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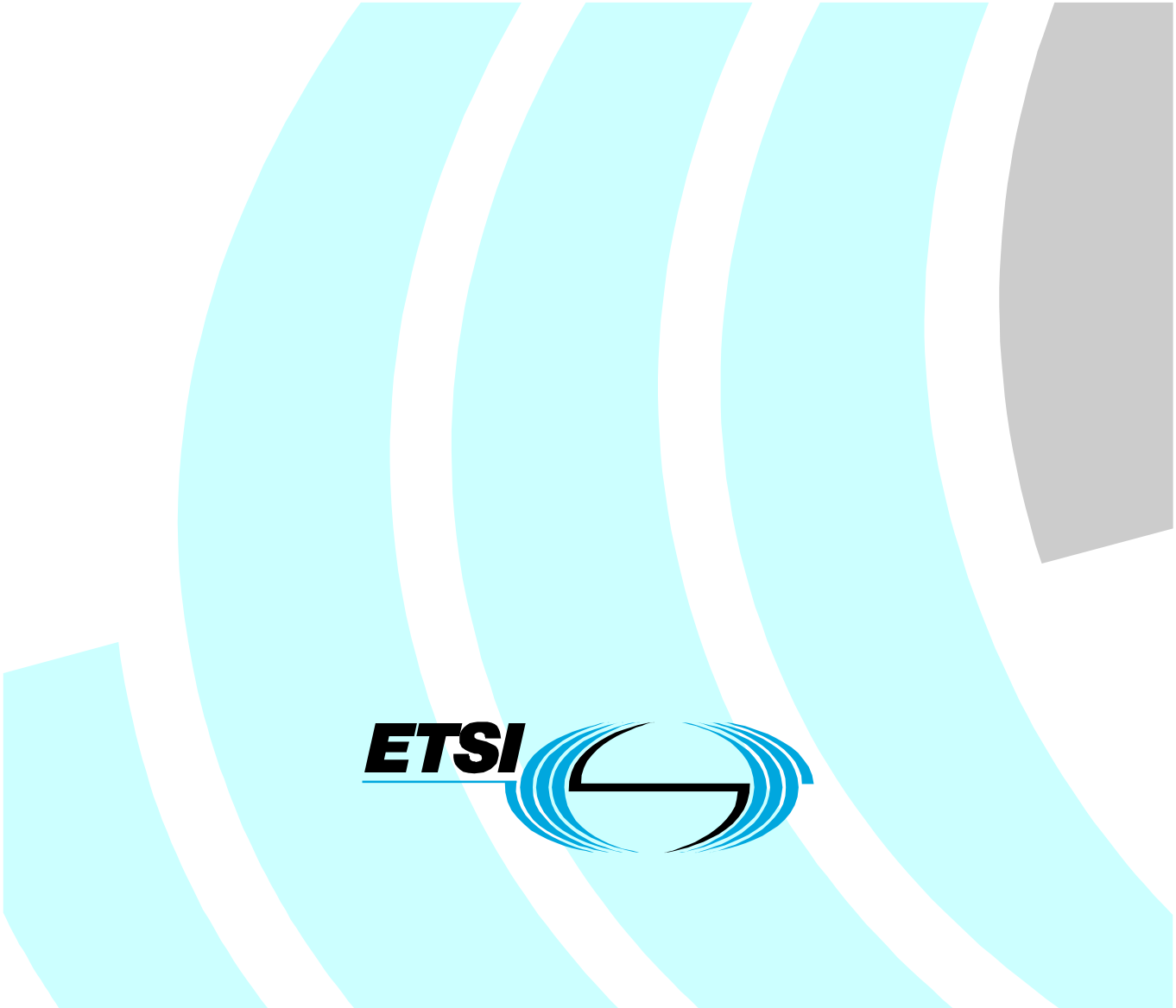
Technical Specification

GEO-Mobile Radio Interface Specifications (Release 2);
General Packet Radio Service;
Part 5: Radio interface physical layer specifications;
Sub-part 7: Radio Subsystem Synchronization;
GMPRS-1 05.010



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Foreword

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- the third digit (n) is incremented when editorial only changes have been incorporated in the specification;
- the second digit (m) is incremented for all other types of changes, i.e. technical enhancements, corrections, updates, etc.

