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

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National foreword

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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.

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 second edition cancels and replaces the first edition (ISO/IEC 23917:2005), which has been technically revised.

The main changes are as follows:

— alignment with the latest edition of ISO/IEC 18092 (the base standard);

— improvement on descriptions of test procedures;

— correction of test scenarios.

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.

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

1 Scope

This document specifies protocol test methods for Near Field Communication Interface and Protocol 1 (NFCIP-1), as defined in ISO/IEC 18092 (the base standard).

The radio frequency (RF) test methods for NFCIP-1 (also defined in ISO/IEC 18092) are specified in ISO/IEC 22536.

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 10373-6, *Cards and security devices for personal identification — Test methods — Part 6: Contactless proximity objects*

ISO/IEC 18092:2023, *Telecommunications and information exchange between systems — Near Field Communication Interface and Protocol (NFCIP-1)*

ISO/IEC 22536, *Information technology — Telecommunications and information exchange between systems — Near Field Communication Interface and Protocol (NFCIP-1) — RF interface test methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 18092 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
activation in active communication mode
flow to activate the device under test (DUT) in *active communication mode* (3.3), which includes initialisation and protocol activation

3.2
activation in passive communication mode
flow to activate the device under test (DUT) in *passive communication mode* (3.5), which includes initialisation and protocol activation

3.3
active communication mode
mode in which both the Initiator and the Target use their own radio frequency (RF) field to enable the communication

[SOURCE: ISO/IEC 18092:2023, 3.1]

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3.4
operating volume
volume with a field strength of at least H_{min} and not exceeding H_{max} generated by a near field communication (NFC) device at manufacturer specified positions

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

[SOURCE: ISO/IEC 18092:2023, 3.17]

3.6
Single Device Detection
SDD
algorithm used by the Initiator to detect one out of several Targets in its radio frequency (RF) field

[SOURCE: ISO/IEC 18092:2023, 3.20]

3.7
scenario
protocol and application-specific sequence of test commands

Note 1 to entry: Scenario description tables list all individual *test commands* (3.8).

3.8
test commands
commands defined for dedicated functional behaviour on a device under test (DUT)

Note 1 to entry: Table 1 lists test commands.

3.9
transport protocol
protocol for data exchange between Initiator and Target, consisting of activation, data exchange and deactivation

Note 1 to entry: The transport protocol is defined in ISO/IEC 18092.

4 Symbols and abbreviated terms

The abbreviated terms in ISO/IEC 18092 and the following apply.

ATR_REQ	ATtribute Request command
ATR_RES	Response to the ATR_REQ
CRC	Cyclic Redundancy Check
~CRC	CRC as defined above with all bits inverted
DEP_REQ	Data Exchange Protocol Request
DEP_RES	Response to the Data Exchange Protocol Request
DID	Device ID
DSL_REQ	DeSeLect Request command
DSL_RES	Response to the DSL_REQ

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DUT	Device Under Test
f_c	Frequency of operating field (carrier frequency)
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 RF field
ID	Identification number
I/O	Input and Output
LT	Lower Tester, the Target-emulation part of the Initiator-Test-apparatus
Mute	No response within a specified timeout
NFCIP-1	Near field communication interface and protocol
PDU	Protocol Data Unit
PNI	Packet Number Information
POL_REQ	POLling Request command
POL_RES	Response to the POL_REQ
PSL_REQ	Parameter SeLect Request command
PSL_RES	Response to the PSL_REQ
RF	Radio Frequency
RFU	Reserved for Future Use
RLS_REQ	ReLease Request command
RLS_RES	Response to the RLS_REQ
RTO PDU	Response TimeOut extension
SAK	Select Acknowledge
SDD	Single Device Detection
t_d	The delay between the end of the Request frame and the start of the first time slot for SDD at $f_c/64$ and $f_c/32$ (equals $512 \times 64/f_c$)
t_s	The period of one time slot (equals $256 \times 64/f_c$)
t_{ADT}	Active delay time
t_{RFW}	RW waiting time
$t_{RF,OFF}$	the time between the start of the rising edge of the last modulation and the start of falling edge when the device turns off the RF field
TSN	Time Slot Number
UT	Upper Tester, the master part of the Initiator-Test-apparatus

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WUPA Wake-UP command, Type A

5 Notational conventions

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 is 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.

5.3 Test report

The test reports (Annexes A and B) include the number of passed tests versus the total number of tests, the number of different samples and the date of the tests (see Annexes A and B).

6 Conformance

A DUT conforms to the protocols specified in ISO/IEC 18092 when it meets the test requirements in this document.

7 Apparatus for testing

7.1 General

This clause is valid for Initiator and Target tests.

The test-apparatus may require information about the implemented protocol and functionality. These parameters shall be recorded in the test report.

