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Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 2: Physical Layer (PHL)

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Project Digital Enhanced Cordless Telecommunications (DECT).

The present document is part 2 of a multi-part EN covering the Common Interface (CI) for the Digital Enhanced Cordless Telecommunications (DECT), as identified below:

Part 1: "Overview";

Part 2: "Physical Layer (PHL)";

Part 3: "Medium Access Control (MAC) layer";

Part 4: "Data Link Control (DLC) layer";

Part 5: "Network (NWK) layer";

Part 6: "Identities and addressing";

Part 7: "Security features";

Part 8: "Speech coding and transmission".

Further details of the DECT system may be found in TR 101 178 [10] and ETR 043 [9].

National transposition dates	
Date of adoption of this EN:	16 February 2001
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1 Scope

The present document gives an introduction and overview of the complete Digital Enhanced Cordless Telecommunications (DECT) Common Interface (CI).

The present document of the DECT CI specifies the physical channel arrangements. DECT physical channels are radio communication paths between two radio end points. A radio end point is either part of the fixed infrastructure or a Portable Part (PP), typically a handset. The assignment of one or more particular physical channels to a call is the task of higher layers.

The Physical Layer (PHL) interfaces with the Medium Access Control (MAC) layer, and with the Lower Layer Management Entity (LLME). On the other side of the PHL is the radio transmission medium which has to be shared extensively with other DECT users and a wide variety of other radio services. The tasks of the PHL can be grouped into five categories:

a) to modulate and demodulate radio carriers with a bit stream of a defined rate to create a radio frequency channel;

b) to acquire and maintain bit and slot synchronization between transmitters and receivers;

c) to transmit or receive a defined number of bits at a requested time and on a particular frequency;

d) to add and remove the synchronization field and the Z-field used for rear end collision detection;

e) to observe the radio environment to report signal strengths.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

[1] ETSI EN 300 175-1: "Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 1: Overview".

[2] ETSI EN 300 175-3: "Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 3: Medium Access Control (MAC) layer".

[3] ETSI EN 300 175-4: "Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 4: Data Link Control (DLC) layer".

[4] ETSI EN 300 175-5: "Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 5: Network (NWK) layer".

[5] ETSI EN 300 175-6: "Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 6: Identities and addressing".

[6] ETSI EN 300 176-1: "Digital Enhanced Cordless Telecommunications (DECT); Approval test specification; Part 1: Radio".

[7] ITU – R M.1457: "Detailed specifications of International Mobile Telecommunications-2000 (IMT-2000)".

[8] EIA TIA/EIA-422-B: "Electrical Characteristics of Balanced Voltage Digital Interface Circuits R (2000)".

[9] ETSI ETR 043: "Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Services and facilities requirements specification".

[10] ETSI TR 101 178: "Digital Enhanced Cordless Telecommunications (DECT); A High Level Guide to the DECT Standardization".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document the following terms and definitions apply:

antenna diversity: see EN 300 175-1 [1]

cell: see EN 300 175-1 [1]

Central Control Fixed Part (CCFP): see EN 300 175-1 [1]

channel: see EN 300 175-1 [1]

cluster: see EN 300 175-1 [1]

Connection Oriented mode (C/O): see EN 300 175-1 [1]

Cordless Radio Fixed Part (CRFP): see EN 300 175-1 [1]

coverage area: see EN 300 175-1 [1]

Dect Network (DNW): see EN 300 175-1 [1]

double duplex bearer: see EN 300 175-1 [1]

double simplex bearer: see EN 300 175-1 [1]

double slot: see EN 300 175-1 [1]

down-link: see EN 300 175-1 [1]

duplex bearer: see EN 300 175-1 [1]

Fixed Part (DECT Fixed Part) (FP): see EN 300 175-1 [1]

Fixed Radio Termination (FT): see EN 300 175-1 [1]

frame: see EN 300 175-1 [1]

full slot (slot): see EN 300 175-1 [1]

guard space: see EN 300 175-1 [1]

half slot: see EN 300 175-1 [1]

handover: see EN 300 175-1 [1]

intercell handover: see EN 300 175-1 [1]

intracell handover: see EN 300 175-1 [1]

Lower Layer Management Entity (LLME): see EN 300 175-1 [1]

multiframe: see EN 300 175-1 [1]

physical channel (channel): see EN 300 175-1 [1]

Portable Part (DECT Portable Part) (PP): see EN 300 175-1 [1]

Portable radio Termination (PT): see EN 300 175-1 [1]

public access service: see EN 300 175-1 [1]

radio channel: see EN 300 175-1 [1]

radio end point: see EN 300 175-1 [1]