The present document is part 5, sub-part 7 of a multi-part deliverable covering the GEO-Mobile Radio Interface Specifications, as identified below:

Part 1: "General specifications";

Part 2: "Service specifications";

Part 3: "Network specifications";

Part 4: "Radio interface protocol specifications";

Part 5: "Radio interface physical layer specifications";

Sub-part 1: "Physical Layer on the Radio Path: General Description; GMR-1 05.001";

Sub-part 2: "Multiplexing and Multiple Access; Stage 2 Service Description; GMR-1 05.002";

Sub-part 3: "Channel Coding; GMR-1 05.003";

Sub-part 4: "Modulation; GMR-1 05.004";

Sub-part 5: "Radio Transmission and Reception; GMR-1 05.005";

Sub-part 6: "Radio Subsystem Link Control; GMR-1 05.008";

Sub-part 7: "Radio Subsystem Synchronization; GMR-1 05.010";

Part 6: "Speech coding specifications";

Part 7: "Terminal adaptor specifications".

Introduction

GMR stands for GEO (Geostationary Earth Orbit) Mobile Radio interface, which is used for mobile satellite services (MSS) utilizing geostationary satellite(s). GMR is derived from the terrestrial digital cellular standard GSM and supports access to GSM core networks.

The present specification is part of the GMR Release 2 specifications. Release 2 specifications are identified in the title and can also be identified by the version number:

- Release 1 specifications have a GMR-1 prefix in the title and a version number starting with "1" (V1.x.x.)
- Release 2 specifications have a GMPRS-1 prefix in the title and a version number starting with "2" (V2.x.x.)

The GMR release 1 specifications introduce the GEO-Mobile Radio interface specifications for circuit mode mobile satellite services (MSS) utilizing geostationary satellite(s). GMR release 1 is derived from the terrestrial digital cellular standard GSM (phase 2) and it supports access to GSM core networks.

The GMR release 2 specifications add packet mode services to GMR release 1. The GMR release 2 specifications introduce the GEO-Mobile Packet Radio Service (GMPRS). GMPRS is derived from the terrestrial digital cellular standard GPRS (included in GSM Phase 2+) and it supports access to GSM/GPRS core networks.

Due to the differences between terrestrial and satellite channels, some modifications to the GSM standard are necessary. Some GSM specifications are directly applicable, whereas others are applicable with modifications. Similarly, some GSM specifications do not apply, while some GMR specifications have no corresponding GSM specification.

Since GMR is derived from GSM, the organization of the GMR specifications closely follows that of GSM. The GMR numbers have been designed to correspond to the GSM numbering system. All GMR specifications are allocated a unique GMR number. This GMR number has a different prefix for Release 2 specifications as follows:

- Release 1: GMR-n xx.zyy
- Release 2: GMPRS-n xx.zyy

where:

- xx.0yy (z = 0) is used for GMR specifications that have a corresponding GSM specification. In this case, the numbers xx and yy correspond to the GSM numbering scheme.
- xx.2yy (z = 2) is used for GMR specifications that do not correspond to a GSM specification. In this case, only the number xx corresponds to the GSM numbering scheme and the number yy is allocated by GMR.
- n denotes the first (n = 1) or second (n = 2) family of GMR specifications.

A GMR system is defined by the combination of a family of GMR specifications and GSM specifications as follows:

- If a GMR specification exists it takes precedence over the corresponding GSM specification (if any). This precedence rule applies to any references in the corresponding GSM specifications.

