INTERNATIONAL STANDARD

ISO/IEC 10373-3

Second edition
2010-10-01

Identification cards — Test methods —

Part 3: Integrated circuit cards with contacts and related interface devices

Cartes d'identification — Méthodes d'essai —

Partie 3: Cartes à circuit(s) intégré(s) à contacts et dispositifs d'interface assimilés

Reference number
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Contents

Page

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 10373-3 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 17, *Cards and personal identification*.

This second edition cancels and replaces the first edition (ISO/IEC 10373-3:2001), which has been technically revised.

ISO/IEC 10373 consists of the following parts, under the general title *Identification cards — Test methods*:

— *Part 1: General characteristics*

— *Part 2: Cards with magnetic stripes*

— *Part 3: Integrated circuit cards with contacts and related interface devices*

— *Part 5: Optical memory cards*

— *Part 6: Proximity cards*

— *Part 7: Vicinity cards*

— *Part 8: USB-ICC*

The following part is under preparation:

— *Part 9: Optical memory cards: Holographic recording method*

Identification cards — Test methods —

Part 3:
Integrated circuit cards with contacts and related interface devices

1 Scope

This part of ISO/IEC 10373 defines test methods for characteristics of integrated circuit cards with contacts and related interface devices according to the definition given in ISO/IEC 7816. Each test method is cross-referenced to one or more base standards, which can be ISO/IEC 7810 or one or more of the supplementary International Standards that define the information storage technologies employed in identification card applications.

NOTE Criteria for acceptability do not form part of this part of ISO/IEC 10373 but will be found in the International Standards mentioned above.

This part of ISO/IEC 10373 defines test methods which are specific to integrated circuit technology with contacts. ISO/IEC 10373-1 defines test methods which are common to one or more card technologies and other parts define other technology-specific tests.

Test methods defined in this part of ISO/IEC 10373 are intended to be performed separately and independently. A given card is not required to pass through all the tests sequentially. The test methods defined in this part of ISO/IEC 10373 are based on ISO/IEC 7816-3.

Conformance of cards and IFDs determined using the test methods defined in this part of ISO/IEC 10373 does not preclude failures in the field. Reliability testing is outside the scope of this part of ISO/IEC 10373.

This part of ISO/IEC 10373 does not define any test to establish the complete functioning of integrated circuit cards. The test methods require only that the minimum functionality be verified. Minimum functionality is defined as follows.

— Any integrated circuit present in the card continues to show an Answer to Reset response which conforms to the base standard.

— Any contacts associated with any integrated circuit present in the card continue to show electrical resistance which conforms to the base standard.

2 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.

ISO/IEC 7810:2003, *Identification cards — Physical characteristics*

ISO/IEC 7816-3:2006, *Identification cards — Integrated circuit cards — Part 3: Cards with contacts — Electrical interface and transmission protocols*

ISO/IEC 7816-4:2005, *Identification cards — Integrated circuit cards — Part 4: Organization, security and commands for interchange*

3 Terms and definitions

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

3.1
card
integrated circuit card with contacts as defined in ISO/IEC 7816

3.2
DUT
device under test
card or IFD that is subject to testing

3.3
etu-factor
parameters negotiable by protocol and parameters selection (PPS), described in ISO/IEC 7816-3:2006, 6.3.1

3.4
IFD
interface device related to integrated circuit cards with contacts as defined in ISO/IEC 7816-3

3.5
normal use
use as an identification card, as defined in ISO/IEC 7810:2003, 4.1, involving equipment processes appropriate to the card technology and storage as a personal document between equipment processes

3.6
test method
method for testing characteristics of identification cards and related interface devices for the purpose of confirming their compliance with International Standards

3.7
test scenario
defined typical protocol and application specific communication to be used with the test methods defined in this part of ISO/IEC 10373

3.8
typical protocol and application specific communication
communication between a DUT and the corresponding test-apparatus based on protocol and application implemented in the DUT and representing its normal use

4 General items applicable to the test methods

4.1 Test environment

Unless otherwise specified, testing of physical, electrical and logical characteristics shall take place in an environment of temperature 23 °C ± 3 °C, of relative humidity 40 % to 60 %.

4.2 Pre-conditioning

Where pre-conditioning is required by the test method, the identification cards to be tested shall be conditioned to the test environment for a period of 24 h before testing unless otherwise specified.

4.3 Selection of test methods

Tests shall be applied as required to test the attributes of the card defined by the relevant base standard (see 4.8).

4.4 Default tolerance

Unless otherwise specified, a default tolerance of ± 5 % shall be applied to the quantity values given to specify the characteristics of the test equipment (e.g. linear dimensions) and the test method procedures (e.g. test equipment adjustments).

4.5 Total measurement uncertainty

The total measurement uncertainty for each quantity determined by these test methods shall be stated in the test report.

4.6 Conventions for electrical measurements

Potential differences are defined with respect to the GND contact of the card and currents flowing to the card are considered positive.

4.7 Apparatus

4.7.1 Apparatus for testing the integrated circuit cards with contacts (card-test-apparatus)

4.7.1.1 Generating the VCC voltage (U_{CC}) and timing

Table 1 — voltage and timing for VCC

Parameter	Operating Condition	Range	Accuracy
U_{CC}	Class A, B, C	-1 V to 6 V	± 20 mV
t_R, t_F	Class A, B, C	0 µs to 500 µs	± 100 µs

4.7.1.2 Measuring ICC

Table 2 — I_{CC} parameters

Characteristic	Mode	Range	Accuracy	Resolution
I_{CC}	Spike Measurement	0 mA to 200 mA	± 2 mA	20 ns
	Active mode	0 mA to 100 mA	± 1 mA	Averaged over 1 ms
	Clock stop	0 µA to 200 µA	± 10 µA	Averaged over 1 ms

4.7.1.3 Generating SPU (C6) voltage

See 5.5 and ISO/IEC 7816-3.

4.7.1.4 Generating the RST voltage and timing

Table 3 — RST voltage and timing

Parameter	Operating Condition	Range	Accuracy
U_{IH}, U_{IL}	Class A, B	-1 V to 6 V	± 20 mV
U_{IH}	Class C	-1 V to 2 V	± 20 mV
U_{IL}	Class C	-1 V to 1 V	± 20 mV
t_R, t_F		0 µs to 2 µs	± 20 ns
NOTE t_R and t_F are generated between 10% and 90% of V_H min and V_L max values.			

4.7.1.5 Measuring the RST current

Table 4 — RST current

Characteristic	Mode	Range	Accuracy	Resolution
I_{IH}	Active	-30 µA to 200 µA	± 10 µA	100 ns
I_{IL}	Active	-200 µA to 30 µA	± 10 µA	100 ns

4.7.1.6 Generating the I/O voltage and timing in reception mode

Table 5 — I/O voltage and timing

Parameter	Mode	Operating Condition	Range	Accuracy
U_{IH}, U_{IL}	Card: Reception, Apparatus: Transmission	Class A, B	-1 V to 6 V	± 20 mV
U_{IH}	Card: Reception, Apparatus: Transmission	Class C	-1 V to 2 V	± 20 mV
U_{IL}	Card: Reception, Apparatus: Transmission	Class C	-1 V to 1 V	± 20 mV
t_R, t_F	Card: Reception, Apparatus: Transmission		0 µs to 2 µs	± 100 ns
NOTE — t_R and t_F are generated between 10% and 90% of V_H min and V_L max values.				

4.7.1.7 Measuring the I/O current in reception mode

Table 6 — I/O current (reception mode)

Parameter	Mode	Range	Accuracy	Resolution
I_{IH}	Card: Reception, Apparatus: Transmission	-300 µA to 30 µA	± 10 µA	100 ns
I_{IL}	Card: Reception, Apparatus: Transmission	-1,5 mA to -0,2 mA	± 50 µA	100 ns
	Card: Reception, Apparatus: Transmission	-200 µA to 30 µA	± 10 µA	100 ns

4.7.1.8 Generating the I/O current

Table 7 — I/O current

Parameter	Mode	Range	Accuracy	Stabilization time after level is reached
I_{OH}	Card: Transmission Apparatus: Reception	20 kΩ pull-up to VCC or equivalent circuit	± 200 Ω	
I_{OL}	Card: Transmission Apparatus: Reception	0 mA to 1,5 mA	± 50 µA	< 100 ns

4.7.1.9 Measuring the I/O voltage and timing

Table 8 — I/O voltage and timing

Characteristic	Operating Condition	Range	Accuracy	Resolution
U_{IH}, U_{IL}	Class A, B, C	-1 V to 6 V	± 20 mV	20 ns
t_R, t_F		0 µs to 2 µs	± 20 ns	
NOTE — t_R and t_F are measured between 10% and 90% of V_H min and V_L max values.				

