INTERNATIONAL STANDARD

**ISO/IEC 7816-3**

Third edition
2006-11-01

# Identification cards — Integrated circuit cards —

## Part 3: Cards with contacts — Electrical interface and transmission protocols

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*Cartes d'identification — Cartes à circuit intégré —*
*Partie 3: Cartes à contacts — Interface électrique et protocoles de transmission*

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# Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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

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

ISO/IEC 7816-3 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 17, *Cards and personal identification*.

This third edition cancels and replaces the second edition (ISO/IEC 7816-3:1997), which has been technically revised. It also incorporates the Amendment ISO/IEC 7816-3:1997/Amd.1:2002.

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In addition, it incorporates material extracted from the first edition of Part 4 (ISO/IEC 7816-4:1995), so that the transmission protocols are no longer present in the second edition of Part 4 (ISO/IEC 7816-4:2005).

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ISO/IEC 7816 consists of the following parts, under the general title *Identification cards — Integrated circuit cards*:

— *Part 1: Cards with contacts — Physical characteristics*

— *Part 2: Cards with contacts — Dimensions and location of the contacts*

— *Part 3: Cards with contacts — Electrical interface and transmission protocols*

— *Part 4: Organization, security and commands for interchange*

— *Part 5: Registration of application providers*

— *Part 6: Interindustry data elements for interchange*

— *Part 7: Interindustry commands for Structured Card Query Language (SCQL)*

— *Part 8: Commands for security operations*

— *Part 9: Commands for card management*

— *Part 10: Cards with contacts — Electronic signals and answer to reset for synchronous cards*

— *Part 11: Personal verification through biometric methods*

— *Part 12: Cards with contacts — USB electrical interface and operating procedures*

— *Part 13: Commands for application management in multi-application environment*

— *Part 15: Cryptographic information application*


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# Introduction

ISO/IEC 7816 is a series of standards specifying integrated circuit cards and the use of such cards for interchange. These cards are identification cards intended for information exchange negotiated between the outside world and the integrated circuit in the card. As a result of an information exchange, the card delivers information (computation result, stored data), and/or modifies its content (data storage, event memorization).

Five parts are specific to cards with galvanic contacts and three of them specify electrical interfaces.

— ISO/IEC 7816-1 specifies physical characteristics for cards with contacts.

— ISO/IEC 7816-2 specifies dimensions and location of the contacts.

— ISO/IEC 7816-3 specifies electrical interface and transmission protocols for asynchronous cards.

NOTE The first and second editions of ISO/IEC 7816-3 specified an optional use of contact C6 to provide the card with programming power required to write or to erase internal non-volatile memory. As every card manufactured since 1990 internally generates programming power, this third edition deprecates this use, as well as the related indications in the Answer-to-Reset and the related controls in each transmission protocol.

— ISO/IEC 7816-10 specifies electrical interface and answer to reset for synchronous cards.

— ISO/IEC 7816-12 specifies electrical interface and operating procedures for USB cards.

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All the other parts are independent of the physical interface technology. They apply to cards accessed by one or more of the following methods: contacts, close coupling and radio frequency.

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— ISO/IEC 7816-4 specifies organization, security and commands for interchange.

— ISO/IEC 7816-5 specifies registration of application providers.

— ISO/IEC 7816-6 specifies interindustry data elements for interchange.

— ISO/IEC 7816-7 specifies commands for structured card query language.

— ISO/IEC 7816-8 specifies commands for security operations.

— ISO/IEC 7816-9 specifies commands for card management.

— ISO/IEC 7816-11 specifies personal verification through biometric methods.

— ISO/IEC 7816-13 specifies commands for application management in multi-application environment.

— ISO/IEC 7816-15 specifies cryptographic information application.

ISO/IEC 10536[3] specifies access by close coupling. ISO/IEC 14443[5] and ISO/IEC 15693[6] specify access by radio frequency. Such cards are also known as contactless cards.

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ISO and IEC draw attention to the fact that it is claimed that compliance with this document may involve the use of patents.

