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Information technology — Telecommunications and information exchange between systems — Close Capacitive Coupling Communication Physical Layer (CCCC PHY)

Technologies de l'information — Téléinformatique — Couche physique pour communication par couplage capacitif fermé

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Foreword

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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.

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ISO/IEC 17982 was prepared by Ecma International (as ECMA-401) and was adopted, under a special "fast-track procedure", by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, in parallel with its approval by national bodies of ISO and IEC.

Introduction

This International Standard specifies the PHY protocol and for wireless communication between the Close Capacitive Coupling Communication (CCCC) devices.

Information technology — Telecommunications and information exchange between systems — Close Capacitive Coupling Communication Physical Layer (CCCC PHY)

1 Scope

This International Standard specifies the CCCC PHY for Full duplex and Broadcast communication in time slots on frequency division multiplex channels.

2 Conformance

Conforming entities implement:

- both Talker and Listener,
- listen before talk (LBT) for both Talker and Listener,
- the capability to execute association on FDC2 and to communicate on (FDC0 and FDC1), (FDC3 and FDC4), or (FDC0, FDC1, FDC3 and FDC4),
- the capability for Talkers and Listeners to use any of the 8 TDS on a FDC,
- both Full duplex and Broadcast communication, and pass the tests in Annex A as specified herein.

3 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 7498-1:1994, *Information technology — Open Systems Interconnection — Basic Reference Model: The Basic Model*

ITU-T V.41, *Data communication over the telephone network — Code-independent error-control system*

4 Terms, definitions and acronyms

For the purposes of this document, the following terms and definitions apply, in addition to those defined in ISO/IEC 7498-1:1994.

CRC	Cyclic Redundancy Check
D	Divisor
DUT	Device Under Test
FDC	Frequency Division Channel

LBT	Listen Before Talk
LEN	Length
Listener	entity that does not initiate communication
P-DU	PHY Data Unit
P-PDU	PHY PDU
PHY	Physical layer
RFU	Reserved for Future Use
TDS	Time Division Slot
Talker	entity that initiates communication

5 Conventions and notations

5.1 Representation of numbers

The following conventions and notations apply in this document.

- A sequence of characters of ‘A’, ‘B’, ‘C”, ‘D, ‘E’ or ‘F’ and decimal digits in parentheses represent numbers in hexadecimal notation unless followed by a ‘b’ character see next.

- Numbers in binary notation and bit patterns are represented by a sequence of 0 and 1 digits or ‘X’ characters in parentheses followed by a ‘b’ character, e.g. (0X11X010)b. Where X indicates that the setting of a bit is not specified, and the leftmost bit is the most significant bit unless the sequence is a bit pattern.

5.2 Names

The names of basic elements, e.g. specific fields, are written with a capital initial letter.

6 General

The protocol architecture of CCCC follows ISO/IEC 7498-1 as the basic model. CCCC devices communicate through mediators, such as conductive and dielectric materials.

Plate-electrodes for CCCC device E and F are equivalent to the reference plate-electrode assembly.

The plate-electrode A faces to the imaginary point at infinity and the plate-electrode B faces to the mediator. The plate-electrode C faces to the mediator and the plate-electrode D faces to the imaginary point at infinity. See Figure 1.

Figure 2 is the equivalent circuit of Figure 1. The voltage of X is the potential of the point at infinity. The voltage of Y is the potential of the point at infinity. It is deemed that the potential of X and Y is identical. Therefore, X and Y is imaginary short. Consequently, device E and F is able to send and receive signal.

Regarding the information transfers from CCCC device E to F, the device E changes the voltage between plate-electrode A and B. It changes the electric charge between plate-electrode B and the mediator. The change in electric charge affects the device F by the capacitive coupling between plate-electrode C and mediator. Plate-electrodes A and B and plate-electrodes C and D have potential differences of reverse polarity; therefore device F senses the information as changes in voltage between plate-electrode C and D.

