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Digital cellular telecommunications system (Phase 2+) (GSM); Radio subsystem link control (GSM 05.08 version 8.3.2 Release 1999)

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Foreword

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

The present document specifies the Radio sub-system link control implemented in the Mobile Station (MS), Base Station System (BSS) and Mobile Switching Centre (MSC) of the digital mobile cellular and personal communication systems operating in the 900 MHz and 1 800 MHz band (GSM 900 and DCS 1 800).

The contents of the present document are 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 republished by ETSI with an identifying change of release date and an increase in version number as follows:

Version 8.x.y

where:

8 indicates release 1999 of GSM Phase 2+.

x the second digit is incremented for all 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 specifies the Radio sub-system link control implemented in the Mobile Station (MS), Base Station System (BSS) and Mobile Switching Centre (MSC) of the digital cellular telecommunications systems GSM.

Unless otherwise specified, references to GSM also include include operation in any band.

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 1999 document, references to GSM documents are for Release 1999 versions (version 8.x.y).

[1] GSM 01.04: "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

[2] GSM 03.03: "Digital cellular telecommunications system (Phase 2+); Numbering, addressing and identification".

[3] GSM 03.09: "Digital cellular telecommunications system (Phase 2+); Handover procedures".

[4] GSM 03.22: "Digital cellular telecommunications system (Phase 2+); Functions related to Mobile Station (MS) in idle mode and group receive mode".

[5] GSM 04.04: "Digital cellular telecommunications system (Phase 2+); Layer 1; General requirements".

[6] GSM 04.06: "Digital cellular telecommunications system (Phase 2+); Mobile Station - Base Station System (MS - BSS) interface; Data Link (DL) layer specification".

[7] GSM 04.08: "Digital cellular telecommunications system (Phase 2+); Mobile radio interface layer 3 specification".

[8] GSM 05.02: "Digital cellular telecommunications system (Phase 2+); Multiplexing and multiple access on the radio path".

[9] GSM 05.05: "Digital cellular telecommunications system (Phase 2+); Radio transmission and reception".

[10] GSM 05.10: "Digital cellular telecommunications system (Phase 2+); Radio subsystem synchronization".

[11] GSM 06.11: "Digital cellular telecommunications system; Full rate speech; Substitution and muting of lost frames for full rate speech channels".

[12] GSM 08.08: "Digital cellular telecommunications system (Phase 2+); Mobile-services Switching Centre - Base Station System (MSC - BSS) interface, Layer 3 specification".

[13] GSM 08.58: "Digital cellular telecommunications system (Phase 2+); Base Station Controller - Base Transceiver Station (BSC - BTS) interface; Layer 3 specification".

[14] GSM 11.10: "Digital cellular telecommunications system (Phase 2+); Mobile Station (MS) conformity specification".

[15] GSM 03.64: "Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); Overall description of the GPRS Radio Interface; Stage 2".

[16] 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".

[17] GSM 04.56: "Digital cellular telecommunications system (Phase 2+); GSM Cordless Telephony System (CTS), Phase 1; CTS radio interface layer 3 specification".

[18] GSM 05.56: "Digital cellular telecommunications system (Phase 2+); GSM Cordless Telephony System (CTS), Phase 1; CTS-FP radio subsystem".

1.2 Abbreviations

Abbreviations used in the present document are listed in GSM 01.04.

2 General

The radio sub-system link control aspects that are addressed are as follows:

- Handover;
- RF Power control, including fast power control for ECSD;
- Radio link Failure;
- Cell selection and re-selection in Idle mode, in Group Receive mode and in GPRS mode (see GSM 03.22);
- CTS mode tasks.

Handover is required to maintain a call in progress as a MS engaged in a point-to-point call or with access to the uplink of a channel used for a voice group call passes from one cell coverage area to another and may also be employed to meet network management requirements, e.g. relief of congestion.

Handover may occur during a call from one TCH or multiple TCHs (in the case of multislot configuration) to another TCH or multiple TCHs. It may also occur from DCCH to DCCH or from DCCH to one or multiple TCH(s), e.g. during the initial signalling period at call set-up.

