

Guide to

Design and use of identification cards having integrated circuits with contacts —

**Part 3: Electronic signals and
transmission protocols**

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- British Printing Industries' Federation
- British Tape Industry Association
- British Telecommunications plc
- Building Societies' Association
- Department of Trade and Industry (National Physical Laboratory)
- Electronic Components Industry Federation
- Electronics and Business Equipment Association
- GAMBICA (BEAMA Ltd.)
- Her Majesty's Stationery Office
- Home Office
- Institute of Data Processing Management (User Standards Forum for Information Technology)
- Institute of Trading Standards Administration
- Railway Industry Association of Great Britain

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National foreword

This British Standard is the English language version of EN 27816-3:1992 including its amendments A1:1993 and A2:1995 and implements it as the UK national standard.

This British Standard is published under the direction of the Information Systems Technology Standards Policy Committee whose Technical Committee IST/17 has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international committee any enquiries on interpretation, or proposals for change, and keep UK interests informed;
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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 28 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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(ISO/IEC 7816-3:1989 edition 1)

Cartes d'identification — Cartes à circuit(s)
intégré(s) à contacts —
Partie 3: Signaux électroniques et protocoles de
transmission
(ISO/IEC 7816-3:1989 édition 1)

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Teil 3: Elektronische Signale und
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This European Standard was approved by CEN on 1992-04-11, amendment A1 was approved by CEN on 1993-11-25, amendment A2 was approved by CEN on 1995-03-09. CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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Foreword

The Technical Board has decided to submit the International Standard ISO/IEC 7816-3:1989 “Identification cards — Integrated circuit(s) cards with contacts — Part 3: Electronic signals and transmission protocols (ISO/IEC 7816-3 — 1st edition 1959)” for Formal Vote. The standard was accepted.

However, the German version of the international standard is not available at the time of publication of the present European Standard.

National Standards identical to this European Standard shall be published at the latest by 92-10-31 and conflicting national standards shall be withdrawn at the latest by 92-10-31.

According to the CEN/CENELEC Common Rules, the following countries are bound to implement this standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Foreword to amendment A1

The Technical Board decided to submit the draft Amendment *Identification cards — Integrated circuits cards with contact — Part 3: Electronic signals and transmission protocols — Amendment 1: Protocol type T = 1, asynchronous half duplex block transmission protocol* (ISO/IEC 7816-3:1989, Amendment 1:1992) to the Unique Acceptance Procedure (UAP).

The result of the Unique Acceptance Procedure was positive.

For the time being, this document exists only in English.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 1994, and conflicting national standards shall be withdrawn at the latest by May 1994.

In accordance with the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Foreword to amendment A2

The text of this Amendment EN 27816-3:1992/A2:1995 to the European Standard EN 27816-3:1992 from ISO/IEC/JTC 1, Information Technology, of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) has been taken over as a European Standard by CEN Technical Board.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 1996, and conflicting national standards shall be withdrawn at the latest by April 1996.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

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

It also covers signal rates, voltage levels, current values, parity conventions, operation procedures, transmission mechanisms and communication with the integrated circuit(s) 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.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO/IEC 7816.

At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO/IEC 7816 are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1177:1985, *Information processing — Character structure for start/stop and synchronous character oriented transmission*.

ISO 7810:1985, *Identification cards — Physical characteristics*.

ISO 7816-1:1987, *Identification cards — Integrated circuit(s) cards with contacts — Part 1: Physical characteristics*.

ISO 7816-2:1988, *Identification cards — Integrated circuit(s) cards with contacts — Part 2: Dimensions and location of the contacts*.

3 Definitions

The term identification card is defined in ISO 7810. For the purpose of this part of ISO/IEC 7816, the following definitions apply:

interface device

a terminal, communication device or machine to which the integrated circuit(s) card is electrically connected during operation

State H : High state logic level.

State L : Low state logic level.

State Z : Mark (as defined in ISO 1177).

State A : Space (as defined in ISO 1177).

“XY” : Hexadecimal notation, equal to XY to the base 16.

4 Electrical characteristics of the contacts

4.1 Electrical functions

Contacts assignments are specified in ISO 7816-2, supporting at least the following electrical circuits:

I/O:	Input or output for serial data to the integrated circuit inside the card.
VPP:	Programming voltage input (optional use by the card).
GND:	Ground (reference voltage).
CLK:	Clocking or timing signal (optional use by the card).
RST:	Either used by itself (reset signal supplied from the interface device) or in combination with an additional internal reset control circuit (optional use by the card). If internal reset is implemented, the voltage supply on VCC is mandatory.
VCC:	Power supply input (optional use by the card).