4.7.1.10 Generating the CLK voltage

Table 9 — CLK voltage

Parameter	Operating Condition	Range	Accuracy	Resolution
U_{IH}, U_{IL}	Class A, B	-1 V to 6 V	± 20 mV	20 ns
U_{IH}	Class C	-1 V to 2 V	± 20 mV	20 ns
U_{IL}	Class C	-1 V to 2 V	± 20 mV	20 ns

4.7.1.11 Generating the CLK waveforms (single cycle measurement)

Table 10 — CLK waveforms

Parameter	Range	Accuracy
Duty cycle	35 % to 65 % of period	± 5 ns
Frequency	0,5 MHz to 5,5 MHz	± 5 kHz
Frequency	5 MHz to 20,5 MHz	± 50 kHz
t_R, t_F	1 % to 10 % of period	± 5 ns
NOTE – t_R and t_F are generated between 10% and 90% of V_H (100%) min and V_L (0%) max.		

4.7.1.12 Measuring the CLK current

Table 11 — CLK current

Characteristic	Mode	Range	Accuracy	Resolution
I_{IH}	active	-30 µA to 150 µA	± 10 µA	20 ns
I_{IL}	active	-150 µA to 30 µA	± 10 µA	20 ns

4.7.1.13 Measuring the contact capacitance of RST, CLK and I/O

Table 12 — Contact capacitance

Characteristic	Range	Accuracy
C	0 pF to 50 pF	± 5 pF
The contact capacitance of a contact shall be measured between the contact and the GND contact.		

4.7.1.14 Generating the sequence of the activation and deactivation of the contacts

Table 13 — Activation and deactivation

Range of switching the signals	Accuracy
0 s to 1 s	± 200 ns (or 1 CLK period, whichever is smaller)

4.7.1.15 Emulating the I/O protocol

The card-test-apparatus shall be able to emulate the protocol T=0 and T=1 and IFD applications which are required to run the typical application specific communications corresponding to the card applications.

NOTE — If a specific functionality is not implemented in the card, the card-test-apparatus is not required to have the corresponding test-capability (e.g. T=1 protocol not implemented in the card).

4.7.1.16 Generating the I/O character timing in reception mode

The card-test-apparatus shall be able to generate the I/O bit stream according to ISO/IEC 7816-3.

All timing parameters like start bit length, guard time, error signaling etc. shall be configurable.

Table 14 — I/O character timing (reception mode)

Symbol	Parameter	Accuracy
ε_t	all timing parameters	± 4 CLK cycles

4.7.1.17 Measuring and monitoring the I/O protocol

The card-test-apparatus shall be able to measure and monitor the timing of the logical low and high states of the I/O-line relative to the CLK-frequency.

Table 15 — Timing characteristics

Characteristic	Accuracy
all timing characteristics	± 2 CLK cycles

4.7.1.18 Protocol Analysis

The card-test-apparatus shall be able to analyze the I/O-bit stream in accordance to T=0 and T=1 protocol according to ISO/IEC 7816-3 and extract the logical data flow for further protocol and application verifications.

NOTE If a specific functionality is not implemented in the card, the card-test-apparatus is not required to have the corresponding test-capability (e.g. T=1 protocol not implemented in the card). Conversely, an apparatus may need extended capabilities, e.g. being able to generate any case 2 command (see ISO/IEC 7816-4:2005) if a card does not support the standard READ BINARY.

4.7.2 Apparatus for testing the interface device (IFD-test-apparatus)

4.7.2.1 Generating the VCC current (I_{CC})

Table 16 — VCC current

Parameter	Mode	Range	Accuracy	Stabilization time after level is reached
I_{CC}	Spike Generation	0 mA to 120 mA	± 2 mA [b]	< 100 ns
	Active mode	0 mA to 70 mA	± 1 mA	< 100 ns
	Idle mode (CLK-Stop)	0 mA to 1,2 mA	± 10 µA	< 100 ns
	Inactive [a]	-1,2 mA to 0 mA	± 10 µA	< 100 ns
t_R, t_F		100 ns	± 50 ns	
pulse length		100 ns to 500 ns	± 50 ns	
pause length frequently		100 ns to 1000 ns	± 50 ns	
pause length randomly		10 µs to 2000 µs	± 1 µs	

[a] The maximum output voltage shall be limited to 5 V.

[b] Dynamic conditions for spike generation.

4.7.2.2 Measuring the VCC voltage (U_{CC}) and timing

Table 17 — VCC voltage and timing

Characteristic	Operating Condition	Range	Accuracy	Resolution
U_{CC}	Class A, B, C	- 1 V to 6 V	± 20 mV	10 ns

4.7.2.3 Measuring the SPU (C6) voltage (U_{CC}) and timing

Table 18 — SPU voltage and timing

Characteristic	Operating Condition	Range	Accuracy	Resolution
U_{CC}	Class A, B, C	- 1 V to 6 V	± 20 mV	10 ns

4.7.2.4 Generating the RST current

Table 19 — RST current

Parameter	Mode	Range	Accuracy	Stabilization time after level is reached
I_{IH}	active	- 30 µA to 200 µA	± 10 µA	< 100 ns
I_{IL}	active	- 250 µA to 30 µA	± 10 µA	< 100 ns
I [a]	inactive	- 1,2 mA to 0 mA	± 10 µA	< 100 ns
[a] The output voltage shall be limited from -0,5 V to 5,5 V.				

4.7.2.5 Measuring RST voltage and timing

Table 20 — RST voltage and timing

Characteristic	Operating Condition	Range	Accuracy	Resolution
U_{IH}, U_{IL}	Class A, B, C	-1 V to 6 V	± 20 mV	20 ns
t_R, t_F		0 µs to 2 µs	± 20 ns	
NOTE — t_R and t_F are measured between 10% and 90% of V_H min and V_L max values.				

4.7.2.6 Generating the I/O currents

Table 21 — I/O currents

Parameter	Mode	Range	Accuracy	Stabilization time after level is reached
I_{IH}, I_{OH}	Apparatus: Reception and Transmission IFD: Transmission and Reception	-400 µA to 50 µA	± 5 µA	< 100 ns
I_{IL}	Apparatus: Reception IFD: Transmission and Reception	0 mA to 1,5 mA	± 10 µA	< 100 ns
I_{OL}	IFD: Reception	0 µA to 1200 µA	± 10 µA	< 100 ns
I [a]	Inactive	- 1,2 mA to 0 mA	± 10 µA	< 100 ns
[a] The output voltage shall be limited to -0,5 V to 5,5 V.				

4.7.2.7 Measuring the I/O voltage and timing

Table 22 — I/O voltage and timing

Characteristic	Operating Condition	Range	Accuracy	Resolution
U_{IH}, U_{IL}	Class A, B, C	-1 V to 6 V	± 20 mV	20 ns
t_R, t_F		0 µs to 2 µs	± 20 ns	
NOTE — t_R and t_F are measured between 10% and 90% of V_H min and V_L max values.				

4.7.2.8 Generating the I/O voltage and timing in transmission mode

Table 23 — I/O voltage and timing (transmission mode)

Parameter	Mode	Operating Condition	Range	Accuracy
U_{IH}, U_{IL}	IFD: Reception, Apparatus: Transmission	Class A, B	-1 V to 6 V	± 20 mV
U_{IH}	IFD: Reception, Apparatus: Transmission	Class C	-1 V to 2 V	± 20 mV
U_{IL}	IFD: Reception, Apparatus: Transmission	Class C	-1 V to 1 V	± 20 mV
t_R, t_F	IFD: Reception, Apparatus: Transmission		0 µs to 2 µs	± 100 ns
NOTE — t_R and t_F are generated between 10% and 90% of V_H min and V_L max values.				

4.7.2.9 Measuring the I/O current in transmission mode

Table 24 — I/O current (transmission mode)

Parameter	Mode	Range	Accuracy	Resolution
I_{OL}	Transmission	0 µA to 1200 µA	± 10 µA	20 ns
I [a]	Inactive	0 mA to 1,2 mA	± 10 µA	20 ns
[a] The output voltage shall be limited to - 0,5 V to 5,5 V.				

4.7.2.10 Generating the CLK current

Table 25 — CLK current

Parameter	Mode	Range	Accuracy	Stabilization time after level is reached
I_{IH}	active	-30 µA to 150 µA	± 10 µA	< 20 ns
I_{IL}	active	-150 µA to 30 µA	± 10 µA	< 20 ns
I [a]	inactive	-1,2 mA to 0 mA	± 10 µA	< 100 ns
[a] The output voltage shall be limited to -0,5 V to 5,5 V.				