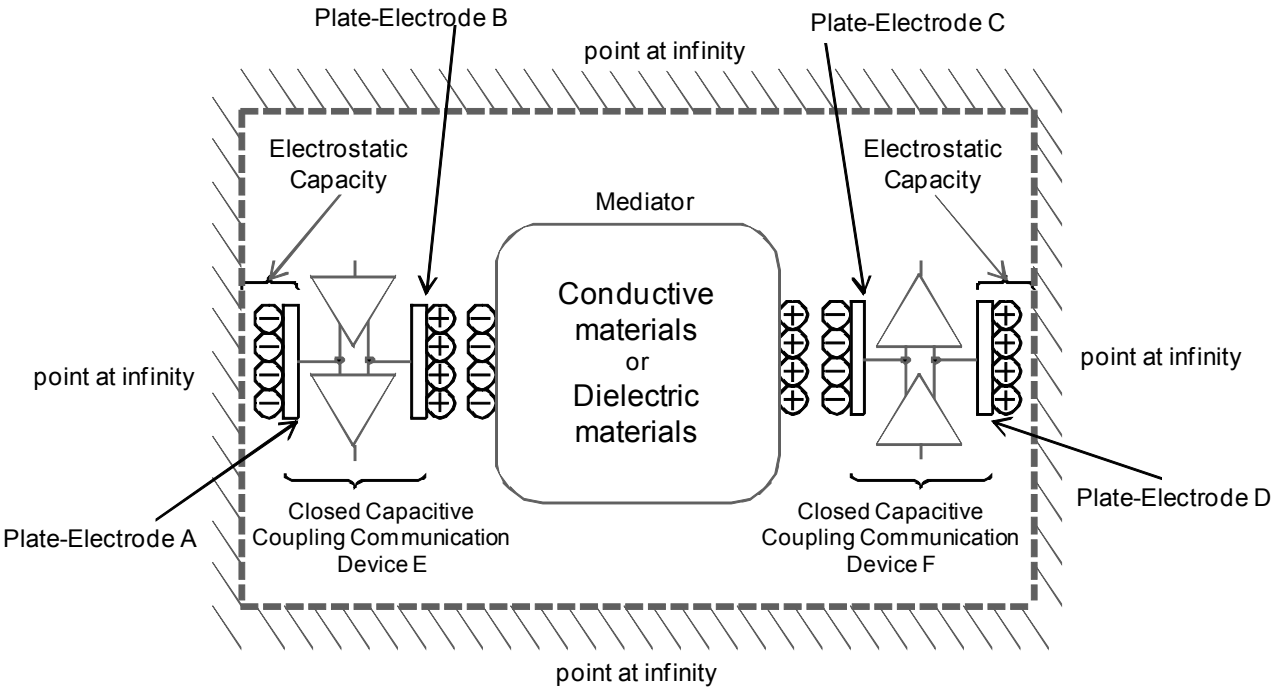

Figure 1 — Electrical model

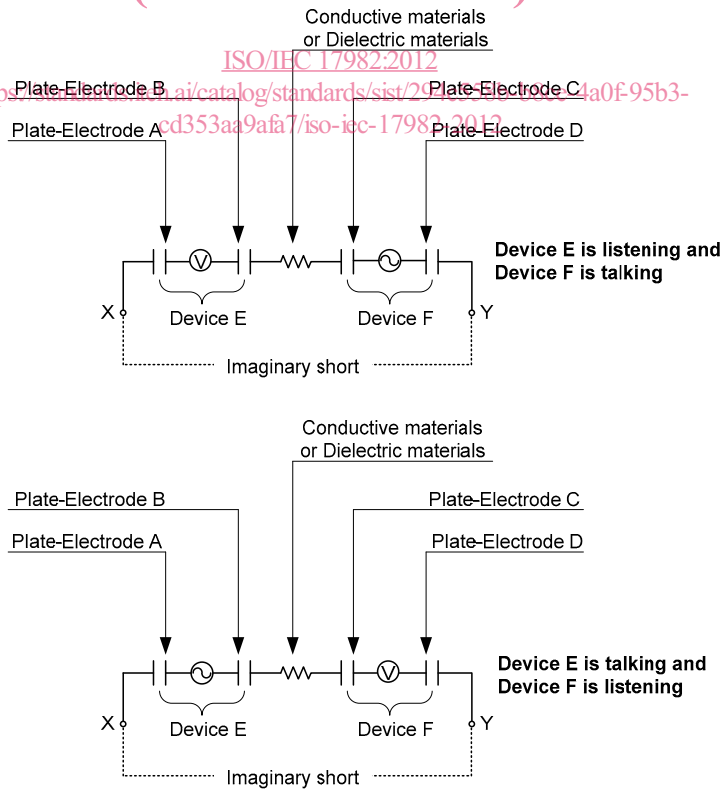

Figure 2 — Equivalent circuit

Information transfer between CCCC device E and F takes place by the synchronous communication, see 13.1. 8.2.1 specifies 5 frequency division channels (FDC) by division of the centre frequency. Each FDC consists of a sequence of time-segments. Each time-segment consists of 8 time division slots (TDS) for time division multiple-access, see Clause 12. Peers use the Listen Before Talk (LBT) procedure in 13.1 to ascertain that a TDS is not occupied. The TDSs are negotiated using the association procedure specified in Clause 14.

15.1 and 15.2 specify Full duplex and Broadcast communication respectively. In Full duplex communication, Talkers and Listeners exchange P-PDUs (see Clause 9) by synchronous communication. In Broadcast communication Talkers broadcast P-PDUs and Listeners receive P-PDUs without acknowledging.

