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ISO/IEC FCD 15693-2

Identification cards -

Contactless integrated circuit(s) cards -

Vicinity cards -

Part 2: Radio frequency power and signal interface

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 organizations 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC directives part 3.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC1. 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.

International Standard ISO/IEC 15693-2 was prepared by Joint Technical Committee ISO/IEC JTC1, Information technology.

ISO/IEC 15693 consists of the following parts, under the general title
Identification cards - Contactless integrated circuit(s) cards - Vicinity cards:

- *Part 1: Physical characteristics*
- *Part 2: Radio frequency power and signal interface*
- *Part 3: Anticollision and Transmission protocols*

Introduction

ISO/IEC 15693 is one of a series of International Standards describing the parameters for identification cards as defined in ISO/IEC 7810 and the use of such cards for international interchange.

This part of ISO/IEC 15693 describes the electrical characteristics of the contactless interface between a vicinity card and a vicinity coupling device. The interface includes power and bi-directional communications.

This International Standard does not preclude the incorporation of other standard technologies on the card.

Contactless card standards cover a variety of types as embodied in ISO/IEC 10536 (Close coupled cards), ISO/IEC 14443 (Proximity cards), ISO/IEC 15693 (Vicinity cards). These are intended for operation when very near, nearby and at a longer distance from associated coupling devices respectively.

Identification cards -
Contactless integrated circuit(s) cards -
Vicinity cards

Part 2:
Radio frequency power and signal interface

1 Scope

This part of ISO/IEC 15693 specifies the nature and characteristics of the fields to be provided for power and bi-directional communications between vicinity coupling devices (VCDs) and vicinity cards (VICCs).

This part of ISO/IEC 15693 shall be used in conjunction with other parts of ISO/IEC 15693.

This part of ISO/IEC 15693 does not specify the means of generating coupling fields, nor the means of compliance with electromagnetic radiation and human exposure regulations which can vary according to country.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO/IEC 15693. 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 15693 are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/IEC 15693   *Identification cards - Contactless integrated circuit(s) cards –*
                  Vicinity cards
ISO/IEC 10373   *Identification cards - Test methods*

3 Terms and definitions

For the purposes of this International Standard, the definitions given in the first part of ISO/IEC 15693 and the following definitions apply:

3.1
modulation index
Defined as [a-b]/[a+b] where a and b are the peak and minimum signal amplitude respectively.

3.2
subcarrier
RF signal produced by modulation of a carrier frequency f_c with a frequency f_s.

1

4   Abbreviations and symbols

For the purpose of this International Standard the following abbreviations and symbols apply.

4.1   Abbreviations

ASK   Amplitude shift keying

EOF   End of frame

PPM   Pulse positioning modulation

RF   Radio frequency

SOF   Start of frame

VCD   Vicinity coupling device

VICC   Vicinity integrated circuit card

4.2   Symbols

a   Carrier amplitude without modulation

b   Carrier amplitude when modulated

f_c Frequency of operating field (carrier frequency)

f_s Frequency of subcarrier modulation

5   Initial dialogue for vicinity cards

The dialogue between the VCD and the VICC (one or more VICCs may be present at the same time) is conducted through the following consecutive operations:

- activation of the VICC by the RF operating field of the VCD,
- VICC waits silently for a command from the VCD,
- transmission of a command by the VCD,
- transmission of a response by the VICC.

These operations use the RF power transfer and communication signal interface specified in the following paragraphs and shall be performed according to the protocols defined in part 3 of ISO/IEC 15693.

6   Power transfer

Power transfer to the VICC is accomplished by radio frequency via coupling antennas in the VCD and in the VICC. The RF operating field that supplies power to the VICC from the VCD is modulated for communication from the VCD to the VICC, as described in clause 7.

6.1   Frequency

The frequency (f_c) of the RF operating field is 13,56 MHz ±7 kHz.

6.2   Operating field

A VICC shall operate as intended continuously between H_{min} and H_{max}.

The minimum operating field is H_{min} and has a value of 150 mA/m rms.

The maximum operating field is H_{max} and has a value of 5 A/m rms.

A VCD shall generate a field of at least H_{min} and not exceeding H_{max} at manufacturer specified positions (operating volume).

In addition, the VCD shall be capable of powering any single reference VICC (defined in the test methods) at manufacturer's specified positions (within the operating volume).