NOTE: Any references to GSM specifications within the GMR specifications are not subject to this precedence rule. For example, a GMR specification may contain specific references to the corresponding GSM specification.

- If a GMR specification does not exist, the corresponding GSM specification may or may not apply. The applicability of the GSM specifications is defined in GMR-1 01.201 [9].

1 Scope

The present document presents the requirements for synchronizing timing and frequency between the MES and the Gateway Station (GS) in the GMR-1 Mobile Satellite System for circuit switch and packet switch modes of operation.

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 and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

[1] GMR-1 01.004 (ETSI TS 101 376-1-1): "GEO-Mobile Radio Interface Specifications; Part 1: General specifications; Sub-part 1: Abbreviations and acronyms; GMR-1 01.004".

[2] GMPRS-1 04.008 (ETSI TS 101 376-4-8): "GEO-Mobile Radio Interface Specifications (Release 2); General Packet Radio Service; Part 4: Radio interface protocol specifications; Sub-part 8: Mobile Radio Interface Layer 3 Specifications; GMPRS-1 04.008".

[3] GMPRS-1 05.002 (ETSI TS 101 376-5-2): "GEO-Mobile Radio Interface Specifications (Release 2); General Packet Radio Service; Part 5: Radio interface physical layer specifications; Sub-part 2: Multiplexing and Multiple Access; Stage 2 Service Description; GMPRS-1 05.002".

[4] GMPRS-1 05.003 (ETSI TS 101 376-5-3): "GEO-Mobile Radio Interface Specifications (Release 2); General Packet Radio Service; Part 5: Radio interface physical layer specifications; Sub-part 3: Channel Coding; GMPRS-1 05.003".

[5] GMPRS-1 05.005 (ETSI TS 101 376-5-5): "GEO-Mobile Radio Interface Specifications (Release 2); General Packet Radio Service; Part 5: Radio interface physical layer specifications; Sub-part 5: Radio Transmission and Reception; GMPRS-1 05.005".

[6] GMPRS-1 05.008 (ETSI TS 101 376-5-6): "GEO-Mobile Radio Interface Specifications (Release 2); General Packet Radio Service; Part 5: Radio interface physical layer specifications; Sub-part 6: Radio Subsystem Link Control; GMPRS-1 05.008".

[7] GMR-1 05.010 (ETSI TS 101 376-5-7) V1.2.1: "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 7: Radio Subsystem Synchronization; GMR-1 05.010".

[8] GMPRS-1 04.060 (ETSI TS 101 376-4-12): "GEO-Mobile Radio Interface Specifications (Release 2); General Packet Radio Service; Part 4: Radio interface protocol specifications; Sub-part 12: Mobile Earth Station (MES) - Base Station System (BSS) interface; Radio Link Control/Medium Access Control (RLC/MAC) protocol; GMPRS-1 04.060".

[9] GMPRS-1 01.201 (ETSI TS 101 376-1-2): "GEO-Mobile Radio Interface Specifications (Phase 2); General Packet Radio Service; Part 1: General specifications; Sub-part 2: Introduction to the GMR-1 family; GMPRS-1 01.201".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the definitions given in GMR-1 01.004 [1] and the following apply:

Frequency Correction (FC): in-call frequency correction sent over FACCH channel

frequency offset: frequency correction sent over AGCH channel

guard time violation: a message to indicate the violation of Rx/Tx burst guard time

Precorrection Indication: timing delay pre-compensated by the MES in the RACH transmission

RACH_TS_OFFSET: RACH window offset relative to the start of BCCH window within the same frame, measured in number of timeslots

RACH_SYMBOL_OFFSET: RACH timing offset in symbols

NOTE: The offset between RACH window and the start of the reference frame seen from the MES. Measured in number of symbols.

