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

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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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 or www.iec.ch/members_experts/refdocs).

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

This third edition cancels and replaces the second edition (ISO/IEC 18092:2013), which has been technically revised. It also incorporates ISO/IEC 18092:2013/Cor 1:2015.

The main changes are as follows:

— adoption of near field communication (NFC) security standard for the Target;

— harmonization with the NFC Forum Digital Protocol Technical Specification[2] and Activity Technical Specification[3].

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

This document 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 (f_c/128, f_c/64 and f_c/32).

This allows, but does not specify, applications in network products and consumer equipment.

The first edition of ISO/IEC 18092 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/SC 6 in parallel with its approval by national bodies of ISO and IEC. The second edition of ISO/IEC 18092 was maintained by ISO/IEC JTC 1/SC 6 and Ecma International. This third edition of ISO/IEC 18092 is maintained by ISO/IEC JTC 1/SC 6 with the goal to be harmonized with the NFC Forum Digital Protocol Technical Specification[2] and Activity Technical Specification[3] maintaining backward compatibility, to enable the NFC security feature and to incorporate clarifications on timings of radio frequency (RF) field switched off.

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

1 Scope

This document defines:

— communication modes for Near Field Communication Interface and Protocol 1 (NFCIP-1) using inductive coupled devices operating at the centre frequency of 13,56 MHz for interconnection of computer peripherals;

— both the active and the passive communication modes of NFCIP-1 to realize a communication network using Near Field Communication (NFC) devices for networked products and for consumer equipment;

— a transport protocol including protocol activation and data exchange methods.

This document specifies:

— modulation schemes;

— codings;

— bit rates;

— frame format of the radio frequency (RF) interface;

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

Information interchange between systems is based on agreement between the interchange parties upon the interchange codes and the data structure.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

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

ISO/IEC 14443-2:2020, *Cards and security devices for personal identification — Contactless proximity objects — Part 2: Radio frequency power and signal interface*

ISO/IEC 14443-3:2018, *Cards and security devices for personal identification — Contactless proximity objects — Part 3: Initialization and anticollision*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 14443-2 and ISO/IEC 14443-3, and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
active communication mode
mode in which both the *Initiator* (3.5) and the *Target* (3.16) use their own radio frequency (RF) field to enable the communication

3.2
collision
transmission by two or more *Targets* (3.16) or *Initiators* (3.5) during the same *time period* (3.17), such that the Initiator or the Target is unable to distinguish from which Target the data originated

3.3
frame
sequence of data bits and optional error detection bits, with frame delimiters at start and end

3.4
$H_{\mathbf{Threshold}}$
threshold value to detect an external radio frequency (RF) field

3.5
Initiator
entity that generates the radio frequency (RF) field and starts the Near Field Communication Interface and Protocol (NFCIP-1) communication

3.6
load modulation
process of amplitude modulating a radio frequency (RF) field by varying the properties of a resonant circuit placed within the RF field

3.7
lsb first
least significant bit first
least significant bit first, indicating a serial data transmission system that sends lsb before all other bits

3.8
Manchester bit encoding
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

3.9
modulation index
signal amplitude ratio of the modulation to the level of the unmodulated carrier, calculated by:

$$[1 - b] / [1 + b]$$

where b is the ratio between the modulated amplitude and the initial signal amplitude

3.10
msb first
most significant bit first
serial data transmission system that sends the msb before all other bits

3.11
NFCIP-1 device
entity supporting the *active communication mode* (3.1) and the *passive communication mode* (3.13)

3.12
NFC identifier
NFCID*n* *(n = 1, 2 or 3)*
number used by the *Single Device Detection* (3.15) sequence for both the *Active communication mode* (3.1) and the *Passive communication mode* (3.13)

3.13
passive communication mode
mode when the *Initiator* (3.5) is generating the radio frequency (RF) field and the *Target* (3.16) responds to an Initiator command in a load modulation scheme