The VCD shall not generate a field higher than the value specified in part 1 of ISO/IEC 15693 (alternating magnetic field) in any possible VICC position.

Test methods for determining the VCD operating field are defined in International Standard ISO/IEC 10373.

7   Communications signal interface VCD to VICC

For some parameters several modes have been defined in order to meet different international radio regulations and different application requirements.

From the modes specified any data coding can be combined with any modulation.

7.1   Modulation

Communications between the VCD and the VICC takes place using the modulation principle of ASK. Two modulation indexes are used, 10% and 100%. The VICC shall decode both. The VCD determines which index is used.

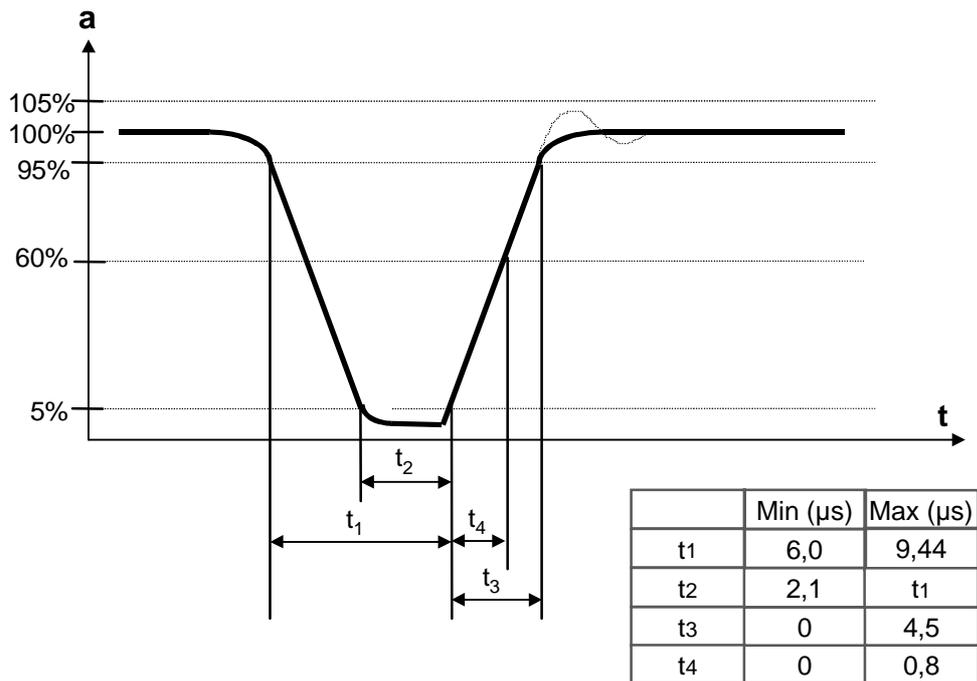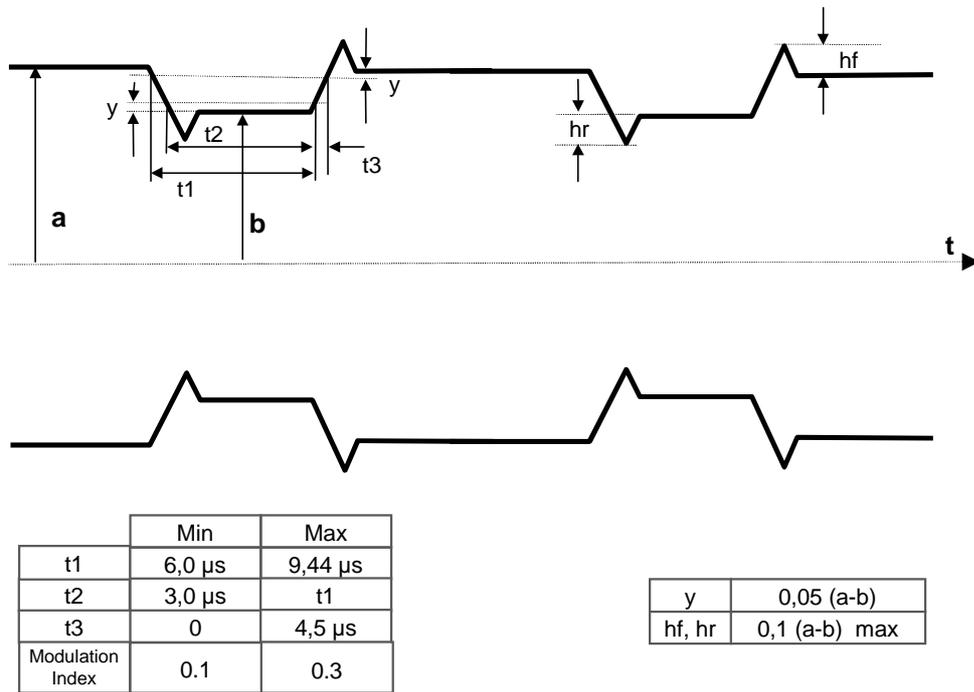Depending of the choice made by the VCD, a "pause" will be created as described in Figures 1 and 2.