4.7.2.11 Measuring the CLK voltage and timing

Table 26 — CLK voltage and timing

Characteristic	Operating Condition	Range	Accuracy	Resolution
U_{IH}, U_{IL}	Class A, B, C	-1 V to 6 V	± 20 mV	20 ns

4.7.2.12 Measuring the CLK waveforms (single cycle measurement)

Table 27 — CLK waveforms

Characteristic	Range	Accuracy
Duty cycle [a]	35 % to 65 % of period	± 2,5 % of period
Frequency [b]	0,5 MHz to 20,5 MHz	± 2,5 % of period
t_R, t_F [c]	1 % to 10 % of period	± 2,5 % of period
The IFD-test-apparatus shall be able to check every cycle during the measurement.		
[a] Duty cycle shall be measured from 50% to 50% of V_H min (100%) and V_L max (0%) rising edge to rising edge. [b] Frequency shall be measured from 50% to 50% of the leading edges of two adjacent clock-cycles of V_H min (100%) and V_L max (0%) rising edge to rising edge. [c] t_R and t_F shall be measured between 10% and 90% of V_H (100%) min and V_L (0%) max.		

4.7.2.13 Measuring the contact capacitance between GND and I/O

Table 28 — Contact capacitance

Characteristic	Range	Accuracy
C	0 pF to 50 pF	± 5 pF

4.7.2.14 Emulating the I/O protocol

The IFD-test-apparatus shall be able to emulate the protocol T=0 and T=1 and card applications which are required to run the Test Scenario.

NOTE If a specific functionality is not implemented in the card, the card-test-apparatus is not required to have the corresponding test-capability (e.g. T=1 protocol not implemented in the card).

4.7.2.15 Generating the I/O character timing in transmission mode

The Test IFD-test-apparatus shall be able to generate the I/O bit stream according to ISO/IEC 7816-3 relative to the CLK-frequency.

All timing parameters like start bit length, guard time and error signaling etc. shall be configurable.

Table 29 — Timing parameters

Symbol	Parameter	Accuracy
ε_t	all timing parameters	± 4 CLK cycles

4.7.2.16 Measuring and monitoring the I/O protocol

The IFD-test-apparatus shall be able to measure and monitor the timing of the logical low and high states of the I/O-line relative to the CLK-frequency.

Table 30 — Timing characteristics

Characteristic	Accuracy
all timing characteristics	± 2 CLK cycles

4.7.2.17 Protocol Analysis

The Test IFD-test-apparatus shall be able to analyze the I/O-bit stream in accordance to T=0 and T=1 protocol according to ISO/IEC 7816-3 and extract the logical data flow for further protocol and application verifications.

NOTE — If a specific functionality is not implemented in the card, the IFD-test-apparatus is not required to have the corresponding test-capability (e.g. T=1 protocol not implemented in the card).

4.7.2.18 Overall Impedance (current and voltage sources inactive)

Table 31 — Impedeance

Contact	Resistance	Accuracy	Capacity	Accuracy
VCC	10 kΩ	± 1 kΩ	30 pF	± 6 pF
I/O	50 kΩ	± 5 kΩ	30 pF	± 6 pF
RST	50 kΩ	± 5 kΩ	30 pF	± 6 pF
CLK	50 kΩ	± 5 kΩ	30 pF	± 6 pF

4.7.3 Test Scenario

Testing of the DUT as defined in Clauses 6, 7, 8 and 9 requires a Test Scenario to be executed. This Test Scenario is a 'typical protocol and application specific communication', dependent from the protocol and application specific functionality foreseen for the normal use of and implemented in the DUT.

The Test Scenario shall be defined by the entity carrying out these tests and shall be documented with the test-results. The Test Scenario shall encompass a representative subset or preferably, if practical, the full functionality of the DUT expected to be utilized during normal use. The Test Scenario shall have a duration of at least 1 s.

NOTE — The testing entity may require information about the implemented protocol and functionality as well as the intended use of the DUT to enable the testing entity to define a Test Scenario.

4.8 Relationship of test methods versus base standard requirements

All relative voltage definitions (e.g. 0,7 × U_{CC}, 0,15 × U_{CC} or U_{CC} + 0,3 V) shall be determined relative to GND and checked against the simultaneously measured value of U_{CC}.

Table 32 — Test methods for electrical characteristics of cards with contacts

Test method from ISO/IEC 10373-3		Corresponding Requirement	
Clause	Name	Base Standard	Clause(s)
5.1	VCC contact	ISO/IEC 7816-3:2006	5.2.1
5.2	I/O contact	ISO/IEC 7816-3:2006	5.2.5
5.3	CLK contact	ISO/IEC 7816-3:2006	5.2.3
5.4	RST contact	ISO/IEC 7816-3:2006	5.2.2
5.5	SPU (C6) contact	ISO/IEC 7816-3:2006	5.2.4

Table 33 — Test methods for logical operations of cards with contacts — Answer to reset

Test method from ISO/IEC 10373-3		Corresponding Requirement	
Clause	Name	Base Standard	Clause(s)
6.1.1	Cold Reset and Answer-to-Reset (ATR)	ISO/IEC 7816-3:2006	6.2.1, 6.2.2, 7, 8
6.1.2	Warm Reset	ISO/IEC 7816-3:2006	6.2.3

Table 34 — Test methods for logical operations of cards with contacts — T=0 Protocol

Test method from ISO/IEC 10373-3		Corresponding Requirement	
Clause	Name	Base Standard	Clause(s)
6.2.1	I/O transmission timing for T=0 protocol	ISO/IEC 7816-3:2006	7.1, 7.2, 10.2
6.2.2	I/O character repetition for T=0 protocol	ISO/IEC 7816-3:2006	7.3, 10.2
6.2.3	I/O reception timing and error signaling for T=0 protocol	ISO/IEC 7816-3:2006	7.1, 7.2, 7.3, 10.2

Table 35 — Test methods for logical operations of cards with contacts — T=1 Protocol

Test method from ISO/IEC 10373-3		Corresponding Requirement	
Clause	Name	Base Standard	Clause(s)
6.3.1	I/O transmission timing for T=1 protocol	ISO/IEC 7816-3:2006	7.1, 7.2, 8.3, 11.2, 11.3, 11.4.2, 11.4.3
6.3.2	I/O reception timing for T=1 protocol	ISO/IEC 7816-3:2006	7.1, 7.2, 8.3, 11.2, 11.3, 11.4.2, 11.4.3
6.3.3	Character Waiting Time (*CWT*) behavior	ISO/IEC 7816-3:2006	11.4.3
6.3.4	card-reaction to IFD exceeding character waiting time (*CWT*)	ISO/IEC 7816-3:2006	11.4.3
6.3.5	Block Guard time (*BGT*)	ISO/IEC 7816-3:2006	11.4.3
6.3.6	Block sequencing by the card	ISO/IEC 7816-3:2006	11.6.3
6.3.7	Reaction of the card to protocol errors	ISO/IEC 7816-3:2006	11.6.3
6.3.8	Recovery of a transmission error by the card	ISO/IEC 7816-3:2006	11.6.3
6.3.9	Resynchronization	ISO/IEC 7816-3:2006	11.6.3
6.3.10	IFSD negotiation	ISO/IEC 7816-3:2006	11.4.2
6.3.11	Abortion by the IFD	ISO/IEC 7816-3:2006	11.6.3

Table 36 — Test methods for physical and electrical characteristics of the IFD

Test method from ISO/IEC 10373-3		Corresponding Requirement	
Clause	Name	Base Standard	Clause(s)
7.1	Activation of contacts	ISO/IEC 7816-3:2006	6.1, 6.2.1, 6.2.2
7.2	VCC contact	ISO/IEC 7816-3:2006	5.2.1
7.3	I/O contact	ISO/IEC 7816-3:2006	5.2.5
7.4	CLK contact	ISO/IEC 7816-3:2006	5.2.3
7.5	RST contact	ISO/IEC 7816-3:2006	5.2.2
7.6	SPU (C6) contact	ISO/IEC 7816-3:2006	5.2.4
7.7	Deactivation of the contacts	ISO/IEC 7816-3:2006	6.4

