
**Information technology —
Telecommunications and information
exchange between systems — Close
proximity electric induction wireless
communications**

*Technologies de l'information — Téléinformatique — Communications
sans fil à induction électrique de proximité rapprochée*

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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.

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Introduction

Today's typical consumer uses digital files to store multimedia content such as music, photos, and videos. But these files are quickly becoming larger in number and size. A continual demand for higher quality results in larger file sizes. And proliferation of smaller, portable devices makes it easier to generate more content in less time. But the desire to store, share, and enjoy that content remains strong. And this usually requires transferring the content from one device to another. For example, storing might involve transferring the content from a video camera to an external disk drive. Sharing photos might involve transferring the contents from one mobile phone to another mobile phone. And enjoying content might involve streaming content from a video camera to a TV using a special video cable.

But with today's available technology, these activities present difficulties to the average consumer. The transfer process may take a long time due to the large file sizes. Or it may involve special cables or complex setup. Therefore, a need exists to make it faster and simpler to transfer large multimedia files. This International Standard specifies a technology that addresses this need by using close proximity electric induction to transfer large files quickly and easily.

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Information technology — Telecommunications and information exchange between systems — Close proximity electric induction wireless communications

1 Scope

This International Standard specifies a connection layer (CNL) and a physical layer (PHY) for transferring data between two close proximity entities using electric induction coupling.

2 Conformance

Implementations conforming to this International Standard implement both the CNL and the PHY. All conforming implementations support a centre frequency of 4,48 GHz and all rate settings specified in Table 2.

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 System Interconnection — Basic Reference Model: The Basic Model*

ITU-T Z.120, *Series Z: Languages and General Software Aspects for Telecommunication Systems, Formal description techniques (FDT) – Message Sequence Chart (MSC)*

4 Terms and definitions

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

4.1

chip

shortest duration digital unit that is transmitted and used to spread the spectrum

4.2

chip rate

rate at which chips are transmitted

4.3

coupler

antenna used to transmit and receive an electric induction field

4.4

electric induction field

electric field with strength inversely proportional to the distance squared

4.5

initiator

sender of a connection request

4.6

PHY rate

chip rate / spreading factor

4.7

responder

receiver of a connection request

4.8

spreading factor

number of duplications

4.9

symbol

modulation pulse in a single I or Q channel as expressed as a baseband waveform

4.10

symbol rate

rate at which symbols are transmitted in each I or Q channel

4.11

target

peer entity

4.12

unique ID

code uniquely identifying each implemented unit

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5 Abbreviations and acronyms

ACK	Acknowledgement
BPSK	Binary Phase Shift Keying
CCF	Convolutional Coding Factor
CNL	CoNnection Layer
CPCI	CNL Protocol Control Information
CPDU	Connection layer Protocol Data Unit
CSDU	Connection layer Service Data Unit
C-Acc	“Connection Accept” message management frame
C-Probe	“Connection Probe” message management frame
C-Req	“Connection Request” message management frame
C-Rls	“Connection Release” message management frame
C-Sleep	“Connection Sleep” message management frame
C-Wake	“Connection Wakeup” message management frame
ECS	Error Check Sequence
EVM	Error Vector Magnitude
FCS	Frame Check Sequence
FEC	Forward Error Collection
HCS	Header Check Sequence
ImACK	Immediate Acknowledgement required
LFSR	Linear Feed-back Shift Register
LiCC	Link Control Command
MSC	Message Sequence Chart
MUX	Multiplexer
NoACK	No Acknowledgement required

PDU	Protocol Data Unit
PHY	Physical Layer
PPCI	PHY Protocol Control Information
PPDU	Phy layer Protocol Data Unit
PSD	Power Spectral Density
PSDU	PHY SDU
SAP	Service Access Point
SDU	Service Data Unit
UID	Unique ID

6 Overview

6.1 Introduction

This International Standard specifies the bottom 2 layers of a close proximity wireless transfer technology. By touching (or bringing very close together) two electronic entities, this technology allows high speed exchange of data. The basic concept consists of a touch-activated multi-purpose interface designed for applications requiring high-speed data transfer between two entities in a point-to-point (1:1) mode, without the need for external physical connectors.

The physical layer has a maximum transmission rate of 560 Mbps, adjusting the data rate downward according to the wireless environment to maintain a robust link even when the surrounding wireless condition fluctuates.

The RF transmit power is kept at a very low level to cause negligible interference with other nearby wireless systems, including other close proximity electric induction systems.

Implementations transmit and receive by means of an electric induction field suitable for near field data exchange. This approach is fundamentally different from traditional wireless systems using microwave radiation.

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Entities establish a link to enable data transfer and serve as initiator and responder respectively. These two roles have no relation to the actual direction of data transfer as illustrated in Figure 1.

