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Contents

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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.

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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.;

y the third digit is incremented when editorial only changes have been incorporated in the specification.

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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).

[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 µs) 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 x 51 x 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 µs;
- 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) mod (26)) + T3 + 51 x 26 x T1 when the synch burst is received,(where T3 = (10 x 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) mod (26)) + T3 + 51 x 26 x T1) mod (2715648) when the CTS-MS receives the last CTSAGCH burst of the non-hopping access procedure, where T2 = T4 mod (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.

For pico-BTS, the timing difference between different carriers shall be less than 2 bit periods, measured at the BTS antenna.

5.4 Initial Timing advance estimation

When the BTS detects an access burst transmission on RACH or PRACH, it shall measure the delay of this signal relative to the expected signal from an MS at zero distance under static channel conditions. This delay, called the timing advance, shall be rounded to the nearest bit period and included in a response from the BTS when applicable.

For the pico-BTS there is no requirement to measure this timing advance. However, either this measured value or a programmable value of timing advance shall be included in the response from the BTS when a timing advance value needs to be sent.

5.5 Maximum timing advance value

The maximum timing advance value shall be 63. If the BTS measures a value larger than this, it shall set the timing advance to 63. (GSM 03.30 defines how the PLMN deals with MS's where the delay exceeds timing advance value 63.)

5.6 Delay tracking

5.6.1 For circuit switched channels

The BTS shall thereafter continuously monitor the delay of the normal bursts sent by from the MS. If the delay changes by more than one bit period, the timing advance shall be advanced or retarded 1 and the new value signalled to the MS.

Restricting the change in timing advance to 1 bit period at a time gives the simplest implementation of the BTS. However the BTS may use a larger change than this but great care must then be used in the BTS design.

5.6.2 For packet switched channels

The BTS shall perform the continuous update timing advance mechanism for all MS working in packet transfer mode for which an PTCCH subchannel is assigned, except for MS class A in dedicated mode. Therefore the BTS shall monitor the delay of the access bursts sent by the MS on PTCCH and respond with timing advance values for all MS performing the procedure on that PDCH. These timing advance values shall be sent via a downlink signalling message on PTCCH.

The BTS shall update the timing advance values in the next downlink signalling message following the access burst.

The BTS may also monitor the delay of the normal bursts and access bursts sent by the MS on PDTCH and PACCH. Whenever an updating of TA is needed, the BTS may send the new TA value in a power control/timing advance message (see GSM 04.60).

For MS class A in dedicated mode the BTS shall follow the procedure described in subclause 5.6.1.

5.6.3 Delay assessment error

For circuit and packed switched channels the delay shall be assessed in such a way that the assessment error (due to noise and interference) is less than 1/2 bit periods for stationary MS. For MS moving at a speed up to 500 km/h the additional error shall be less then 1/4 bit period.

The control loop for the timing advance shall be implemented in such a way that it will cope with MSs moving at a speed up to 500 km/h.

5.6.4 Pico-BTS delay tracking

The pico-BTS has no requirement to track timing advance for any class of channels. However, it shall include either the measured timing advance as specified above or a programmable timing advance value in the response from the BTS when a timing advance value needs to be sent.

5.7 Timeslot length

Optionally, the BTS may use a timeslot length of 157 bit periods on timeslots with TN = 0 and 4, and 156 bit periods on timeslots with TN = 1, 2, 3, 5, 6, 7, rather than 156,25 bit periods on all timeslots.

5.8 Range of Timing advance

The timing advance shall be in the range 0 to 63. The value 0 corresponds to no timing advance, i.e. the MS transmissions to the BTS are 468,75 bits periods behind (see subclause 6.4). The value 63 corresponds to maximum timing advance, i.e. the MS transmissions are 405,75 bit periods behind.

6 MS Requirements for Synchronization

The MS shall only start to transmit to the BTS if the requirements of subclauses 6.1 to 6.4 are met.

The conditions under which the requirements of subclauses 6.1 to 6.4 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.

In discontinuous reception (DRX), the MS should meet the requirements of subclauses 6.1 to 6.3 during the times when the receiver is required to be active.

