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Technical Specification

GEO-Mobile Radio Interface Specifications;
Part 3: Network specifications;
Sub-part 6: Handover Procedures;
GMR-2 03.009

Reference

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GMR, GSM, GSO, handover, interface, MES, mobile, MSS, radio, satellite, S-PCN

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Contents

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IPRs:

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TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,715,365	US
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,754,974	US
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,226,084	US
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,701,390	US
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,826,222	US

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Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 377 V1.1.1	Ericsson Mobile Communication	Improvements in, or in relation to, equalisers	GB	GB 2 215 567	GB
TS 101 377 V1.1.1	Ericsson Mobile Communication	Power Booster	GB	GB 2 251 768	GB
TS 101 377 V1.1.1	Ericsson Mobile Communication	Receiver Gain	GB	GB 2 233 846	GB
TS 101 377 V1.1.1	Ericsson Mobile Communication	Transmitter Power Control for Radio Telephone System	GB	GB 2 233 517	GB

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Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 377 V1.1.1	Hughes Network Systems		US	Pending	US

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Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	2.4-to-3 KBPS Rate Adaptation Apparatus for Use in Narrowband Data and Facsimile Communication Systems	US	US 6,108,348	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Cellular Spacecraft TDMA Communications System with Call Interrupt Coding System for Maximizing Traffic ThroughputCellular Spacecraft TDMA Communications System with Call Interrupt Coding System for Maximizing Traffic Throughput	US	US 5,717,686	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Enhanced Access Burst for Random Access Channels in TDMA Mobile Satellite System	US	US 5,875,182	
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System	US	US 5,974,314	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System	US	US 5,974,315	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System with Mutual Offset High-argin Forward Control Signals	US	US 6,072,985	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System with Spot Beam Pairing for Reduced Updates	US	US 6,118,998	US

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES).

The contents of the present document are subject to continuing work within TC-SES and may change following formal TC-SES approval. Should TC-SES 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 1.m.n

where:

- 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 3, sub-part 6 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";

Sub-part 1: "Network Functions; GMR-2 03.001";

Sub-part 2: "Network Architecture; GMR-2 03.002";

Sub-part 3: "Numbering, Addressing and Identification; GMR-2 03.003";

Sub-part 4: "Restoration Procedures; GMR-2 03.007";

Sub-part 5: "Organization of Subscriber Data; GMR-2 03.008";

Sub-part 6: "Handover Procedures; GMR-2 03.009";

Sub-part 7: "Technical Realization of Short Message Service (SMES) Point-to-Point; GMR-2 03.040";

Sub-part 8: "Location Registration Procedures; GMR-2 03.012";

Sub-part 9: "Discontinuous Reception (DRX) in the GMR-2 System; GMR-2 03.013";

Sub-part 10: "Security Related Network Functions; GMR-2 03.020";

Sub-part 11: "Functions Related to Mobile Earth Station (MES) in idle Mode; GMR-2 03.022";

Sub-part 12: "Technical Realization of Facsimile Group 3 Transparent; GMR-2 03.045";

Sub-part 13: "Transmission Planning Aspects of the Speech Service in the Public Satellite Mobile Network (PSMN) system; GMR-2 03.050";

Sub-part 14: "Call Waiting (CW) and Call Hold (HOLD) Supplementary Services - Stage 2; GMR-2 03.083";

Sub-part 15: "Multiparty Supplementary Services; GMR-2 03.084";

Sub-part 16: "Technical Realization of Operator Determined Barring; GMR-2 03.015";

Sub-part 17: "Call Barring (CB) Supplementary Services - Stage 2; GMR-2 03.088";

Part 4: "Radio interface protocol specifications";

Part 5: "Radio interface physical layer specifications";

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.

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 as follows:

GMR-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-n 01.201.

1 Scope

The present document contains a description of the procedures to be used for intra-beam channel handovers to counter in-call interference or blockage. Unlike the terrestrial GSM system, the GMR-2 system does not experience handovers between gateway subsystems or MSCs. Each gateway subsystem and MSC can have access to all the MESs within the satellite field-of-view. Additionally, the satellite-to-MES beams cover such a large geographic area that beam-to-beam handovers are not considered necessary. Handover control, as specified herein in response to interference or blockage, is primarily applicable to "non-mobile-to-mobile" Basic Rate - Normal Mode Speech connections. Optionally, handovers may be provided on "non-mobile-to-mobile" data and Basic Rate - Robust Mode Speech connections in response to interference only. In the latter case, an operator-defined subset of these specifications applies.

