards*:

— *Part 1: Physical characteristics*

— *Part 2: Radio frequency power and signal interface*

— *Part 3: Initialization and anticollision*

— *Part 4: Transmission protocol*

Introduction

ISO/IEC 14443 is one of a series of International Standards describing the parameters for identification cards as defined in ISO/IEC 7810 and the use of such cards for international interchange.

This part of ISO/IEC 14443 describes the electrical characteristics of two types of contactless interface between a proximity card and a proximity coupling device. The interface includes both power and bi-directional communication. It is intended to be used in conjunction with other parts of ISO/IEC 14443.

Contactless card standards cover a variety of types as embodied in ISO/IEC 10536 (close-coupled cards), ISO/IEC 14443 (proximity cards) and ISO/IEC 15693 (vicinity cards). These are intended for operation when very near, nearby and at a longer distance from associated coupling devices, respectively.

Identification cards — Contactless integrated circuit cards — Proximity cards —

Part 2: Radio frequency power and signal interface

1 Scope

This part of ISO/IEC 14443 specifies the characteristics of the fields to be provided for power and bi-directional communication between proximity coupling devices (PCDs) and proximity cards or objects (PICCs).

This part of ISO/IEC 14443 does not specify the means of generating coupling fields, nor the means of compliance with electromagnetic radiation and human exposure regulations, which can vary according to country.

2 Normative references

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

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

ISO/IEC 14443-1:2016, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 1: Physical characteristics*

ISO/IEC 14443-3:2016, *Identification cards — Contactless integrated circuit cards — Proximity cards — Part 3: Initialization and anticollision*

3 Terms and definitions

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

3.1
bit duration
time during which a logic level is defined, at the end of which a new bit starts

3.2
binary phase shift keying
phase shift keying where the phase shift is 180 degrees, resulting in two phase state possibilities

3.3
modified Miller
method of bit coding whereby a logic level during a bit duration is represented by the position of a pulse within the bit frame

3.4
modulation index
m
[1 − *b*] / [1 + *b*], where *b* is the ratio between the modulated amplitude and the initial signal amplitude

Note 1 to entry: The value of the index may be expressed as a percentage.

3.5
NRZ-L
method of bit coding whereby a logic level during a bit duration is represented by one of two defined physical states of a communication medium

3.6
operating volume
for each PICC class, the positions where the corresponding Reference PICC shows PCD compliance with all requirements of this part of ISO/IEC 14443 for this class

3.7
subcarrier
signal of frequency, *fs*, used to modulate a carrier of frequency, *fc*

3.8
Manchester
method of bit coding whereby a logic level during a bit duration is represented by a sequence of two defined physical states of a communication medium, the order of the physical states within the sequence defining the logical state

3.9
TR0
guard time between the end of a PCD transmission and the start of the PICC subcarrier generation

3.10
TR1
synchronization time between the start of the PICC subcarrier generation and the start of the PICC subcarrier modulation

4 Symbols and abbreviated terms

a	pulse shape factor, Type A
ACP	actual constellation point
AP	actual phase value
ASK	amplitude shift keying
b	ratio between the modulated and initial signal amplitude, Type B
BPSK	binary phase shift keying
EMD	electromagnetic disturbance, parasitically generated by the PICC
EPI	elementary phase interval
etu	elementary time unit
fc	frequency of operating field (carrier frequency)
fs	frequency of subcarrier
H	equivalent homogenous magnetic field strength
$H_{INITIAL}$	field strength of the unmodulated RF field
h_{ovs}	envelope overshoot for bit rates of *fc*/64, *fc*/32 and *fc*/16, Type A
h_f	envelope undershoot, Type B

h_r	envelope overshoot, Type B
ISI	inter symbol interference
ISI_d	inter symbol interference angle
ISI_m	inter symbol interference magnitude
NP	nominal phase value
NRZ-L	non-return to zero, (L for level)
OOK	on/off keying
PauseA	PCD modulation pulse, Type A
Ø0	initial phase of the subcarrier
P_H	complex constellation point of the maximum NP
P_L	complex constellation point of the minimum NP
PNP	previous nominal phase
PR	phase range
PSK	phase shift keying
PCD	proximity coupling device
PICC	proximity card or object
RF	radio frequency
t_1	PauseA length
t_2	PauseA “Low” time for a bit rate of *fc*/128
t_3	PauseA rise time for a bit rate of *fc*/128
t_4	PauseA rise time section for a bit rate of *fc*/128
t_5	PauseA “Low” time for bit rates of *fc*/64, *fc*/32 and *fc*/16
t_6	PauseA rise time for bit rates of *fc*/64, *fc*/32 and *fc*/16
$t_{6,\,max,\,PCD}$	maximum value of t_6 for PCD transmission
$t_{6,\,max,\,PICC}$	maximum value of t_6 for PICC reception
t_b	bit duration, Type A
t_f	envelope fall time, Type B
$t_{f,\,max,\,PCD}$	maximum fall time for PCD transmission, Type B
$t_{f,\,max,\,PICC}$	maximum fall time for PICC reception, Type B
t_r	envelope rise time, Type B
$t_{r,\,max,\,PCD}$	maximum rise time for PCD transmission, Type B