For CTS, the CTS-MS shall fulfil all the requirements of subclauses 6.1 to 6.4, 6.7, 6.8, 6.10 and 6.11 where «BTS» designates the CTS-FP. The CTS-MS shall always use a TA value of zero. The CTS-MS shall only start to transmit to the CTS-FP if the requirements of subclauses 6.1 to 6.4 are met. The conditions under which the requirements of subclauses 6.1 to 6.4 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. In discontinuous reception (DRX), the CTS-MS should meet the requirements of subclauses 6.1 to 6.3 during the times when the receiver is required to be active.

6.1 MS carrier frequency

The MS carrier frequency shall be accurate to within 0,1 ppm, or accurate to within 0.1 ppm compared to signals received from the BTS (these signals will have an apparent frequency error due to BTS frequency error and Doppler shift). In the latter case, the signals from the BTS must be averaged over sufficient time that errors due to noise or interference are allowed for within the above 0,1 ppm figure. The MS shall use the same frequency source for both RF frequency generation and clocking the timebase.

6.2 Internal timebase

The MS shall keep its internal timebase in line with that of signals received from the BTS. If the MS determines that the timing difference exceeds 2 μ seconds, it shall adjust its timebase in steps of 1/4 bit period. This adjustment shall be performed at intervals of not less than 1 second and not greater than 2 seconds until the timing difference is less than 1/2 bit periods.

6.3 Assessment of BTS timing

In determining the timing of signals from the BTS, the timings shall be assessed in such a way that the timing assessment error is less than 1/2 bit periods. The assessment algorithm must be such that the requirements of 6.2 can be met.

6.4 Timing of transmission

The MS shall time its transmissions to the BTS according to signals received from the BTS. The MS transmissions to the BTS, measured at the MS antenna, shall be 468,75-TA bit periods (i.e. 3 timeslots-TA) behind the transmissions received from the BTS, where TA is the last timing advance received from the current serving BTS. The tolerance on these timings shall be ± 1 bit period. For CTS, the tolerance on these timings shall be ±1/2 bit period.

In case of a multislot configuration, the MS shall use a common timebase for transmission of all channels. In this case, the MS may optionally use a timeslot length of 157 bit periods on timeslots TN = 0 and 4, and 156 bit periods on timeslots with TN = 1, 2, 3, 5, 6 and 7, rather than 156,25 bit periods on all timeslots. In case of a circuit switched multislot configuration, the common timebase shall be derived from the main channel and the TA values received on other channels shall be neglected. In case of a packet switched multislot configuration the common timebase shall be derived from all timeslots monitored by the MS. In this case, the MS may assume that the BTS uses a timeslot length of 156,25 bit periods on all timeslots.

6.5 Application of Timing Advance

6.5.1 For circuit switched channels

When the MS receives a new value of TA from the BTS on the SACCH, it shall implement the new value of TA at the first TDMA frame belonging to the next reporting period (as defined in GSM 05.08), after the SACCH frame containing the new TA value. On channels used for a voice group call, the TA value sent by the BTS applies only to an MS currently allocated the uplink.

The MS shall signal the used TA to the BTS on the SACCH.

6.5.2 For packet switched channels

The following requirements apply for all MS in packet transfer mode, except MS class A in dedicated mode.

The MS shall transmit access bursts with TA value=0.

Within the packet resource assignments (see GSM 04.08 and GSM 04.60) for uplink or downlink messages the MS gets the Timing Advance Index (TAI). The MS shall send access bursts on the subchannel defined by the TAI on the PTCCH. These access bursts received on PTCCH are used by the BTS to derive the timing advance.

When the MS receives the updated value of TA from the BTS on the downlink PTCCH, it shall always use the last received TA value for the uplink transmission of normal bursts.

If an MS is allocated different TAI values for simultaneous uplink and downlink packet transfer, the MS may chose to use any one or both PTCCH subchannels. If two subchannels are used, the MS shall always use the received TA value corresponding to the last transmitted PTCCH uplink burst.

If the MS receives a packet resource assignment or power control/timing advance message (see GSM 04.08 and GSM 04.60) without a TAI, the MS shall not use the continuous timing advance procedure.

Upon initiation of the continuous timing advance procedure the MS shall disregard the TA values on PTCCH until it has sent its first access burst on PTCCH.

