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Information technology — Telecommunications and information exchange between systems — Near Field Communication — Interface and Protocol (NFCIP-1)

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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.

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The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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ISO/IEC 18092 was prepared by ECMA (as ECMA-340) and was adopted, under a special “fast-track procedure”, by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, in parallel with its approval by national bodies of ISO and IEC.

Introduction

This International Standard specifies the interface and protocol for simple wireless communication between close coupled devices. These Near Field Communication (NFC) devices communicate with transfer rates of 106, 212, and 424 kbps.

This NFC Interface and Protocol (NFCIP-1) standard allows, but does not specify, applications in network products and consumer equipment.

Information technology — Telecommunications and information exchange between systems — Near Field Communication — Interface and Protocol (NFCIP-1)

1 Scope

This International Standard defines communication modes for Near Field Communication Interface and Protocol (NFCIP-1) using inductive coupled devices operating at the centre frequency of 13,56 MHz for interconnection of computer peripherals. It also defines both the Active and the Passive communication modes of Near Field Communication Interface and Protocol (NFCIP-1) to realize a communication network using Near Field Communication devices for networked products and also for consumer equipment. This International Standard specifies, in particular, modulation schemes, codings, transfer speeds, and frame format of the RF interface, as well as initialization schemes and conditions required for data collision control during initialization. Furthermore, this International Standard defines a transport protocol including protocol activation and data exchange methods.

Information interchange between systems also requires, at a minimum, agreement between the interchange parties upon the interchange codes and the data structure.

2 Conformance

A system implementing the Active and the Passive communication mode shall be in conformance with this International Standard if it meets all the mandatory requirements specified herein.

3 Normative references

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

ITU-T V.41:1988, *Code-independent error-control system*

4 Terms and definitions

For the purposes of this International Standard, the following definitions apply.

4.1
active communication mode
move in which both the Initiator and the Target use their own RF field to enable the communication

4.2
ASK modulation
Amplitude Shift Keying, in which the amplitude of the carrier frequency is modulated according to the logic of the data to be transmitted

NOTE The degree of modulation is expressed by $(a - b)/(a + b) \times 100$ [%], where a and b respectively represent the maximum and minimum amplitudes of the modulated signal waveform.

4.3
Binary Coded Decimal (BCD)
a system for representing each of the decimal numbers 0 to 9 by a four-bit binary code

NOTE The bits, from left to right, are worth 8, 4, 2 and 1 respectively in decimal, so for example the number 6 in BCD is 0110.

4.4
collision
transmission by two or more Targets or Initiators during the same time period, such that the Initiator or the Target is unable to distinguish from which Target the data originated

4.5
frame
sequence of data bits and optional error detection bits, with frame delimiters at start and end

4.6
$H_{Threshold}$
the minimum value of an external RF field that a NFCIP-1 device shall detect in order not to disturb ongoing communication by ensuring that its own RF field is switched off

4.7
initiator
generator of the RF field and starter of the NFCIP-1 communication

4.8
load modulation
process of amplitude modulating a radio frequency field by varying the properties of a resonant circuit placed within the radio frequency field

4.9
lsb first
least significant bit first, indicating a serial data transmission system that sends lsb before all other bits

4.10
LSB first
Least Significant Byte first, indicating a serial data transmission system that sends LSB before all other bytes

4.11
Manchester coding
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

NOTE The order of the physical states within the sequence defines the logical state. The coding system which divides into half at the changing point in the middle point of bit self-sustaining time, and makes the direction of the changes correspond to two logic value.

4.12
modulation index
defined as $(a - b)/(a + b)$ where a and b are the peak and the minimum signal amplitude respectively with the value of the index possibly expressed as a percentage

NOTE When the maximum amplitude of the modulated signal waveform is set to a and the minimum value is set to b, the degree of abnormal conditions is usually expressed as a percent.