Within the GMR-2 system, channel handovers can also occur during call initiation procedures and because of Resource Allocation Plan changes. During normal call initiation, handovers occur between a Satellite-Standalone Dedicated Control Channel (S-SDCCH) and a Satellite-Traffic Channel (S-TCH) as the connection transitions from a signalling mode to a conversation mode. During mobile-to-mobile call initiation, handovers occur in changing from a mobile-to-PSTN radio resource to a mobile-to-mobile resource. These handovers are not specified herein. Rather they are part of the normal Circuit-Switched Call Control and Radio Resource Management procedures described in GMR-2 04.008 [2].

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, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, subsequent revisions do apply.

[1] GMR-2 01.004 (ETSI TS 101 377-1-1): "GEO-Mobile Radio Interface Specifications; Part 1: General specifications; Sub-part 1: Abbreviations and Acronyms".

[2] GMR-2 04.008 (ETSI TS 101 377-4-7): "GEO-Mobile Radio Interface Specifications; Part 4: Radio interface protocol specifications; Sub-part 7: Mobile radio interface Layer 3 Specifications".

[3] GMR-2 05.005 (ETSI TS 101 377-5-5): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 5: Radio Transmission and Reception".

[4] GMR-2 05.008 (ETSI TS 101 377-5-6): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 6: Radio Subsystem Link Control".

3 Abbreviations

For the purposes of the present document, the abbreviations given in GMR-2 01.004 [1] apply.

4 Handover Procedures

The Intra-Spotbeam Handover procedure supports changing traffic channels (TCHs) within a spotbeam, while a call is in progress. This must be done without interrupting the call. The procedure is performed entirely under the control of the Gateway Station Controller (GSC) without involving the MSC. Handover strategy and measurements of received signal strength (RXLEV) and received signal quality (RXQUAL) (i.e., bit-error-rate [BER]), are defined in GMR-2 05.008 [4]. Measurement, of ground transmit power levels (TXPWR), is defined in GMR-2 05.005 [3]. In general, the handover process is initiated by exceeding a TXPWR threshold as a result of link power control actions in response to degraded RXLEV and RXQUAL parameters. After process initiation, handover typically occurs as a result of exceeding RXLEV and RXQUAL thresholds as determined by comparing real time parameter measurements against prescribed thresholds. Two classes of handover can occur. One consists of switching to a new frequency and/or time slot while maintaining the same Basic Rate - Normal Mode Speech (i.e., 3,6 kbit/s vocoder, 6 kbit/s bearer rate) channel. The other consists of switching the frequency and/or time slot and changing from a Basic Rate - Normal Mode Speech channel to a Basic Rate - Robust Mode Speech (i.e., 3,6 kbit/s vocoder, 12 kbit/s bearer rate) channel. The latter involves maintaining the same vocoder but switching to a more powerful error correction code to give the robust channel feature. A handover, that maintains the Normal Mode Speech channel, typically occurs in response to interference. It is determined by exceeding the RXQUAL threshold (i.e., high BER) while not exceeding the RXLEV threshold (i.e., received signal strength is adequate). A handover, that includes switching to a Robust Mode Speech channel, typically occurs in response to blocking. It is determined by exceeding both the RXQUAL and RXLEV thresholds.

On the radio interface, the Traffic Channel Assignment procedure is used to perform intra-beam handovers. When an intra-beam handover is required, the tasks performed by the GSC for a successful handover are very similar to those performed for the original Traffic Channel Assignment (see GMR-2 04.008 [2] for details):

i) Allocate a new radio channel for the TCH based on the mobile's bearer capabilities and location (spotbeam);

ii) Allocate a new 64 kbit/s digital circuit (i.e., DS-0) between the Gateway Transceiver Subsystem's Traffic Channel Equipment (TCE) and the GSC;

iii) Connect the new DS-0 and existing DS-0 into a switch-broadcast configuration. In this mode and taking a forward link example, user data received from the MSC A-Interface circuit will be sent on both DS-0's to the MES. Until the intra-Beam handover has been completed successfully, only user data received from the existing DS-0 connection will be sent to the user. The interim configuration is shown in figure 4-1:

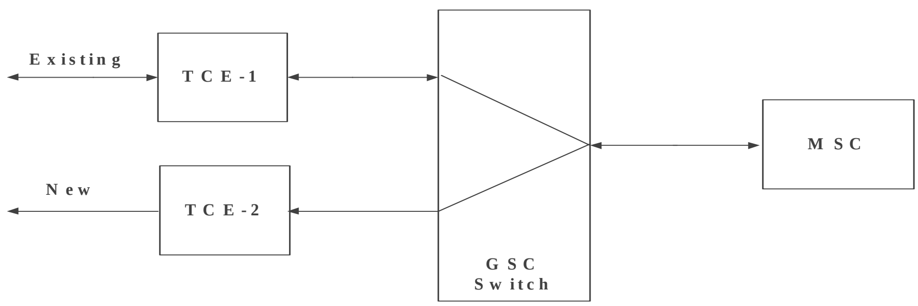

Figure 4-1: Intra-Beam Handover Interim Configuration

iv) Request the MES to switch from the existing radio channel to the new radio channel;

v) After the switch-over has successfully completed, release the existing connection and change the mode of the new connection within the GSC switch matrix from switch-broadcast to normal.

The only difference between the above Intra-Beam Handover procedure and the Traffic Channel Assignment procedure is that the GSC will connect the DS-0 associated with the new radio channel immediately after it is activated. In this configuration, all user data received from the MSC on the A-Interface PCM circuit will be forwarded on both the existing and new radio channels. This method eliminates the loss of user data to the MES. The overall procedure is depicted in figure 4-2.