$t_{r,\,max,\,PICC}$	maximum rise time for PICC reception, Type B
t_x	pulse position, Type A
$V_{E,\,PCD}$	EMD limit, PCD
$V_{E,\,PICC}$	EMD limit, PICC
V_{LMA}	load modulation amplitude
$V_{LMA,\,PCD}$	minimum load modulation amplitude for PCD reception
$V_{LMA,\,PICC}$	minimum load modulation amplitude for PICC transmission
#	number

5 General considerations

5.1 Initial dialogue

The initial dialogue between the PCD and the PICC shall be conducted through the following consecutive operations:

— activation of the PICC by the RF operating field of the PCD;

— the PICC shall wait silently for a command from the PCD;

— transmission of a command by the PCD;

— transmission of a response by the PICC.

These operations shall use the RF power and signal interface specified in the following clauses.

5.2 Compliance

5.2.1 PICC compliance

The PICC shall comply with all mandatory requirements of this part of ISO/IEC 14443 and may support optional requirements (bit rate, class, etc.). The PICC should fulfill all the requirements of one particular class in order to improve interoperability.

5.2.2 PCD compliance

The PCD shall comply with all mandatory requirements of this part of ISO/IEC 14443 and may support optional requirements (bit rate, support of PICCs of optional classes, etc.).

The PCD

— shall support PICCs of “Class 1”, “Class 2” and “Class 3”,

— may optionally support PICCs of “Class 4”,

— may optionally support PICCs of “Class 5” and

— may optionally support PICCs of “Class 6”.

PCD requirements measured with Reference PICCs 1, 2, and 3 are mandatory for all PCDs.

PCD requirements measured with Reference PICC 4 are only mandatory for PCDs supporting operation with “Class 4” PICCs.

PCD requirements measured with Reference PICC 5 are only mandatory for PCDs supporting operation with “Class 5” PICCs.

PCD requirements measured with Reference PICC 6 are only mandatory for PCDs supporting operation with “Class 6” PICCs.

For each supported PICC class, the PCD manufacturer shall indicate the operating volume within which the PCD fulfills all requirements of this part of ISO/IEC 14443.

NOTE As an indication of each operating volume, the manufacturer may give the operating range (e.g. 0 to X cm with PCD and PICC relative positions, e.g. PCD and PICC antennas parallel and concentric).

5.2.2.1 PCD supporting PICCs of particular class(es)

If a PCD is expected to operate with PICCs of only particular class(es), it is not mandatory for this PCD to support PICCs of other classes. This PCD shall comply with all other relevant clauses of this part of ISO/IEC 14443. The PCD manufacturer shall clearly state which class(es) are supported.

NOTE A PCD which does not support one of the mandatory classes 1, 2 and 3 is not fully compliant with this part of ISO/IEC 14443. It may be advertised as “supporting “Class X” PICCs only” or “compliant with Class(es) X requirements only”.

6 Power transfer

The PCD shall produce a high frequency alternating magnetic field. This field inductively couples to the PICC to transfer power and is modulated for communication.

6.1 Frequency

The frequency, *fc*, of the RF operating field shall be 13,56 MHz ± 7 kHz.

6.2 Operating field strength

Within the manufacturer specified operating volumes (see 3.6), the PCD shall generate a field strength of at least H_{min} and not exceeding H_{max} under unmodulated conditions, see Table 1.

The PCD

— shall support PICCs of “Class 1”, “Class 2” and “Class 3”,

— may optionally support PICCs of “Class 4”,

— may optionally support PICCs of “Class 5” and

— may optionally support PICCs of “Class 6”.

PCD requirements measured with Reference PICCs 1, 2, and 3 are mandatory for all PCDs.

PCD requirements measured with Reference PICC 4 are only mandatory for PCDs supporting operation with “Class 4” PICCs.

PCD requirements measured with Reference PICC 5 are only mandatory for PCDs supporting operation with “Class 5” PICCs.