Table 37 — Test methods for logical operations of the IFD — Answer to reset

Test method from ISO/IEC 10373-3		Corresponding Requirement	
Clause	Name	Base Standard	Clause(s)
8.1.1	Card Reset (cold reset)	ISO/IEC 7816-3:2006	6.2.2
8.1.2	card Reset (warm reset)	ISO/IEC 7816-3:2006	6.2.3

Table 38 — Test methods for logical operations of the IFD — T=0 Protocol

Test method from ISO/IEC 10373-3		Corresponding Requirement	
Clause	Name	Base Standard	Clause(s)
8.2.1	I/O transmission timing for T=0 protocol	ISO/IEC 7816-3:2006	7.1, 7.2, 10.2
8.2.2	I/O character repetition for T=0 protocol	ISO/IEC 7816-3:2006	7.3, 10.2
8.2.3	I/O reception timing and error signaling for T=0 protocol	ISO/IEC 7816-3:2006	7.1, 7.2, 7.3, 10.2

Table 39 — Test methods for logical operations of the IFD — T=1 Protocol

Test method from ISO/IEC 10373-3		Corresponding Requirement	
Clause	Name	Base Standard	Clause(s)
8.3.1	I/O transmission timing for T=1 protocol	ISO/IEC 7816-3:2006	7.1, 7.2, 8.3, 11.2, 11.3, 11.4.2, 11.4.3
8.3.2	I/O reception timing for T=1 protocol	ISO/IEC 7816-3:2006	7.1, 7.2, 8.3, 11.2, 11.3, 11.4.2, 11.4.3
8.3.3	IFD Character Waiting Time (*CWT*) behavior	ISO/IEC 7816-3:2006	11.4.3
8.3.4	IFD-reaction to card exceeding *CWT*	ISO/IEC 7816-3:2006	11.4.3
8.3.5	Block Guard time (*BGT*)	ISO/IEC 7816-3:2006	11.4.3
8.3.6	Block sequencing by the IFD	ISO/IEC 7816-3:2006	11.6.3
8.3.7	Recovery of a transmission error by the IFD	ISO/IEC 7816-3:2006	11.6.3
8.3.8	IFSC negotiation	ISO/IEC 7816-3:2006	11.4.2
8.3.9	Abortion by the card	ISO/IEC 7816-3:2006	11.6.3

5 Test methods for electrical characteristics of cards with contacts

5.1 VCC contact

The purpose of this test is to measure the current consumed by the card on the VCC contact and to check if the card operates within the specified range of U_{CC} (see ISO/IEC 7816-3:2006, 5.2.1).

5.1.1 Apparatus

See 4.7.1

5.1.2 Procedure

Connect the card to the card-test-apparatus.

a) Set the following parameters in the card-test-apparatus (begin with lowest voltage class supported by the card):

Table 40 — Card-test apparatus parameters

Parameter	Setting
U_{CC}	U_{CC} min
f_{CLK}	f_{CLK} max [a]
[a] f_{CLK} max in accordance with ISO/IEC 7816-3:2006, 8.3	

b) Reset the card.

c) Run the Test Scenario. During this communication the following signals shall be continuously monitored and the following values determined:

Table 41 — Monitored signals

Characteristic	Value
I_{CC}	I_{CC} max

d) Perform a clock stop in accordance with ISO/IEC 7816-3:2006, 6.3.2 if supported by the card. During the clock stop the signals and values shown in Table 41 shall be continuously monitored and the values determined.

e) Restart f_{CLK} in accordance with ISO/IEC 7816-3:2006, 5.3.4.

f) Run the Test Scenario. During this communication the signals and values shown in Table 41 shall be continuously monitored and the values determined.

g) Repeat step b) to f) with U_{CC} = U_{CC} max.

h) Repeat test a) to g) for all voltage classes supported by the card.

5.1.3 Test report

Report the values determined in the procedure and whether all communications were in conformance with ISO/IEC 7816-3.

5.2 I/O contact

The purpose of this test is to measure the contact capacitance of the I/O contact, the I/O output voltages (U_{OH} , U_{OL}) under normal operating conditions (I_{OL} max/min and I_{OH} max/min), I/O t_R and t_F during transmission mode of the card and the I/O input current (I_{IL}) during reception mode of the card.

5.2.1 Apparatus

See 4.7.1

5.2.2 Procedure

Connect the card to the card-test-apparatus.

a) Measure the capacitance C_{IO} of the I/O-contact.

b) Set the following parameters in the card-test-apparatus (begin with lowest voltage class supported by the card):

Table 42 — Card-test apparatus parameters

Parameter	Setting
U_{CC}	U_{CC} max
U_{IH}	U_{IH} min
U_{IL}	U_{IL} min
I_{OH}	[a]
I_{OL}	I_{OL} max
t_R	t_R max
t_F	t_F max

[a] Instead of a current source for I_{OH} a 20 kΩ resistor to VCC or an equivalent circuit shall be used to prevent over voltage damages to the card.

c) Reset the card.

d) Run the Test Scenario. During this communication the following characteristics shall be continuously monitored and the following values determined:

Table 43 — Values to be determined

Characteristic	Value
I_{IH}	I_{IH} max
I_{IL}	I_{IL} max
U_{OH}	U_{OH} min, U_{OH} max
U_{OL}	U_{OL} min, U_{OL} max
t_R	t_R max
t_F	t_F max

e) Power down the card.

f) Set the card-test-apparatus to the parameters shown in Table 42.

g) Reset the card.

h) Run the Test Scenario. During this communication the characteristics and values shown in Table 43 shall be continuously monitored and the values determined.

i) Power down the card.

j) Repeat step b) to i) for all supported voltage classes.

5.2.3 Test report

Report the capacitance of the I/O-contact, the values determined in the procedure and whether all communications were in conformance with ISO/IEC 7816-3.

5.3 CLK contact

The purpose of this test is to measure the current consumed by the card on the CLK contact and to check if the card runs with the specified clock frequencies and waveforms (see ISO/IEC 7816-3:2006, 5.2.3, 8.3).

5.3.1 Apparatus

See 4.7.1

5.3.2 Procedure

Connect the card to the card-test-apparatus.

a) Measure the capacitance C_{CLK} of the CLK contact.

b) Set the following parameters in the card-test-apparatus (begin with lowest voltage class supported by the card):

Table 44 — Card-test apparatus parameters

Signal	Setting
U_{CC}	U_{CC} max
U_{IH}	U_{IH} min
U_{IL}	U_{IL} min
f_{CLK}	f_{CLK} min
Duty cycle	40 % high

c) Reset the card.

d) Set f_{CLK} to f_{CLK} max in accordance with ISO/IEC 7816-3:2006, 5.2.3, 8.3.

e) Run the Test Scenario. During this communication the following characteristics shall be continuously monitored and the following values determined:

Table 45 — Values to be determined

Characteristic	Value
I_{IH}	I_{IH} max
I_{IL}	I_{IL} max

f) Power down the card.

g) Set the card-test-apparatus to the parameters shown in Table 44.

h) Reset the card.

i) Run the Test Scenario. During this communication the characteristics and values shown in Table 45 shall be continuously monitored and the values determined.

j) Power down the card.

k) Repeat step b) to j) for all supported voltage classes.

5.3.3 Test report

Report the capacitance of the CLK contact, the values determined in the procedure and whether all communications were in conformance with ISO/IEC 7816-3.

5.4 RST contact

The purpose of this test is to measure the current consumed by the card on the RST contact and to check if the card runs with the allowed min and max timing values and voltages of a RST signal (see ISO/IEC 7816-3:2006, 5.2.2).

5.4.1 Apparatus

See 4.7.1

5.4.2 Procedure

Connect the card to the card-test-apparatus.

a) Measure the capacitance C_{RST} of the RST-contact.

b) Set the following parameters in the card-test-apparatus (begin with lowest voltage class supported by the card):

Table 46 — Card-test apparatus parameters

Parameter	Setting
U_{CC}	U_{CC} max
U_{IH}	U_{IH} min
U_{IL}	U_{IL} min
f_{CLK}	f_{CLK} min

c) Reset the card.

d) Run the Test Scenario. During this communication the following signals shall be continuously monitored and the following values determined:

Table 47 — Values to be determined

Characteristic	Value
I_{IH}	I_{IH} max
I_{IL}	I_{IL} max

e) Power down the card.

f) Set the card-test-apparatus to the parameters shown in Table 46.

g) Reset the card.

h) Run the Test Scenario. During this communication the characteristics and values shown in Table 47 shall be continuously monitored and the values determined.

i) Power down the card.

j) Repeat step b) to i) for all supported voltage classes.

5.4.3 Test report

The test report shall state the capacitance of the RST-contact, the values determined in the procedure and whether all communications were in conformance with ISO/IEC 7816-3.