Length information and CRC is added to the SDU to construct a PHY Data Unit (P-DU), see Clause 10. The sender segments the P-DU into P-PDUs. The receiving entity reassembles the P-PDUs into the P-DU, see Clause 11, and forwards the SDU to its PHY User as illustrated in Figure 3.

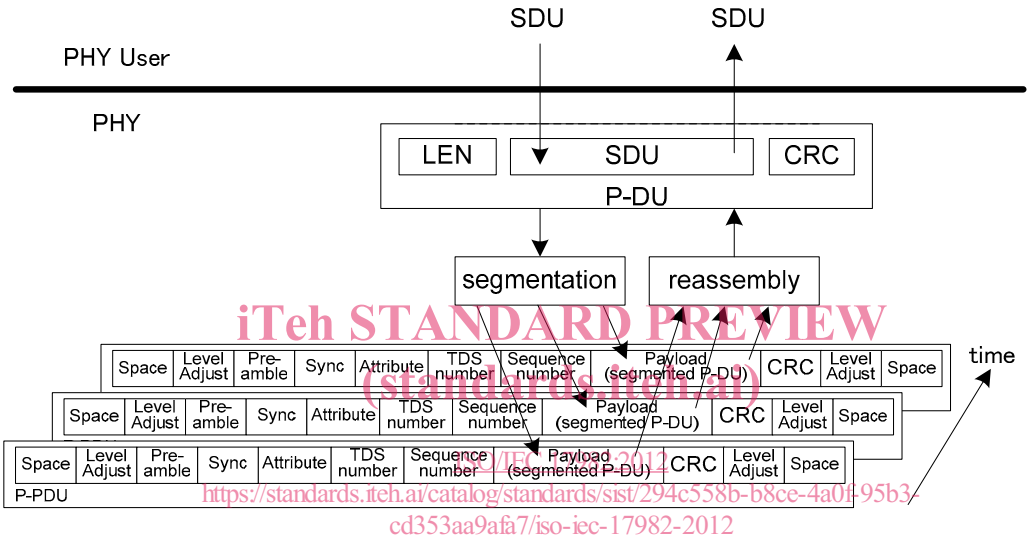

Figure 3 — PHY model

7 Reference plate-electrode assembly

The reference plate-electrode assembly for the CCCC devices shall consist of plate-electrode *A* and plate-electrode *B* specified in Figure 4. Dimensional characteristics are specified for those parameters deemed to be mandatory.

a = 20,0 ± 0,1 mm

b = 20,0 ± 0,1 mm

The distance c between plate-electrode *A* and *B* shall be 5,0 ± 0,1 mm by horizontal flat surface.

d = 0,30 ± 0,03 mm

The displacement of centre of area e between plate-electrode *A* and *B* shall be at most 0,1 mm.