	Min (µs)	Max (µs)
t1	6,0	9,44
t2	2,1	t1
t3	0	4,5
t4	0	0,8

Figure 1: 100% Modulation Waveform

	Min	Max
t1	6,0 µs	9,44 µs
t2	3,0 µs	t1
t3	0	4,5 µs
Modulation Index	0.1	0.3

y	0,05 (a-b)
hf, hr	0,1 (a-b) max

The clock recovery must be operational after t_4 max

Figure 2: 10% Modulation Waveform

The VICC shall be operational for any degree of modulation index from between 10% and 30%.

7.2   Data rate and data coding

Data coding shall be implemented using pulse position modulation.

Two data coding modes shall be supported by the VICC. The selection shall be made by the VCD and indicated to the VICC within the Start of frame (SOF). See 7.3.

7.2.1   Data coding mode: 1 out of 256

The value of one single byte shall be represented by the position of one pause. The position of the pause on 1 of 256 successive time periods of 18,88 µs (256/f_c), determines the value of the byte. In this case the transmission of one byte takes 4,833 ms and the resulting data rate is 1,65 kbits/s (f_c/8192).

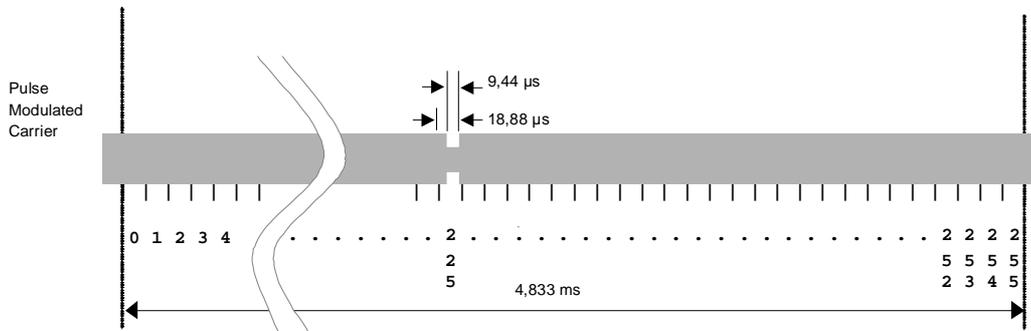Figure 3 illustrates this pulse position modulation technique.

Figure 3: 1 out of 256 coding mode

In Figure 3 Data E1 hex (225 dec) is sent by the VCD to the VICC.

The pause shall occur during the second half of the position of the time period that determines the value, as shown in Figure 4.
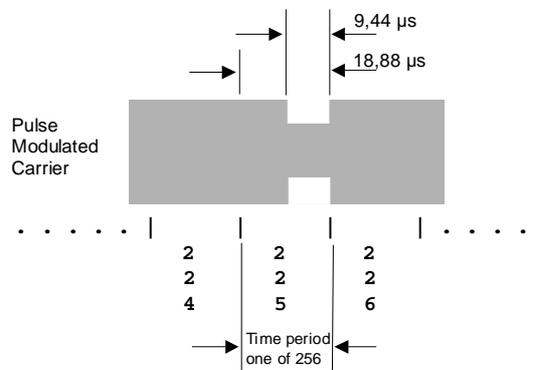

Figure 4: Detail of one time period

7.2.2 Data coding mode: 1 out of 4

Pulse position modulation for 1 out of 4 mode shall be used, in this case the position determines two bits at a time. Four successive pairs of bits form a byte, where the least significant pair of bits is transmitted first.

The resulting data rate is 26,48 kbits/s (f_c/512).