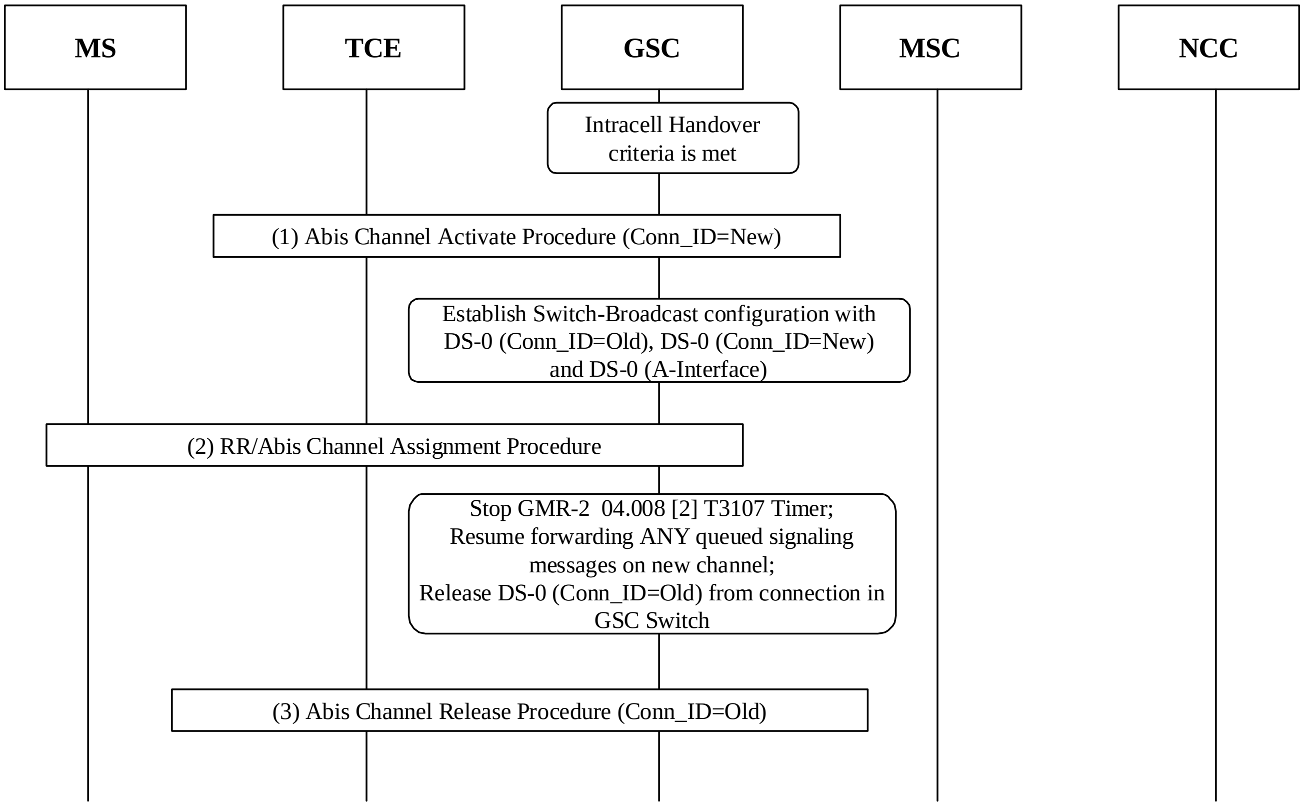

Figure 4-2: Network Intra-Beam Handover Procedures

5 Handover Process

5.1 General

This clause specifies the basic intra-spotbeam handover process to be implemented. It contains a description of the algorithm capability including descriptions of optional algorithm capabilities.

5.1.1 Functional Requirement

The process is described based on the following assumptions:

- the necessity for an intra-spotbeam handover according to radio criteria is recognized in the gateway;
- handovers shall occur on the forward and return links simultaneously in response to exceeding the threshold on either link;
- untraced handover for radio criteria may be performed directly by the gateway;

- all parameters controlling the handover control processes in each gateway shall be administered by means of O&M.

5.1.1.1 Applicable Definitions

- power level and signal strength parameters are in units of dBm. C/N_0 is in units of dB-Hz;
- whereas for the purpose of measurement reporting the variables RXLEV, and RXQUAL are integer valued indices identifying a reporting band; the algorithm discussed in the present document uses these same variables as real number values of received signal strength and received signal quality (CER). The assumed real number values for a given reporting band are specified for each of these parameters in GMR-2 05.008 [4], clause 10;
- this algorithm uses a "**_UL_** " (**U**p**L**ink) and "**_DL_**" (**D**own**L**ink) nomenclature. They are used to indicate link directions. UL and DL are used in the same context as GSM. Each represents the direction from the handset perspective. DL is used for the Forward Direction. It is received by the handset on the Downlink from the spacecraft. UL is used for the Return Direction. It is transmitted by the handset on the Uplink to the spacecraft. It is noted that, in accordance with the above definitions, RXLEV_UL and RXQUAL_UL are measurement values in the Return Direction. However, the actual measurements are taken at the gateway on a "spacecraft downlink".

5.2 Handover Control Process Sample Generation and Threshold Comparisons

For the purpose of intra-spotbeam handover control processing, the gateway shall continuously process the measurements (see GMR-2 05.005 [3] and GMR-2 05.008 [4]) indicated below and shall store the thresholds and parameters shown in tables 5-1 and 5-2, respectively.

i) 5-second average of measurements reported by MES on the S-SACCH:

  - 5-second average of Forward RXLEV (RXLEV_DL);
  - 5-second average of Forward RXQUAL (RXQUAL_DL);
  - 5-second average of Return RXPWR (RXPWR_UL).

ii) 5-second average of measurements performed in the gateway:

  - 5-second average of Return RXLEV (RXLEV_UL);
  - 5-second average of Return RXQUAL (RXQUAL_UL);
  - 5-second average of Forward RXPWR (RXPWR_DL).

A new processed value for each of the measurements shall be calculated in the TCE every 5 seconds and forwarded to the GSC over the A-bis interface.

The gateway shall store different values of the RXLEV, RXQUAL and TXPWR threshold parameters shown in table 5-1 for all combinations of the following:

i) MES Classmark (All Thresholds except "TXPWR_XX_H" are configurable by the below stated classmark categories. "TXPWR_XX_H" is configurable by all four MES Classmarks 1, 2, 3 and 4):

  a) MES Classmark = 1 (fixed terminal);

  b) MES Classmark > 1 (mobile terminal classmarks 2,3 and 4).

ii) Traffic Channel Mode: TCH/QBS.

Table 5-2 lists the configurable parameters which are set at a gateway level. Only one version of these parameters is stored.