Radio Fixed Part (RFP): see EN 300 175-1 [1]

Repeater Part (REP): see EN 300 175-1 [1]

RF carrier (carrier): see EN 300 175-1 [1]

RF channel: see EN 300 175-1 [1]

simplex bearer: see EN 300 175-1 [1]

Single Radio Fixed Part (SRFP): see EN 300 175-1 [1]

TDMA frame: see EN 300 175-1 [1]

Wireless Relay Station (WRS): see EN 300 175-1 [1]

3.2 Abbreviations

For the purposes of the present document the following abbreviations apply:

ACP	Adjacent Channel Power
ACK	Acknowledgement
CCFP	Central Control Fixed Part
CI	Common Interface (standard)
CRFP	Cordless Radio Fixed Part
dBc	dB relative to the peak power of an unmodulated carrier
dBm	dB relative to 1 milliwatt
DECT	Digital Enhanced Cordless Telecommunications
DLC	Data Link Control layer
EIRP	Effective Isotropic Radiated Power
ERP	Effective Radiated Power
FP	Fixed Part
FT	Fixed radio Termination
GFSK	Gaussian Frequency Shift Keying
GMSK	Gaussian Minimum Shift Keying
LLME	Lower Layer Management Entity
MAC	Medium Access Control layer
NTP	Normal Transmitted Power
PHL	Physical Layer
PHS	Portable HandSet
PP	Portable Part
ppm	parts per million
PT	Portable radio Termination
REP	Repeater Part
RF	Radio Frequency
RFP	Radio Fixed Part
RSSI	Radio Signal Strength Indicator
SAR	Specific Absorption Rate
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
WRS	Wireless Relay Station

4 PHL services

A physical channel provides a simplex bit-pipe between two radio end points. To establish, for example, a duplex telephone connection, two physical channels have to be established between the endpoints.

Radio spectrum is needed to create a physical channel. The radio spectrum space has three dimensions:

- geometric (geographic) space;
- frequency; and
- time.

Spectrum is assigned to physical channels by sharing it in these three dimensions.

DECT provides a mechanism called "handover", to release a physical channel and to establish another one in any or all of the three dimensions without releasing the end to end connection.

The requirements of the present document should be read in conjunction with EN 300 176-1 [6].

The requirements specified apply for nominal conditions unless extreme conditions are stated. Tests at extreme conditions may include combinations of limit values of extreme temperature and of power supply variation, defined for each case in EN 300 176-1 [6].

Nominal and extreme temperature ranges are defined below:

Nominal temperature:	PP, FP, RFP, CCFP	+15	°C to +35 °C;
Extreme temperature:	PP	0	°C to +40 °C;
	FP, RFP, CCFP, class E1	+10	°C to +40 °C;
	FP, RFP, CCFP, class E2	-10	°C to +55 °C.

The environmental class E1 refers to installation in indoor heated and/or cooled areas allowing for personal comfort, e.g. homes, offices, laboratories or workshops. The environmental class E2 refers to all other installations.

For nominal temperature, each measurement is made at the temperature of the test site, which shall be within +15 °C to +35 °C. For extreme temperatures, additional measurements are made, at each limit value of the extreme temperature.

4.1 RF channels (access in frequency)

4.1.1 Nominal position of RF carriers

Ten RF carriers shall be placed into the frequency band 1 880 - 1 900 MHz with centre frequencies Fc given by:

$$Fc = F0 - c \times 1{,}728 \text{ MHz.}$$

where: F0 = 1 897,344 MHz; and

c = 0,1, ..., 9.

Above this band, additional carriers are defined with centre frequencies Fc given by:

$$Fc = F9 + c \times 1{,}728 \text{ MHz;}$$

and $c \geq 10$ and RF band = 00001. (See EN 300 175-3 [2], clause 7.2.3.3.1).

Annex F shows the carrier frequencies for c = 0 to 9 and for $c \geq 10$ and RF band = 00001.

The frequency band between Fc - 1,728/2 MHz and Fc + 1,728/2 MHz shall be designated RF channel c.

NOTE: A nominal DECT RF carrier is one whose centre frequency is generated by the formula:

Fg = F0 - g x 1,728 MHz, where g is any integer.

All DECT equipment should when allowed be capable of working on all 10 RF channels, c= 0,1, ..., 9.

New or modified carrier positions and/or frequency bands can (locally) be defined when needed by utilizing reserved RF bands, e.g. for emerging DECT applications in the UMTS/IMT-2000 bands [7].