5.5 SPU (C6) contact

There is no standard test that applies to the SPU (C6) contact. If this contact field is used in a proprietary application, then application specific tests should be applied.

6 Test methods for logical operations of cards with contacts

6.1 Answer to reset

6.1.1 Cold Reset and Answer-to-Reset (ATR)

The purpose of this test is to determine the behavior of the card during the cold reset procedure according to ISO/IEC 7816-3:2006, 6.2.2.

6.1.1.1 Apparatus

See 4.7.1

6.1.1.2 Procedure

Connect the card to the card-test-apparatus.

During the following procedure the contacts VCC, RST, CLK and I/O shall be continuously monitored and all signal transitions (level and timing) as well as the logical content of the communication shall be recorded.

a) Activate the card in accordance with ISO/IEC 7816-3:2006, 6.2.1.

b) Set RST to state H 400 clock-cycles after CLK was activated.

c) If the card reacts with sending an ATR, signal a transmission error in accordance with ISO/IEC 7816-3:2006, 7.3 for at least one character (randomly chosen) of the ATR.

d) Run the Test Scenario with the card.

e) Deactivate the card.

6.1.1.3 Test report

Report the signal recordings and the ATR.

6.1.2 Warm Reset

The purpose of this test is to determine the behavior of the card during the warm reset procedure according to ISO/IEC 7816-3:2006, 6.2.3.

6.1.2.1 Apparatus

See 4.7.1

6.1.2.2 Procedure

Connect the card to the card-test-apparatus.

During the following procedure the contacts VCC, RST, CLK and I/O shall be continuously monitored and all signal transitions (level and timing) as well as the logical content of the communication shall be recorded:

a) Activate and reset the card in accordance with ISO/IEC 7816-3:2006, 6.2.1 and 6.2.2.

b) Run the Test Scenario with the card.

c) Generate a warm reset with a duration of 400 clock-cycles in accordance with ISO/IEC 7816-3:2006, 6.2.3.

d) If the card reacts with sending an ATR, signal a transmission error in accordance with ISO/IEC 7816-3:2006, 7.3 for at least one character (randomly chosen) of the ATR.

e) Run the Test Scenario with the card.

f) Power down the card.

6.1.2.3 Test report

Report the signal recordings and the ATR.

6.2 T=0 Protocol

The subsequent tests are applicable only if the card supports the T=0 protocol.

Note – ε_t is defined in Table 14 — I/O character timing (reception mode).

6.2.1 I/O transmission timing for T=0 protocol

The purpose of this test is to determine the timing of the data transmitted by the card (see ISO/IEC 7816-3:2006, 7.1, 7.2, 10.2).

6.2.1.1 Apparatus

See 4.7.1

6.2.1.2 Procedure

Connect the card to the card-test-apparatus.

During the following procedure the contacts VCC, RST, CLK and I/O shall be continuously monitored and all signal transitions (level and timing) as well as the logical content of the communication shall be recorded:

a) Run the Test Scenario with the card with nominal bit-timing parameters (see ISO/IEC 7816-3:2006, 10.2).

b) Repeat a) with every provided etu-factor.

c) Repeat a) and b) for all provided applications.

6.2.1.3 Test report

Report the protocol recordings.

6.2.2 I/O character repetition for T=0 protocol

The purpose of this test is to determine use and timing of the character repetition by the card (see ISO/IEC 7816-3:2006, 7.3).

6.2.2.1 Apparatus

See 4.7.1

6.2.2.2 Procedure

Connect the card to the card-test-apparatus.

a) Run the Test Scenario with the card with nominal bit-timing parameters (see ISO/IEC 7816-3:2006, 10.2).

b) During the following part of the procedure the contacts VCC, RST, CLK and I/O shall be continuously monitored and all signal transitions (level and timing) as well as the logical content of the communication shall be recorded.

c) On each byte sent by the card generate five successive error conditions according to ISO/IEC 7816-3:2006, 7.3 with minimum duration (1 etu + ε_t) and minimum time between the leading edge of the start bit and the leading edge of the error signal ((10,5 - 0,2) etu + ε_t).

d) On each byte sent by the card generate five successive error conditions according to ISO/IEC 7816-3:2006, 7.3 with maximum duration (2 etu - ε_t) and maximum time between the leading edge of the start bit and the leading edge of the error signal ((10,5 + 0,2) etu - ε_t).

e) Repeat c) to d) for all provided ATRs (see class selection in ISO/IEC 7816-3:2006, 6.2.4).

6.2.2.3 Test report

Report the protocol recordings.

6.2.3 I/O reception timing and error signaling for T=0 protocol

The purpose of this test is to determine the reception timing and error signaling of the card (see ISO/IEC 7816-3:2006, 7.1, 7.2, 7.3, 10.2).

6.2.3.1 Apparatus

See 4.7.1

6.2.3.2 Procedure

Connect the card to the card-test-apparatus.

During the following procedure the contacts VCC, RST, CLK and I/O shall be continuously monitored and all signal transitions (level and timing) as well as the logical content of the communication shall be recorded.

a) Set the following bit-timing-parameters at the card-test-apparatus:

Table 48 — Card test apparatus bit timing parameters

Parameter	Value	See
Character frame length	maximum (tn = (n + 0,2) etu -ε_t)	ISO/IEC 7816-3:2006, Clause 7
Delay between two consecutive characters	9600 etu	Remark: No maximum value defined for the card in ISO/IEC 7816-3

b) Run the Test Scenario with the card.

c) Generate five consecutive parity errors for a single byte after which a single valid byte is transmitted, followed by five consecutive parity errors for the next single byte in the transmission.

d) Repeat a) to b) with every provided etu-factor.

e) Set the following bit-timing-parameters at the card-test-apparatus:

Table 49 — Card test apparatus bit timing apparatus

Parameter	Value	See
Character frame length	Minimum (tn = (n - 0,2) etu + ε_t)	ISO/IEC 7816-3:2006, Clause 7
Delay between two consecutive characters	12 etu + R $\times$ N/f + ε_t	ISO/IEC 7816-3:2006, Clause 7

f) Repeat b) to d).

g) Repeat a) to f) for all provided applications.

6.2.3.3 Test report

Report the protocol recordings.

6.3 T=1 Protocol

The subsequent test methods are applicable only if the card supports the T=1 protocol.

If an accidental transmission error occurs during a test, any error recovery procedure shall be performed according to ISO/IEC 7816-3:2006, 11.6.2.

NOTE Some of the subsequent descriptions of test methods contain scenarios to illustrate the described procedures. Some of these scenarios are based on the assumption that the card contains a transparent file with a length of 36 bytes and the content '31 32 33 34 …54 ', and understands I(0,0)(INF='00 B0 00 00 02') as READ BINARY 2 BYTES.

6.3.1 I/O transmission timing for T=1 protocol

The purpose of this test is to determine the timing of the data transmitted by the card (see ISO/IEC 7816-3:2006, 7.1, 7.2, 8.3, 11.2, 11.3, 11.4.2, 11.4.3).

6.3.1.1 Apparatus

See 4.7.1

6.3.1.2 Procedure

During the following procedure the contacts VCC, RST, CLK and I/O shall be continuously monitored and all signal transitions (level and timing) as well as the logical content of the communication shall be recorded:

a) Run a typical T=1 and application specific communication with the card for at least 1 s with nominal bit-timing parameters (see ISO/IEC 7816-3:2006, 11.2) and the minimum delay between two consecutive characters defined by N (see ISO/IEC 7816-3:2006, 8.3) in the ATR.

b) Repeat a) with every provided etu-factor.

c) Repeat a) to b) for each provided application.

6.3.1.3 Test report

Report the protocol recordings.

6.3.2 I/O reception timing for T=1 protocol

The purpose of this test is to determine the reception timing of the card using the T=1 Protocol (see ISO/IEC 7816-3:2006, 7.1, 7.2, 8.3, 11.2, 11.3, 11.4.2, 11.4.3).

6.3.2.1 Apparatus

See 4.7.1

6.3.2.2 Procedure

Connect the card to the card-test-apparatus.