The network may request the MS to send 4 access bursts to calculate a new TA value. For this purpose the network sets the system information element CONTROL_ACK_TYPE to indicate that the MS is to respond with a PACKET_CONTROL_ACKNOWLEDGEMENT consisting of 4 access bursts (see GSM 04.60), and sends a PACKET_POLLING_REQUEST to the MS. In this case, the MS shall transmit 4 consecutive access bursts on the assigned resources.

If the MS receives a packet resource assignment or power control/timing advance message (see GSM 04.08 and GSM 04.60), the MS shall use the included TA value for normal burst transmissions until it receives a new value on PTCCH. If the message does not contain a TA value, the MS shall not change its TA value.

When entering packet transfer mode, the MS is not allowed to transmit normal bursts until it has received a valid TA value by any of the methods described above.

A MS class A in dedicated mode shall follow the procedures described in subclause 6.5.1.

6.6 Access to a new BTS

When the MS accesses a new BTS or the serving BTS is changed, or the MS initiates a packet transfer, the MS shall change the TA as follows:

Random access and Packet random access:

- the MS shall use a TA value of 0 for the Random Access burst sent. When a TA is received from the BTS that TA shall be used.

Synchronized or Pseudo Synchronized handover:

- after the Handover Access bursts which shall be sent with a TA value of 0 the MS shall use a TA calculated as specified in annex A. When a TA is received from the new BTS that TA shall be used. The transmission of the Handover Access burst is optional if so indicated by the BTS.

Non-synchronized handover:

- the MS shall use a TA value of 0 for the Handover Access bursts sent. When a TA is received in a physical information message that TA shall be used. Before a TA is received from the new BTS no valid "used TA" shall be signalled to the new BTS.

Pre-synchronized handover:

- after the Handover Access bursts which shall be sent with a TA value of 0 the MS shall use a TA as specified in the HO command by the old BTS, or a default value of 1, if the old BTS did not provide a TA value. The transmission of the Handover Access burst is optional if so indicated by the BTS.

6.7 Temporary loss of signal

During a temporary total loss of signal, of up to 64 SACCH block periods, the MS shall update its timebase with a clock which is accurate to within 0,2 ppm, or to within 0.2 ppm of the signals previously received from the BTS.

6.8 Timing of intracell channel change

When the MS receives an intracell channel change command or a handover command (see GSM 04.08), it shall be ready to transmit on the new channel within 120 ms of the last timeslot of the message block containing the command, unless the access is delayed to an indicated starting time, in which case it shall be ready to transmit on the new channel at the designated starting time, or within 120 ms, whichever is the later. The time between the end of the last complete speech or data frame or message block sent on the old channel and the time the MS is ready to transmit on the new channel shall be less than 20 ms.

6.9 Application of new Timing Advance value

When the MS receives a new TA value in response to a handover access burst, the MS shall be ready to transmit using the new TA value within 40 ms of the end of the last timeslot of the message block containing the new TA value.

When the MS receives a new or updated TA value on the downlink PTCCH or downlink PACCH, the MS shall be ready to transmit using the new TA value within 40 ms of the end of the last timeslot of the message block containing the new TA value.

6.10 Definition of "ready to transmit within x ms"

The phrase "ready to transmit within x ms" means that the MS shall transmit no later than:

- the first burst of the first TCH or control channel block that occurs after the x ms, in case of an intracell channel change;

- the first burst of the TCH or control channel that occurs after the x ms, in case of a handover;
- the first burst of the PDTCH or control channel that occurs after the x ms.

NOTE: The MS shall keep the timings of the neighbour BTS's that it is monitoring (according to GSM 05.08) to an accuracy of ±1 bit periods.

6.11 Definition of additional reaction times for GPRS mobile stations

6.11.1 Uplink and downlink assignment reaction times

An MS shall be ready to transmit and receive using a new assignment no later than the next occurrence of block B((x+3) mod 12) where block B(x) is the last radio block containing the uplink assignment. This applies also for the reception of the first USF for dynamic uplink assignment.

If the MS is required to transmit a PACKET CONTROL ACKNOWLEDGEMENT subsequent to a PACKET DOWNLINK ASSIGNMENT, the MS shall be ready to receive on the new assignment no later than the next occurrence of block B((x+2) mod 12) where block B(x) is radio block containing the PACKET CONTROL ACKNOWLEDGEMENT.