PCD requirements measured with Reference PICC 6 are only mandatory for PCDs supporting operation with “Class 6” PICCs.

Table 1 — PCD field strength

	PCD	
	H_{min} A/m (rms)	H_{max} A/m (rms)
Measured with Reference PICC 1	1,5	7,5
Measured with Reference PICC 2	1,5	8,5
Measured with Reference PICC 3	1,5	8,5
Measured with Reference PICC 4 (optional)	2,0	12
Measured with Reference PICC 5 (optional)	2,5	14
Measured with Reference PICC 6 (optional)	4,5	18

The PCD shall not generate a field strength higher than the average and maximum levels specified for all mandatory and optional classes in ISO/IEC 14443-1:2016, 4.4 (alternating magnetic field) in any possible PICC position and orientation, measured with the associated Reference PICCs.

Test methods for the PCD operating field are defined in ISO/IEC 10373-6 and use a dedicated Reference PICC for each class.

NOTE 1 Although field measurements with some Reference PICCs may show values higher than 7,5 A/m (rms), the H_{max} limits specified in Table 1 do not allow PCDs to produce higher field strength than with first and second edition of ISO/IEC 14443-2. This is because PCD field distribution is usually not homogenous within the operating volumes and References PICCs have different measurement areas.

If the PICC meets the requirements of one particular class as specified in ISO/IEC 14443-1, then the PICC shall operate as intended continuously between H_{min} and H_{max} defined for its class, see Table 2; this includes all PICC requirements defined in this part of ISO/IEC 14443 and processing of the manufacturer specified set of commands.

If the PICC does not claim to meet the requirements of one particular class as specified in ISO/IEC 14443-1, then:

— if the PICC antenna fits within the external rectangle defined in “Class 2” as specified in ISO/IEC 14443-1, then

  — the PICC shall operate as intended continuously between H_{min} and H_{max} defined for “Class 2”, see Table 2,

  — the PICC shall pass the loading effect test defined for “Class 2”;

— if the PICC antenna fits within the external rectangle or external circle defined in “Class 3” as specified in ISO/IEC 14443-1, then

  — the PICC shall operate as intended continuously between H_{min} and H_{max} defined for “Class 3”, see Table 2,

  — the PICC shall pass the loading effect test defined for “Class 3”;

— if the PICC antenna does not claim to fit within the external rectangle or external circle defined in “Class 2” or “Class 3” as specified in ISO/IEC 14443-1, then

  — the PICC shall operate as intended continuously between H_{min} and H_{max} defined for “Class 1”, see Table 2,

  — the PICC shall pass the loading effect test defined for “Class 1”.

NOTE 2 If the PICC does not claim to meet the requirements of one particular class, then the requirements defined above may not be sufficient to guarantee proper operation and interoperability with PCDs.

Table 2 — PICC operating field strength

	PICC	
	H_{min} A/m (rms)	H_{max} A/m (rms)
"Class 1" PICC	1,5	7,5
"Class 2" PICC	1,5	8,5
"Class 3" PICC	1,5	8,5
"Class 4" PICC	2,0	12
"Class 5" PICC	2,5	14
"Class 6" PICC	4,5	18

NOTE 3 Margins of field strength are effectively included by the test methods as specified in ISO/IEC 10373-6.

7 Signal interface

The PCD modulates the amplitude of the alternating magnetic field strength with modulation pulses in order to transmit data from the PCD to the PICC.

The PICC loads the alternating magnetic field with a modulated subcarrier signal (load modulation) in order to transmit data from the PICC to the PCD.

Within the manufacturer specified operating volumes (see 3.6), the PCD shall generate modulation pulses as described in the following clauses and shall be capable of receiving the minimum load modulation amplitude.

NOTE 1 As an indication of the operating volume, the manufacturer may give the operating range (e.g. 0 to X cm) within which all ISO/IEC 14443-2 requirements are fulfilled.

Test methods for the PCD communication signal interface are defined in ISO/IEC 10373-6.

Two communication signal interfaces, Type A and Type B, are described in the following clauses. The PCD shall alternate between modulation methods when idling before detecting the presence of a PICC of Type A or Type B.

Only one communication signal interface may be active during a communication session until deactivation by the PCD or removal of the PICC. Subsequent session(s) may then proceed with either modulation method.

Figure 1 and Figure 2 illustrate the concepts described in the following clauses.