4.13
msb first
most significant bit indicating a serial data transmission system that sends the msb before all other bits

4.14
MSB first
Most Significant Byte indicating a serial data transmission system that sends the MSB before all other bytes

4.15
NFCIP-1 device
general term for either an Initiator or a Target communicating in the Active or the Passive communication mode

4.16
NFC Identifier (NFCID*n*)
a randomly generated number used by the RF Collision Avoidance and Single Device Detection sequence for both the Active and the Passive communication modes

4.17
passive communication mode
when the Initiator is generating the RF field and the Target responds to an Initiator command in a load modulation scheme

4.18
RF Collision Avoidance (RFCA)
method to detect the presence of a RF field based on the carrier frequency and method to detect and resolve collisions on protocol level

4.19
SEL_PAR

total number of valid bits of NFCID1 CL*n* including SEL_CMD and SEL_PAR transmitted by the Initiator

4.20
sensing

an NFCIP-1 device in the Active communication mode expecting a Response to a Request it has sent on the RF field to detect the start of communication to receive the Request

4.21
Single Device Detection (SDD)
an algorithm used by the initiator to detect one out of several Targets in its RF field

4.22
subcarrier
signal of frequency (fs) used to modulate a carrier of frequency (fc)

4.23
Target
responds to Initiator command either using load modulation scheme (RF field generated by Initiator) or using modulation of self generated RF field

4.24
Time Period
defines the number of slots used for RF Collision Avoidance

4.25
Time Slot
method of preparing a time window when a Target answers, and assigning and identifying two or more logic channels

4.26
transaction
includes the initialization and the transparent data exchange between an Initiator and a Target either in the Active or the Passive communication mode

5 Conventions and notations

5.1 Representation of numbers

The following conventions and notations apply in this document unless otherwise stated.

— Letters and digits in parentheses represent numbers in hexadecimal notation.

— The setting of bits is denoted by ZERO or ONE.

— Numbers in binary notation and bit patterns are represented by strings of digits 0 and 1 shown with the most significant bit to the left. Within such strings, X may be used to indicate that the setting of a bit is not specified within the string.

5.2 Names

The names of basic elements, e.g. specific fields, are written with a capital initial letter.

6 Acronyms

ALL_REQ	Wake up ALL Request
ASK	Amplitude Shift Keying
ATR	Attribute Request and Attribute Response
ATR_REQ	Attribute Request
ATR_RES	Attribute Response
BCC	NFCID1 CL*n* check byte, calculated as exclusive-or over the 4 previous bytes
BCD	Binary Code Decimal
bd	Bit duration
BRi	Receiving bit duration supported by Initiator
BRt	Receiving bit duration supported by Target
BSi	Sending bit duration supported by Initiator
BSt	Sending bit duration supported by Target
CL*n*	Cascade Level n, $3 \geq n \geq 1$
CMD	Command
CRC	Cyclic Redundancy Check
CT	Cascade Tag
D	Divisor
DEP	Data Exchange Protocol Request and Data Exchange Protocol Response
DEP_REQ	Data Exchange Protocol Request
DEP_RES	Data Exchange Protocol Response
DIDi	Initiator Device ID
DIDt	Target Device ID
DRi	Data rate Received by initiator
DRt	Data rate Received by initiator
DSi	Data rate Send by initiator
DSL	Deselect Request and Deselect Response
DSL_REQ	Deselect Request
DSL_RES	Deselect Response
DSt	Data rate Send by Target
fc	Frequency of operating field (carrier frequency)
fd	Baseband frequency of Manchester coding
FRT	Frame Response Time
fs	Frequency of subcarrier (fc/16)
Gi	Optional information field for Initiator
Gt	Optional information field for Target
ID	Identification number
lsb	least significant bit

