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Digital cellular telecommunications system (Phase 2+) (GSM); Radio subsystem
synchronization (GSM 05.10 version 7.3.1 Release 1998)

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European Standard (Telecommunications series)

Digital cellular telecommunications system (Phase 2+); Radio subsystem synchronization (GSM 05.10 version 7.3.1 Release 1998)

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Special Mobile Group (SMG).

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Special Mobile Group (SMG), and is now submitted for the ETSI standards One-step Approval Procedure.

The contents of the present document may be subject to continuing work within SMG and may change following formal SMG approval. Should SMG modify the contents of the present document it will then be re-submitted for formal approval procedures by ETSI with an identifying change of release date and an increase in version number as follows:

Version 7.x.y

where:

7 GSM Phase 2+ Release 1998.

x the second digit is incremented for changes of substance, i.e. technical enhancements, corrections, updates, etc.;

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1 Scope

The present document defines the requirements for synchronization on the GSM radio sub-system. However, it does not define the synchronization algorithms to be used in the Base Transceiver Station (BTS), CTS Fixed Part (CTS-FP) and Mobile Station (MS). These are up to the manufacturer to specify.

The present document is for GSM, DCS 1 800 and PCS 1 900.

1.1 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.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.
- For this Release 1998 document, references to GSM documents are for Release 1998 versions (version 7.x.y).

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- [1] GSM 01.04: "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".
 - [2] GSM 03.60: "Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); Service Description Stage 2".
 - [3] GSM 03.64: "Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); GPRS Radio Interface Stage 2".
 - [4] GSM 04.08: "Digital cellular telecommunications system (Phase 2+); Mobile radio interface layer 3 specification".
 - [5] GSM 04.60: "Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); Mobile Station (MS) - Base Station System (BSS interface; Radio Link Control (RLC) and Medium Access Control (MAC) Layer Specification".
 - [6] GSM 05.02: "Digital cellular telecommunications system (Phase 2+); Multiplexing and multiple access on the radio path".
 - [7] GSM 05.05: "Digital cellular telecommunications system (Phase 2+); Radio transmission and reception".
 - [8] GSM 05.08: "Digital cellular telecommunications system (Phase 2+); Radio subsystem link control".
 - [9] GSM 03.30: "Digital cellular telecommunications system (Phase 2+); Radio network planning aspects".
 - [10] GSM 03.52: "Digital cellular telecommunications system (Phase 2+); GSM Cordless Telephony System (CTS), Phase 1; Lower layers of the CTS Radio Interface; Stage 2".
 - [11] GSM 05.56: "Digital cellular telecommunications system (Phase 2+); GSM Cordless Telephony System (CTS), Phase 1; CTS-FP Radio subsystem".

1.2 Definitions and abbreviations

In addition to those below, abbreviations used in this EN are listed in GSM 01.04.

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

BTS: Base Transceiver Station.

CTS-FP: CTS Fixed Part.

CTS-MS: MS operating in CTS mode.

Timing Advance: signal sent by the BTS to the MS which the MS uses to advance its timings of transmissions to the BTS so as to compensate for propagation delay.

Quarter bit number: timing of quarter bit periods (12/13 μ s) within a timeslot.

Timeslot number: timing of timeslots within a TDMA frame.

TDMA frame number: count of TDMA frames relative to an arbitrary start point.

Current Serving BTS: BTS on one of whose channels (TCH, DCCH, CCCH or PDCH) the MS is currently operating.

Current Serving CTS-FP: CTS-FP on one of whose channels (TCH or CTS control channels) the CTS-MS is currently operating.

Timebase counters: set of counters which determine the timing state of signals transmitted by a BTS or MS.

MS timing offset: delay of the received signal relative to the expected signal from an MS at zero distance under static channel conditions with zero timing advance. This is accurate to ± 1 bit, and reported once per SACCH or after a RACH as required (i.e. at the same rate as timing advance). For example, for an MS with a round trip propagation delay of P bits, but with a timing advance of T bits, the reported timing offset will be P-T quantized to the nearest bit. For GPRS the MS timing offset is not reported.

Timing Advance Index: Timing Advance Index TAI used for GPRS, which determines the position of the subchannel on PTCCH (see GSM 05.02) used by the MS to send an access burst, from which the network can derive the timing advance.

Observed Frequency Offset (OFO): difference of frequency of signals received by a CTS-MS from a CTS-FP and a BTS. The Observed Frequency Offset is measured and reported by the CTS-MS on CTS-FP requirement. The Observed Frequency Offset is expressed in ppm with an accuracy of 1/64 ppm (i.e. about 0,016 ppm).

2 General description of synchronization system

This clause gives a general description of the synchronization system. Detailed requirements are given in clauses 3 to 7.

The BTS sends signals on the BCCH to enable the MS to synchronize itself to the BTS and if necessary correct its frequency standard to be in line with that of the BTS. The signals sent by the BTS for these purposes are:

- a) Frequency correction bursts;
- b) Synchronization bursts.

The timings of timeslots, TDMA frames, TCH frames and control channel frames are all related to a common set of counters which run continuously whether the MS and BTS are transmitting or not. Thus, once the MS has determined the correct setting of these counters, all its processes are synchronized to the current serving BTS.