NOTE The use of two remaining contacts will be defined in the appropriate application standards.

4.2 Voltage and current values

4.2.1 Measurement conventions

All measurements are defined with respect to contact GND and in an ambient temperature range of 0° C to 50° C.

All currents flowing into the card are considered positive.

All timings shall be measured relative to the appropriate threshold levels as defined in 4.2.3 to 4.2.7.

A contact is inactive when it remains between 0 V and 0,4 V referenced to contact GND for currents less than 1 mA.

4.2.2 Abbreviations

V_{IH}	High level input voltage
V_{IL}	Low level input voltage
V_{CC}	Power supply voltage at VCC
V_{PP}	Programming voltage at VPP
V_{OH}	High level output voltage
V_{OL}	Low level output voltage
t_R	Rise time between 10 % and 90 % of signal amplitude
t_F	Fall time between 90 % and 10 % of signal amplitude
I_{IH}	High level input current
I_{IL}	Low level input current
I_{CC}	Supply current at VCC
I_{PP}	Programming current at VPP
I_{OH}	High level output current
I_{OL}	Low level output current
C_{IN}	Input capacitance
C_{OUT}	Output capacitance

4.2.3 I/O

This contact is used as input (reception mode) or output (transmission mode) for data exchange. Two possible states exist for I/O:

- mark or high state (state Z), if the card and the interface device are in reception mode or if this state is imposed by the transmitter;
- space or low state (state A), if this state is imposed by the transmitter.

When the two ends of the line are in reception mode, the line shall be maintained in state Z. When the two ends are in non-matched transmit mode, the logic state of the line may be indeterminate. During operation, the interface device and the card shall not both be in transmit mode.

4.2.4 VPP

This contact may be used to supply the voltage required to program or to erase the internal non-volatile memory. Two possible states exist for VPP: idle state and active state, as defined in Table 2. The idle state shall be maintained by the interface device unless the active state is required.

Table 1 — Electrical characteristics of I/O under normal operation conditions

Symbol	Conditions		Minimum	Maximum	Unit
V_{IH}	Either or ^a	$I_{IH \max} = \pm 500 \mu A$	2	V_{CC}	V
		$I_{IH \max} = \pm 20 \mu A$	$0,7 \times V_{CC}$	V_{CC}^c	V
V_{IL}		$I_{IL \max} = -1 \text{ mA}$	0 ^c	0,8	V
V_{OH}^b	Either or	$I_{OH \max} = -100 \mu A$	2,4	V_{CC}	V
		$I_{OH \max} = -20 \mu A$	3,8	V_{CC}	V
V_{OL}		$I_{OL \max} = 1 \text{ mA}$	0	0,4	V
$t_R t_F$	$C_{IN} = 30 \text{ pF}; C_{OUT} = 30 \text{ pF}$			1	μs

^a For the interface device, take into account both conditions.

^b It is assumed that a pull-up resistor is used in the interface device (recommended value: 20 k Ω).

^c The voltage on I/O shall remain between $-0,3 \text{ V}$ and $V_{CC}+0,3 \text{ V}$.

Table 2 — Electrical characteristics of VPP under normal operation conditions

Symbol	Conditions	Minimum	Maximum	Unit
V_{PP}	Idle State	$0,95 \times V_{CC}$	$1,05 \times V_{CC}$	V
I_{PP}	(programming non active)		20	mA
V_{PP}	Active State	$0,975 \times P$	$1,025 \times P$	V
I_{PP}	(programming the card)		I	mA

The card provides the interface device with the values of P and I (default values: P = 5 and I = 50). See 6.1.4.4.

Table 3 — Electrical characteristics of CLK under normal operation conditions

Symbol	Conditions		Minimum	Maximum	Unit
V_{IH}	Either	$I_{IH\ max} = \pm 200\ mA$	2,4	V_{CC}^b	V
	or ^a	$I_{IH\ max} = \pm 20\ mA$	$0,7 \times V_{CC}$	V_{CC}^b	V
	or ^a	$I_{IH\ max} = \pm 10\ mA$	$V_{CC} - 0,7$	V_{CC}^b	V
V_{IL}	$I_{IL\ max} = \pm 200\ mA$		0 ^b	0,5	V
$t_R\ t_F$	$C_{IN} = 30\ pF$			9 % of period with a maximum of 0,5 μs	

^a For the interface device, take into account the three conditions.
^b The voltage on CLK shall remain between $-0,3\ V$ and $V_{CC}+0,3\ V$.