LSB	Least Significant Byte
MI	Multiple Information link for Data Exchange Protocol
msb	most significant bit
MSB	Most Significant Byte
NAD	Node Address
NFCID1	Random Identifier for single device detection in the Passive communication mode at 106 kbps
nfcid1*n*	Byte number *n* of NFCID1
NFCID2	Random ID for SDD in the Passive communication mode at 212 kbps and 424 kbps
nfcid2*n*	Byte number n of the Random Identifier NFCID2
NFCID3	Random ID for transport protocol activation
nfcid3*n*	Byte number n of the Random Identifier NFCID3
P	Odd parity bit
PA	Preamble
pdu	protocol data unit
PFB	Control information for transaction
PNI	Packet Number Information
PPi	Protocol Parameters used by Initiator
PPt	Protocol Parameters used by Target
PSL	Parameter Selection Request and Parameter Selection Response
PSL_REQ	Parameter Selection Request
PSL_RES	Parameter Selection Response
RF	Radio Frequency
RFCA	RF Collision Avoidance
RFU	Reserved for Future Use
RLS	Release Request and Release Response
RLS_REQ	Release Request
RLS_RES	Release Response
RWT	Response Waiting Time
SB	Start byte for data exchange protocol at 106 kbps
SDD	Single Device Detection
SDD_REQ	Single Device Detection Request command
SEL_CMD	Select Command byte
SEL_PAR	Select Parameter byte
SEL_REQ	Select Request command
SENS_REQ	Sense Request command
SENS_RES	Sense Response command
SLP_REQ	Sleep Request command
SYNC	Synchronous pattern
TO	Timeout value
WT	Waiting Time
WUP	Wakeup Request and Wakeup Response
WUP_REQ	Wakeup Request
WUP_RES	Wakeup Response

7 General

This International Standard defines both the Active and the Passive communication modes as follows:

In the Active communication mode, both the Initiator and the Target shall use their own RF field to enable communication. The Initiator starts the NFCIP-1 communication. The Target responds to an Initiator command in the Active communication mode using self-generated modulation of self-generated the RF field.

In the Passive communication mode, the Initiator generates the RF field and starts the communication. The Target responds to an Initiator command in the Passive communication mode using a load modulation scheme.

The communication over the RF interface in the Active and the Passive communication mode shall include modulation schemes, transfer speed and bit coding. In addition it shall include the start of communication, the end of communication, the bit and byte representation, the framing and error detection, the single device detection, the protocol and parameter selection and the data exchange and de-selection of Near Field Communication Interface and Protocol (NFCIP-1) devices.

All NFCIP-1 devices shall have communication capability on 106 kbps and may switch to another transfer speed or stay at 106 kbps. All NFCIP-1 devices shall have communication capability on 212 kbps and may switch to another transfer speed or stay at 212 kbps. All NFCIP-1 devices shall have communication capabilities on 424 kbps and may switch to another transfer speed or stay at 424 kbps.

The mode (Active or Passive) shall not be changed during one transaction until the deactivation of the Target or removal of the Target, even though the transfer speed of Initiator to Target and the transfer speed of the Target to the Initiator may not be the same. The change of transfer speed during one transaction may be performed by a parameter change procedure.

The transaction is started by device initialisation and terminated by device de-selection (or equivalent).

8 RF field

The carrier frequency of the RF field shall be 13,56 MHz.

The minimum unmodulated RF field shall be H_{min} and has a value of 1,5 A/m rms.

The maximum unmodulated RF field shall be H_{max} and has a value of 7,5 A/m rms.

This field shall be modulated during communication.

8.1 Passive Communication Mode

An Initiator shall produce a RF field to energise the target.

A Target shall operate continuously between H_{min} and H_{max}.

8.2 Active Communication Mode

An Initiator and a Target shall alternately generate a RF field of at least H_{min} and not exceeding H_{max} at manufacturer specified positions (operating volume).

8.3 External RF field threshold value

NFCIP-1 devices shall detect external RF fields at 13,56MHz with a value higher than $H_{Threshold}$ while performing external RF field detection.

The threshold value is $H_{Threshold}$ = 0,1875 A/m.

9 RF Signal Interface

9.1 Bit duration

The bit duration *bd* is calculated by the following formula:

$$1\ bd = 128/(D \times fc)$$

The values of the divisor D depend on the bit rate and are given by Table 1. The fc is the carrier frequency as defined in clause 8.

Table 1 — Definition of Divisor D

Communication Mode	kbps	Divisor D
active or passive	106	1
active or passive	212	2
active or passive	424	4
Active	847	8
Active	1 695	16
Active	3 390	32
Active	6 780	64

NOTE The Initiator for starting the communication chooses the initial bit rate.

9.2 Active communication mode

The specification of both from the Initiator to the Target and from the Target to the Initiator shall be identical.