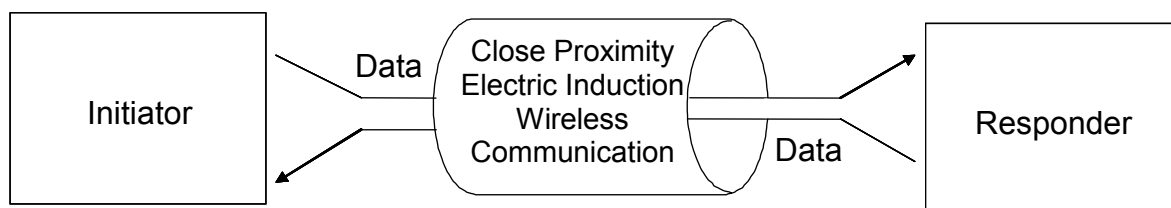
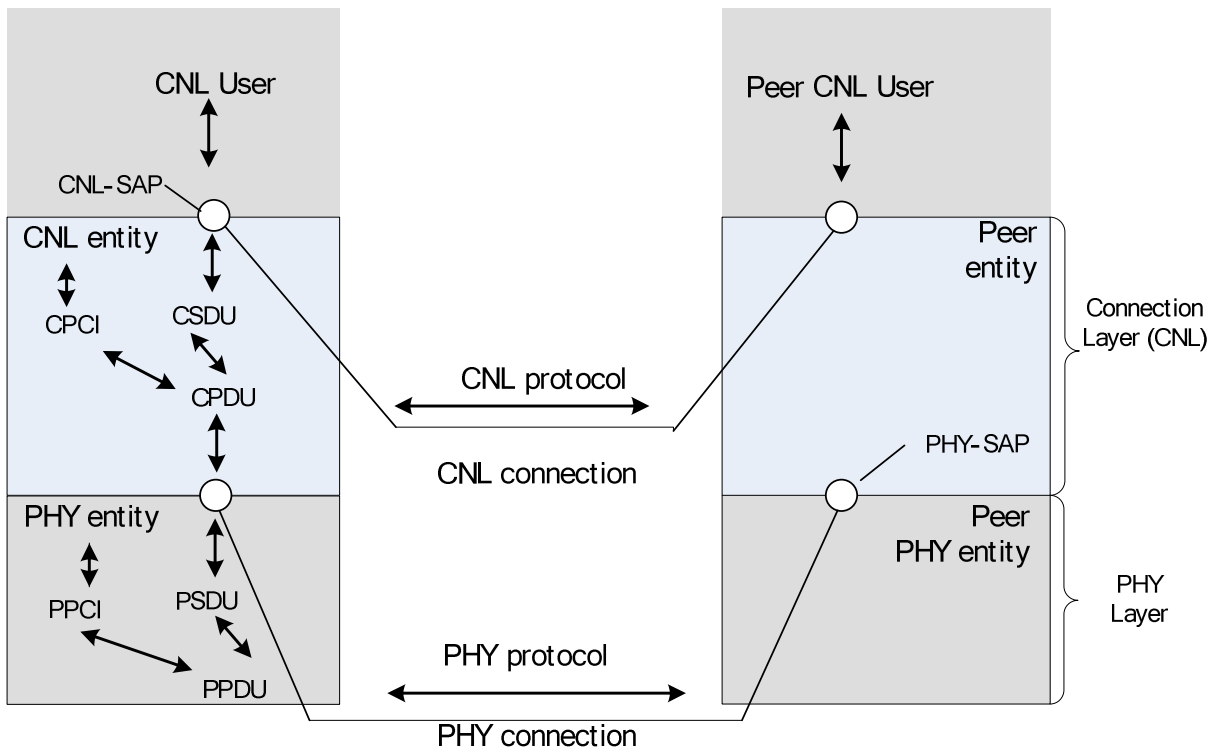


Figure 1 — Connection between Initiator and Responder

The initiator sends a “connection request”, and the responder is its peer that receives a “connection request”. Entities can assume either of these roles.

As specified in Figure 2, this International Standard uses the OSI Basic Reference Model specified in ISO/IEC 7498-1.



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 Figure 2 — OSI Basic Reference Model used in this International Standard
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7 Transmit signal

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7.1 Modulation scheme parameters

The modulation scheme uses Pi/2 shift BPSK and a chip rate (R_c) of 560 Mcps, as illustrated in Table 1. Here, the chip rate refers to the shortest duration digital units that are transferred over the air as well as the digital bits that are used to spread the transmitted bandwidth. Since the modulation scheme uses Pi/2 shift BPSK, the reciprocal number of the chip rate ($1/R_c$) represents the interval between samples of an envelope concatenated along the time axis and the symbol rate (R_s) on one channel (I_{ch} or Q_{ch}) is half the occupied bandwidth (R_c) of the envelope. Hence, the relationship of $R_s = R_c/2$ is established.