Table 4 — Electrical characteristics of RST under normal operation conditions

Symbol	Conditions		Minimum	Maximum	Unit
V_{IH}	Either	$I_{IH\ max} = \pm 200\ \mu A$	4	V_{CC}^b	V
	or ^a	$I_{IH\ max} = \pm 10\ \mu A$	$V_{CC} - 0,7$	V_{CC}^b	V
V_{IL}	$I_{IL\ max} = \pm 200\ mA$		0 ^b	0,6	V

^a For the interface device, take into account both conditions.
^b The voltage on RST shall remain between $-0,3\ V$ and $V_{CC}+0,3\ V$.

Rise or fall time: 200 μs maximum. The rate of change of V_{PP} shall not exceed 2 V/ μs .

The maximum power $V_{PP} \times I_{PP}$ shall not exceed 1,5 W when averaged over any period of 1 s.

4.2.5 CLK

The actual value of the frequency, delivered by the interface device on CLK, is designated by f . For the range of values, see 6.1.4.4.

Duty cycle for asynchronous operation shall be between 45 % and 55 % of the period during stable operation. When switching the frequency from one value to another, care shall be taken to ensure that no pulse is shorter than 45 % of the shorter period. Two different times are recommended for switching the frequency value:

- either immediately after the answer to reset,
- or immediately after a successful PTS procedure is completed.

No data transmission shall be performed when switching the frequency value.

4.2.6 RST

The reset signal at RST is delivered according to subclause 5.2.

4.2.7 VCC

This contact is used to supply the power voltage V_{CC} .

Table 5 — Electrical characteristics of VCC under normal operation conditions

Symbol	Minimum	Maximum	Unit
V_{CC}	4,75	5,25	V
I_{CC}		200	mA

5 Operating procedure for integrated circuit(s) cards

This operating procedure applies to every integrated circuit(s) card with contacts.

- 1 – connection and activation of the contacts by the interface device;
- 2 – reset of the card;
- 3 – information exchange between the card and the interface device, always initiated by an Answer-to-Reset sent by the card;
- 4 – deactivation of the contacts by the interface device.

Those operations are specified in the following clauses.

NOTE 1 Operations 2 and 3 may be repeated.

NOTE 2 An active state on VPP should only be provided and maintained when requested by the card.

5.1 Connection and activation of the contacts

The electrical circuits shall not be activated until the contacts are connected to the interface device so as to avoid possible damage to any card meeting these standards.