6.11.2 Change in channel coding scheme commanded by network

Upon receipt of a command from the network to change the channel coding scheme, the MS shall begin to transmit blocks using the new channel coding scheme no later than the next occurrence of block B((x+3) mod 12) where block B(x) is the radio block containing the command.

6.11.3 Contention resolution reaction time

Upon contention resolution during one phase access, the mobile station shall start transmitting RLC data blocks without the TLLI field no later than the next occurrence of block B((x+3) mod 12) where block B(x) is the radio block containing the contention resolution message (see GSM 04.60).

6.11.4 Reaction time in response to other commanding messages

Upon a receipt of a commanding message or indication from the network requiring an action by the mobile station, if the reaction time for such action is not specified elsewhere, the mobile station shall begin to perform the required action no later than the next occurrence of block B((x+6) mod 12), where block B(x) is the radio block containing the commanding message or indication form the network.

6.12 Observed Frequency Offset (OFO) reported by the CTS-MS

When required the CTS-MS shall compute the Observed Frequency Offset between the CTS-FP and a specified BTS (see GSM 05.08). The CTS-FP and BTS received signals frequencies shall be estimated with an accuracy of 0,1 ppm, averaging the signals over sufficient time. The conditions under which this requirements 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.

7 CTS-FP Requirements for Synchronization

7.1 Frequency source default requirements

The CTS-FP shall use a single frequency source of absolute accuracy better than 5 ppm for both RF frequency generation and clocking the timebase. The same source shall be used for all carriers of the CTS-FP.

7.2 Frequency source for a CTS-FP assisted by a CTS-MS

When the CTS-FP is informed of its Observed Frequency Offset with a BTS, the CTS-FP carrier frequency shall be accurate for one hour to within 2 ppm, or accurate for one hour to within 2 ppm according to the received Observed Frequency Offset.

However, if the Observed Frequency Offset is greater than 2 ppm, the CTS-FP frequency source correction shall have a slope of 0,1 ppm for 936 TDMA frames, i.e. 4,320 seconds.

7.3 Internal CTS-FP carrier timing

The channels of different carriers transmitted by a CTS-FP shall be synchronized together, i.e. controlled by the same set of counters. The timing difference between the different carriers shall be less than 2 bit periods, measured at the CTS-FP antenna.

7.4 Timeslot length

Optionally, the CTS-FP may use a timeslot length of 157 bit periods on timeslots with TN = 0 and 4, and 156 bit periods on timeslots with TN = 1, 2, 3, 5, 6, 7, rather than 156,25 bit periods on all timeslots.

7.5 Assessment of CTS-MS delay

In order to implement the procedure of control of the CTS-FP service range (specified in GSM 05.08), the CTS-FP shall monitor the delay of the CTS-MS signal relative to the expected signal from a CTS-MS at zero distance under static channel conditions. The delay of the normal bursts sent by from the CTS-MS shall be assessed in such a way that the assessment error (due to noise and interference) is less than 1/4 bit period. The conditions under which this requirement must be met shall be 3 dB below the reference sensitivity level in GSM 05.56 and 3 dB less carrier to interference ratio than the reference interference ratios in GSM 05.56.

Annex A (normative): Additional requirements for pseudo-synchronization, synchronized handovers and pseudo-synchronized handovers

A.1 General descriptions and definitions

A.1.1 Conventions

The following conventions are adopted in this annex:

- the modulating bit period is denoted T = 48/13 µs;
- all timing values are considered for descriptive purposes as real numbers modulo the largest period defined in the system i.e. 3394560000T. When transmitted over the air interface, such a value shall be rounded to the nearest integer multiple of a 1/2 bit period T/2 and that integer shall be reduced mod some integer multiple of 256 as defined in GSM 04.08;
- the Timing Advance (TA) value, when the distance between the base station and the MS is equal to or less than 35 km, represents the estimated two way propagation delay in T units. For the purpose of the calculations in this annex the timing advance values are considered to represent the estimated one way propagation delay in T/2 units which is equivalent to twice the delay in T units.

A.1.2 Definitions

Assuming that some MS has to perform handover from BTS 0 (the "current" or "old" BTS) to BTS 1 (the "new" BTS), the following quantities are defined.