SA_BCCH_STN: BCCH window offset relative to the start of the frame, in number of timeslots

SA_FREQ_OFFSET: twice of the downlink beam center Doppler due to satellite motion only

SA_SIRFN_DELAY: within each multiframe, the first FCCH channel frame number relative to the start of the multiframe

SB_FRAME_TS_OFFSET: offset between downlink frame N and uplink frame N+7 at the spot-beam center, measured in number of timeslots

SB_SYMBOL_OFFSET: additional offset between downlink frame N and uplink frame N+7 at the spot beam center, measured in number of symbols

Timing Correction (TC): in-call timing correction sent over FACCH channel

timing offset: timing correction sent over AGCH channel

3.2 Abbreviations

For the purposes of the present document, the abbreviations defined in GMR-1 01.004 [1] and the following apply:

GMPRS	Geo-Mobile Packet Radio Service
GtT	Gateway-to-Terminal call
MAC	Medium Access Control
MMS	Mobile Satellite Services
PACCH	Packet Associated Control Channel
PDCH	Packet Data Channel
PNB	Packet Normal Burst
PRACH	Packet Random Access Channel
PTCCH/D	Packet Timing advance Control Channel/Downlink
PTCCH/U	Packet Timing advance Control Channel/Uplink
PUI	PUblic Information
TA	Timing Advance
TAI	Timing Advance Indicator
TC	Timing Correction
TtG	Terminal-to-Gateway call
UFN	Uplink Frame Number
USF	Uplink State Flag

4 General description of synchronization system

Same as clause 4 in GMR-1 05.010 [7].

4.1 System timing structure

Same as clause 4.1 in GMR-1 05.010 [7].

4.2 Timebase counter

Same as clause 4.2 in GMR-1 05.010 [7].

4.3 General requirement

4.3.1 Timing and frequency reference point

Same as clause 4.3.1 in GMR-1 05.010 [7].

4.3.2 MES requirement

Same as clause 4.3.2 in GMR-1 05.010 [7].

4.3.3 Network requirement

Same as clause 4.3.3 in GMR-1 05.010 [7].

4.3.4 Measurement conditions

Same as clause 4.3.4 in GMR-1 05.010 [7].

5 Timing synchronization, TtG/GtT call

Same as clause 5 in GMR-1 05.010 [7], except for the addition of the next paragraph, which follows the second paragraph.

For the case in which the MES operates in the packet mode, receive timing shall be corrected by monitoring BCCH, PCH or PDCH and transmission timing shall be corrected with factors provided by the Gateway Station (GS). The GS provides correction factors via AGCH or PACCH based on the MES mode and situation, which is explained here.

5.1 General description

Same as clause 5.1 in GMR-1 05.010 [7], except for the addition of the next paragraph, which follows the fifth paragraph.

If packet transfer mode is initiated via the RACH then the procedure is identical to that described for circuit switched service in clause 5.3.1. Packet switched time and frequency synchronization for the PDCH and the PRACH is described in clause 5.6.

5.2 Timing of forward link common channels

Same as clause 5.2 in GMR-1 05.010 [7].

5.2.1 FCCH/BCCH timing

Same as clause 5.2.1 in GMR-1 05.010 [7].

5.2.2 CCCH timing

Same as clause 5.2.2 in GMR-1 05.010 [7].

5.3 Idle mode timing synchronization

5.3.1 Initial timing acquisition

Same as clause 5.3.1 in GMR-1 05.010 [7].

5.3.2 Paging mode

Same as clause 5.3.2 in GMR-1 05.010 [7].

5.3.3 Alerting mode

Same as clause 5.3.3 in GMR-1 05.010 [7].

5.4 Synchronization at initial access

5.4.1 Synchronization process

Same as clause 5.4.1 in GMR-1 05.010 [7].

5.4.2 RACH timing pre-correction

Same as clause 5.4.2 in GMR-1 05.010 [7].

5.4.3 Description of parameters

Same as clause 5.4.3 in GMR-1 05.010 [7].

5.4.4 Timing accuracy

Same as clause 5.4.4 in GMR-1 05.010 [7].