The handover may be either from channel(s) on one cell to other channel(s) on a surrounding cell, or between channels on the same cell which are carried on the same frequency band. Examples are given of handover strategies, however, these will be determined in detail by the network operator.

For a multiband MS, specified in GSM 02.06, the handover described is also allowed between any channels on different cells which are carried on different frequency bands, e.g. between a GSM 900/TCH and a DCS 1 800/TCH. Handover between two co-located cells, carried on different frequency bands, is considered as inter-cell handover irrespective of the handover procedures used.

Adaptive control of the RF transmit power from an MS and optionally from the BSS is implemented in order to optimize the uplink and downlink performance and minimize the effects of co-channel interference in the system.

The criteria for determining radio link failure are specified in order to ensure that calls which fail either from loss of radio coverage or unacceptable interference are satisfactorily handled by the network. Radio link failure may result in either re-establishment or release of the call in progress. For channels used for a voice group call, an radio uplink failure results in the freeing up of the uplink.

Procedures for cell selection and re-selection whilst in Idle mode (i.e. not actively processing a call), are specified in order to ensure that a mobile is camped on a cell with which it can reliably communicate on both the radio uplink and downlink. The operations of an MS in Idle Mode are specified in GSM 03.22.

Cell re-selection is also performed by the MS when attached to GPRS, except when the MS simultaneously has a circuit switched connection. Optional procedures are also specified for network controlled cell re-selection for GPRS. Cell re-selection for GPRS is defined in subclause 10.1.

An MS listening to a voice group call or a voice broadcast use cell re-selection procedures to change cell. This may be supported by a list of cells carrying the voice group or voice broadcast call downlink, provided to the MS by the network. The operations of an MS in Group Receive Mode are specified in GSM 03.22.

Information signalled between the MS and BSS is summarized in tables 1, 2 and 3. A full specification of the Layer 1 header is given in GSM 04.04, and of the Layer 3 fields in GSM 04.08.

For CTS, information signalled between the CTS-MS and CTS-FP is summarized in tables 4, 5 and 6. A full specification of the CTS Layer 3 fields is given in GSM 04.56.

For COMPACT, specific procedures are defined in clause 12.

3 Handover

3.1 Overall process

The overall handover process is implemented in the MS, BSS and MSC. Measurement of radio subsystem downlink performance and signal levels received from surrounding cells, is made in the MS. These measurements are signalled to the BSS for assessment. The BSS measures the uplink performance for the MS being served and also assesses the signal level of interference on its idle traffic channels. Initial assessment of the measurements in conjunction with defined thresholds and handover strategy may be performed in the BSS. Assessment requiring measurement results from other BTS or other information resident in the MSC, may be performed in the MSC.

GSM 03.09 describes the handover procedures to be used in PLMNs.

3.2 MS measurement procedure

A procedure shall be implemented in the MS by which it monitors the downlink RX signal level and quality from its serving cell and the downlink RX signal level and BSIC of surrounding BTS. The method of identification of surrounding BTS is described in subclause 7.2. The requirements for the MS measurements are given in subclause 8.1.

3.3 BSS measurement procedure

A procedure shall be implemented in the BSS by which it monitors the uplink RX signal level and quality from each MS being served by the cell. In the case of a multislot configuration the evaluation shall be performed on a timeslot per timeslot basis. A procedure shall be implemented by which the BSS monitors the levels of interference on its idle traffic channels.

3.4 Strategy

The handover strategy employed by the network for radio link control determines the handover decision that will be made based on the measurement results reported by the MS/BSS and various parameters set for each cell. Network directed handover may also occur for reasons other than radio link control, e.g. to control traffic distribution between cells. The exact handover strategies will be determined by the network operator, a detailed example of a basic overall algorithm appears in annex A. Possible types of handover are as follows:

Inter-cell handover:

Intercell handover from the serving cell to a surrounding cell will normally occur either when the handover measurements show low RXLEV and/or RXQUAL on the current serving cell and a better RXLEV available from a surrounding cell, or when a surrounding cell allows communication with a lower TX power level. This typically indicates that an MS is on the border of the cell area.