9.2.1 106 kbps

9.2.1.1 Bit rate

The bit rate for the transmission during initialisation and single device detection shall be fc/128 (106 kbps).

9.2.1.2 Modulation

Communication from the Initiator to a Target and a Target to the Initiator for a bit rate of fc/128 shall use the modulation principle of ASK 100 % of the RF operating field to create a “Pulse” as shown in Figure 1.

The envelope of the field shall decrease monotonically to less than 5 % of its initial value $H_{INITIAL}$ and remain less than 5 % for more than t2. (See Table 2.) This envelope shall comply with Figure 1.

If the envelope of the 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 $H_{INITIAL}$.

Overshoots shall remain within 90 % and 110 % of $H_{INITIAL}$.

The Target shall detect the “End of Pulse” after the field exceeds 5 % of $H_{INITIAL}$ and before it exceeds 60 % of $H_{INITIAL}$. The “End of Pulse” is defined by t4 in Table 2. This definition applies to all modulation envelope timings.

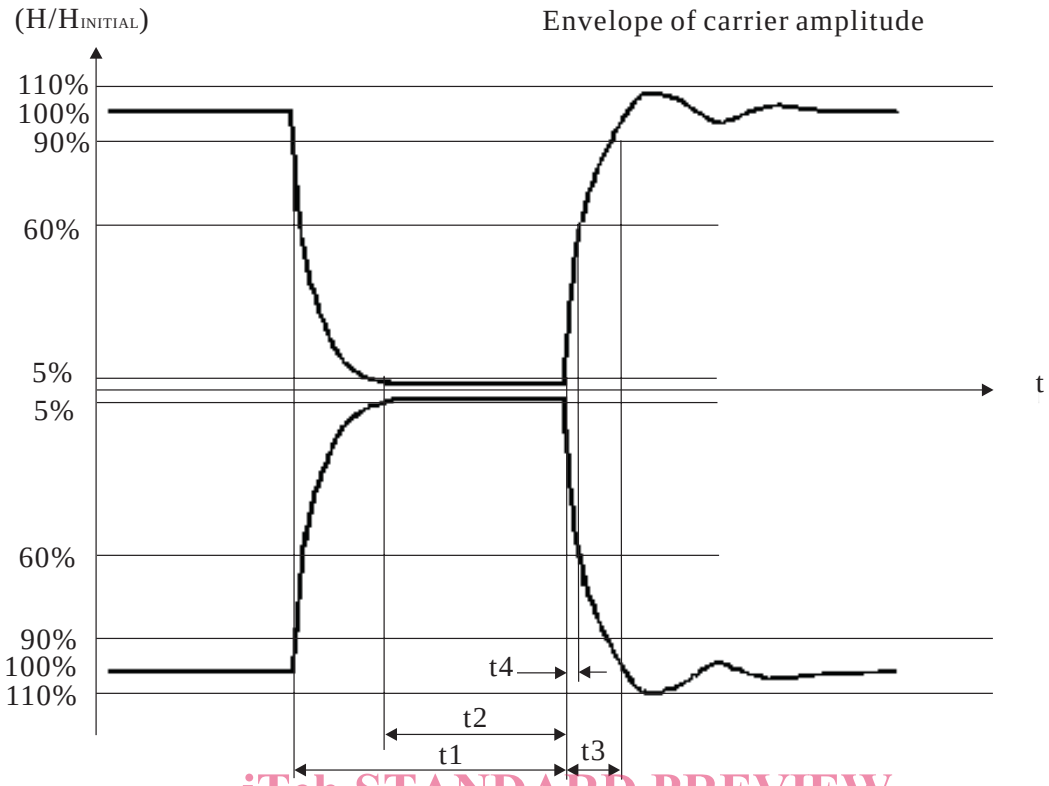

Figure 1 — Pulse shape

Table 2 — Pulse shape value

Pulses length (Condition)	t1 [µs]	t2 [µs] (t1 ⩽ 2,5)	t2 [µs] (t1 > 2,5)	t3 [µs]	t4 [µs]
Maximum	3,0	t1		1,5	0,4
Minimum	2,0	0,7	0,5	0,0	0,0

9.2.1.3 Bit representation and coding

The following coding shall be used:

— Start of communication: at the beginning of the bit duration a “Pulse” shall occur.