5.5 Dedicated mode synchronization

Same as clause 5.5 in GMR-1 05.010 [7].

5.5.1 In-call timing relationship

Same as clause 5.5.1 in GMR-1 05.010 [7].

5.5.2 In-call synchronization scenario

Same as clause 5.5.2 in GMR-1 05.010 [7].

5.5.3 Transmission timing drift rate

Same as clause 5.5.3 in GMR-1 05.010 [7].

5.5.4 RX/TX guard time violation

Same as clause 5.5.4 in GMR-1 05.010 [7].

5.5.5 Packet Transfer mode time slot synchronization

The MES shall read MAC_FORWARD_TS_OFFSET and MAC_RETURN_TS_OFFSET parameters in the BCCH. These parameters have the unit of time slot (duration 1,667 ms). The MES shall offset the position of MAC-slot 0 by MAC_FORWARD_TS_OFFSET from the starting of absolute frame reference in the forward link. Similarly the MES shall derive the position of MAC-slot 0 in a frame in the return link by adding MAC_RETURN_TS_OFFSET to the starting point of absolute frame reference.

MAC-slot has values 0, 1, …, 7. Thus last few MAC-slots will continue to the next frame. When the MES requires frame reference for any calculation, it will use the frame number associated with the MAC-slot 0 as reference.

5.6 Packet transfer mode synchronization

In packet transfer mode, either the PDCH channel or the PRACH channel is used. The synchronization scheme addressed below applies to both of these two channels.

5.6.1 Packet transfer mode timing relationship

The uplink and downlink frame timing relationship described in clause 5.5.1 shall apply to packet transfer mode. The time between the start of receive frame N and the start of transmit frame N + 7 at the MES is given by, ΔT_{OF} .

To interpret the Uplink State Flag (USF) in the downlink PUI (see GMPRS-1 04.060 [8]), the MES shall apply the following rule. If the MES receives a USF in its receive downlink frame N, it shall apply the USF to the uplink frame numbered (N + USF_DELAY value), where the USF delay value is decoded from the USF_DELAY parameter that is contained in System Information. The USF_DELAY decodes to values of 7, 8, 9 or 10 for the USF delay value.

Thus the MES response time defined as the time measured from the end of the time slot in which the MES received a PNB(m,3), containing the USF assigned to the MES, and the start of the time slot in which the MES is granted uplink access by the USF (see GMPRS-1 04.060 [8]) is given by:

$$T_{RESP} = \Delta T_{OF} - TS \times MAC\_FORWARD\_TS\_OFFSET + TS \times MAC\_RETURN\_TS\_OFFSET - 5\ ms + (USF\_DELAY - 7) \times 40\ ms$$

The MES shall be able to transmit a PNB in the assigned time slot and frame provided the response time, T_{RESP} is greater than or equal to 40 ms.

The GS shall determine USF_DELAY value for a spot beam such than for every MES within the boundary of the spot beam, the above requirement shall be satisfied.

During the packet transfer mode, the value of $2[T_U - T_0]$ may be updated via PTCCH/D or PACCH messages to compensate for any timing drift caused by MES oscillator and MES-satellite relative motion as described in clause 5.6.2.

5.6.2 Time synchronization for Packet switched channels

In the downlink, an open-loop synchronization scheme is used. The MES receiver timing shall be derived from its internal timebase, but frequently corrected by timing detection of the received PDCH bursts during packet transfer mode. The task of receiver timing correction has to be performed often enough to handle the worst case timing drift rate specified in clause 4.3.2. The target timing accuracy is to achieve demodulation performances specified by GMPRS-1 05.005 [5].

In the uplink, a closed-loop synchronization scheme is used. The synchronization process is detailed below.