Although this document does not define a dedicated test circuit for timing measurements and to check the correctness of the framing, the influence of such a circuit shall be avoided.

7.2 Generating the I/O character timing in reception mode

The target-test-apparatus and the lower tester (LT) shall be able to generate the I/O bit stream according to ISO/IEC 18092. All timing parameters (e.g. start bit length, guard time, bit width, request guard time, start of frame width, end of frame width) shall be set to any value within the defined ranges of ISO/IEC 18092. The limits shall be tested according to ISO/IEC 22536.

7.3 Measuring and monitoring the RF I/O protocol

The target-test-apparatus and the LT shall be able to measure the timing of the logical low and high states of the incoming demodulated data.

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7.4 Test scenario and report

Testing of the DUT as defined in this document requires a test scenario to be executed. A test scenario is defined as a protocol and application specific sequence of test commands.

The test commands are listed in Table 1. The test commands are specified based on PDUs specified in ISO/IEC 18092.

Table 1 — Test commands

Test command	Description
$A(ACK)_{xx}$	DEP_REQ or DEP_RES PDU coded as ACK/NACK PDU with ACK/NACK bit set to ZERO and PNI set to xx.
$A(NACK)_{xx}$	DEP_REQ or DEP_RES PDU coded as ACK/NACK PDU with ACK/NACK bit set to ONE and PNI set to xx.
S(A)	DEP_REQ or DEP_RES PDU coded as Supervisory PDU (as defined in ISO/IEC 18092) with the Timeout bit set to ZERO. No PNI is used for this command.
S(TO)	DEP_REQ or DEP_RES PDU coded as Supervisory PDU (as defined in ISO/IEC 18092) with the Timeout bit set to ONE. No PNI is used for this command.
$TEST_COMMAND1_{xx}$	Default Test command, it is a DEP_REQ frame coded as information PDU with "More Information" bit set to ZERO (no chaining) and the PNI set to xx. The Initiator or the target-test-apparatus sends this PDU.
$TEST_RESPONSE1_{xx}$	Response to TEST_COMMAND1 (DEP_RES) with the PNI set to xx.
$TEST_COMMAND2_{xx}$	Test command used for tests of the chaining procedure. This command forces the counterpart (either Initiator or Target) to use chaining in the next DEP_REQ. This command is a DEP_REQ or DEP_RES frame, for an Initiator or Target respectively, with its "More Information" bit set to ZERO and it uses the same PDU as TEST_COMMAND1, but this PDU has different data.
$TEST_COMMAND3B_{xx}$	The first part of a chaining command. This command marks the beginning of a DEP_REQ or DEP_RES frame, for an Initiator or Target respectively, with its "More Information" bit set to ONE and the PNI set to xx.
$TEST_COMMAND3n_{xx}$	The middle part of a chaining command. This command is sent after TEST_COMMAND3B and before TEST_COMMAND3E. The lowercase *n* represents a number ranging from 0 to 9. This command has the "More Information" bit set to ONE and the PNI set to xx.
$TEST_COMMAND3E_{xx}$	The last part of a chaining command. This command marks the end of the chaining procedure and is a DEP_REQ or DEP_RES frame, for an Initiator or Target respectively, with the "More Information" bit set to ZERO and the PNI set to xx.
$TEST_RESPONSE3_{xx}$	Response to a chaining command, which can be a DEP_REQ or DEP_RES frame, for an Initiator or Target respectively, with the "More Information" bit set to ZERO and the PNI set to xx.
$TEST_COMMAND4_{xx}$	Test command used for tests dealing with frame waiting time. The Initiator sends this command and forces the Target to use a Supervisory PDU with the timeout bit set to ONE and the PNI set to xx.
$TEST_RESPONSE4_{xx}$	Response to TEST_COMMAND4. It is a DEP_RES with the "More Information" bit set to ZERO and the PNI set to xx. It may be the same as TEST_RESPONSE1.
$TEST_COMMAND5_{xx}$	Test command used for tests of the deactivation. This command forces the Initiator to send a DSL_REQ. It is a DEP_RES with the "More Information" bit set to ZERO and the PNI set to xx.
$TEST_COMMAND6_{xx}$	Test command used for tests of the deactivation. This command forces the Initiator to send an RLS_REQ. It is a DEP_RES with the "More Information" bit set to ZERO and the PNI set to xx.

The PDUs that are actually used in these commands shall be recorded in the test report templates in Annexes A and B.

The result of the test scenario shall be documented in a test report as defined in Annexes A and B.

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7.5 RFU bits

A test shall fail and the DUT shall be declared non-compliant in case an RFU field is not set to its defined value.

7.6 General rules

The following rules apply:

— An Initiator (Target-test-apparatus) always sends a request, whereas a Target (LT) sends a response.

— A response shall follow a request.