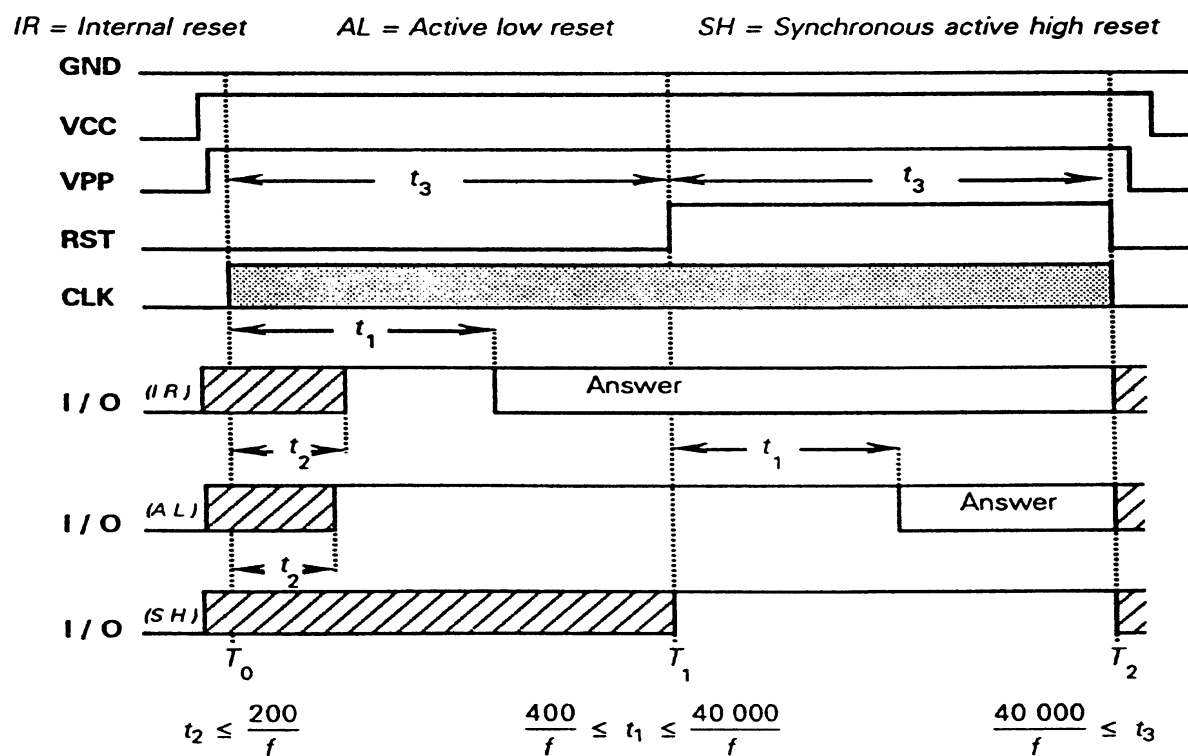


Figure 1 — Reset of the card

NOTE The hatched area indicates a period when the state of I/O is undefined.

The activation of the contacts by the interface device shall consist of the consecutive operations:

- RST is in state L;
- VCC shall be powered;
- I/O in the interface device shall be put in reception mode;
- VPP shall be raised to idle state;
- CLK shall be provided with a suitable and stable clock. See 4.2.5.

5.2 Reset of the card

A card reset is initiated by the interface device, whereupon the card shall respond with an Answer-to-Reset as described in clause 6.

By the end of the activation of the contacts (RST in state L, VCC powered and stable, I/O in reception mode in the interface device, VPP stable at idle state, CLK provided with a suitable and stable clock), the card **answering asynchronously** is ready for reset. See Figure 1.

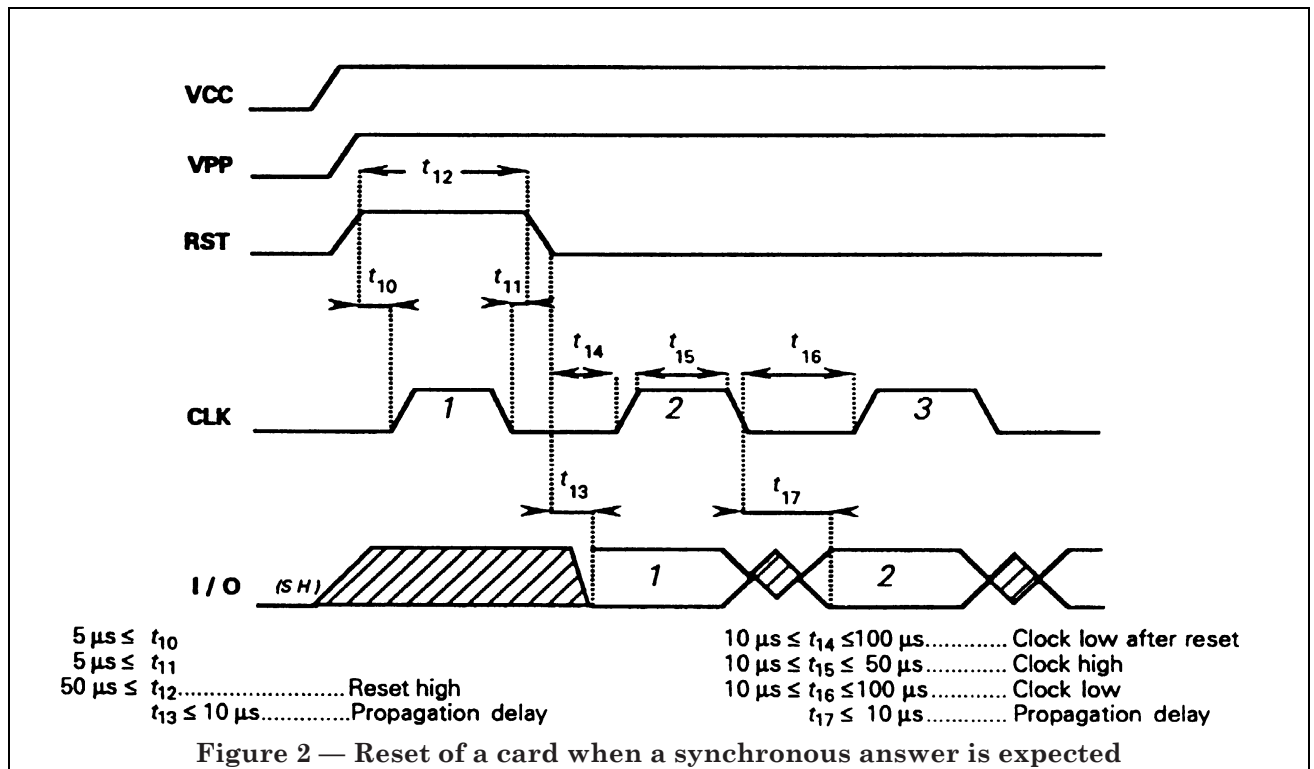
The clock signal is applied to CLK at time T_0 . The I/O line shall be set to state Z within 200 clock cycles of the clock signal (t_2) being applied to CLK (time t_2 after T_0).