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The holders of these patent rights have assured ISO and IEC that they are willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statements of the holders of these patent rights are registered with ISO and IEC. Information may be obtained from the following companies.

| Patent holder | Patent number | Details | Foreign equivalents |
|---|---|---|---|
| Toshiba Corporation<br>Intellectual Property Division<br>1-1, Shibaura 1-Chome<br>Minato-ku, Tokyo<br>105-8001, Japan | JPN 2537199 | *Integrated circuit card,*<br>(priority date: 1986-06-20;<br>publication date: 1996-07-08) | FRA 8708646,<br>FRA 8717770,<br>USA 4833595,<br>USA 4901276 |
| | USA 5161231 | *Processing system which transmits a predetermined error code upon detection of an incorrect transmission code,*<br>(priority date: 1991-03-12;<br>publication date: 1992-11-03) | FRA 8713306,<br>FRA 9209880 |

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

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# Identification cards — Integrated circuit cards —

# Part 3:
# Cards with contacts — Electrical interface and transmission protocols

## 1 Scope

This part of ISO/IEC 7816 specifies the power and signal structures, and information exchange between an integrated circuit card and an interface device such as a terminal.

It also covers signal rates, voltage levels, current values, parity convention, operating procedure, transmission mechanisms and communication with the card.

It does not cover information and instruction content, such as identification of issuers and users, services and limits, security features, journaling and instruction definitions.

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## 2 Normative references

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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 7816-2, *Identification cards — Integrated circuit cards — Part 2: Cards with contacts — Dimensions and location of the contacts*

ISO/IEC 7816-4, *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**
**block**
byte string comprising two or three fields defined as prologue field, information field and epilogue field

**3.2**
**class of operating conditions**
set of values for voltage and current

**3.3**
**cold reset**
first reset occurring after activation

**3.4**
**destination node address**
portion of the node address byte, identifying the intended receiver of the block

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**3.5**
**elementary time unit**
nominal duration of a moment within an asynchronous character

**3.6**
**epilogue field**
final field of a block, conveying the error detection code

**3.7**
**identification card**
card identifying its holder and issuer, which may carry data required as input for the intended use of the card and for transactions based thereon

[ISO/IEC 7810[2]]

**3.8**
**information block**
block whose primary purpose is to convey application layer information

**3.9**
**information field**
field of a block, conveying data, generally application data

**3.10**
**interface device**
terminal, communication device or machine to which the card is electrically connected during operation

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**3.11**
**length byte**
portion of the prologue field, encoding the number of bytes in the information field of the block

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**3.12**
**node address byte**
portion of the prologue field, indicating both destination and source addresses of the block

**3.13**
**operating card**
card that can correctly carry out all its functions

**3.14**
**procedure byte**
byte transmitted by the card for indicating the progression of a T=0 command and controlling the exchange of data bytes

**3.15**
**prologue field**
first field of a block, consisting of three bytes defined as node address, protocol control and length

**3.16**
**protocol control byte**
portion of the prologue field, encoding transmission control information

**3.17**
**receive ready block**
block conveying the send-sequence number of the expected I-block, used as a positive or negative acknowledgment

**3.18**
**redundancy code**
content of the epilogue field, computed from all the bytes in the prologue field and in the information field


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**3.19**
**source node address**
portion of the node address byte, identifying the transmitter of the block

**3.20**
**supervisory block**
block conveying transmission control information

**3.21**
**transmission control**
function used to control the data transmission between the interface device and the card, including block transmission with sequence control, synchronization and recovery of transmission errors