The material of the plate-electrodes shall be 99% to 100% copper or equivalent.

The twisted-pair wire shall be connected inside the circle area *f* specified in Figure 4. The *f* has a diameter of 2,0 ± 0,5 mm. The twisted-pair wire shall be stranded wire and 26, 27, or 28 specified American Wire Gauge (AWG). The length of the twisted-pair wire for the reference plate-electrode assembly shall be less than 1,0 m.

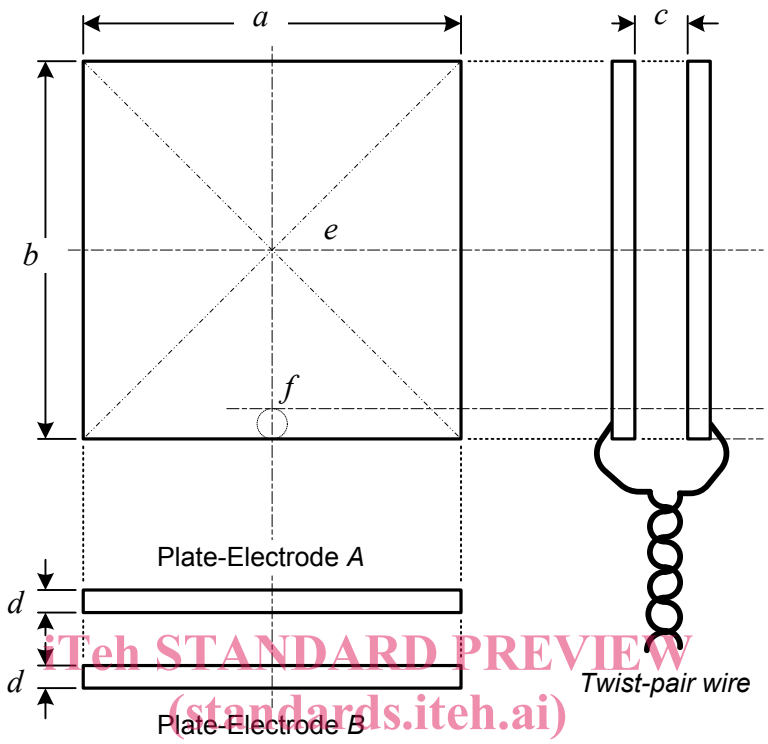

Figure 4 — CCCC reference plate-electrode assembly

8 PHY parameters

8.1 Voltage conditions

The following conditions of the voltage between the outer and the inner plate-electrode shall be used for communication.

- +m volts
- –m volts
- 0 volt
- OPEN

The value *m* depends on implementations. 0 volt is achieved by shorting the two plate-electrodes in a plate-electrode assembly. OPEN is achieved by disconnection of the plate-electrode assembly from the driver circuits.

8.2 Bit representation

8.2.1 Bit duration

The centre frequency f_c is 40,68 MHz ± 50 ppm.

The bit duration T equals D/f_c seconds.

Table 1 specifies the relation between FDC and D.

Table 1 — FDC and D

FDC	D
0	11
1	7
2	5
3	3
4	1

8.2.2 Bit encoding

Manchester bit encoding is specified in Figure 5. Depending on the relative orientation, bits are received with either positive or negative polarity. The half bit time transition shall be between 0,4 T and 0,6 T.

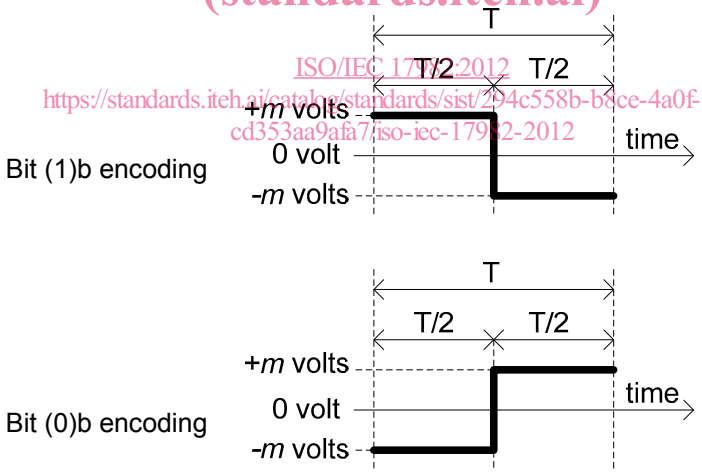

Figure 5 — Bit encoding

8.3 Transmission

P-PDUs shall be transmitted byte-wise in the sequence specified in 9.1. Bytes shall be transmitted with least significant bit first.