Table 1 — Tx signal parameters

Chip Rate: R_c	560 Mcps
Chip duration: $T_c = 1/R_c$	1,786 nsec
Symbol Rate: R_s	280 Msps
Carrier Center Frequency: F_c	4,48 GHz
Modulation	Pi/2 shift BPSK + DSSS
FEC	1/2 Convolutional code + Reed Solomon code

7.2 Transmitter functional block diagram

The transmitter functional block diagram is illustrated in Figure 3. Data from the CNL is first encoded by the Reed-Solomon encoder and the Convolutional encoder. Whether the Convolutional encoder is on or off is determined by the Rate Setting in use, as defined in Table 2.

The spreader spreads the encoded data by duplicating symbols by the spreading factor or process gain G_{SF} .

The spread data is then scrambled by the scrambler. Scrambling is accomplished using a pseudo random sequence generated by the Linear Feedback Shift Register (LFSR) in the Scrambler Sequence Generator. Of the fields of the frame format specified in Figure 14, the Preamble, PHY Header and Payload are scrambled using different random seeds.

The Pi/2 shift BPSK mapper spreads a binary sequence into complex number signals by multiplying the input signal by a rotator whose rotation angle differs by 90 degrees for each sample.

The baseband waveform generator illustrated in Figure 3 is a filter that uses the baseband waveform specified in Figure 12 as the impulse response. The generated baseband signal $S_{BB}(t)$ is then up-converted to centre frequency F_c by the RF module.

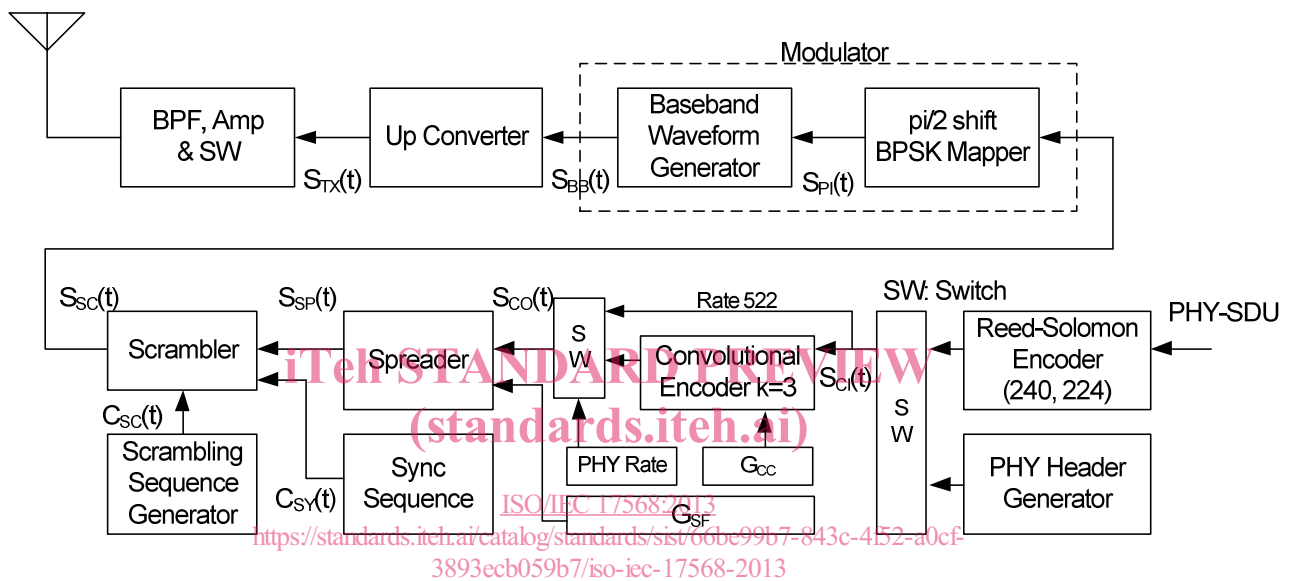


Figure 3 — Transmitter functional block diagram

7.2.1 Supported Rate Settings and rate dependent parameters

Table 2 specifies the rates used by the PHY. For rate control, the PHY manipulates the following parameters:

- Spreading factor (G_{SF}) = 1, 2, 4, 8, or 16
- Convolutional code factor (G_{CC}):
 - $G_{CC} = \frac{1}{2}$ if Convolutional code is used
 - $G_{CC} = 1$ otherwise
- Reed-Solomon Factor (G_{RS}):
 - $G_{RS} = 224/240$ if Reed-Solomon coding is used
 - $G_{RS} = 1$ otherwise

From the above parameters, the rates are calculated as follows.

