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

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 18092 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*.

This second edition cancels and replaces the first edition (ISO/IEC 18092:2004), which has been technically revised.

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 bit rates of 106, 212, and 424 kbit/s.

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

The first edition of ISO/IEC 18092:2004 was prepared by Ecma International (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. This second edition of ISO/IEC 18092 was maintained by JTC 1/SC 6 and Ecma International; it cancels and replaces the first edition (ISO/IEC 18092:2004), which has been technically revised with fully backward compatibility.

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 initialisation schemes and conditions required for data collision control during initialisation. 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.

It may also implement the NFC-SEC Option as specified in ISO/IEC 13157-1.

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*

ISO/IEC 13157-1:2010, *Information technology — Telecommunications and information exchange between systems — NFC Security — Part 1: NFC-SEC NFCIP-1 security services and protocol*

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

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

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

4 Terms and definitions

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

4.1
active communication mode
mode 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

4.3
Binary Coded Decimal
BCD
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 threshold value to detect an external RF field

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

4.12
modulation index
signal amplitude ratio of [*p*eak – *minimum]* / [*peak* + *minimum*]

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
entity [ISO/IEC 18092]

4.16
NFC Identifier
NFCIDn
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
NFC-SEC
NFCIP-1 Security Services and Protocol as specified in ISO/IEC 13157-1

4.18
passive communication mode
when the Initiator is generating the RF field and the Target responds to an Initiator command in a load modulation scheme

4.19
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

4.20
SAK
Select acknowledge [ISO/IEC 14443-3]

NOTE SAK replaces the SEL_RES [ISO/IEC 18092:2004].

4.21
sensing
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

4.22
Single Device Detection
SDD
algorithm used by the Initiator to detect one out of several Targets in its RF field (anti-collision [ISO/IEC 14443-3])

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
initialisation, data exchange and device de-selection

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 single quotation mark 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. For example (XXXX)b.

5.2 Names

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

6 Abbreviated terms

ALL_REQ	Wake up ALL Request
ATR	Attribute Request and Attribute Response
ATR_REQ	Attribute Request
ATR_RES	Attribute Response
BCD	Binary Code Decimal
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
CMD	Command
CRC	Cyclic Redundancy Check
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
etu	elementary time unit
fc	Frequency of operating field (carrier frequency)
fd	Baseband frequency of Manchester coding

fs [ISO/IEC 14443-2]	Subcarrier
FRT	Frame Response Time
Gi	Optional information field for Initiator
Gt	Optional information field for Target
HLTA [ISO/IEC 14443-3]	HaLT command, Type A
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	*fc*/128 UID
nfcid1*n*	Byte number *n* of NFCID1
NFCID2	Random ID for SDD in Passive communication mode at *fc*/64 and *fc*/32 bit rates
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
PCD	Proximity Coupling Device [ISO/IEC 14443-2]
pdu	protocol data unit
PFB	Control information for transaction
PICC	Proximity Card or object [ISO/IEC 14443-2]
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 *fc*/128
SDD	Single Device Detection (anti-collision)
SEL_CMD	Select Command byte
SYNC	Synchronisation pattern
TO	Timeout value
UID	Unique Identifier [ISO/IEC 14443-3]
WT	Waiting Time
WUP	Wakeup Request and Wakeup Response
WUP_REQ	Wakeup Request
WUP_RES	Wakeup Response

7 General

NFCIP-1 Targets and Initiators shall implement both the Active and the Passive communication modes.

In the Active communication mode, both the Initiator and the Target use their own RF field to communicate. The Initiator starts the NFCIP-1 transaction. The Target responds to an Initiator command in the Active communication mode by modulating its own RF field.

In the Passive communication mode, the Initiator generates the RF field and starts the transaction. The Target responds to an Initiator command in the Passive communication mode by modulating the Initiators' RF field which is referred to as load modulation.

This International Standard specifies requirements for modulation, bit rates and bit coding. In addition it specifies requirements for 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.

Transactions start with device initialisation and end with device de-selection. Initiators and Targets exchange commands, responses and data in alternating or half duplex communication.

NFCIP-1 devices are capable to start transactions at bit rates of *fc*/128, *fc*/64 and *fc*/32. Initiators select one of those bit rates to start a transaction and they may change the bit rate using PSL_REQ/PSL_RES commands during a transaction.

The mode (Active or Passive) shall not be changed during one transaction.

8 RF field

8.1 Values

fc is 13,56 MHz.

H_{min} is 1,5 A/m (rms).

H_{max} is 7,5 A/m (rms).

$H_{Threshold}$ is 0,1875 A/m (rms).

8.2 Passive communication Mode

The Initiator shall generate field strength of at least H_{min} and not exceeding H_{max} at manufacturer specified positions (i.e. operating volume) under un-modulated conditions.

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

8.3 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 (i.e. operating volume) under un-modulated conditions.

8.4 External RF field detection

NFCIP-1 devices shall detect external RF fields at *fc* with field strength higher than $H_{Threshold}$.

9 RF Signal Interface

9.1 Bit duration

One *etu* equals 128/(D × *fc*), where the values of the divisor D depend on the bit rate and communication mode, see Table 1.