**3.22**
**warm reset**
any reset that is not a cold reset

## 4 Symbols and abbreviated terms

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

| | |
|---|---|
| A, B, C | classes of operating conditions |
| APDU | application protocol data unit |
| *BGT* | block guard time |
| *BWI* | block waiting time integer |
| *BWT* | block waiting time |
| *CGT* | character guard time |
| $C_{IN}$ | input capacitance |
| CLA | class byte |
| CLK | clock contact |
| $C_{OUT}$ | output capacitance |
| CRC | cyclic redundancy code |
| *CWI* | character waiting time integer |
| *CWT* | character waiting time |
| (C(6) C(7)) | value of the concatenation of bytes C(6) and C(7) (the first byte is the most significant byte) |
| *D* | baud rate adjustment integer |
| DAD | destination node address |
| *Dd, Di, Dn* | default values, indicated values and negotiated values of *D* |
| etu | elementary time unit |
| *F* | clock rate conversion integer |
| *f* | frequency value of the clock signal provided to the card by the interface device |
| *Fd, Fi, Fn* | default values, indicated values and negotiated values of *F* |
| GND | ground contact |
| *GT* | guard time |

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| | |
|---|---|
| H | high state |
| I-block | information block |
| $I_{CC}$ | current at VCC |
| IFS | maximum information field size |
| IFSC | IFS for the card |
| IFSD | IFS for the interface device |
| $I_{IH}$ | high level input current |
| $I_{IL}$ | low level input current |
| INF | information field |
| INS | instruction byte |
| $I_{OH}$ | high level output current |
| $I_{OL}$ | low level output current |
| I/O | input/output contact |
| L | low state |
| $L_c$ field | length field for coding number $N_c$ |
| $L_e$ field | length field for coding number $N_e$ |
| LEN | length byte |
| LRC | longitudinal redundancy code |
| $N$ | extra guard time integer |
| NAD | node address byte |
| $N_a$ | exact number of available data bytes |
| $N_c$ | number of bytes in the command data field |
| $N_e$ | maximum number of bytes expected in the response data field |
| $N_m$ | number of remaining data bytes |
| $N_r$ | number of bytes in the response data field |
| $N_x$ | number of extra data bytes still available |
| OSI | open systems interconnection |
| PCB | protocol control byte |
| PPS | protocol and parameters selection |
| P1 P2 | parameter bytes |
| R-block | receive ready block |
| RFU | reserved for future use |
| RST | reset contact |
| SAD | source node address |
| S-block | supervisory block |
| SPU | standard or proprietary use contact |

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| | |
|---|---|
| state H | high electrical level |
| state L | low electrical level |
| SW1 SW2 | status bytes |
| T | type |
| T=0 | half duplex transmission of characters |
| T=1 | half duplex transmission of blocks |
| TA, TB, … | interface bytes |
| TCK | check character |
| $t_F$ | fall time, from 90 % to 10 % of signal amplitude |
| TPDU | transmission protocol data unit |
| $t_R$ | rise time, from 10 % to 90 % of signal amplitude |
| TS | initial character |
| T0 | format byte |
| $T_1$, $T_2$, … | historical bytes |
| $U_{CC}$ | voltage at VCC |
| $U_{IH}$ | high level input voltage |
| $U_{IL}$ | low level input voltage |
| $U_{OH}$ | high level output voltage |
| $U_{OL}$ | low level output voltage |

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NOTE In accordance with ISO 31[1], the symbols $U_{CC}$, $U_{IH}$, $U_{IL}$, $U_{OH}$ and $U_{OL}$ replace the former symbols $V_{CC}$, $V_{IH}$, $V_{IL}$, $V_{OH}$ and $V_{OL}$.

| | |
|---|---|
| VCC | supply power contact |
| *WI* | waiting time integer |
| *WT* | waiting time |
| WTX | waiting time extension |
| X | clock stop indicator |
| Y | class indicator |
| 'XY' | notation using the hexadecimal digits '0' to '9' and 'A' to 'F', equal to XY to the base 16 |

# 5 Electrical characteristics

## 5.1 General

### 5.1.1 Contact assignment

The dimensions and location of the contacts shall be as specified in ISO/IEC 7816-2.

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This part of ISO/IEC 7816 supports at least the following contacts.

— C1: supply power input (VCC, see 5.2.1).

— C2: reset signal input (RST, see 5.2.2).

— C3: clock signal input (CLK, see 5.2.3).

— C5: ground (GND, reference voltage).