- t_0 (resp. t_1) denotes the one way line of sight propagation delay between the MS and BTS 0 (resp. BTS 1).
- RTD (Real Time Difference) denotes the value of the local system time in BTS 0 minus that of BTS 1.
- OTD (Observed Time Difference) denotes the timing difference between BTS 0 and BTS 1 as measured by the MS with the same sign conventions as for RTD.

All these four values are slowly time-varying due to the MS movement and oscillators drift in the BTS's, but they are defined here just prior handover execution.

A.1.3 Details of operations

The following relation holds:

$$OTD = RTD + t_1 - t_0$$

Synchronized and pseudo synchronized handovers work as follows:

- for the pseudo synchronized handover, it is assumed that RTD is known to BTS 0 and MS supports the scheme, BTS 0 may order pseudo-synchronized handover to BTS 1, including RTD in the "HANDOVER COMMAND" message;
- for the synchronized handover, BTS 0 may order synchronized handover to BTS 1, and the MS sets RTD equal to 0;

- under normal operating conditions, t_0 should be closely related to the latest received Timing Advance sent by BTS 0 to the MS; since the MS must have got synch to BTS 1 before performing handover, OTD, RTD and t_0 are available to the MS, hence the value of t_1 that can be used to set the new Timing Advance parameter without receiving it from BTS 1;
- after successful handover, either synchronized, non-synchronized or pseudo-synchronized, the MS shall provide to BTS 1 the value of OTD + t_0 in the "HANDOVER COMPLETE" message, allowing BTS 1 to obtain a non biased estimate of RTD given the transmitted OTD + t_0 and it is estimated value to t_1. In practice, additional processing will be required to mitigate the effects of estimation errors and quantization effects; this matter is left unspecified.

A.2 BTS requirements

A.2.1 The pseudo-synchronization scheme

If the pseudo-synchronization scheme is supported, the BTS shall comply with the following requirements, in addition to those of the main part of the recommendations.

A.2.1.1 BTS a time difference estimate

The BTS shall maintain for each of a set of neighbouring BTS a time difference estimate encoded as in A 1.1. These time differences can be updated when a MS supporting the pseudo-synchronization scheme enters the cell via a handover: the MS provides the observed time difference corrected for the propagation time with the previous BTS but not corrected for the propagation to the current BTS. When the adaptive frame alignment process in the new BTS has assessed the propagation time, it is used to correct the observed time difference given by the MS and the result is used (possibly after some unspecified processing) to update the value of the time difference with the previous BTS. Other means for maintaining the time difference estimates may be used.

A.2.1.2 The reception epoch criterion

The reception epoch criterion used for evaluating the MS time shift (see subclause 5.6) shall be as close as possible to line of sight path reception epoch, so that with MS supporting the pseudo-synchronization scheme the timing advance for stationary MS is as close as possible to the double propagation delay.

A.2.1.3 Pseudo-synchronized handover

When a handover is requested, if the MS supports pseudo-synchronization, it may be chosen to order a pseudo-synchronized handover. In that case, the time difference between the two BTS, memorized as specified in A.2.1 and encoded as specified in A.1.1 must be sent to the MS.

A.2.2 The synchronization requirement

If the pseudo-synchronization scheme is supported, the BTS shall comply with the following requirements, in addition to those of the main part of the specifications.

The BTS shall maintain synchronization with a set of neighbouring BTS. In this context, synchronization means that the timing of the TDMA frame at the BTSs is the same, i.e. the timeslot zeros from the BTS transmitted are synchronous with the timeslot zeros of the carriers on the set of neighbouring BTSs. All timings are to be referenced at the BTS.

A.3 MS requirements

The MS shall comply to the following requirements.

A.3.1 Provision of time difference information

The reception epoch criterion used for clocking the timebase shall be as close as possible to line of sight path reception epoch so that the timing advance when the MS is stationary is as close as possible to the double propagation delay. However the quantization mentioned in subclause A.1.1 does not impose any additional requirement on the resolution of the measurement.

A.3.2 After each successful handover

After each successful handover the MS shall give to the new BTS the sum of the observed time difference and the last timing advance value received from the old BTS, if required by the BTS encoded as subclause A 1.1.