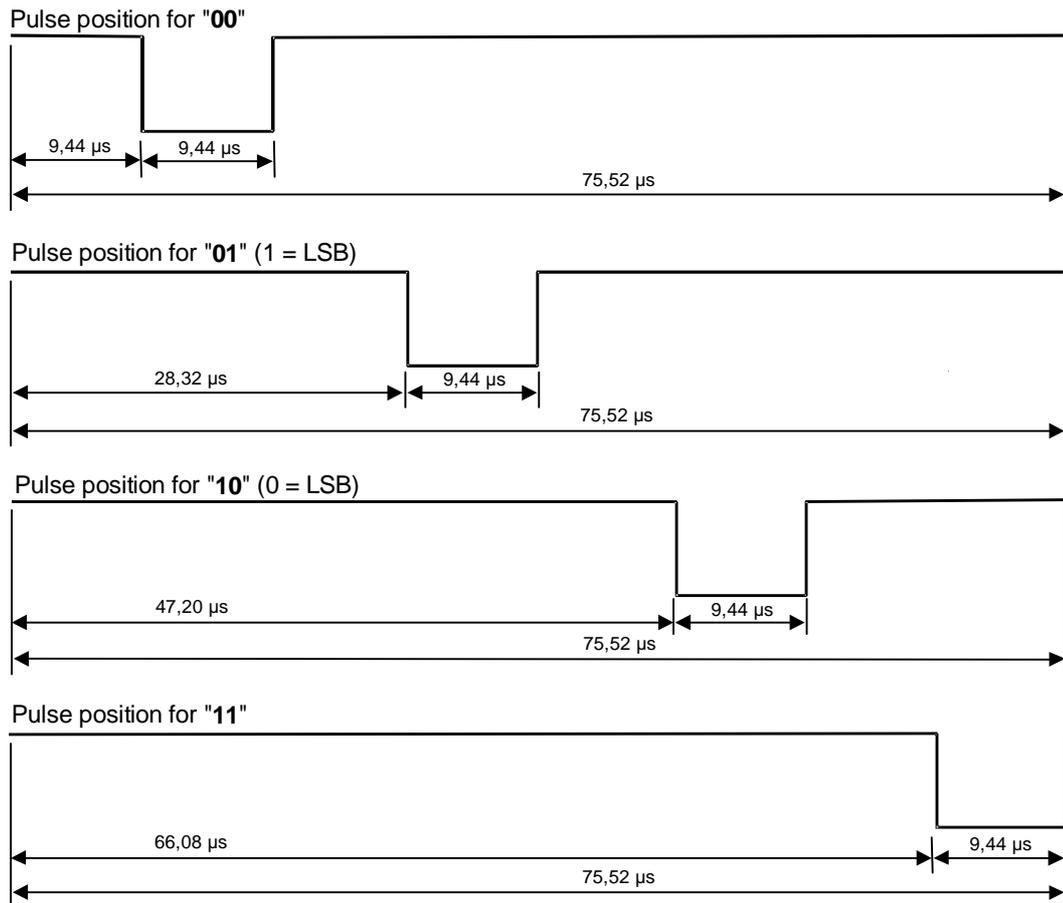Figure 5 illustrates the 1 out of 4 pulse position technique and coding.

Pulse position for "**00**"

9,44 µs   9,44 µs   75,52 µs

Pulse position for "**01**" (1 = LSB)

28,32 µs   9,44 µs
                                            75,52 µs

Pulse position for "**10**" (0 = LSB)

47,20 µs   9,44 µs
                                75,52 µs

Pulse position for "**11**"

66,08 µs   9,44 µs
                                75,52 µs

Figure 5: 1 out of 4 coding mode

For example Figure 6 shows the transmission of E1 hex (225 dec) by the VCD.

75,52 µs   75,52 µs   75,52 µs   75,52 µs

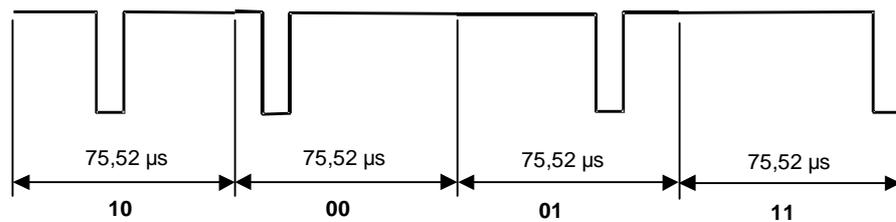**10**   **00**   **01**   **11**

Figure 6: 1 out of 4 coding example

7.3 VCD to VICC frames

Framing has been chosen for ease of synchronization and independence of protocol.