— C6: standard or proprietary use (SPU, see 5.2.4).

— C7: input/output for serial data (I/O, see 5.2.5).

NOTE This document deprecates the use of contact C6 to provide the card with programming power because every card manufactured since 1990 internally generates programming power.

### 5.1.2 Measurement conventions

By definition, when a card and an interface device are mechanically connected, each contact of the card and the corresponding contact of the interface device together form an “electrical circuit”.

All measurements on an electrical circuit are defined with respect to GND and in an ambient temperature range 0° C to 50° C. All currents flowing into the card are considered positive. All timings shall be measured with respect to the appropriate threshold levels.

By definition, an electrical circuit is “not active” when the voltage with respect to GND remains between 0 V and 0,4 V for currents less than 1 mA flowing into the interface device.

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### 5.1.3 Classes of operating conditions

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This document defines three classes of operating conditions, based on the nominal supply voltage provided to the card by the interface device through VCC:

— 5 V for class A.

— 3 V for class B.

— 1,8 V for class C.

The card shall support one or more classes. If the interface device applies a class supported by the card, then the card shall operate as specified.

— If the card supports more than one class, those classes shall be consecutive.

— If the interface device offers more than one class, the order in which those classes are applied is not within the scope of this document.

No card shall be damaged when the interface device applies a class not supported by the card (by definition, a damaged card no longer operates as specified or contains corrupt data).

## 5.2 Contacts

### 5.2.1 VCC (C1)

This contact is used to supply the card with power.


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**Table 1 — Electrical characteristics of VCC under normal operating conditions**

| Symbol | Conditions | Minimum | Maximum | Unit |
|---|---|---|---|---|
| $U_{CC}$ | Class A<br>Class B<br>Class C | 4,5<br>2,7<br>1,62 | 5,5<br>3,3<br>1,98 | V |
| $I_{CC}$ | Class A, at maximum allowed frequency<br>Class B, at maximum allowed frequency<br>Class C, at maximum allowed frequency<br>When the clock is stopped, see 6.3.2 | | 60<br>50<br>30<br>0,5 | mA |
| The current value is averaged over 1 ms. | | | | |

The maximum current is defined for the card. The interface device shall be able to deliver this current within the range specified for the voltage value and may deliver more. The supply power shall maintain the voltage value within the specified range despite transient power consumption as defined in Table 2.

**Table 2 — Spikes on $I_{CC}$**

| Class | Maximum charge [a] | Maximum duration | Maximum variation [b] of $I_{CC}$ |
|---|---|---|---|
| A | 20 nA.s | 400 ns | 100 mA |
| B | 10 nA.s | 400 ns | 50 mA |
| C | 6 nA.s | 400 ns | 30 mA |

[a] The maximum charge is half the product of the maximum duration and the maximum variation.
[b] The maximum variation is the difference in supply current with respect to the average value.

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### 5.2.2 RST (C2)

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This contact is used to provide the card with reset signal. See 6.2.2 (cold reset) and 6.2.3 (warm reset).

**Table 3 — Electrical characteristics of RST under normal operating conditions**

| Symbol | Conditions | Minimum | Maximum | Unit |
|---|---|---|---|---|
| $U_{IH}$ | | 0,8 $U_{CC}$ | $U_{CC}$ | V |
| $I_{IH}$ | $U_{IH}$ | –20 | +150 | µA |
| $U_{IL}$ | | 0 | 0,12 $U_{CC}$ | V |
| $I_{IL}$ | $U_{IL}$ | –200 | +20 | µA |
| $t_R$ $t_F$ | $C_{IN}$ = 30 pF | | 1 | µs |
| The voltage shall remain between – 0,3 V and $U_{CC}$ + 0,3 V. | | | | |

### 5.2.3 CLK (C3)

This contact is used to provide the card with clock signal. The actual value of the frequency of the clock signal is denoted $f$. The minimum value shall be 1 MHz. At least during activation (see 6.2.1) and cold reset (see 6.2.2), the maximum value shall be 5 MHz. For the maximum value supported by the card, see Table 7.