- Chip Rate = 560 Mcps
- Symbol Rate = 280 Msps

- PHY Rate (Mbps) = Chip Rate (Mcps) / G_{SF}
- Data Rate (Mbps) = PHY Rate (Mbps) x CCF x G_{RS}

Table 2 — Rates (Data Rate is rounded down to the nearest 1 Mbps)

Rate Settings	Chip Rate (Mcps)	Symbol Rate (MSPS)	PHY Rate (Mbps)	Data Rate (Mbps)	Spreading Factor: G_{SF}	Convolutional Code Used?	Reed-Solomon Code Used?
Rate 522	560	280	560	522	1	No	Yes
Rate 261	560	280	560	261	1	Yes	Yes
Rate 130	560	280	280	130	2	Yes	Yes
Rate 65	560	280	140	65	4	Yes	Yes
Rate 32	560	280	70	32	8	Yes	Yes
PHY Header	560	280	35	17	16	Yes	No

7.2.2 Reed-Solomon encoder

Table 3 specifies the parameters of the Reed-Solomon encoder. Reed-Solomon code is employed for the CPDU inner coding.

Table 3 — Reed-Solomon encoder parameters

Function	Description
Galois field	$GF(2^8)$
Primitive polynomial	$p(X) = X^8 + X^4 + X^3 + X^2 + 1$
Primitive element	<div style="display: flex; justify-content: space-around;"> MSB LSB </div> $\alpha = [00000010]$
Generating polynomial	$g(X) = \prod_{i=0}^{15} (X - \alpha^i)$
Code length	240 Bytes
Data length	224 Bytes

PSDU data shall be Reed-Solomon encoded as follows.

- 1) Starting with Byte 00 (see Figure 18), each block of 224 bytes shall be transferred to the Reed-Solomon encoder to generate the 16 parity bytes. The bit-ordering of each byte and each Galois field symbol shall be identical. Simultaneously, the same 224 bytes shall be transferred unchanged in the same order to the next stage of processing. These 224 bytes are referred to as message bytes.
- 2) After each block of message bytes are transferred to the next stage of processing, the 16 bytes of Reed-Solomon parity shall be transferred to the next stage of processing in the order of MSB first of each parity byte. The parity bytes shall be transferred starting from higher order to lower order.

Note that the Reed-Solomon encoder transfers and processes data in byte-by-byte order. See Annex E for examples of Reed-Solomon Encoder data values.

7.2.3 Convolutional encoder

Table 4 specifies the parameters of the Convolutional encoder. Convolutional code is employed for the PHY Header and the CPDU outer coding.

Table 4 — Convolutional encoder parameters

Function	Description
Constraint length	K=3
Polynomial	G0=7oct, G1=5oct

Table 5 specifies the relation between the Rate Setting and the number of convolutional encoders.

Figure 4 and Figure 5 specify the input/output relationship for the convolutional encodings. The input signal in both Figure 4 and Figure 5 is the RS-Encoded data as specified in Figure 14.

Table 5 — Rate Settings and number of convolutional encoders

Rate Setting	Num. of Conv. Enc.	Input/Output bit ordering
Rate 522		No convolutional code
Rate 261	2	See Figure 4
Rate 130	1	See Figure 5
Rate 65	1	See Figure 5
Rate 32	1	See Figure 5
PHY Header	1	See Figure 5

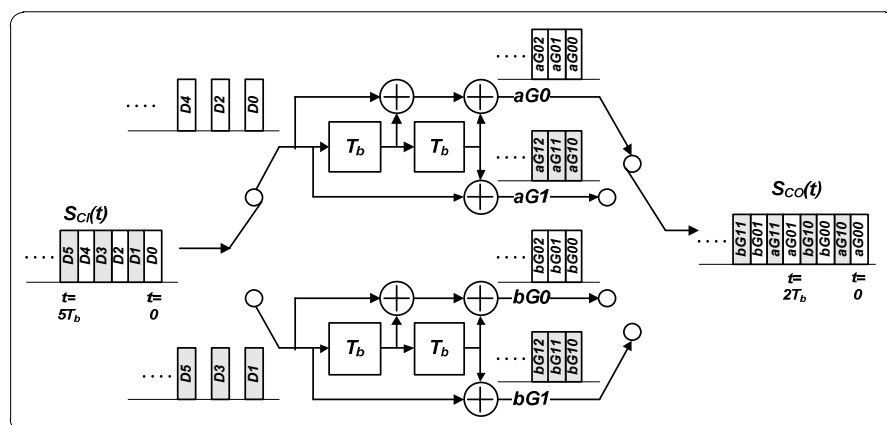


Figure 4 — Convolutional encoder for Rate 261