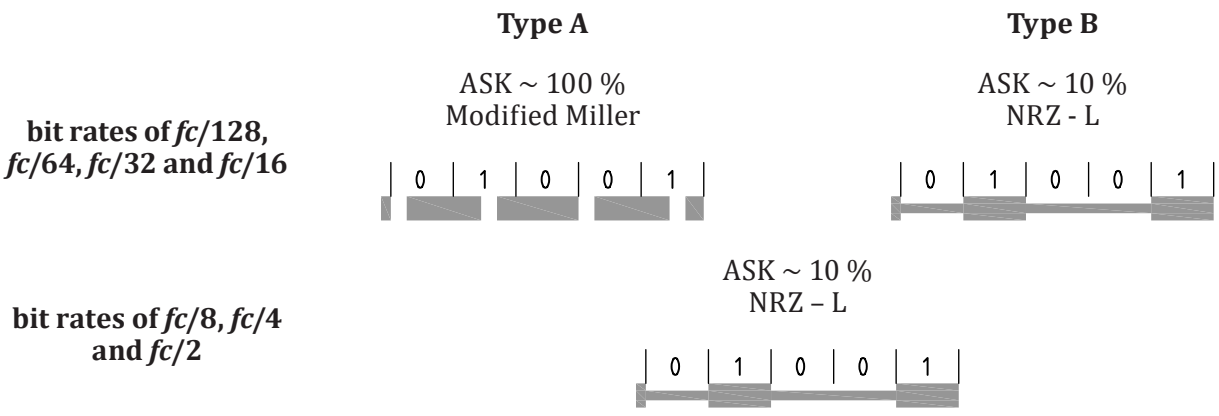


Figure 1 — Example PCD to PICC communication signals for Type A and Type B interfaces

NOTE 2 For the coding of modified Miller, see 8.1.3.1.