Unless otherwise specified, the duty cycle of the clock signal shall be between 40 % and 60 % of the cycle during stable operation. When switching the frequency from one value to another, care should be taken to ensure that no pulse is shorter than 40 % of the shortest cycle allowed by the card (see maximum frequency in Table 7). No information shall be exchanged when switching the frequency value. Two different times are recommended for switching the frequency value, either

— after completion of an answer to reset, see 8.1, while the card is waiting for a character, or

— after completion of a successful PPS exchange, see 9.3, while the card is waiting for a character.

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**Table 4 — Electrical characteristics of CLK under normal operating conditions**

| Symbol | Conditions | Minimum | Maximum | Unit |
|---|---|---|---|---|
| $U_{IH}$ | | 0,7 $U_{CC}$ | $U_{CC}$ | V |
| $I_{IH}$ | $U_{IH}$ | –20 | +100 | µA |
| $U_{IL}$ | Class A and class B | 0 | 0,5 | V |
| $U_{IL}$ | Class C | 0 | 0,2 $U_{CC}$ | V |
| $I_{IL}$ | $U_{IL}$ | –100 | +20 | µA |
| $t_R$ $t_F$ | $C_{IN}$ = 30 pF | | 9 % of cycle | |
| The voltage shall remain between – 0,3 V and $U_{CC}$ + 0,3 V. | | | | |

### 5.2.4 SPU (C6)

This contact is available for either standard or proprietary use, as input and/or output.

Depending upon whether the card uses SPU or not, the first TB for T=15 shall be present or absent in the Answer-to-Reset: this global interface byte (see 8.3) indicates whether the use is standard or proprietary. ISO/IEC JTC 1/SC 17 reserves the standard use for future use.

When the card is powered through VCC, if contact C6 is connected in the interface device, then the voltage shall remain between – 0,3 V and $U_{CC}$ + 0,3 V.

No card shall be damaged by an interface device where contact C6 is connected to VCC or GND as such an interface device complies with the previous edition (ISO/IEC 7816-3:1997).

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### 5.2.5 I/O (C7)

This contact is used as input (reception mode) or output (transmission mode). The information exchange uses two states of the electrical circuit as follows:

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— state H if the card and the interface device are in reception mode or if the transmitter imposes this state;

— state L if the transmitter imposes this state.

When both the card and the interface device are in reception mode, the electrical circuit shall be at state H. When the card and the interface device are in non-matched transmission mode, the state may be indeterminate. During operation, the interface device and the card shall not be simultaneously in transmission mode.

The interface device shall be able to support the defined range of input currents when the input voltages are within the allowed range. The impedance presented by the interface device to the card shall allow the card to keep the output voltages within the defined range.

**Table 5 — Electrical characteristics of I/O under normal operating conditions**

| Symbol | Conditions | Minimum | Maximum | Unit |
|---|---|---|---|---|
| $U_{IH}$ | | 0,7 $U_{CC}$ | $U_{CC}$ | V |
| $I_{IH}$ | $U_{IH}$ | –300 | +20 | µA |
| $U_{IL}$ | | 0 | 0,15 $U_{CC}$ | V |
| $I_{IL}$ | $U_{IL}$ | –1000 | +20 | µA |
| $U_{OH}$ | External pull-up resistor: 20 kΩ to $U_{CC}$ | 0,7 $U_{CC}$ | $U_{CC}$ | V |
| $I_{OH}$ | $U_{OH}$ and external pull-up resistor: 20 kΩ to $U_{CC}$ | | +20 | µA |
| $U_{OL}$ | $I_{OL}$ = 1 mA for class A [a] and class B [a]<br>$I_{OL}$ = 500 µA for class C [a] | 0 | 0,15 $U_{CC}$ | V |
| $t_R$ $t_F$ | $C_{IN}$ = 30 pF; $C_{OUT}$ = 30 pF | | 1 | µs |
| The voltage shall remain between – 0,3 V and $U_{CC}$ + 0,3 V. | | | | |
| [a] Interface device implementations should not require the card to sink more than 500 µA. | | | | |


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# 6 Card operating procedure

## 6.1 Principles

The electrical circuits shall remain not active until the contacts of the card are mechanically connected to the contacts of the interface device. The interaction between the interface device and the card shall be conducted through the following sequence of operations.