The MS times its transmissions to the BTS in line with those received from the BTS. The BTS sends to each MS a "timing advance" parameter (TA) according to the perceived round trip propagation delay BTS-MS-BTS. The MS advances its timing by this amount, with the result that signals from different MS's arriving at the BTS and compensated for propagation delay. This process is called "adaptive frame alignment".

Additionally, synchronization functions may be implemented in both the MS and the BTS to support the so-called pseudo synchronization scheme. The support of this scheme is optional except that MS shall measure and report the Observed Timing Difference (OTD), which is a mandatory requirement. The detailed specifications of the pseudo-synchronization scheme are included in annex A.

In CTS, the CTS-FP sends signals on the CTSBCH to enable the MS to synchronize itself to the CTS-FP and if necessary correct its frequency standard to be in line with that of the CTS-FP.

The signals sent by the CTS-FP for these purposes are:

- a) frequency correction bursts;
- b) synchronization bursts.

The timings of timeslots, TDMA frames, CTSBCH, CTSARCH, CTSAGCH and CTSPCH frames are all related to a first common set of counters which run continuously whether the CTS-MS and CTS-FP are transmitting or not. Thus, once the CTS-MS has determined the correct setting of these first counters, the CTS-MS is able to attach to the current serving CTS-FP. In addition, during CTS-MS attachment, the CTS-FP sends to the CTS-MS the remaining counters for SACCH and TCH frames. Then, all processes of the CTS-MS are synchronized to the current serving CTS-FP.

The CTS-MS times its transmissions to the CTS-FP in line with those received from the CTS-FP. The timing advance parameter is set to zero for CTS.

Additionally, the CTS-FP may be assisted by a CTS-MS to adjust its frequency source. When required by the CTS-FP, the CTS-MS estimates if possible and reports the Observed Frequency Offset of the CTS-FP with a specified BTS. The CTS-FP may then adjust its frequency source according to this value.

3 Timebase counters

3.1 Timing state of the signals

The timing state of the signals transmitted by a BTS, a MS or a CTS-FP is defined by the following counters:

- Quarter bit number QN (0 - 624)- Bit number BN (0 - 156);
- Timeslot number TN (0 - 7);
- TDMA frame number FN (0 to $(26 \times 51 \times 2048) - 1 = 2715647$); or
- for a non attached CTS-MS, TDMA frame number modulo 52 T4 (0 - 51).

In CTS, the CTS-MS shall manage different sets of counters for CTS operation and GSM operation.

3.2 Relationship between counters

The relationship between these counters is as follows:

- QN increments every 12/13 μ s;
- BN = Integer part of QN/4;
- TN increments whenever QN changes from count 624 to 0;
- FN increments whenever TN changes from count 7 to 0; or
- for a CTS-MS, T4 increments whenever TN changes from count 7 to 0.

4 Timing of transmitted signals

The timing of signals transmitted by the MS, BTS and CTS-FP are defined in GSM 05.02.

The MS can use the timing of receipt of the synchronization burst to set up its timebase counters as follows:

QN is set by the timing of the training sequence;

TN = 0 when the synch burst is received;

FN = $51 ((T3-T2) \bmod (26)) + T3 + 51 \times 26 \times T1$ when the synch burst is received, (where $T3 = (10 \times T3') + 1$, $T1$, $T2$ and $T3'$ being contained in information fields in synchronization burst).

For CTS, the timebase counters are set as follows:

QN is set by the timing of the training sequence;

TN is set according to the CTSBCH-SB position (see Annex C);

T4 = 51 when the CTSBCH-SB is received (prior to attachment);

FN = $(51 ((T3-T2) \bmod (26)) + T3 + 51 \times 26 \times T1) \bmod (2715648)$ when the CTS-MS receives the last CTSAGCH burst of the non-hopping access procedure, where $T2 = T4 \bmod (26)$, and $T1$ and $T3$ being contained in this CTS immediate assignment message.

Thereafter, the timebase counters are incremented as in subclause 3.2.

(When adjacent BTS's are being monitored for handover purposes, or for cell reselection purposes in group receive mode, the MS may choose to store the values of QN, TN and FN for all the BTS's whose synchronization bursts have been detected relative to QN, TN and FN for its current serving BTS).

5 BTS Requirements for Synchronization

The conditions under which the requirements of subclauses 5.4 and 5.6 must be met shall be 3 dB below the reference sensitivity level in GSM 05.05 and 3 dB less carrier to interference ratio than the reference interference ratios in GSM 05.05.

5.1 Frequency source

The BTS shall use a single frequency source of absolute accuracy better than 0,05 ppm for both RF frequency generation and clocking the timebase. The same source shall be used for all carriers of the BTS.

For the pico BTS class the absolute accuracy requirement is relaxed to 0,1ppm.

NOTE: BTS frequency source stability is one factor relating to E-OTD LCS performance and the reader is referred to Annex C for the relationship between BTS frequency source stability and E-OTD LCS performance characteristics.

5.2 Timebase counters

It is optional whether the timebase counters of different BTS's are synchronized together.

5.3 Internal BTS carrier timing

The channels of different carriers transmitted by a BTS shall be synchronized together, i.e. controlled by the same set of counters. The timing difference between the different carriers shall be less than 1/4 bit periods, measured at the BTS antenna.