— If the PNIs for the TEST_RESPONSE*n* and TEST_COMMAND*n* are the same, then TEST_COMMAND*n* is correct.

8 Target test methods

8.1 General

The DUT shall answer as specified in the scenarios, optionally inserting one or more RTO PDUs before responding with the PDU as specified in the scenarios.

8.2 Apparatus for testing the Target (Target-test-apparatus)

The Target-test-apparatus tests the DUT by emulating an Initiator.

The Target-test-apparatus shall execute the initialisation and protocol activation and perform data exchange commands.

8.3 List of protocol test methods related to ISO/IEC 18092

To test Targets performing initialisation and SDD in Passive communication mode at $f_c/128$, the PICC test methods of ISO/IEC 10373-6 and the test methods listed in Table 1 shall be executed.

Table 2 — Activation in Passive communication mode at fc/128

Test method		Corresponding requirement	
Clause in this document	Name	Base standard	Clause(s)
8.4.1	SDD for transport protocol activation	ISO/IEC 18092:2023	11.3.1

To test Targets performing initialisation and SDD in Passive communication mode at $f_c/64$ and $f_c/32$ the test methods listed in Table 2 shall be executed.

Table 3 — Activation in Passive communication mode at fc/64 and fc/32

Test method		Corresponding requirement	
Clause in this document	Name	Base standard	Clause(s)
8.5.1	Activation time	ISO/IEC 18092:2023	11.3.2.3
8.5.2	Frame format	ISO/IEC 18092: 2023	11.3.2.2
8.5.3	SDD timing	ISO/IEC 18092: 2023	11.3.2.3
8.5.4	SDD for transport protocol activation	ISO/IEC 18092: 2023	11.3.2.3 11.3.2.4

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To test Targets performing initialisation in Active communication mode, the test method in Table 3 shall be executed.

Table 4 — Activation in Active communication mode

Test method		Corresponding requirement	
Clause in this document	**Name**	**Base standard**	**Clause(s)**
8.6.1	RFCA	ISO/IEC 18092: 2023	11.2.3

To test Targets using the transport protocol, the test methods listed in Table 4 shall be executed.

Table 5 — Logical operation of the Transport Protocol

Test method		Corresponding requirement	
Clause in this document	**Name**	**Base standard**	**Clause(s)**
8.7.1	Handling of ATR_REQ	ISO/IEC 18092: 2023	12.6.1.3
8.7.2	Handling of PSL_REQ	ISO/IEC 18092: 2023	12.6.3.3
8.7.3	Handling of DEP_REQ Information PDUs	ISO/IEC 18092: 2023	12.7.1.2
8.7.4	Handling of DEP_REQ Information PDUs with the more information bit set to ONE	ISO/IEC 18092: 2023	12.7.1.3
8.7.5	Handling of DEP_REQ supervisory PDUs with timeout bit set to ONE	ISO/IEC 18092: 2023	12.7.1.3
8.7.6	Handling of DEP_REQ supervisory PDUs with timeout bit set to ZERO	ISO/IEC 18092: 2023	12.7.1.3
8.7.7	Handling of DSL_REQ	ISO/IEC 18092: 2023	12.8.2.3
8.7.8	Handling of RLS_REQ	ISO/IEC 18092: 2023	12.8.3.3
8.7.9	Handling of WUP_REQ (Active communication mode only)	ISO/IEC 18092: 2023	12.6.2.4

8.4 Activation in Passive communication mode at $f_c/128$

8.4.1 SDD for transport protocol activation

8.4.1.1 Purpose

The purpose of this test is to determine the activation of transport protocol when the Target supports the transport protocol (see ISO/IEC 18092: 2023, 11.3.1).

8.4.1.2 Procedure

Repeat steps a) to e) for the data rates of $f_c/128$.

a) Place the DUT into the operating volume.

b) Generate an RF field between the limits H_{min} and H_{max} and verify that the field strength does not influence the test results.

c) Perform SDD and receive a valid SAK with support of transport protocol.

d) Send an ATR_REQ command frame.

e) Verify that a valid ATR_RES frame is sent by the DUT.

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8.4.1.3 Test report

The test report shall indicate whether the DUT behaves correctly.

8.5 Activation in Passive communication mode at $f_c/64$ and $f_c/32$

8.5.1 Activation time

8.5.1.1 Purpose

The purpose of this test is to verify that the Target responds to a POL_REQ with a POL_RES within two seconds after power up (see ISO/IEC 18092: 2023, 11.3.2.3).

8.5.1.2 Procedure

Repeat steps a) to e) for the data rates of $f_c/64$ and $f_c/32$.

a) Place the DUT into the operating volume.

b) Generate an RF field between the limits H_{min} and H_{max} and verify that the field strength does not influence the test results.

c) Send a POL_REQ command frame with TSN is set to 0 at the selected data rate.

d) If there is no POL_RES received after t_d and t_s are passed, send the POL_REQ again. Repeat this step until a response from the DUT is received.

e) Measure the timing between RF-on and the beginning of the first response of the DUT. If the DUT responds in less than 2 sec, the test is PASS, otherwise it is FAIL.