4.1.2 Accuracy and stability of RF carriers

At an RFP the transmitted RF carrier frequency corresponding to RF channel c shall be in the range Fc ± 50 kHz at extreme conditions.

At a PP the centre frequency accuracy shall be within ± 50 kHz at extreme conditions either relative to an absolute frequency reference or relative to the received carrier, except that during the first 1 s after the transition from the idle-locked state to the active-locked state the centre frequency accuracy shall be within ± 100 kHz at extreme conditions relative to the received carrier.

NOTE: The above state transition is defined in EN 300 175-3 [2].

The maximum rate of change of the centre frequency at both the RFP and the PP while transmitting, shall not exceed 15 kHz per slot.

4.2 Time Division Multiple Access (TDMA) structure (access in time)

4.2.1 Frame, full-slot, double-slot, and half-slot structure

To access the medium in time, a regular TDMA structure is used. The structure repeats in frames of 11 520 symbols, and the data is transmitted at a symbol rate of 1 152 ksymbol/s. Within this frame 24 full-slots are created, each consisting of two half-slots. A double slot has a length of two full slots, and starts concurrently with an even numbered full slot (see figures 1, 2 and 3).

NOTE: Some DECT documents sometimes refer to bits instead of symbols due to the fact that symbol and bit become synonyms for the mandatory 2-level modulation, for which most physical layer tests are defined, see EN 300 176-1 [6].

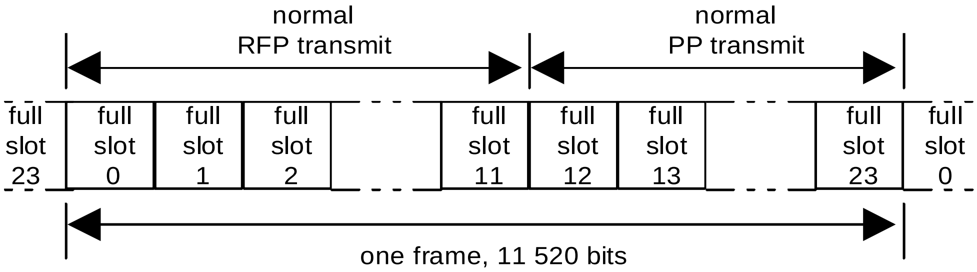

Figure 1: Full slot format

Full-slots are numbered from K = 0 to 23, and half-slots are numbered L = 0 or 1, where half-slot 0 occurs earlier than half-slot 1. Normally full-slots K = 0 to 11 are used in the RFP to PP direction, while full slots K = 12 to 23 are normally used in the PP to RFP direction. Double slots are numbered K = 0 to 22 for even values of K.

Each full-slot has a duration of 480 symbol intervals. Symbol intervals within a full-slot are denoted f0 to f479 where interval f0 occurs earlier than interval f1. Each half-slot has a duration of 240 symbol intervals. Half-slots commence at f0 or f240 (see figure 2).

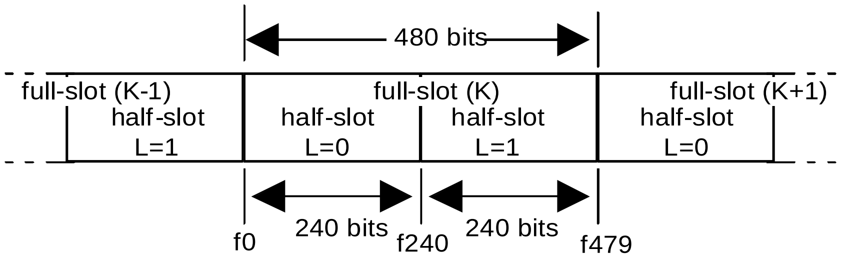

Figure 2: Half-slot format

Each double slot has a duration of 960 symbol intervals. Symbol intervals within a double slot are denoted f0 to f959. Symbols f0 to f479 coincide with the same notation for full slots with even K, K(e).

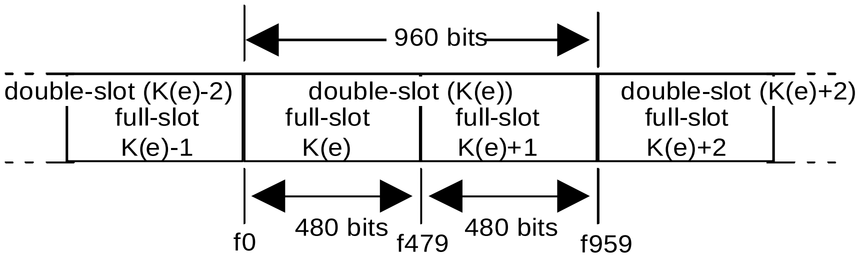

Figure 3: Double slot format

NOTE: Each radio end point has its own timing of the TDMA structure due to propagation delay and non-synchronized systems.