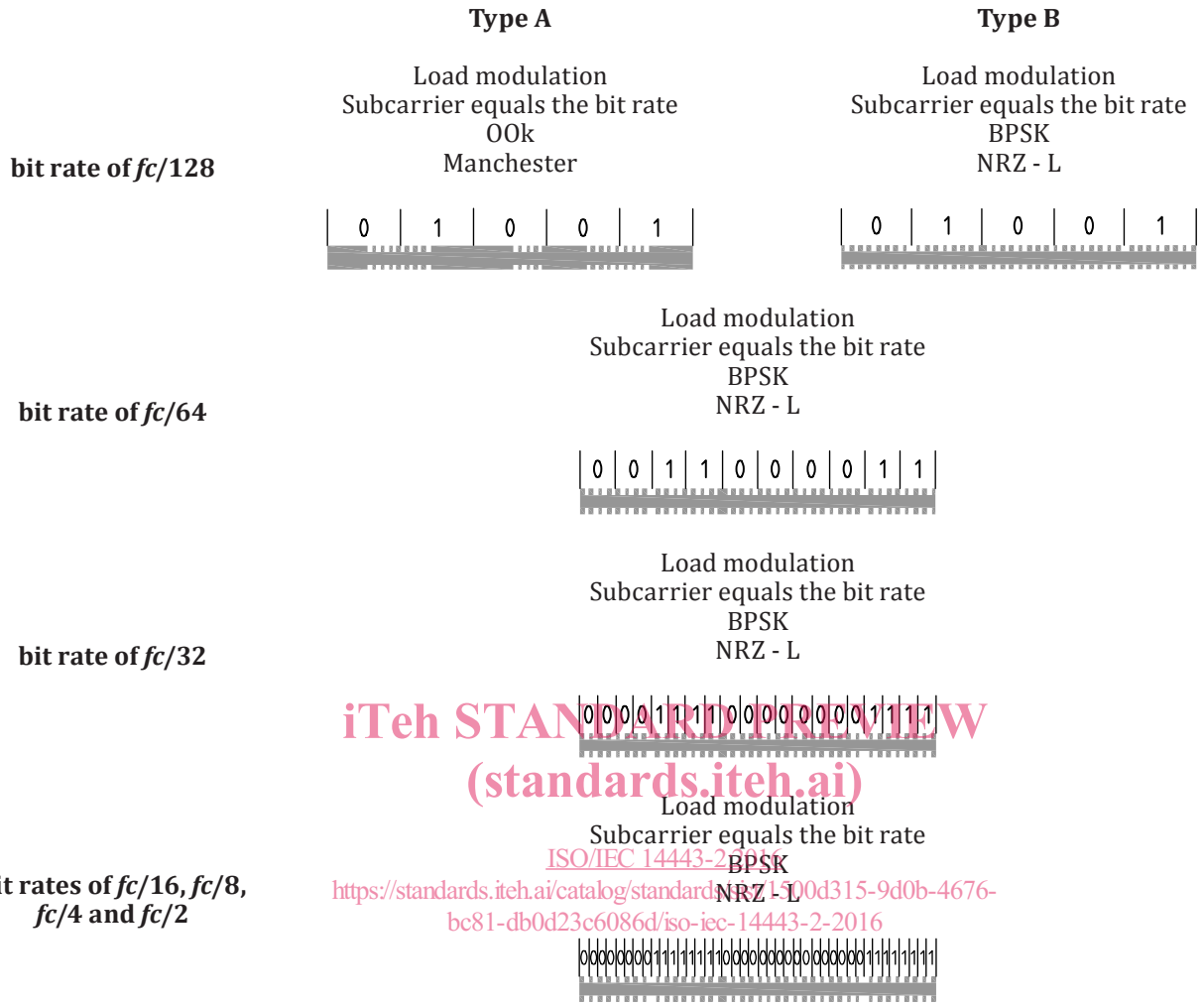


Figure 2 — Example PICC to PCD communication signals for Type A and Type B interfaces

8 Communication signal interface Type A

8.1 Communication PCD to PICC

8.1.1 Bit rate

The bit rate for the transmission during initialization and anticollision shall be *fc*/128 (~106 kbit/s).

The bit rate for the transmission after initialization and anticollision shall be one of the following:

— *fc*/128 (~106 kbit/s);

— *fc*/64 (~212 kbit/s);

— *fc*/32 (~424 kbit/s);

— *fc*/16 (~848 kbit/s);

— *fc*/8 (~1,70 Mbit/s);

— *fc*/4 (~3,39 Mbit/s);

— $fc/2$ (~6,78 Mbit/s);

— $3fc/4$ (~10,17 Mbit/s);

— fc (~13,56 Mbit/s);

— $3fc/2$ (~20,34 Mbit/s);

— $2fc$ (~27,12 Mbit/s).

8.1.2 Modulation

8.1.2.1 Modulation for a bit rate of *fc*/128

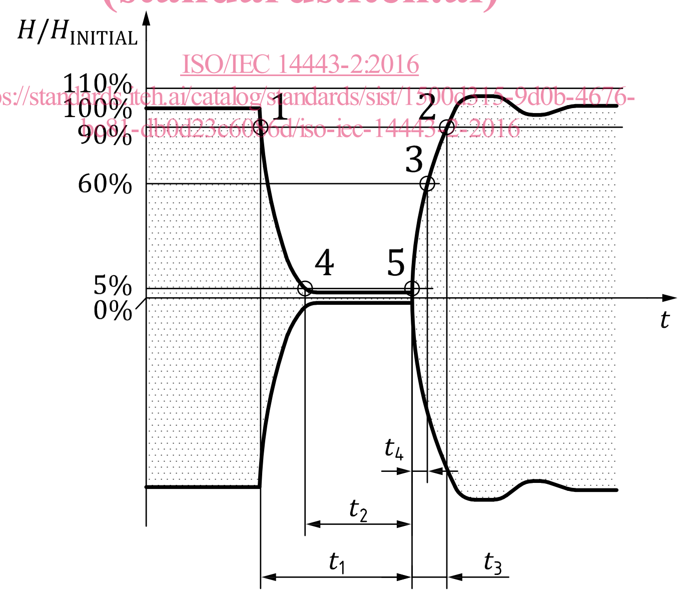
Communication from PCD to PICC for a bit rate of $fc/128$ shall use the modulation principle of ASK 100 % of the RF operating field to create a PauseA as shown in Figure 3.

The envelope of the PCD field shall decrease monotonically to less than 5 % of its initial value H_{INITIAL} and remain less than 5 % for more than t_2. This envelope shall comply with Figure 3.

If the envelope of the PCD field does not decrease monotonically, the time between a local maximum and the time of passing the same value before the local maximum shall not exceed 0,5 µs. This shall only apply if the local maximum is greater than 5 % of H_{INITIAL}.

The PauseA length t_1 is the time between 90 % of the falling edge and 5 % of the rising edge of the H-field signal envelope.

In case of an overshoot, the field shall remain within 90 % of H_{INITIAL} and 110 % of H_{INITIAL}.



Key

1 start of t_1

2 end of t_3

3 end of t_4

4 start of t_2

5 end of t_1 and t_2, start of t_3 and t_4

Figure 3 — PauseA for a bit rate of *fc*/128

The PCD shall generate a PauseA with timing parameters defined in Table 3.