Intercell handover may also occur from the DCCH on the serving cell to a TCH or multislot configuration on another cell during call establishment. This may be used as a means of providing successful call establishment when no TCH resource is available on the current serving cell.

Inter-cell handover between cells using different frequency bands is allowed for a multi band MS.

Intra-cell handover:

Intra-cell handover from one channel/timeslot in the serving cell to another channel/timeslot in the same cell will normally be performed if the handover measurements show a low RXQUAL, but a high RXLEV on the serving cell. This indicates a degradation of quality caused by interference even though the MS is situated within the serving cell. The intra-cell handover should provide a channel with a lower level of interference. Intra-cell handover can occur either to a timeslot on a new carrier or to a different timeslot on the same carrier. Similarly, intra-cell handover may occur between different multislot configurations in the same cell. These multislot configurations may comprise different number of timeslots and may partly overlap.

Intra-cell handover from one of the bands of operation to another one is allowed for a multiband MS.

GSM 08.08 defines the causes for handover that may be signalled from BSS to MSC.

4 RF power control

4.1 Overall process

RF power control is employed to minimize the transmit power required by MS or BSS whilst maintaining the quality of the radio links. By minimizing the transmit power levels, interference to co-channel users is reduced.

4.2 MS implementation

RF power control shall be implemented in the MS.

The power control level to be employed by the MS on each uplink channel, except PDCH , is indicated by means of the power control information sent either in the layer 1 header of each SACCH message block (see GSM 04.04) on the corresponding downlink channel, or in a dedicated signalling block (see GSM 04.08). Power control for PDCH is defined in subclause 10.2.

The MS shall employ the most recently commanded power control level appropriate to each channel for all transmitted bursts on either a TCH (including handover access burst), FACCH, SACCH or SDCCH.

The MS shall confirm the power control level that it is currently employing in the SACCH L1 header on each uplink channel. The indicated value shall be the power control level actually used by the mobile for the last burst of the previous SACCH period.

In the E-TCH mode, the MS shall, if so indicated by the BSS in the SACCH L1 header (see GSM 04.04) or Assignment command (see GSM 04.18), use FPC (fast power control). The MS shall employ the most recently commanded fast power control level on each uplink E-TCH channel. The power control level to be employed by the MS is indicated by means of the power control information sent via fast inband signalling once every FPC reporting period (see subclause 4.7). If FPC is in use, the MS shall report, in the SACCH L1 header, the power control level used at the end of the normal power control reporting period.

In the E.TCH mode and channel coding asymmetry configuration using 8 PSK for uplink, the MS shall use the fast inband signalling in uplink for fast measurement repoting.

NOTE: The term "normal power control" is used in this specification only for clarification and is otherwise only referred to as "power control".

In case of a multislot configuration, each bi-directional channel shall be power controlled individually by the corresponding SACCH or fast inband signalling link, whichever is applicable. Power control information on downlink unidirectional channels shall be neglected.

When accessing a cell on the RACH (random access) and before receiving the first power command during a communication on a DCCH or TCH (after an IMMEDIATE ASSIGNMENT), all GSM and class 1 and class 2 DCS 1 800 MS shall use the power level defined by the MS_TXPWR_MAX_CCH parameter broadcast on the BCCH of the cell. The class 3 DCS 1 800 MS shall use the power level defined by MS TXPWR MAX CCH plus the value POWER OFFSET also broadcast on the BCCH of the cell.

If a power control level defined in GSM 05.05 is received but the level is not supported by the MS, the MS shall use the supported output power which is closest to the output power indicated by the received power control level.

4.3 MS power control range

The range over which a MS shall be capable of varying its RF output power shall be from its maximum output down to its minimum, in steps of nominally 2 dB.

GSM 05.05 gives a detailed definition of the RF power level step size and tolerances.

The fast power control scheme for ECSD is based on differential control to adjust the employed RF power level. The possible DL power control commands are listed in the following table.