Frames shall be delimited by a start of frame (SOF) and an end of frame (EOF) and are implemented using code violation. Unused options are reserved for future use by ISO/IEC.

The VICC shall be ready to receive a frame from the VCD within 300 µs after having sent a frame to the VCD.

The VICC shall be ready to receive a frame within 1ms of activation by the powering field.

7.3.1 SOF to select 1 out of 256 code

The SOF sequence described in Figure 7 selects the 1 out of 256 data coding mode.
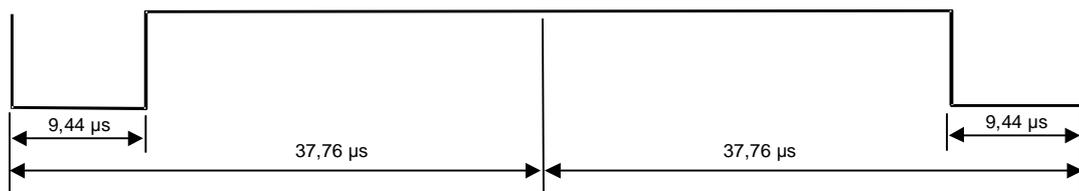
Figure 7: Start of frame of the 1 out of 256 mode

7.3.2 SOF to select 1 out of 4 code

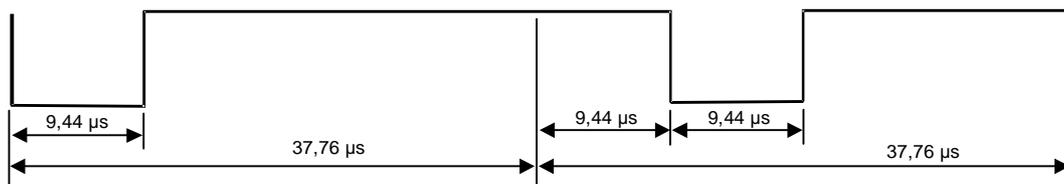The SOF sequence described in Figure 8 selects the 1 out of 4 data coding mode.

Figure 8: Start of frame of the 1 out of 4 mode

7.3.3 EOF for either data coding mode

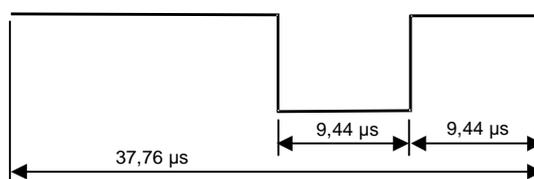The EOF sequence for either coding mode is described in Figure 9.

Figure 9: End of frame for either mode

8   Communications signal interface VICC to VCD

For some parameters several modes have been defined in order to allow for use in different noise environments and application requirements.

8.1   Load modulation

The VICC shall be capable of communication to the VCD via an inductive coupling area whereby the carrier is loaded to generate a subcarrier with frequency f_s. The subcarrier shall be generated by switching a load in the VICC.

The load modulation amplitude shall be at least 10 mV when measured as described in the test methods.

Test methods for VICC load modulation are defined in International Standard ISO/IEC 10373.

8.2   Subcarrier

One or two subcarriers may be used as selected by the VCD using the first bit in the protocol header as defined in 15693-3. The VICC shall support both modes.

When one subcarrier is used, the frequency f_{s1} of the subcarrier load modulation shall be $f_c/32$ (423,75 kHz).

When two subcarriers are used, the frequency f_{s1} shall be $f_c/32$ (423,75 kHz), and the frequency f_{s2} shall be $f_c/28$ (484,28 kHz).

If two subcarriers are present there shall be a continuous phase relationship between them.

8.3   Data Rates

A low or high data rate may be used. The selection of the data rate shall be made by the VCD using the second bit in the protocol header as defined in 15693-3. The VICC shall support those data rates show in Table 1.

Data Rate	Single Subcarrier	Dual Subcarrier
Low	6,62 kbits/s ($f_c/2048$)	6,67 kbits/s ($f_c/2032$)
High	26,48 kbits/s ($f_c/512$)	26,69 kbits/s ($f_c/508$)

Table 1: Data rates

8.4   Bit representation and coding

Data shall be encoded using Manchester coding, according to the following schemes.