— ONE: after a time of half the bit duration a “Pulse” shall occur.

— ZERO: For the full bit duration no modulation shall occur with the following two exceptions:

  — If there are two or more contiguous ZEROs, from the second ZERO on a Pulse shall occur at the beginning of the bit duration.

  — If the first bit after a “start of communication” is ZERO, a ‘Pulse’ shall occur at the beginning of the bit duration.

— End of Communication: ZERO followed by one bit duration without modulation.

— No information: shall be coded with at least two full bit duration without modulation.

9.2.1.4 Byte encoding

The byte encoding shall be least significant bit (lsb) first.

9.2.2 212 kbps and 424 kbps

9.2.2.1 Bit rate

The bit rates for the transmission during initialisation and single device detection shall respectively be fc/64 (212 kbps) or fc/32 (424 kbps).

9.2.2.2 Modulation

The Initiator and the Target shall use the modulation of ASK with the modulation index of 8 % to 30 % of the operating field. The modulation waveform shall comply with Figure 2. The rising and falling edges of the modulation shall be monotonic. The modulation for the transmission during initialisation and single device detection shall be the same. *a* and *b* define the peak and the minimum signal amplitude. See 4.11.

Table 3 — Modulated waveform

	212 kbps	424 kbps
tf	2,0 µs max	1,0 µs max
tr	2,0 µs max	1,0 µs max
y	0,1 (*a* – *b*)	0,1 (*a* – *b*)
hf, hr	0,1 (*a* – *b*) max	0,1 (*a* – *b*) max

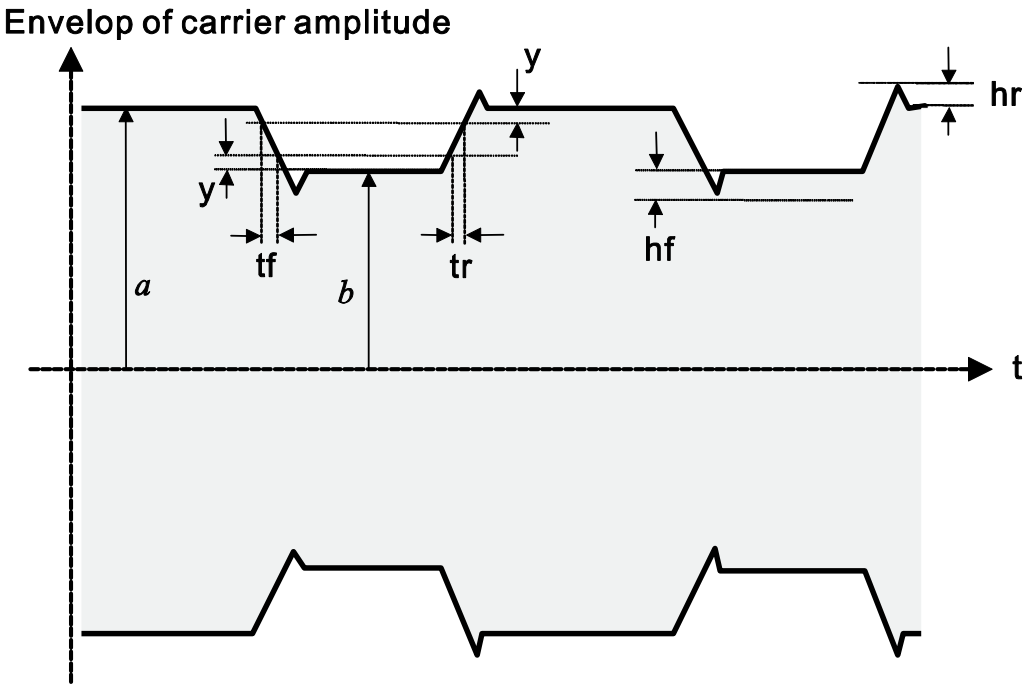

Figure 2 — Modulated Waveform