8.4 DC balance of a P-PDU

The DC balance of a P-PDU is (Sp - Sn) / (Sp + Sn) x 100 [%] where Sp is the integral of the positive voltage parts of one P-PDU and where Sn is the integral of the negative voltage parts of one P-PDU. The DC balance shall be less than ± 10 % per P-PDU.

8.5 Reception of a P-PDU

While receiving a P-PDU, receivers shall put the voltage condition to OPEN.

9 P-PDU

9.1 Structure

Figure 6 specifies the P-PDU as a sequence of 0,5 T of Space, 1,5 T of Level adjust, 2 T of Pre-amble, 5 T of Sync, 2 T of Attribute, 3 T of TDS number, 2 T of Sequence number, 32 T of Payload, 16 T of CRC, and 2 T of Post-amble. The P-PDU continues/ends with 1,5T of Level adjust and another 0,5T Space. The bit encoding specified in 8.2.2 shall be applied to Attribute, TDS number, Sequence number, Payload, and CRC.

66 T is represented by t_1, t_2, t_3, … t_{66}.

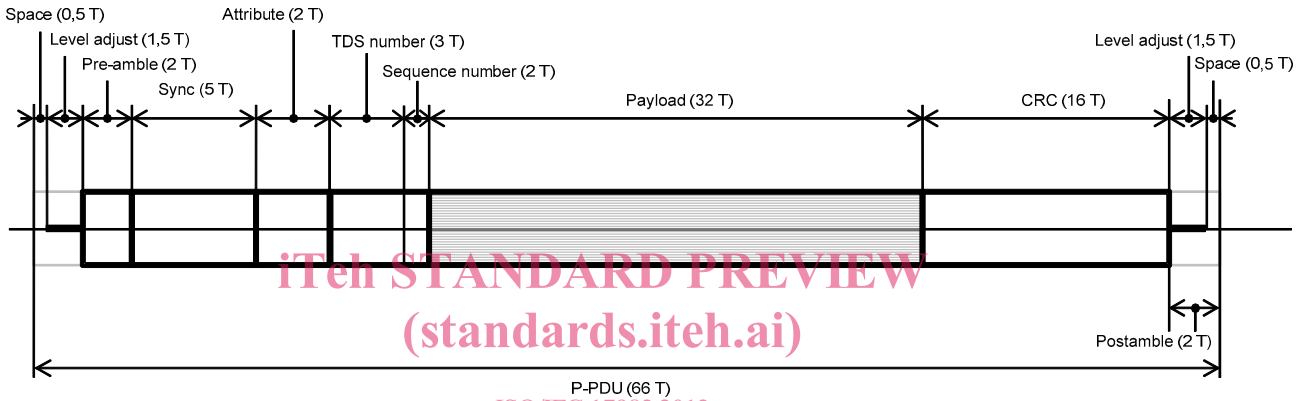

Figure 6 — P-PDU structure

9.2 Space

The Space duration shall be 0,5 T with voltage condition OPEN.

9.3 Level adjust

Level adjust shall be 1,5 T of 0 volt.

9.4 Pre-amble and Sync

Figure 7 specifies Pre-amble and Sync patterns. The transmitter shall apply pattern *P*. If the receiver detects Sync pattern *P* then it shall decode the bits in a P-PDU as positive polarity. If the receiver detects Sync pattern *Q* then it shall decode the bits in a P-PDU as negative polarity. The divisor value shall be detected from Pre-amble and Sync. Other patterns shall not be handled as Pre-amble and Sync.