A.3.3 Synchronized or a pseudo synchronized handover

When a synchronized or a pseudo synchronized handover occurs, the MS shall synchronize to the new BTS and shall use as initial timing advance value the value calculated modulo 256 from the observed time difference between the two BTS, the real time difference and the last timing advance value received from the previous BTS, according to subclause A.1.3. Calculated values between 230 and 255 shall be regarded as negative timing advance. The Real Time Difference (RTD) is in the case of pseudo synchronized handover given with the handover command and in the case of synchronized handover set to 2500*INT(OTD/2500+0,5) by the MS. If the initial timing advance value calculated is outside the range 0 to 63 the MS shall do as follows:

- if the initial timing advance value calculated is greater than 63, the cell shall be considered as out of range. The MS shall, if it attempts to transmit on the new cell, use a timing advance value of 63 as the initial timing advance value. Whether the MS transmits on the new cell or not depends on the NCI bit as specified in GSM 04.08;

- if the initial timing advance value calculated is less than 0, the MS shall use a timing advance value of 0 as the initial timing advance value.

Annex B (informative): CTSBCH timeslot shifting properties for CTS-MS synchronization

The determination of TN for CTS-MS synchronization is eased by specific properties of the CTSBCH timeslot shifting procedure. Three successive CTSBCH detection and decoding are always sufficient to set TN.

The CTSBCH shifting procedure may be either active or not. This is signalled by a flag in the CTSBCH-SB (see GSM 05.02).

B.1 Determination of TN by the CTS-MS when CTSBCH shifting is not active

When the CTSBCH shifting is not active, the CTSBCH TN is equal to the TNC found in the CTSBCH-SB.

Therefore, the CTS-MS sets TN to TNC when decoding the CTSBCH-SB.

B.2 Determination of TN by the CTS-MS when CTSBCH shifting is active

When the CTSBCH shifting procedure is active, the TN can be derived by the CTS-MS according to following procedure :

1) the CTS-MS detects 3 successive CTSBCH-FB, decodes the three associated CTSBCH-SB and stores the two timeslot shifts values between the three successive CTSBCH-FB;

2) the CTS-MS checks that the three FPBI (see GSM 05.02) extracted from the three CTSBCH-SB are identical and that the three CTSBCH shifting flags all indicate CTSBCH shifting active;

3) the CTS-MS extracts the TNSCN from the FPBI according to the rule defined in GSM 05.02;

4) the CTS-MS uses timeslot number series couple ($TNS_{TNSCN,0}$, $TNS_{TNSCN,1}$) (see GMS 05.02) and the two stored CTSBCH shift values to determine the three timeslot numbers of the three observed CTSBCH. Due to specific properties of the shifting series, only one mapping is possible.

Annex C (informative): BTS frequency source stability and E-OTD LMU reporting periods for LCS

C.1 BTS frequency source stability and E-OTD LMU reporting periods

E-OTD location systems require measurements of OTDs made at both the LMUs and MS. It is by comparing the two sets of OTDs that a location estimate can be determined (see GSM 03.71 annex C). In order to reduce signalling requirements each LMU's measurements of OTDs are only reported at intervals by the LMU to the SMLC. (For MS-assisted E-OTD the LMU's OTDs are retained by an SMLC whereas for MS-based E-OTD the OTD's are further reported to the MS periodically (see GSM 03.71)). The maximum allowable interval between LMU reports depends on both the predictability of the BTS frequency source and the level of accuracy required of the location estimate.

C.2 Frequency source stability

The predictable component of the BTS frequency source behaviour includes any long term difference between the BTS frequency source's actual and nominal frequencies.

C.3 Relationship to E-OTD reporting periods

The relationship between the E-OTD reporting period ΔT, the BTS frequency source's rms time interval error TIE_{rms} (RMS of Time Interval Error, see ITU-T Recommendation G.810), and the maximum admissible range error r_{max} is given by (see GSM 05.50, annex V.7):

$$\sqrt{2} \cdot C_{\mathrm{p}} \cdot \nu \cdot \Delta T \cdot TIE_{\mathrm{rms}} \leq r_{\mathrm{max}}$$

in which ν is the speed of the waves (usually taken as c, the speed of light in vacuum) and C_{p} is a constant which sets the percentile $100p$ associated with r_{max}. (When the *TIE* has a Gaussian distribution $C_{67\%} = 1.0$, $C_{95\%} = 2.0$, and $C_{99.7\%} = 3.0$.) In practice, the BTS frequency source stability TIE_{rms} and required E-OTD range accuracy r_{max} are likely to be given and Table 1 allows the corresponding value of the E-OTD reporting period ΔT to be read off.