— The interface device shall apply a class of operating conditions to the electrical circuits, i.e., activation, cold reset and possibly one or more warm resets. If the card supports the class, it shall answer to reset according to clause 8. The interface device ends up with a complete and valid Answer-to-Reset and a class of operating conditions. The interface device shall be able to repeat the entire operation.

— For exchanging information, the card and the interface device shall agree on a transmission protocol and values of transmission parameters. Clause 10 specifies T=0, the half-duplex transmission of characters with the interface device as the master. Clause 11 specifies T=1, the half-duplex transmission of blocks. Clause 12 specifies the transmission of command-response pairs by T=0 and by T=1. When no transmission is expected from the card (e.g., after processing a command-response pair and before initiating the next one), the interface device may stop the clock signal if the card supports clock stop.

— The interface device shall perform a deactivation.

The deactivation should be completed before the mechanical disconnection between the contacts of the card and the contacts of the interface device.

## 6.2 Activation, resets and class selection

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### 6.2.1 Activation

In order to initiate an interaction with a mechanically connected card, the interface device shall activate the electrical circuits according to a class of operating conditions: A, B or C, see 5.1.3, in the following order.

ISO/IEC 7816-3:2006
https://standards.iteh.ai/catalog/standards/sist/375db46f-0e0c-4c90-986c-5ff3b1ec76f7/iso-iec-7816-3-2006

— RST shall be put to state L, see 5.2.2.

— VCC shall be powered, see 5.2.1.

— I/O in the interface device shall be put in reception mode, see 5.2.5. The interface device shall ignore the state on I/O during activation.

— CLK shall be provided with a clock signal, see 5.2.3.

NOTE 1 The delays between powering VCC, setting I/O in reception mode and providing the clock signal on CLK are not defined.

NOTE 2 The interface device may perform a deactivation due to short circuits.

Figure 1 summarizes activation (before time $T_a$) and cold reset (after time $T_a$).

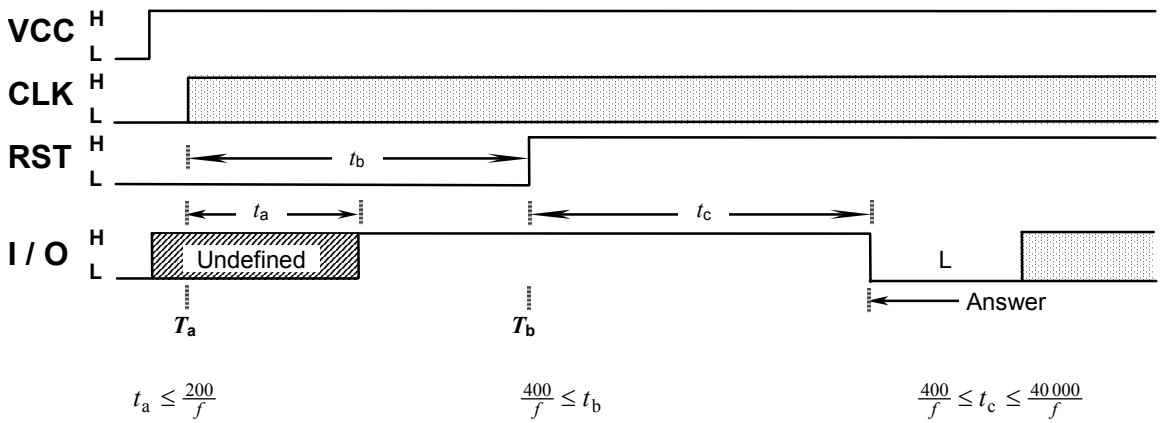


**Figure 1 — Activation and cold reset**

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