During the following procedure the contacts VCC, RST, CLK and I/O shall be continuously monitored and all signal transitions (level and timing) as well as the logical content of the communication shall be recorded.

a) Set the following bit-timing-parameters at the card-test-apparatus:

Table 50 — Card-test apparatus bit timing parameters

Parameter	Value	See
Character frame length	Maximum (tn = (n + 0,2) etu - ε_t)	ISO/IEC 7816-3:2006, Clause 7
Guard time	Maximum	ISO/IEC 7816-3:2006, Clause 7, 11.4.3
Delay between two consecutive characters	(11 +2^{CWI}) etu - ε_t	ISO/IEC 7816-3:2006, 11.4.3

b) Run a typical T=1 and application specific communication with the card for at least 1 s.

c) Repeat a) to b) with every provided etu-factor.

d) Set the following bit-timing-parameters at the card-test-apparatus:

Table 51 — Card-test apparatus bit timing parameters

Parameter	Value	See
Character frame length	Minimum (tn = (n - 0,2) etu + ε_t)	ISO/IEC 7816-3:2006, Clause 7
Guard time	Minimum	ISO/IEC 7816-3:2006, Clause 7, 11.4.3
Delay between two consecutive characters	12 etu + R x N/f + ε_t	ISO/IEC 7816-3:2006, 8.3

e) Run a typical T=1 and application specific communication with the card for at least 1 s.

f) Repeat d) to e) with every provided etu-factor.

6.3.2.3 Test report

Report the protocol recordings.

6.3.3 Character Waiting Time (*CWT*) behavior

The purpose of this test is to determine the reaction of the card regarding *CWT* (see ISO/IEC 7816-3:2006, Clause 7, 11.4.3).

NOTE The notation used in the description of the procedure below is defined in ISO/IEC 7816-4:2005.

6.3.3.1 Apparatus

See 4.7.1

6.3.3.2 Procedure

Connect the card to the card-test-apparatus.

a) Be positioned in a transparent file made of at least 2 bytes.

b) Send a block of n bytes to the card with the *CWT* announced in the ATR.

c) Record presence, content and timing of the card response.

Scenario 1 — Character Waiting Time (*CWT*) behavior

card-test-apparatus		card
I(0,0)(INF†=’00 B0 00 00 02’)	⟶	
	⟵	card response
† INF FIELD of COMMAND is READ BINARY 2 BYTES		

6.3.3.3 Test report

Report the presence, the content and the timing of the card response.

6.3.4 card-reaction to IFD exceeding character waiting time (*CWT*)

The purpose of this test is to determine the reaction of the card on the IFD exceeding *CWT* (see ISO/IEC 7816-3:2006, 5.2.5, Clause 7, 11.2).

6.3.4.1 Apparatus

See 4.7.1

6.3.4.2 Procedure

Connect the card to the card-test-apparatus.

a) Send less than n bytes of a block of n bytes to the card.

b) Record the presence, the content and the timing of the card response.

NOTE The reaction of the card on possible collisions resulting from the interruption should be investigated.

6.3.4.3 Test report

Report the presence, the content and the timing of the card response.

6.3.5 Block Guard time (*BGT*)

The purpose of this test is to measure the time between the leading edges of two consecutive characters (*BGT*) sent in opposite directions (see ISO/IEC 7816-3:2006, 11.4.3).

6.3.5.1 Apparatus

See 4.7.1

6.3.5.2 Procedure

Connect the card to the card-test-apparatus.

6.3.5.2.1 Procedure 1

a) Be positioned in a transparent file made of at least 2 bytes.

b) Build a correct I-block

c) Send the I-block to the card.

d) The card should respond with a correct I-Block according to Rule 1.

Scenario 2 — Block Guard time (*BGT*), Procedure 1

card-test-apparatus		card
I(0,0)(INF = '00 B0 00 00 02')	⟶	
	⟵	I(0,0)(INF = '31 32 90 00')

e) Record the timing starting with the start bit of the last character from the card-test-apparatus up to the start bit of the first character of the card response.

6.3.5.2.2 Procedure 2

a) Be positioned in a transparent file made of at least 2 bytes.

b) Build an I-block with a wrong EDC (error detection character).

c) Send the I-block to the card.

d) The card should send correctly a negative acknowledgement R-block indicating an EDC error in its protocol control byte (PCB) according to Rule 7.1:

Scenario 3 — Block Guard time (*BGT*), Procedure 2

card-test-apparatus		card
I(0,0)(INF = '00 B0 00 00 02')(EDC = Wrong)	⟶	
	⟵	R(0)(PCB='81')

e) Record the timing starting with the start bit of the last character from the card-test-apparatus up to the start bit of the first character of the card response (see ISO/IEC 7816-3, 11.4.3).

6.3.5.3 Test report

Report the recorded timings.

6.3.6 Block sequencing by the card

The purpose of this test is to determine the reaction of the card to a transmission error (see ISO/IEC 7816-3:2006, 11.6.3).

Erroneous block: block which suffered a transmission error, i.e. one or more characters of wrong parity, or an error in the epilogue.

6.3.6.1 Apparatus

See 4.7.1

6.3.6.2 Procedure

Connect the card to the card-test-apparatus.

6.3.6.2.1 Procedure 1

a) Reset the card.

b) Send an erroneous block to the card.

c) If the card does not start sending a block within *BWT* or sends R(0) then send the correct block again.

Scenario 4 — Block sequencing by the card, Procedure 1

card-test-apparatus		card
I(0,0)(INF = ’00’)(EDC = Wrong)	→	
	←	R(0)(PCB=’81’)
I(0,0)(INF = ’00 B0 00 00 02’)	→	
	←	I(0,0)(INF = Response)

d) Record the response of the card.

6.3.6.2.2 Procedure 2

a) Reset the card.

b) Send block I(0,0) to the card, with the INF field containing a command supported by the card.

c) Wait for the answer of the card, and send an erroneous block to the card.

d) If the card does not start sending a block within *BWT* or sends R(1) with bit b1 of the PCB set to 1 then send the erroneous block again up to 3 times.

Scenario 5 — Block sequencing by the card, Procedure 2

card-test-apparatus		card
I(0,0)(INF = '00 B0 00 00 02')	→	
	←	I(0,0)(INF = '31 32 90 00')
I(1,0)(INF = '00')(EDC = Wrong)	→	
	←	R(1)(PCB='91')
I(1,0)(INF = '00')(EDC = Wrong)	→	
	←	R(1)(PCB='91')
I(1,0)(INF = '00')(EDC = Wrong)	→	
	←	card response

e) Record the response of the card including whether the card stays mute after receiving the last block or not.

6.3.6.2.3 Procedure 3 (with chaining)

a) Reset the card.

b) Send block I(0,1) to the card, with the INF field containing a command needing chaining supported by the card.

c) Wait for the answer of the card, and send an erroneous block to the card.

d) If the card does not start sending a block in *BWT* or sends R(1) with bit b1 of the PCB set to 1 then send the erroneous block again.

Scenario 6 — Block sequencing by the card, Procedure 3 (with chaining)

card-test-apparatus		card
I(0,1)(INF = Beginning of the command)	→	
	←	R(1)(PCB='90')
I(1,0)(INF = End of the command)(EDC = Wrong)	→	
	←	R(1)(PCB='91')
I(1,0)(INF = End of the command)(EDC = Wrong)	→	
	←	R(1)(PCB='91')
I(1,0)(INF = End of the command)	→	
	←	card response

e) Record the reaction of the card.

6.3.6.3 Test report

Report the reaction of the card for each procedure.

6.3.7 Reaction of the card to protocol errors

The purpose of this test is to analyze the reaction of the card to a protocol error (see ISO/IEC 7816-3:2006, 11.6.3).

Faulty block: Invalid block with unknown PCB encoding, or known PCB encoding with wrong N(S), N(R) or M, or PCB not matching with the expected block.

6.3.7.1 Apparatus

See 4.7.1

6.3.7.2 Procedure

Connect the card to the card-test-apparatus.

a) Reset the card.

b) Send a faulty block to the card.

c) If the card does not start sending a block within *BWT* or sends R(0) with bit b2 of the PCB set to 1 then send the correct block. If the card remains mute the test ends at this point.

Scenario 7 — Reaction of the card to protocol errors

card-test-apparatus		card
I(0,0)(INF = '00 B0 00 00 02')(PCB=Wrong)	→	
	←	R(0)(PCB='82') or mute card
I(0,0)(INF = '00 B0 00 00 02')	→	
	←	card response

This test may be repeated with different types of wrong PCB.

6.3.7.3 Test report

Report the reaction of the card.

6.3.8 Recovery of a transmission error by the card

The purpose of this test is to analyze the card reaction to a negative acknowledgement (see ISO/IEC 7816-3:2006, 11.6.3).

Negative acknowledgement: R-Block with N(R) out of sequence.