8.5.1.3 Test report

The test report shall indicate whether the DUT behaves correctly for both data rates.

8.5.2 Frame format

8.5.2.1 Purpose

The purpose of this test is to determine that the frame formats at $f_c/64$ and $f_c/32$ are correct (see ISO/IEC 18092: 2023, 11.3.2.2).

8.5.2.2 Procedure

Repeat steps a) to d) for the data rates of $f_c/64$ and $f_c/32$.

a) Place the DUT into the operating volume.

b) Generate an RF field between the limits H_{min} and H_{max} and verify that the field strength does not influence the test results.

c) Send the POL_REQ command frame at the selected data rate.

d) Verify the correct framing of the response from the DUT.

8.5.2.3 Test report

The test report shall indicate whether the DUT behaves correctly for both data rates and shall include results for the characteristics as shown in Table 6.

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Table 6 — Expected results for characteristics of frame formats

Characteristic	Expected result
Preamble	minimum 48 bits all logical ZEROs
SYNC	1st byte is ´B2´ 2nd byte is ´4D´
value of the length byte	´12´
CRC bytes	according to ISO/IEC 18092: 2023, Annex A

8.5.3 SDD timing

8.5.3.1 Purpose

The purpose of this test is to determine the correct response to the POL_REQ (see ISO/IEC 18092: 2023, 11.3.2.3) in a timely manner.

8.5.3.2 Procedure

Repeat steps a) to f) for the data rates of $f_c/64$ and $f_c/32$. Initially TSN is set to 0.

a) Place the DUT into the operating volume.

b) Generate an RF field between the limits H_{min} and H_{max} and verify that the field strength does not influence the test results.

c) Send a POL_REQ command frame with TSN at the selected data rate.

d) Record the time between POL_REQ and POL_RES. If the DUT does not respond in the last time slot available repeat step c).

e) Analyse the content of the response.

f) Increase the TSN to the next allowed value and repeat steps a) to e) until the maximum TSN value is reached.

8.5.3.3 Test report

The test report shall indicate whether the DUT behaves correctly for both data rates and shall include results for the characteristics as shown in Table 7.

Table 7 — Expected result of characteristics of SDD timing

Characteristic	Expected result
1st byte of the payload	´01´
time between end of POL_REQ and end of POL_RES	t_d + (TSN + 1) * t_s

8.5.4 SDD for transport protocol activation

8.5.4.1 Purpose

The purpose of this test is to determine the activation of transport protocol when the Target supports the transport protocol (see ISO/IEC 18092: 2023, 11.3.2.3 and 11.3.2.4).

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8.5.4.2 Procedure

Repeat steps a) to g) for the data rates of $f_c/64$ and $f_c/32$. Initially TSN is set to 0.

a) Place the DUT into the operating volume.

b) Generate an RF field between the limits H_{min} and H_{max} and verify that the field strength does not influence the test results.

c) Send a POL_REQ command frame with TSN at the selected data rate.

d) Record the 6-byte number of POL_RES and the time between POL_REQ and POL_RES. If the DUT does not respond in the last time slot available repeat step c).

e) Analyse the content of the response.

f) If the 6-byte number of POL_RES is identical to the 6-byte number of POL_RES previously received, turn the RF field off and then repeat step a) to e).

g) Send an ATR_REQ command frame.

h) Verify that a valid ATR_RES frame is sent by the DUT.

8.5.4.3 Test report

The test report shall indicate whether the DUT behaves correctly for both data rates and shall include results for the characteristics as shown in Table 8.

Table 8 — Expected result of characteristics of SDD for transport protocol

Characteristic	Expected result
1st byte of the payload	´01´
2nd byte of the payload	´01´
3rd byte of the payload	´FE´

8.6 Activation in Active communication mode

8.6.1 RFCA

8.6.1.1 Purpose

The purpose of this test is to determine the behaviour of the DUT in Active communication mode during RFCA (see ISO/IEC 18092: 2023, 11.2.3).

8.6.1.2 Procedure

Repeat steps a) to g) for the data rates of $f_c/128$, $f_c/64$ and $f_c/32$.

a) Place the DUT into the operating volume.

b) Generate an RF field between the limits H_{min} and H_{max} and verify that the field strength does not influence the test results.

c) Send a valid ATR_REQ command frame at the selected data rate and switch off the RF afterwards.

d) Receive a valid ATR_RES frame at the selected data rate.

e) Measure the time between RF-off of the Target test-apparatus and RF-on of the DUT.

f) Measure the time between the start of the rising edge of the last modulation and RF-off of the DUT.

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