Table 1 — Divisor D

Communication Mode	bit rate	Divisor D
active or passive	*fc*/128 (~106 kbit/s)	1
active or passive	*fc*/64 (~212 kbit/s)	2
active or passive	*fc*/32 (~424 kbit/s)	4
Active	*fc*/16 (~848 kbit/s)	8
Active	*fc*/8 (~1695 kbit/s)	16
Active	*fc*/4 (~3390 kbit/s)	32
Active	*fc*/2 (~6780 kbit/s)	64

NOTE 1 The Initiator selects the communication mode (either Active or Passive) and bit rate (*fc*/128, *fc*/64 or *fc*/32 specified by the following clauses).

NOTE 2 This Standard does not specify the modulation and the bit coding beyond the bit rate of *fc*/32.

9.2 Active communication mode

Targets and Initiators shall comply with the following specifications for both communication directions, i.e. Initiator to Target and Target to Initiator.

9.2.1 Requirements for *fc*/128

9.2.1.1 Bit rate

The bit rate for the transmission during initialisation and single device detection shall be *fc*/128.

9.2.1.2 Modulation

See 8.1.2.1 of ISO/IEC 14443-2. During transmission, both the Initiator and the Target shall conform to PCD values. During reception, both the Initiator and the Target shall conform to PICC values.

9.2.1.3 Bit representation and coding

See 8.1.3 of the ISO/IEC 14443-2 for a bit rate of *fc*/128.

9.2.1.4 Byte transmission

Initiators and targets shall transmit bytes with the lsb first.

9.2.2 Requirements for *fc*/64 and *fc*/32

9.2.2.1 Bit rates

The bit rates for the transmission during initialisation and single device detection shall respectively be *fc*/64 or *fc*/32.

9.2.2.2 Modulation

See 9.1.2 of ISO/IEC 14443-2 for the bit rate of *fc*/64 and *fc*/32. During transmission, both the Initiator and the Target shall apply the PCD values. During reception, both the Initiator and the Target shall apply the PICC values.

NOTE The modulation index range is stricter than that in ISO/IEC 18092:2004.

The Target should accept a modulation index range from 8 % to 30 % to operate with Initiators compliant to ISO/IEC 18092:2004 using a modulation index higher than 14 %.

9.2.2.3 Bit representation and coding

Manchester bit encoding shall be employed as illustrated in Figure 1 and Figure 2.

Bit coding format is Manchester with logic levels defined as:

— Logic “ZERO”: The first half of the bit duration is carrier low field amplitude, and the second half of the bit duration shall be carrier high field amplitude (no modulation applied).

— Logic “ONE”: The first half of the bit duration is carrier high field amplitude (no modulation applied), and the second half of the bit duration shall be carrier low field amplitude.

Reverse polarity in amplitude shall be permitted. Polarity shall be detected from the SYNC.

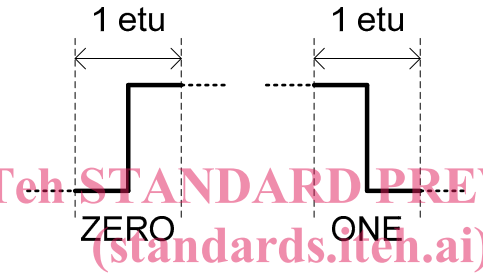

Figure 1 — Manchester bit encoding (obverse amplitude)

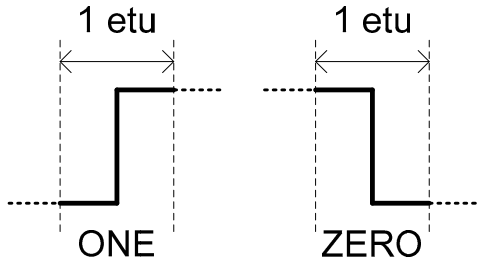

Figure 2 — Manchester bit encoding (reverse amplitude)

9.2.2.4 Byte transmission

Initiators and Targets shall transmit bytes with the msb first.

9.3 Passive communication mode

9.3.1 Initiator to Target requirements for *fc*/128

See 9.2.1.

9.3.2 Target to Initiator requirements for *fc*/128

9.3.2.1 Bit rate

See 9.2.1.1.

9.3.2.2 Modulation

See 8.2.2 of ISO/IEC 14443-2.

9.3.2.3 Subcarrier Frequency

See 8.2.3 of ISO/IEC 14443-2.

9.3.2.4 Subcarrier modulation

See 8.2.4 of ISO/IEC 14443-2 for a bit rate of *fc*/128.

9.3.2.5 Bit representation and coding

See 8.2.5.1 of ISO/IEC 14443-2.

9.3.2.6 Byte transmission

Initiators and Targets shall transmit bytes with the lsb first.

9.3.3 Initiator to Target requirements for *fc*/64 and *fc*/32

9.3.3.1 Bit rate

See 9.2.2.1.

9.3.3.2 Modulation

See 9.1.2 of ISO/IEC 14443-2 for the bit rate of *fc*/64 and *fc*/32. During transmission, the Initiator shall apply the PCD values.

NOTE The modulation index range is stricter than that in ISO/IEC 18092:2004.

9.3.3.3 Bit representation and coding

See 9.2.2.3.

9.3.3.4 Byte transmission

See 9.2.2.4.

9.3.4 Target to Initiator requirements for *fc*/64 and *fc*/32

9.3.4.1 Bit rate

See 9.2.2.1.