6.3.8.1 Apparatus

See 4.7.1

6.3.8.2 Procedure

Connect the card to the card-test-apparatus.

a) Reset the card.

b) Send block I(0,0) to the card, with the INF field containing a command supported by the card (Read Binary of two bytes without offset) and wait for the answer contained in block I(0,0) or I(1,0).

c) Send R(0) or R(1) to the card. Get the response from the card.

d) The card should repeat the I-block.

Scenario 8 — Recovery of a transmission error by the card

card-test-apparatus		card
I(0,0)(INF = '00 B0 00 00 02')	→	
	←	I(0,0)(INF = '31 32 90 00')
R(0)(PCB='81')	→	
	←	I(0,0)(INF = '31 32 90 00')
I(1,0)(INF = '00 B0 00 00 02')	→	
	←	I(1,0)(INF = '31 32 90 00')
R(1)(PCB='91')	→	
	←	I(1,0)(INF = '31 32 90 00')

6.3.8.3 Test report

Report the reaction of the card.

6.3.9 Resynchronization

The purpose of this test is to check the behavior of the card after a resynchronization (see ISO/IEC 7816-3:2006, 11.6.3).

6.3.9.1 Apparatus

See 4.7.1

6.3.9.2 Procedure

Connect the card to the card-test-apparatus.

a) Reset the card.

b) Exchange two I-blocks in each direction with a command supported by the card.

c) Send 2 negative acknowledgement blocks and then an S(RESYNCH request) block to the card.

d) Record the response of the card.

e) If the card sends S(RESYNCH response), send I(0,0) block.

f) Record the response of the card.

Scenario 9 — Resynchronization

card-test-apparatus		card
I(0,0)(INF = '00 B0 00 00 02')	→	
	←	I(0,0)(INF = '31 32 90 00')
I(1,0)(INF = '00 B0 00 00 03')	→	
	←	I(1,0)(INF = '31 32 33 90 00')
R(1)(PCB='91')	→	
	←	I(1,0)(INF = '31 32 33 90 00')
R(1)(PCB='91')	→	
	←	I(1,0)(INF = '31 32 33 90 00')
S(RESYNCH request)	→	
	←	S(RESYNCH response)
I(0,0)	→	
	←	card response

6.3.9.3 Test report

Report the reaction of the card.

6.3.10 IFSD negotiation

The purpose of this test is to check the IFSD negotiation (see ISO/IEC 7816-3:2006, 11.4.2).

6.3.10.1 Apparatus

See 4.7.1

6.3.10.2 Procedure

Connect the card to the card-test-apparatus.

a) Reset the card.

b) Exchange one I-block in each direction with a command supported by the card.

c) Send block S(IFS request) to the card.

Scenario 10 — IFSD negotiation

card-test-apparatus		card
I(0,0)(INF = '00 B0 00 00 02')	→	
	←	I(0,0)(INF = '31 32 90 00')
S(IFS request)	→	
	←	card response

d) Record the response of the card.

6.3.10.3 Test report

Report the response of the card.

6.3.11 Abortion by the IFD

The purpose of this test is to check the chaining abortion behavior of the card (see ISO/IEC 7816-3:2006, 11.6.3).

6.3.11.1 Apparatus

See 4.7.1

6.3.11.2 Procedure

a) Reset the card.

b) Exchange one I-block in each direction with a command supported by the card.

c) Send block I(1,1) to the card, with the INF field containing a command needing chaining supported by the card.

d) Wait for the answer of the card, and send S(ABORT request).

Scenario 11 — Abortion by the IFD

card-test-apparatus		card
I(0,0)(INF = '00 B0 00 00 02')	→	
	←	I(0,0)(INF = '31 32 90 00')
I(1,1)(INF = '00-B0')	→	
	←	R(0)(PCB='80')
S(ABORT request)	→	
	←	card response

e) Record the presence and content of a response of the card.

6.3.11.3 Test report

Report the presence and content of a response of the card.

7 Test methods for physical and electrical characteristics of the IFD

7.1 Activation of contacts

The purpose of this test is to determine the sequence of the activation of contacts during the activation of the card activation phase (see ISO/IEC 7816-3:2006, 6.1, 6.2.1, 6.2.2).

7.1.1 Apparatus

See 4.7.2

7.1.2 Procedure

Connect the IFD to the IFD-test-apparatus.

a) Measure level and timing of the signals on the IFD contacts for at least 1 s.

b) Activate the IFD.

c) Measure level and timing of the signals on the IFD contacts for at least 1 s.

The activities necessary to 'Activate the IFD' are very dependent on the construction of the IFD. They shall include all activities necessary until the IFD provides the 'Cold reset of the card' procedure as defined in ISO/IEC 7816-3:2006, 6.2.1.

7.1.3 Test report

Report the recorded levels and timing of the signals on all IFD contacts.

The value of 20 ns shall be used as the minimum delay between two subsequent signal transitions during the activation of contacts until a different value is defined in ISO/IEC 7816-3.

7.2 VCC contact

The purpose of this test is to measure the voltage provided by the IFD on the VCC contact (see ISO/IEC 7816-3:2006, 5.2.1).

7.2.1 Apparatus

See 4.7.2

7.2.2 Procedure

Connect the IFD to the IFD-test-apparatus.

a) Set the following parameters in the IFD-test-apparatus (begin with lowest voltage class supported by the IFD):

Table 52 — IFD test apparatus parameters

Parameter	Setting
I_{CC}	I_{CC} min

b) Activate the IFD.

c) The IFD resets the IFD-test-apparatus (ISO/IEC 7816-3:2006, 6.2.2).

d) Generate an ATR with the following parameters:

Table 53 — ATR parameters

Parameter	Setting	See
Fi	Lowest available value	ISO/IEC 7816-3:2006, 8.3
X	'11'	ISO/IEC 7816-3:2006, 8.3

e) If the IFD generates a PPS, then transmit a PPS response with the requested parameters.

f) Let the IFD run the Test Scenario with the IFD-test-apparatus. During the whole communication generate current spikes randomly from 1 kHz to 100 kHz within the range defined in ISO/IEC 7816-3:2006, 5.2.1. During this communication the following signals shall be continuously monitored and the following values determined:

Table 54 — Values to be determined

Characteristic	Value
U_{CC}	U_{CC} min, U_{CC} max

g) If the IFD generates a clock stop (see ISO/IEC 7816-3:2006, 6.3.2), set parameter I_{CC} at the IFD-test-apparatus to I_{CC} max for the time of the clock stop. During the clock stop the signals shall be continuously monitored and the values shown in Table 54 determined.

h) Deactivate the IFD.

i) Set the following parameters in the IFD-test-apparatus (begin with lowest voltage class supported by the IFD):

Table 55 — IFD test apparatus parameters

Parameter	Setting
I_{CC}	I_{CC} max

j) Activate the IFD.

k) The IFD resets the IFD-test-apparatus (ISO/IEC 7816-3:2006, 6.2.2).

l) Generate an ATR with the following parameters:

Table 56 — ATR parameters

Parameter	Setting	See
Fi	Highest available value	ISO/IEC 7816-3:2006, 8.3
X	'11'	ISO/IEC 7816-3:2006, 8.3

m) If the IFD generates a PPS, then transmit a PPS response with the requested parameters.

n) Let the IFD run the Test Scenario with the IFD-test-apparatus. During the whole communication generate current spikes randomly from 1 kHz to 100 kHz within the range defined in ISO/IEC 7816-3:2006, 5.2.1. During this communication the signals shall be continuously monitored and the values shown in Table 54 determined.

o) If the IFD generates a clock stop (see ISO/IEC 7816-3:2006, 6.3.2), set parameter I_{CC} at the IFD-test-apparatus to I_{CC} max for the time of the clock stop. During the clock stop the following signals shall be continuously monitored and the values shown in Table 54 determined.

p) Deactivate the IFD.

q) Repeat step a) to p) for all voltage classes supported by the IFD.

7.2.3 Test report

Report the determined values U_{CC} min, U_{CC} max for all scenarios above together with the measurement conditions (I_{CC} and *Fi*).

7.3 I/O contact

The purpose of this test is to measure the contact capacitance of the I/O contact, the I/O output voltages (U_{OH}, U_{OL}) under normal operating conditions (I_{OL} max/min and I_{OH} max/min), I/O t_R and t_F during transmission mode of the IFD and the I/O input current (I_{IL}) during reception mode of the IFD.