3.14
RF Collision Avoidance
RFCA
method to detect the presence of a radio frequency (RF) field based on the carrier frequency

3.15
Single Device Detection
SDD
algorithm used by the *Initiator* (3.5) to detect one out of several *Targets* (3.16) in its radio frequency (RF) field

3.16
Target
entity that responds to *Initiator* (3.5) command either using load modulation scheme (radio frequency (RF) field generated by Initiator) or using modulation of self-generated RF field

3.17
time period
number of slots used for *RF Collision Avoidance* (3.14)

3.18
time slot
method of preparing a time window when a *Target* (3.16) answers, and assigning and identifying two or more logic channels

4 Symbols and abbreviated terms

The abbreviated terms in ISO/IEC 14443-2 and ISO/IEC 14443-3, and the following apply.

ATR	Attribute
ATR_REQ	Attribute Request
ATR_RES	Attribute Response
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
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 Target
DSi	Data rate Send by Initiator
DSL	Deselect
DSL_REQ	Deselect Request
DSL_RES	Deselect Response
DSt	Data rate Send by Target
etu	elementary time unit
f_c	frequency of operating field (carrier frequency)
G(x)	generator polynomial for CRC generation
Gi	optional information field for Initiator
Gt	optional information field for Target
HLTA	HaLT command, Type A
H_{max}	maximum field strength of the Initiator antenna field
H_{min}	minimum field strength of the Initiator antenna field
$H_{Threshold}$	threshold value to detect an external radio frequency (RF) field
ID	identification number
LEN_{MAX}	maximum frame size
LRi	length reduction of Initiator
LRt	length reduction of Target
lsb	least significant bit
lsb first	least significant bit first
LSB	Least Significant Byte
MI	Multiple Information link for Data Exchange Protocol
msb	most significant bit
MSB	Most Significant Byte

NAD	Node Address
NFCID1	UID for SDD in Passive communication mode at $f_c/128$
NFCID2	ID for SDD in Passive communication mode at $f_c/64$ and $fc/32$
NFCID3	random ID for transport protocol activation
NFC-SEC	NFCIP-1 Security Services and Protocol (specified in ISO/IEC 13157-1)
PA	preamble
PCD	Proximity Coupling Device
pdu	protocol data unit
PFB	control information for transaction
PICC	proximity card or object
PNI	Packet Number Information
PPi	Protocol Parameters used by Initiator
PPt	Protocol Parameters used by Target
PSL	Parameter Selection
PSL_REQ	Parameter Selection Request
PSL_RES	Parameter Selection Response
RF	Radio Frequency
RFCA	RF Collision Avoidance
RFU	Reserved for Future Use
RLS	Release
RLS_REQ	Release Request
RLS_RES	Release Response
t_{RW}	Response Waiting Time
SAK	Select AcKnowledge
SB	start byte for data exchange protocol at $f_c/128$
SDD	Single Device Detection (anticollision)
SYNC	synchronisation pattern
TO	Time Out
UID	Unique Identifier
WT	Waiting Time
WUP	Wakeup

WUPA	Wake UP command, Type A
WUP_REQ	Wakeup Request
WUP_RES	Wakeup Response

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 marks 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, e.g. (XXXX)b.

5.2 Names

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

6 Conformance

A system implementing the active and the passive communication mode shall be in conformance with this document if it meets all the mandatory requirements specified herein.

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, which consists of initialisation, protocol activation, data exchange and optional device deactivation. 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 document 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 (SDD), the protocol activation and parameter selection and the data exchange and deactivation of NFCIP-1 devices.

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 $f_c/128$, $f_c/64$ and $f_c/32$. Initiators select one of those bit rates to start a transaction and they may change the bit rate using the parameter selection during a transaction.

The mode (active or passive) shall not be changed during a transaction.

8 RF field

8.1 Values

f_c is 13,56 MHz.

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

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

$H_{Threshold}$ is 0,187 5 A/m (rms).