All timings shown refer to the high data rate from the VICC to the VCD. For the low data rate the same subcarrier frequency or frequencies are used, in this case the number of pulses shall be multiplied by 4 and all times will increase by this factor.

8.4.1 Bit coding when using one subcarrier

A logic 0 starts with 8 pulses of 423,75 kHz (f_c/32) followed by an unmodulated time of 18,88 μs (256/f_c). As shown in Figure 10.
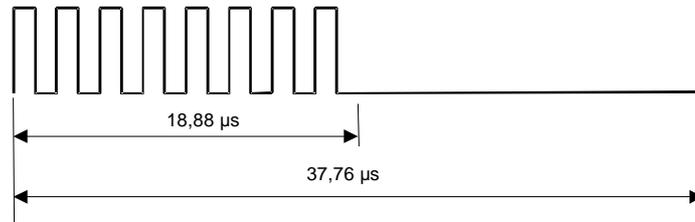

Figure 10: Logic 0

A logic 1 starts with an unmodulated time of 18,88 μs (256/f_c) followed by 8 pulses of 423,75 kHz (f_c/32). As shown in Figure 11.
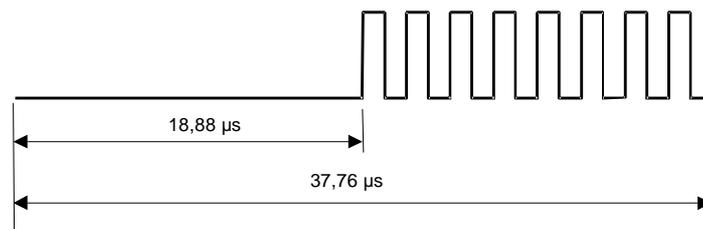

Figure 11: Logic 1

8.4.2 Bit coding when using two subcarriers

A logic 0 starts with 8 pulses of 423,75 kHz (f_c/32) followed by 9 pulses of 484,28 kHz (f_c/28). As shown in Figure 12.
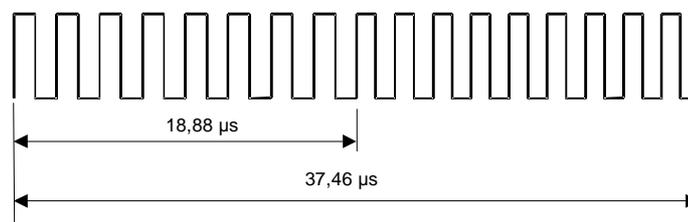

Figure 12: Logic 0

A logic 1 starts with 9 pulses of 484,28 kHz (f_c/28) followed by 8 pulses of 423,75 kHz (f_c/32). As shown in Figure 13.
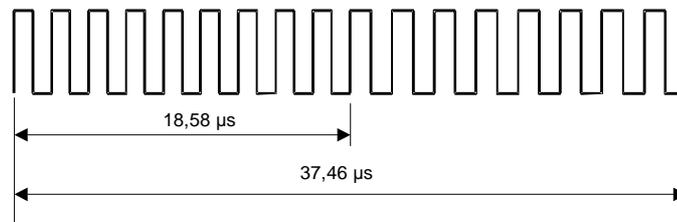
18,58 µs

37,46 µs

Figure 13: Logic 1

8.5   VICC to VCD frames

Framing has been chosen for ease of synchronization and independence of protocol.

Frames are delimited by a Start of frame (SOF) and an End of frame (EOF) and are implemented using code violation. Unused options are reserved for future use by the ISO/IEC.

All timings shown below refer to the high data rate from the VICC to the VCD. For the low data rate the same subcarrier frequency or frequencies are used, in this case the number of pulses shall be multiplied by 4 and all times will increase by this factor.

The VCD shall be ready to receive a frame from the VICC within 300 µs after having sent a frame to the VICC.

8.5.1   SOF when using one subcarrier

SOF comprises 3 parts:
* an unmodulated time of 56,64 µs (768/f_c),
* 24 pulses of 423,75 kHz (f_c/32),
* a logic 1 which starts with an unmodulated time of 18,88 µs. (256/f_c) followed by 8 pulses of 423,75 kHz (f_c/32).