Table 1: Relationship between frequency source stability, E-OTD reporting period and E-OTD range errors.

E-OTD Reporting Period (Δ*T*)	E-OTD MTIE ± @ 95%	r_{max} ± @ 95%	BTS frequency source stability - Normalised TIE_{rms}
1 second	50ns 100ns 200ns	15 meters 30 meters 60 meters	0.018 µs/sec 0.036 µs/sec 0.072µs/sec
3 seconds	50ns 100ns 200ns	15 meters 30 meters 60 m eters	0.006 µs/sec 0.012µs/sec 0.024 µs/sec
10 seconds	50ns 100ns 200ns	15 meters 30 meters 60 meters	0.0018 µs/sec 0.0036 µs/sec 0.0072 µs/sec
30 seconds	50ns 100ns 200ns	15 meters 30 meters 60 meters	0.0006 µs/sec 0.0012 µs/sec 0.0024 µs/sec
100 seconds	50ns 100ns 200ns	15 meters 30 meters 60 meters	0.00018 µs/sec 0.00036 µs/sec 0.00072 µs/sec
300 seconds	50ns 100ns 200ns	15 meters 30 meters 60 meters	0.00006 µs/sec 0.00012 µs/sec 0.00024µs/sec
1000 seconds	50ns 100ns 200ns	15 meters 30 meters 60 meters	0.000018 µs/sec 0.000036 µs/sec 0.000072 µs/sec

For example given the requirement for r_{max} ± @ 95% shall be better than 60m and an observed frequency stability is 0.,0072 µs/sec then the resulting E-OTD Reporting Period (Δ*T*) from the LMU making the observations will be no greater than 100 seconds.

Annex D (informative): Change control history

SPEC	SMG#	CR	Phase	Version	New_Version	SUBJECT
05.10	s25	A013	R97	6.0.0	6.1.0	Clarification of the use of TAI
05.10	s25	A014	R97	6.0.0	6.1.0	Renaming of GPRS RR states
05.10	s25	A015	R97	6.0.0	6.1.0	GPRS, Missing Timing Advance Updates on PTCCH
05.10	s26	A016	R97	6.1.0	6.2.0	Correction to timing advance for GPRS
05.10	s26	A009	R98	6.2.0	7.0.0	Pico BTS
05.10	s27	A017	R97	6.2.0	6.3.0	Packet polling procedure for calculating new TA
05.10	s28	A020	R97	6.3.0	6.4.0	GPRS MS timing requirements
05.10	s28	A021	R97	6.3.0	6.4.0	Correction of Timing Advance Procedure
05.10	s28	A023	R97	6.3.0	6.4.0	Definition of additional GPRS related reaction times
05.10	s28	A026	R97	6.3.0	6.4.0	Continuous timing advance procedure failure
05.10	s28	A018	R98	6.4.0	7.0.0	Harmonization between GSM and PCS 1900 standard
05.10	s28	A019	R98	6.4.0	7.0.0	Synchronization requirements for CTS
05.10	s28	A025	R98	6.4.0	7.0.0	Synchronization requirements for the control of the CTS service
05.10	s29	A027	R98	7.0.0	7.1.0	Correction of CTS-FP frequency source correction slope
05.10	s29	A033	R98	7.0.0	7.1.0	Timing advance for access bursts on PTCCH/U
05.10	s29	A036	R98	7.0.0	7.1.0	Reaction time after contention resolution during one phase
05.10	s30	A041	R98	7.1.0	7.2.0	Definition of other reaction times
05.10	s31b	A055	R98	7.2.0	7.3.0	BTS Synchronisation, Location Accuracy and LMU update rates
05.10				7.3.0	7.3.1	Update to Version 7.3.1 for Publication

History

Document history				
V7.1.0	July 1999	One-step Approval Procedure	OAP 9952:	1999-07-28 to 1999-11-26
V7.1.1	December 1999	Publication		
V7.3.0	May 2000	One-step Approval Procedure	OAP 20000929:	2000-05-31 to 2000-09-29
V7.3.1	October 2000	Publication		