8.2 Passive communication mode

The Initiator shall generate field strength of at least H_{min} and not exceeding H_{min} 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 an 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 f_c with field strength higher than $H_{Threshold}$.

9 RF signal interface

9.1 General

This clause specifies bit duration and RF signal interface requirements for active and passive communication modes.

NOTE Active and passive communication modes have also been adopted by NFC Forum, as shown in Reference [2] and [3].

9.2 Bit duration

One etu equals 128/(D × f_c), 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	f_c/128 (~106 kbit/s)	1
Active or Passive	f_c/64 (~212 kbit/s)	2
Active or Passive	f_c/32 (~424 kbit/s)	4
Active	f_c/16 (~848 kbit/s)	8
Active	f_c/8 (~1 695 kbit/s)	16
Active	f_c/4 (~3 390 kbit/s)	32
Active	f_c/2 (~6 780 kbit/s)	64

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

NOTE 2 This document does not specify the modulation and the bit coding beyond the bit rate of $f_c/32$.

9.3 Active communication mode

9.3.1 General

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

9.3.2 Requirements for $f_c/128$

9.3.2.1 Bit rate

The bit rate for the transmission during initialisation and SDD shall be $f_c/128$.

9.3.2.2 Modulation

The modulation shall be in accordance with ISO/IEC 14443-2:2020, 8.1.2 for a bit rate of $f_c/128$. 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.

9.3.2.3 Bit representation and coding

The bit representation and coding shall be in accordance with ISO/IEC 14443-2:2020, 8.1.3 for a bit rate of $f_c/128$.

9.3.2.4 Byte transmission

Initiators and targets shall transmit bytes with the lsb first.

9.3.3 Requirements for $f_c/64$ and $f_c/32$

9.3.3.1 Bit rates

The bit rates for the transmission during initialisation and SDD shall respectively be $f_c/64$ or $f_c/32$.

9.3.3.2 Modulation

The modulation shall be in accordance with ISO/IEC 14443-2:2020, 9.1.2 for the bit rate of $f_c/64$ and $f_c/32$. 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.

The Target should accept a modulation index range from 8 % to 30 % to operate with Initiators using a modulation index higher than 14 % for backward compatibility.

9.3.3.3 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.

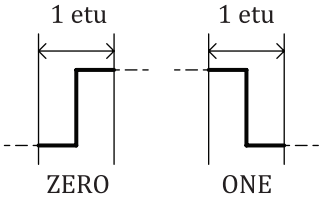

Figure 1 — Manchester bit encoding (obverse amplitude)

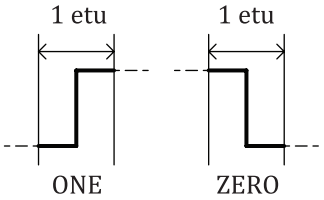

Figure 2 — Manchester bit encoding (reverse amplitude)

9.3.3.4 Byte transmission

Initiators and Targets shall transmit bytes with the msb first.

9.4 Passive communication mode

9.4.1 Requirements for $f_c/128$

9.4.1.1 Initiator to Target requirements

See 9.3.2.

9.4.1.2 Target to Initiator requirements

9.4.1.2.1 Bit rate

See 9.3.2.1.

9.4.1.2.2 Modulation

The modulation shall be in accordance with ISO/IEC 14443-2:2020, 8.2.2.

9.4.1.2.3 Subcarrier Frequency

The subcarrier frequency shall be in accordance with ISO/IEC 14443-2:2020, 8.2.3 for a bit rate of $f_c/128$.

9.4.1.2.4 Subcarrier modulation

The subcarrier modulation shall be in accordance with ISO/IEC 14443-2:2020, 8.2.4 for a bit rate of $f_c/128$.

9.4.1.2.5 Bit representation and coding

The bit representation and coding shall be in accordance with ISO/IEC 14443-2:2020, 8.2.6 for a bit rate of $f_c/128$.