The GS shall perform the scheduled timing advance mechanism for all MES working in packet transfer mode for which a PTCCH/U subchannel is assigned. Therefore the GS shall monitor the delay of the PNB bursts sent by the MES on PTCCH/U and respond with timing advance values for all MES performing the procedure on that PDCH. These timing advance values shall be sent via a downlink signalling message on PTCCH/D (see GMPRS-1 04.060 [8]). These are scheduled timing corrections.

The GS shall update the timing advance values for a MES in the next downlink signalling message addressed to that MES following the reception of a packet access burst from the MES. These are initial timing corrections.

The GS may also monitor the delay of the packet normal bursts sent by the MES on PDTCH and PACCH. Whenever an updating of Timing Advance (TA) is needed, the GS may send the new TA value in a link synchronization message (see GMPRS-1 04.060 [8]). This is unsolicited timing correction.

After every reception of a scheduled timing correction, an unsolicited timing correction or an initial timing correction, the MES shall restart a timer, T3202 = PACKET_RANDOM_ACCESS_TIMER. For random access, the MES may use a PAB in any PRACH or a RACH burst in any RACH provided its timer T3202 has not expired. There are procedures requiring to use RACH to access the network even if T3202 is not expired (see GMPRS-1 04.008 [2]). For random access after T3202 has expired, the MES shall use a RACH burst in a RACH. The GS shall broadcast the value of PACKET_RANDOM_ACCESS_TIMER in system information (see GMPRS-1 04.008 [2] and GMPRS-1 04.060 [8]).

The MES shall apply the full timing correction to all transmitted bursts within 120 ms of the end of any downlink frame in which a timing correction was received.

The adjustment shall be applied to the MES transmission in such a way: if the Control Flag associated with the Timing Correction message is 1, then this message overrides all previous messages; Otherwise, if the Control Flag is 0, the adjustment shall be made in addition to any previous messages.

The MES shall ignore a Timing Correction message with Control Flag set to 0 if a previous Timing Correction message with Control Flag set to 0 was received within two seconds of the latest message.

The range of the timing adjustment shall be from -0,34 ms to +0,34 ms or -320 T_{SB}/40 to +320 T_{SB}/40, with a unit of T_{SB}/40.

On the PDCH downlink burst corresponding to an assigned PTCCH/U timeslot, the GS shall set the USF to the reserved value (see GMPRS-1 04.060 [8]). If the MES receives two consecutive downlink bursts in the PDCH corresponding to its assigned PTCCH/U time slot in which the USF is set to another value than reserved, the MES shall declare the link dead (see GMPRS-1 05.008 [5]).

The GS shall not reassign any Timing Advance Indicator (TAI) (see GMPRS-1 04.060 [8]) value which it has assigned to an MES before completion of at least three timing correction cycles or three PKT_TIMING_CORR_CYCLE multiframes.

5.6.2.1 Derivation of the assigned PTCCH/U

The MES shall derive its assigned PTCCH/U from the TAI value (see GMPRS-1 04.060 [8]) and the value of PKT_TIMING_CORR_CYCLE parameter broadcast by the GS in system information. (see GMPRS-1 04.008 [2]). Using:

$$P = TAI \bmod 4$$

$$RMF = INT(TAI/4)$$

the MES shall have an assigned PTCCH/U in every uplink frame number, UFN, which satisfies the following equations.

$$RMF = INT(UFN/16) \bmod (PKT\_TIMING\_CORR\_CYCLE)$$

and

$$UFN \bmod 16 = 15$$

The MES shall calculate the MAC-slot number for its assigned PTCCH/U from the following equations:

MAC-slot number = 2 x P + (RMF mod 2)

The MES shall transmit a PNB in every assigned PTCCH/U.

The GS shall transmit a timing correction in every downlink frame number, DFN = UFN + 10 in timeslot number equal to 0.

5.6.3 Transmission timing drift rate

In packet transfer mode, to reduce the number of PTCCH and PRACH messages and to improve timing accuracy and stability of MES transmission, the MES timing drift rate shall be used for transmission timing correction. This timing drift rate R shall be derived from the Frequency Correction message received from AGCH channel as well as PACCH according to clause 5.5.3.