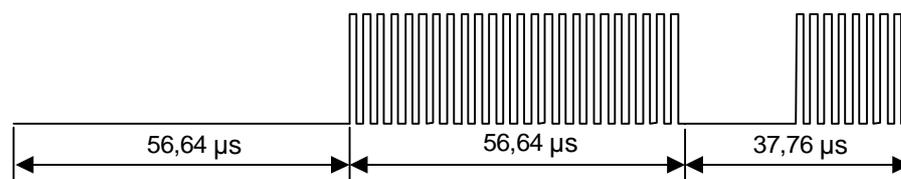The SOF for one subcarrier is illustrated in Figure 14.

56,64 µs   56,64 µs   37,76 µs

Figure 14: Start of frame when using one subcarrier

8.5.2   SOF when using two subcarriers

SOF comprises 3 parts:
* 27 pulses of 484,28 kHz (f_c/28),
* 24 pulses of 423,75 kHz (f_c/32),
* a logic 1 which starts with 9 pulses of 484,28 kHz (f_c/28) followed by 8 pulses of 423,75 kHz (f_c/32).

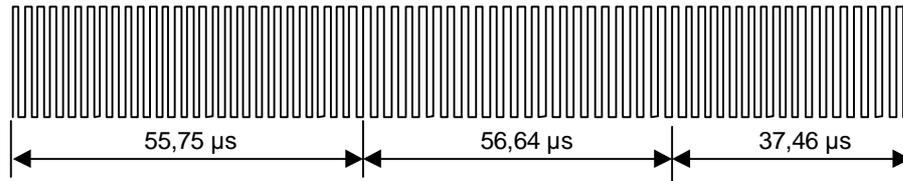The SOF for 2 subcarriers is illustrated in Figure 15.

Figure 15: Start of frame when using two subcarriers

8.5.3 EOF when using one subcarrier

EOF comprises 3 parts:
*   a logic 0 which starts with 8 pulses of 423,75 kHz ($f_c/32$), followed by an unmodulated time of 18,88 µs ($256/f_c$),
*   24 pulses of 423,75 kHz ($f_c/32$),
*   an unmodulated time of 56,64 µs ($768/f_c$).

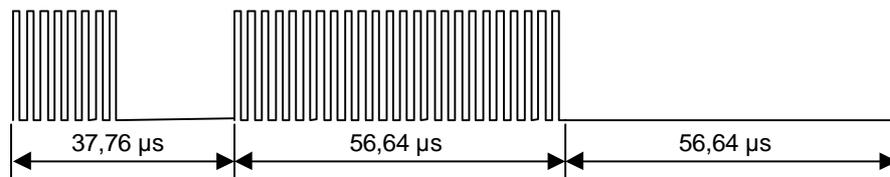The EOF for 1 subcarrier is illustrated in Figure 16.

Figure 16: End of frame when using one subcarrier

8.5.4 EOF when using two subcarriers

EOF comprises 3 parts:
*   a logic 0 which starts with 8 pulses of 423,75 kHz ($f_c/32$) followed by 9 pulses of 484,28 kHz ($f_c/28$),
*   24 pulses of 423,75 kHz ($f_c/32$),
*   27 pulses of 484,28 kHz ($f_c/28$).

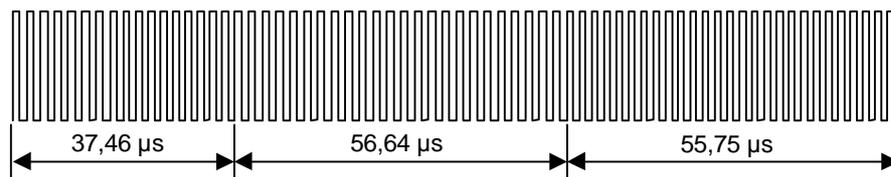The EOF for 2 subcarriers is illustrated in Figure 17.

Figure 17: End of frame when using 2 subcarriers

11

ANNEX A (Informative)

Compatibility with other Card Standards

This standard does not preclude the addition of other existing card standards on the VICC, such as those listed as follows.

ISO/IEC 7811	*Identification cards - Recording technique*
ISO/IEC 7812	*Identification cards - Identification of issuers*
ISO/IEC 7813	*Identification cards - Financial transaction cards*
ISO/IEC 7816	*Identification cards - Integrated circuit(s) cards with contacts*
ISO/IEC 10536	*Identification cards - Contactless integrated circuit(s) cards - Close-coupled cards*
ISO/IEC 14443	*Identification cards - Contactless integrated circuit(s) cards - Proximity cards*