4.2.2 Reference timer accuracy and stability

The reference timer of a RFP or a PP is a notional clock to which the timing parameters of the TDMA framing are related.

A PP shall have its reference timer stability and accuracy better than 25 ppm at extreme conditions.

RFPs that can work with more than one duplex pair of physical channels per frame are known as multi-channel RFPs. Single channel RFPs can only work with one duplex pair of physical channels per frame (excluding handover situations).

A multi channel RFP shall have its reference timer stability and accuracy better than 5 ppm and better than 10 ppm at extreme conditions.

A single channel RFP shall have reference timer stability and accuracy better than 10 ppm at extreme conditions.

4.2.3 RFP transmission jitter

The nominal time when a packet should occur at the RFP antenna is (by this definition) synchronous to the RFP reference timer.

The jitter of a RFP packet transmission in a slot refers to the occurrence at the antenna of the start of symbol p0 of that packet. The jitter is defined in relation to the reference timer of that RFP.

The jitter of a packet transmission shall be less than ± 1 µs at extreme conditions.

The jitter between p0 and every other symbol in a packet shall be within ± 0,1 µs.

NOTE: 0,1 µs corresponds to 250 ppm.

4.2.4 PP reference timer synchronization

A PP shall take its reference timer parameters, including half-slot, full-slot, frame, multi-frame and receiver scan (see synchronization, EN 300 175-3 [2]) from any channel of any of the RFPs that it is locked to.

It is allowed (but not required) to have more than one PP reference timer.

The reference timer used for a PP transmission to a RFP shall be synchronized to packets (see clause 4.4) received from that RFP or from a RFP to which handover (see clause 4.2.5) is allowed.

This reference timer for packet transmission timing is nominally (by this definition) synchronized to the time when the last packet used for synchronization occurred at the PP antenna.

When a PP transmits a packet, the start of transmission of symbol p0 of the packet shall occur at the PP antenna ± 2 µs at extreme conditions from the nominal transmission time as given by an ideal PP reference timer with 0 ppm accuracy. An exception is allowed for a dummy bearer change request packet transmission (see EN 300 175-3 [2], clause 7.2.5.6), when the nominal transmission time shall be given by the actual PP reference timer.

NOTE: The reason for the exception is that a residential PP may need to send the dummy bearer change request after a sudden slot theft in the idle locked mode. In this case the last synchronization of the reference timer can be more than 16 frame old. For all other packet transmissions, including bearer set up, the synchronization is normally less than one frame old.

The jitter between p0 and every other symbol in a packet shall be within ± 0,1 µs.

Connections to different RFPs are allowed (but not required) to have different reference timers.

4.2.5 System synchronization

RFPs on the same FP shall be in half-slot, full-slot and frame synchronism. If internal handover is provided (see EN 300 175-3 [2] and EN 300 175-4 [3]), receiver scan and multiframe synchronism is also required.

The difference between reference timers of RFPs of the same FP shall be less than 4 µs if internal handover is provided between these RFPs.

NOTE: Related to its reference timer, the PP or RFP synchronization window (see EN 300 175-3 [2]) should be at least ± 14 symbols, when expecting a first reception and if intracell handover is provided, else ± 4 symbols.

4.2.6 Inter-system synchronization

Synchronization between FPs can be provided via an optional synchronization port (see annex B).

NOTE: RFPs of synchronized FPs should have geographically unique Fixed Part MAC Identities (FMIDs) (see EN 300 175-6 [5]).

4.2.7 Reference timer adjustment for synchronization

To obtain system and inter-system synchronization, a RFP or PP may alter the length of a single frame by any amount, or, it may alter the length of successive frames by up to 2 symbols.

NOTE 1: Framelength alterations should be performed in accordance to the reference timer stability and accuracy requirements for RFPs and PPs as specified in clause 4.2.2.

NOTE 2: If the timing of RFPs is adjusted outside the specification of clause 4.2.2 then PPs are not expected to remain in the IDLE_LOCKED state. Therefore such timing adjustments should be made as infrequently as possible by RFP reference timers.

4.3 Cells (access in space)

The third dimension to divide spectrum space is the geographical volume. Propagation losses may allow time-frequency combinations to be reused in different places.