6 Frequency synchronization, TtG/GtT call

Same as clause 6 in GMR-1 05.010 [7], except add the following sentence at the end of the clause.

In the case of data service, PDCH frequency is corrected with corrective factors given over the AGCH. During packet transfer mode, frequency correction shall be provided to the MES by the GS through the PTCCH in the same way as timing correction.

6.1 General description

Same as clause 6.1 in GMR-1 05.010 [7].

6.2 Frequency of common channels

Same as clause 6.2 in GMR-1 05.010 [7].

6.3 Idle mode frequency synchronization

6.3.1 Initial frequency acquisition

Same as clause 6.3.1 in GMR-1 05.010 [7].

6.3.2 Paging mode

Same as clause 6.3.2 in GMR-1 05.010 [7].

6.3.3 Alerting mode

Same as clause 6.3.3 in GMR-1 05.010 [7].

6.4 Synchronization at initial access

Same as clause 6.4 in GMR-1 05.010 [7].

6.4.1 Frequency compensation strategy

Same as clause 6.4.1 in GMR-1 05.010 [7], except add PDCH to the last bullet item in the clause.

6.4.2 Parameter description

Same as clause 6.4.2 in GMR-1 05.010 [7], except for the addition of the next paragraph, which follows the second paragraph.

For Packet switched service, receiving the frequency correction from the AGCH, the MES shall adjust its frequency of PDCH transmission to an accuracy better than 10 Hz 1-sigma under the conditions defined in GMR 05.005 [5].

6.5 Dedicated mode synchronization

Same as clause 6.5 in GMR-1 05.010 [7].

6.6 Packet transfer mode synchronization

Packet transfer mode synchronization is maintained in the same way as for dedicated mode as described in clause 6.5 with the following modifications.

The GS shall estimate the MES frequency drift based on the received PTCCH/U bursts from the MES and shall send back corrections to the MES via PTCCH/D.

As described in clause 6.5 these Frequency Corrections shall be relative to the currently used frequency offset, different from the Frequency Correction sent over AGCH channel.

The MES shall ignore a Frequency Correction message with a relative offset if a previous Frequency Correction message with a relative offset was received within two seconds of the latest message.

The Frequency Correction shall have a range from -2 048 Hz to +2 047 Hz, with accuracy better than 1 Hz. For both uplink and downlink signals, the MES tracking loop needs to handle the worst case Doppler frequency change. When the MES receives a new value of Frequency Correction, it shall apply the change within 120 ms after the end of the frame in which it received the correction.

7 Frame and message synchronization, TtG/GtT call

7.1 Frame synchronization

7.1.1 Frame number definition

Same as clause 7.1.1 in GMR-1 05.010 [7].

7.1.2 Frame synchronization scenario

Same as clause 7.1.2 in GMR-1 05.010 [7].

7.2 Message synchronization

7.2.1 Power control message synchronization

Same as clause 7.2.1 in GMR-1 05.010 [7].

7.2.1.1 Synchronization in master-to-slave direction

Same as clause 7.2.1.1 in GMR-1 05.010 [7].

7.2.1.2 Synchronization in slave-to-master direction

Same as clause 7.2.1.2 in GMR-1 05.010 [7].

7.2.2 SACCH message synchronization, TCH6/TCH9 call

Same as clause 7.2.2 in GMR-1 05.010 [7].

Annex A (informative): Worst-case delay and Doppler features

Same as annex A in GMR-1 05.010 [7].

Annex B (informative): Range of timing correction factor

Same as annex B in GMR-1 05.010 [7].

Annex C (informative): Differential Doppler frequency

Same as annex C in GMR-1 05.010 [7].

Annex D (informative): SACCH message synchronization, TtG/GtT call

Same as annex D in GMR-1 05.010 [7].

History

Document history		
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