Codeword	Power control command
0	Not used
1	Increase output power by four power control levels
2	Increase output power by three power control levels
3	Increase output power by two power control levels
4	Increase output power by one power control level
5	No output power level change
6	Decrease output power by one power control level
7	Decrease output power by two power control levels

If a power control command is received but the requested output power is not supported by the MS, the MS shall use the supported output power which is closest to the requested output power.

4.4 BSS implementation

RF power control, including fast power control for ECSD, may optionally be implemented in the BSS.

4.5 BSS power control range

The range over which the BSS shall be capable of reducing its RF output power from its maximum level shall be nominally 30 dB, in 15 steps of nominally 2 dB.

GSM 05.05 gives a detailed definition of the RF power level step size and tolerances.

4.6 Strategy

The RF power control strategy employed by the network determines the ordered power level that is signalled to the MS, and the power level that is employed by the BSS.

The power level to be employed in each case will be based on the measurement results reported by the MS/BTS and various parameters set for each cell. The exact strategies will be determined by the network operator. A detailed example of a basic algorithm appears in annex A.

4.7 Timing

Upon receipt of a command from an SACCH to change its power level on the corresponding uplink channel, the MS shall change to the new level at a rate of one nominal 2 dB power control step every 60 ms (13 TDMA frames), i.e. a range change of 15 steps should take about 900 ms. The change shall commence at the first TDMA frame belonging to the next reporting period (as specified in subclause 8.4). The MS shall change the power one nominal 2 dB step at a time, at a rate of one step every 60 ms following the initial change, irrespective of whether actual transmission takes place or not.

In case of channel change, except for multislot configuration change, the commanded power control level shall be applied on each new channel immediately. The multislot configuration change message does not command the MS to use new power control levels. For those time slots not used by the MS before the multislot configuration change procedure, the MS shall use the power control level used on the main channel before the multislot configuration change.

Switching between the normal power control mechanism and FPC shall be done if FPC is enabled or disabled via signalling in the SACCH L1 header. The respective power control mechanism to be used shall then be active as from the first TDMA frame belonging to the next reporting period (see subclause 8.4). The initial power control level to be used by the MS immediately after switching shall, in both cases, be the level last commanded by the normal power control mechanism.

The basic timing cycle for the fast power control mechanism is the FPC reporting period of length 4 TDMA frames, which is mapped into the 26-multiframe according to the following figure.

FN:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
RP:	0	0	0	0	1	1	1	1	2	2	2	2	S	3	3	3	3	4	4	4	4	5	5	5	5	I

FN = TDMA Frame no modulo 26
RP = FPC reporting period number

DL measurements made during RP(n) shall be reported to the network during the next occurance of RP((n+2) mod 6). Power control commands received from the network during RP(n) are effectuated on the corresponding UL channel during the next occurance of RP((n+1) mod 6).

4.8 Dedicated channels used for a voice group call or voice broadcast

The network shall not allocate the uplink of the channel used for a voice group call to more than one MS. If marked busy, no other MS shall transmit on the channel. This marking is indicated by the network, as defined in GSM 03.68 and 04.08. Any MS allocated the uplink of a channel used for a voice group call shall only transmit if the uplink is marked busy, and shall stop using the uplink if it happens to become marked free. An MS not allocated the uplink may perform a random access procedure on the uplink to gain access to talk, only if the uplink is marked as free.

On a channel used during a voice group call, the uplink power control shall only apply to the MS currently allocated that uplink, and the MS power control level ordered by the network shall be ignored by all other MSs listening to the downlink.

When performing a random access on a cell to gain access to the uplink of a channel used for a voice group call, until receiving the first dedicated power command from the network, the MS shall use the last received power level command as defined by the MS_TXPWR_MAX_CCH parameter broadcast on the BCCH of the cell, or if MS_TXPWR_MAX_CCH corresponds to a power control level not supported by the MS as defined by its power class in GSM 05.05, the MS shall act as though the closest supported power control level had been broadcast.

RF downlink power control will normally not be applied on channels used for a voice group call or voice broadcast.