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Digital cellular telecommunications system (Phase 2+) (GSM); Radio subsystem link control (GSM 05.08 version 6.7.2 Release 1997)

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GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS

ETSI

(GSM 05.08 version 6.7.2 Release 1997) **2** **ETSI EN 300 911 V6.7.2 (2000-07)**

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Contents

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Foreword

This European Standard (Telecommunications series) has been produced by the 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 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 6.x.y

where:

6 indicates release 1997 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.

National transposition dates	
Date of adoption of this EN:	19 May 2000
Date of latest announcement of this EN (doa):	31 August 2000
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	28 February 2001
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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 GSM and DCS 1 800 systems.

Unless otherwise specified, references to GSM also include DCS 1 800.

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 1997 document, references to GSM documents are for Release 1997 versions (version 6.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".

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;

-   Radio link Failure;

-   Cell selection and re-selection in Idle mode, in Group Receive mode and in GPRS mode (see GSM 03.22).

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.

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.

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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 case of a multislot configuration, each bi-directional channel shall be power controlled individually by the corresponding SACCH. 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.

4.4　BSS implementation

RF power control 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.

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.

5   Radio link failure

5.1   Criterion

The criterion for determining Radio Link Failure in the MS shall be based on the success rate of decoding messages on the downlink SACCH. For a circuit switched multislot configuration, only the main SACCH shall be used for determining Radio Link Failure.

For GPRS, Radio Link Failure is determined by the RLC/MAC protocol (see GSM 04.60).

5.2 MS procedure

The aim of determining radio link failure in the MS is to ensure that calls with unacceptable voice/data quality, which cannot be improved either by RF power control or handover, are either re-established or released in a defined manner. In general the parameters that control the forced release should be set such that the forced release will not normally occur until the call has degraded to a quality below that at which the majority of subscribers would have manually released. This ensures that, for example, a call on the edge of a radio coverage area, although of bad quality, can usually be completed if the subscriber wishes.

The radio link failure criterion is based on the radio link counter S. If the MS is unable to decode a SACCH message (BFI = 1),S is decreased by 1. In the case of a successful reception of a SACCH message (BFI = 0) S is increased by 2. In any case S shall not exceed the value of RADIO_LINK_TIMEOUT. If S reaches 0 a radio link failure shall be declared. The action to be taken is specified in GSM 04.08. The RADIO_LINK_TIMEOUT parameter is transmitted by each BSS in the BCCH data (see table 1).

The MS shall continue transmitting as normal on the uplink until S reaches 0.

The algorithm shall start after the assignment of a dedicated channel and S shall be initialized to RADIO_LINK_TIMEOUT.

The detailed operation shall be as follows:

- The radio link time-out algorithm shall be stopped at the reception of a channel change command.

- (Re-)initialization and start of the algorithm shall be done whenever the MS switches to a new channel (this includes the old channel in assignment and handover failure cases), at the latest when the main signalling link (see GSM 04.08) has been established.

- The RADIO_LINK_TIMEOUT value used at (re-)initialization shall be that used on the previous channel (in the Immediate Assignment case the value received on the BCCH), or the value received on SACCH if the MS has received a RADIO_LINK_TIMEOUT value on the new channel before the initialization.

- If the first RADIO_LINK_TIMEOUT value on the SACCH is received on the new channel after the initialization, the counter shall be re-initialized with the new value.

An MS listening to a voice group call or a voice broadcast, upon a downlink radio link failure shall return to idle mode and perform cell re-selection.

5.3 BSS procedure

The criteria for determining radio link failure in the BSS should be based upon either the error rate on the uplink SACCH(s) or on RXLEV/RXQUAL measurements of the MS. The exact criteria to be employed shall be determined by the network operator.

For channels used for a voice group call, the radio link failure procedures in the BSS shall be reset upon the re-allocation of the uplink to another MS. Upon a uplink radio failure, the network shall mark it as free, see subclause 4.8.

Whenever the uplink is not used, and for channels used for voice broadcast, the BSS radio link failure procedures shall not apply on that channel.

6 Idle mode tasks

6.1 Introduction

Whilst in idle mode, an MS shall implement the cell selection and re-selection procedures described in GSM 03.22. These procedures make use of measurements and sub-procedures described in this clause.

The procedures ensure that the MS is camped on a cell from which it can reliably decode downlink data and with which it has a high probability of communications on the uplink. Once the MS is camped on a cell, access to the network is allowed.

This clause makes use of terms defined in GSM 03.22.

The MS shall not use the discontinuous reception (DRX) mode of operation (i.e. powering itself down when it is not expecting paging messages from the network) while performing the cell selection algorithm defined in GSM 03.22. However use of powering down is permitted at all other times in idle mode.

For the purpose of cell selection and reselection, the MS shall be capable of detecting and synchronizing to a BCCH carrier and read the BCCH data at reference sensitivity level and reference interference levels as specified in GSM 05.05. An MS in idle mode shall always fulfil the performance requirement specified in GSM 05.05 at levels down to reference sensitivity level or reference interference level. The allowed error rates (see GSM 05.05) might impact the cell selection and reselection procedure, e.g. trigger cell reselection. Moreover, one consequence of the allowed error rates is that in the case of no frequency hopping and a TU3 (TU1.5 for DCS 1 800) propagation profile it can not be expected that an MS will respond to paging unless the received signal level is 2 dB higher than the specified reference level.

For the purposes of cell selection and reselection, the MS is required to maintain an average of received signal levels for all monitored frequencies. These quantities, termed the "received level averages" (RLA_C), shall be unweighted averages of the received signal levels measured in dBm. The accuracy of the received signal level measurements for idle mode tasks shall be the same as for radio link measurements (see subclause 8.1.2).

The times given in subclauses 6.2, 6.3 and 6.6 refer to internal processes in the MS required to ensure that the MS camps as quickly as possible to the most appropriate cell.

For the cell selection, the MS shall be able to select the correct (fourth strongest) cell and be able to respond to paging on that cell within 30 seconds of switch on, when the three strongest cells are not suitable. This assumes a valid SIM with PIN disabled and ideal radio conditions.

The tolerance on all the timing requirements in clause 6 is ± 10 %, except for PENALTY_TIME where it is ± 2 s.

6.2 Measurements for normal cell selection

The measurements of this clause shall be performed by an MS which has no prior knowledge of which GSM or DCS 1 800 RF channels are BCCH carriers.

The MS shall search all RF channels in the system (124 for P-GSM, 174 for E-GSM, 194 for R-GSM, and 374 for DCS 1 800), take readings of received RF signal level on each RF channel, and calculate the RLA_C for each. The averaging is based on at least five measurement samples per RF carrier spread over 3 to 5 s, the measurement samples from the different RF carriers being spread evenly during this period.

A multi band MS shall search all channels within its bands of operation as specified above. The number of channels searched will be the sum of channels on each band of operation.

BCCH carriers can be identified by, for example, searching for frequency correction bursts. On finding a BCCH carrier, the MS shall attempt to synchronize to it and read the BCCH data.