An internally reset card is reset after a few cycles of the clock signal. The Answer-to-Reset on I/O shall begin between 400 and 40 000 clock cycles (t_1) after the clock signal is applied to CLK (time t_1 after T_0).

A card with an active low reset is reset by maintaining RST in state L for at least 40 000 clock cycles (t_3) after the clock signal is applied to CLK (time t_3 after T_0). Thus, if no Answer-to-Reset begins within 40 000 clock cycles (t_3) with RST in state L, RST is put to state H (at time T_1). The Answer-to-Reset on I/O shall begin between 400 and 40 000 clock cycles (t_1) after the rising edge of the signal on RST (time t_1 after T_1).

If the Answer-to-Reset does not begin within 40 000 clock cycles (t_3) with RST in state H (t_3 after T_1), the signal on RST shall be returned to state L (at time T_2) and the contacts shall be deactivated by the interface device. See subclause 5.4.

With a **card answering synchronously**, the interface device sets all lines to state L. See Figure 2. VCC is then powered, VPP is set to idle state, CLK and RST remain in state L, I/O is put in reception mode in the interface device. RST shall be maintained in state H for at least 50 μ s (t_{12}), before returning to state L again.



The clock pulse is applied after an interval (t_{10}) from the rising edge of the reset signal. The duration for the state H of the clock pulse can be any value between 10 μ s and 50 μ s; no more than one clock pulse during reset high is allowed. The time interval between the falling edges on CLK and RST is t_{11} .

The first data bit is obtained as an answer on I/O while CLK is in state L and is valid after an interval t_{13} from the falling edge on RST.

NOTE 1 The internal state of the card is assumed not to be defined before reset. Therefore the design of the card has to avoid improper operation.

NOTE 2 In order to continue the dialogue with the card, RST shall be maintained in the state where an answer occurs on I/O.

NOTE 3 Reset of a card can be initiated by the interface device at its discretion at any time.

NOTE 4 Interface devices may support one or more of these types of reset behaviour. The priority of testing for asynchronous or synchronous cards is not defined in this standard.

5.3 Information exchange

The card answers after reset with a sequence defined in clause 6.

All information exchanged over the I/O circuit corresponds to the execution of commands, including a possible PTS procedure as specified in clause 7.

The operating procedure of commands depends on the type of transmission (asynchronous or synchronous) and on the protocol type. The asynchronous half duplex character transmission protocol, with the interface device as the master, is specified in clause 8. The asynchronous half duplex block transmission protocol is specified in clause 9 (ISO/IEC 7816-3:1989/Amd. 1:1992).

NOTE 1 Further protocol types between the card and the interface device are for further study.

NOTE 2 The inter-industry commands for interchange are to be specified in the next part of ISO/IEC 7816. Other commands are specified either in existing standards or in additional standards to be defined.

5.4 Deactivation of the contacts

When information exchange is terminated or aborted (unresponsive card or detection of card removal), the electrical contacts shall be deactivated.

The deactivation by the interface device shall consist of the consecutive operations:

- State L on RST;
- State L on CLK;
- VPP inactive;
- State A on I/O;
- VCC inactive.