7.3.1 Apparatus

See 4.7.2

7.3.2 Procedure

Connect the IFD to the IFD-test-apparatus.

a) Measure the capacitance C_{IO} of the I/O-contact.

b) Set the following parameters in the IFD-test-apparatus (begin with lowest voltage class supported by the IFD):

Table 57 — IFD test apparatus parameters

Parameter	Setting
I_{CC}	I_{CC} max
I_{IH}	I_{IH} max
I_{IL}	I_{IL} max
U_{OH}	U_{OH} min
U_{OL}	U_{OL} max
t_R	t_R min
t_F	t_F min

c) Activate the IFD.

d) The IFD resets the IFD-test-apparatus (ISO/IEC 7816-3:2006, 6.2.2).

e) Generate an ATR.

f) Let the IFD run the Test Scenario with the IFD-test-apparatus. During this communication the following characteristics shall be continuously monitored and the following values determined:

Table 58 — Values to be determined

Characteristic	Value
U_{IH}	U_{IH} min, U_{IH} max
U_{IL}	U_{IL} min, U_{IL} max
I_{OH}	I_{OH} max
I_{OL}	I_{OL} max
t_R	t_R max
t_F	t_F max

g) Deactivate the IFD.

h) Set the following parameters in the IFD-test-apparatus (begin with lowest voltage class supported by the IFD) as shown in Table 59:

Table 59 — IFD test apparatus parameters

Parameter	Setting
I_{CC}	I_{CC} max
I_{IH}	I_{IH} min
I_{IL}	I_{IL} min
U_{OH}	U_{OH} min
U_{OL}	U_{OL} min
t_R	t_R max
t_F	t_F max

i) Reset the card.

j) Run the Test Scenario. During this communication the following characteristics shall be continuously monitored and the values shown in Table 58 determined.

k) Deactivate the IFD.

l) Repeat step b) to k) for all supported voltage classes.

7.3.3 Test report

The test report shall state the capacitance of the I/O contact, the values determined in the procedure and whether all communications were in conformance with ISO/IEC 7816-3.

7.4 CLK contact

The purpose of this test is to determine the characteristics of the CLK signal (see ISO/IEC 7816-3:2006, 5.2.3).

7.4.1 Apparatus

See 4.7.2

7.4.2 Procedure

Connect the IFD to the IFD-test-apparatus.

a) Set the following parameters in the IFD-test-apparatus (begin with lowest voltage class supported by the IFD).

Table 60 — IFD test apparatus parameters

Parameter	Setting
I_{CC}	I_{CC} max
I_{IH}	I_{IH} max
I_{IL}	I_{IL} max

b) Activate the IFD.

c) The IFD resets the IFD-test-apparatus (ISO/IEC 7816-3:2006, 6.2.2).

d) Generate an ATR with the following parameters:

Table 61 — ATR parameters

Parameter	Setting	See
Fi	*Fi* max	ISO/IEC 7816-3:2006, 8.3
Di	*Di* min	ISO/IEC 7816-3:2006, 8.3

e) If the IFD generates a PPS, then transmit a PPS response with the requested parameters.

f) Let the IFD run the Test Scenario with the IFD-test-apparatus. During this communication the following characteristics shall be continuously monitored and the following values determined:

Table 62 — Values to be determined

Characteristic (CLK)	Value
U_{IH}	U_{IH} min, U_{IH} max
U_{IL}	U_{IL} min, U_{IL} max
t_R	t_R max
t_F	t_F max
Duty Cycle	min, max

g) Deactivate the IFD.

h) Set the parameters in the IFD-test-apparatus (begin with lowest voltage class supported by the IFD) as shown in Table 63.

Table 63 — IFD test apparatus parameters

Parameter	Setting
I_{CC}	I_{CC} max
I_{IH}	I_{IH} min
I_{IL}	I_{IL} min

i) Activate the IFD.

j) The IFD resets the IFD-test-apparatus (ISO/IEC 7816-3:2006, 6.2.2).

k) Generate an ATR with the parameters shown in Table 61.

l) If the IFD generates a PPS, then transmit a PPS response with the requested parameters.

m) Let the IFD run the Test Scenario with the IFD-test-apparatus. During this communication the characteristics shall be continuously monitored and the values shown in Table 62 determined.

n) Deactivate the IFD.

o) Repeat step a) to n) for all supported voltage classes.

7.4.3 Test report

The test report shall state the values determined in the procedure, the corresponding parameters and whether all communications were in conformance with ISO/IEC 7816-3.

7.5 RST contact

The purpose of this test is to determine the characteristics of the RST signal (see ISO/IEC 7816-3:2006, 5.2.2).

7.5.1 Apparatus

See 4.7.2

7.5.2 Procedure

Connect the IFD to the IFD-test-apparatus.

a) Set the following parameters in the IFD-test-apparatus (begin with lowest voltage class supported by the IFD):

Table 64 — IFD test apparatus parameters

Parameter	Setting
I_{CC}	I_{CC} max
I_{IH}	I_{IH} max
I_{IL}	I_{IL} max

b) Activate the IFD.

c) The IFD resets the IFD-test-apparatus (ISO/IEC 7816-3:2006, 6.2.2).

d) Generate an ATR.

e) If the IFD generates a PPS, then transmit a PPS response with the requested parameters.

f) Let the IFD run the Test Scenario with the IFD-test-apparatus. During this communication the following characteristics shall be continuously monitored and the following values determined:

Table 65 — Values to be determined

Characteristic (RST)	Value
U_{IH}	U_{IH} min, U_{IH} max
U_{IL}	U_{IL} min, U_{IL} max
t_R	t_R max
t_F	t_F max

g) Deactivate the IFD.

h) Set the parameters in the IFD-test-apparatus (begin with lowest voltage class supported by the IFD) as shown in Table 66:

Table 66 — IFD test apparatus parameters

Parameter	Setting
I_{CC}	I_{CC} max
I_{IH}	I_{IH} min
I_{IL}	I_{IL} min

i) Activate the IFD.

j) The IFD resets the IFD-test-apparatus (ISO/IEC 7816-3:2006, 6.2.2).

k) Generate an ATR.

l) If the IFD generates a PPS, then transmit a PPS response with the requested parameters.

m) Let the IFD run the Test Scenario with the IFD-test-apparatus. During this communication the characteristics and values shown in Table 65 shall be continuously monitored and the values determined.

n) Deactivate the IFD.

o) Repeat step a) to n) for all supported voltage classes.

7.5.3 Test report

Report the values determined in the procedure and the corresponding parameters.

7.6 SPU (C6) contact

This test shall only be applied when SPU (C6) in the card is not electrically isolated. The purpose of this test is to measure the voltage provided by the IFD on the SPU (C6) contact (see ISO/IEC 7816-3:2006, 5.2.4).

7.7 Deactivation of the contacts

The purpose of this test is to determine the deactivation sequence of the contacts by the IFD (see ISO/IEC 7816-3:2006, 6.4).

7.7.1 Apparatus

See 4.7.2

7.7.2 Procedure

Connect the IFD to the IFD-test-apparatus.

a) Activate the IFD.

b) The IFD resets the IFD-test-apparatus (ISO/IEC 7816-3:2006, 6.2.2).

c) Generate an ATR.

d) If the IFD generates a PPS, then transmit a PPS response with the requested parameters.

e) Let the IFD run the Test Scenario with the IFD-test-apparatus. For every deactivation procedure during or at the end of the communication, starting with the falling edge of the RST-signal, continuously monitor the contacts VCC, RST, CLK and I/O and record voltage and timing of all signal transitions on these contacts.

The value of 20 ns shall be used as the minimum delay between two subsequent signal transitions during the activation of contacts until a different value is defined in ISO/IEC 7816-3.

7.7.3 Test report

Report the recorded levels and timing of the signals on all IFD contacts.

8 Test methods for logical operations of the IFD

8.1 Answer to reset

8.1.1 Card Reset (cold reset)

The purpose of this test is to determine the cold reset provided by the IFD (see ISO/IEC 7816-3:2006, 6.2.2).

8.1.1.1 Apparatus

See 4.7.2

8.1.1.2 Procedure

Connect the IFD to the IFD-test-apparatus.

a) Activate the IFD.

b) Continuously monitor the RST signal and determine the timing (relative to the CLK-signal) and voltage of all transitions on the RST contact for at least 1 s.

8.1.1.3 Test report

Report voltage and timing of all signal transitions on the RST contact.

8.1.2 card Reset (warm reset)

The purpose of this test is to determine the warm reset provided by the IFD (see ISO/IEC 7816-3:2006, 6.2.3).

8.1.2.1 Apparatus

See 4.7.2

8.1.2.2 Procedure

Connect the IFD to the IFD-test-apparatus.

a) Activate the IFD.

b) The IFD resets the IFD-test-apparatus (ISO/IEC 7816-3:2006, 6.2.2).