Table 5-1: Operator Configurable Radio Criteria Thresholds for Handover Control (Configurable by MES Classmark, Traffic Channel Mode) (note 2)

Parameter Name	Direction	Description	Threshold Parameters		Averaging Parameters
RXLEV_UL_H	RETURN	RXLEV threshold on uplink for intra-spotbeam handovers with change of bearer rate and channel coding. Real number (dBm): range (note 1) specified in tables 5-5 and 5-6 of clause 5.6.	P_HC	N_HC	HC_Hreqave
RXQUAL_UL_H		RXQUAL threshold on uplink for intra-spotbeam handovers. Real number: range (note 1) specified in tables 5-5 and 5-6 of clause 5.6.	P_HC	N_HC	HC_Hreqave
TXPWR_UL_H		Return link transmit power threshold to trigger a handover control assessment. Real number (dBm): range (note 1) as specified in table 5-8 of clause 5.6.	P_HC	N_HC	HC_Hreqave
RXLEV_DL_H	FORWARD	RXLEV threshold on downlink for intra-spotbeam handovers with change of bearer rate and channel coding. Real number (dBm): range (note 1) specified in tables 5-3 and 5-4 of clause 5.6.	P_HC	N_HC	HC_Hreqave
RXQUAL_DL_H		RXQUAL threshold on downlink for intra-spotbeam handovers. Real number: range (note 1) specified in tables 5-3 and 5-4 of clause 5.6.	P_HC	N_HC	HC_Hreqave
TXPWR_DL_H		Forward link transmit power threshold to trigger a handover control assessment. Real number (dBm): range (note 1) specified in table 5-7 of clause 5.6.	P_HC	N_HC	HC_Hreqave
NOTE 1: The range of configurable values for all threshold settings includes real values for threshold comparison and flag values to modify the functionality of the algorithm. Reference the threshold descriptions in clause 5.4. NOTE 2: All Thresholds except "TXPWR_XX_H" are configurable for two categories of classmark; Classmark = 1 (Fixed Terminals) and Classmark > 1 (Mobile Terminals with MES classmark = 2, 3, and 4). "TXPWR_XX_H" is configurable by all four MES Classmarks 1, 2, 3 or 4.					

Table 5-2: Operator Configurable Handover Control Parameters (Configured at Gateway Level)

Parameter	Description
HC_Hreqave	RXLEV, RXQUAL averaging period defined in terms of number of handover measurement cycles for handover control threshold comparisons (i.e. the number groups of "5-second SACCH cycle measurements report averages" that will be averaged together to form a single handover control algorithm sample). Range (1, 32); step size 1 (note 1).
P_HC	The number of handover algorithm samples used in the handover control algorithm, decision window for the threshold comparison process. Range (1, 32); step size 1. (note 2)
N_HC	The number of algorithm samples required to break threshold in order for a handover to be requested. Range (0, 32); step size 1.
T_Hand_RQD	Minimum interval between intraspotbeam handovers for an individual MES. Range (0,30 s); step size is 1 second
Max_Handover	Maximum number of intra-spotbeam handovers for an individual MES (Range 1 to 10, step size = 1)
Lost_Meas_Flag	Flag indicating what action the handover control algorithm should take when it encounters an invalid measurement report. (0 = Preclude assessment until decision window is refreshed with all valid data; 1= request handover to TCH/HR.)
MAX_HC_Proc_load	Handover control processor loading threshold. Functionally equivalent and implemented in the GSC handover algorithm as the GSC "Congestion_Step" parameter.
NOTE 1: HC_Hreqt is the total number of handover measurements used to form samples in the handover control decision window and HC_Hreqt = [P_HC]*[HC_Hreqave]). NOTE 2: HC_Hreqt is the total number of handover measurements used to form samples in the handover control decision window and HC_Hreqt = [P_HC]*[HC_Hreqave].	

5.3 Algorithm Sample and Decision Window Generation/Measurement Averaging Process

The overall functional depiction of the generation of a set of handover algorithm samples making up a handover decision window is shown in figure 5-1.

5.3.1 Handover Control Sliding Window Process

Every 5 seconds the gateway shall take the last 5 seconds worth of valid SACCH cycle measurements, for a given call, scale them using the SCALE_Δ_dB_Bin values corresponding to the power control bin they are currently in, and average these values together in a "Pre-Processed Measurement Report" to form a single "Handover Control measurement bin value". Whereas for power control, a new measurement value is placed in the PC_measurement bin(1) each SACCH cycle epoch, for handover control a new value is entered into HC_measurement bin(1) every 5 seconds. This 5-second averaging epoch will be referred to as the handover measurement epoch. The way in which the handover algorithm samples are recalculated depends upon the configuration of HC_Hreqave.

The handover control algorithm decision window is sized to evaluate "P_HC" algorithm samples, numbered (1) through (P_HC), which are derived from "HC_Hreqt" handover measurement bins numbered (1) through (HC_Hreqt). The value in Sample (1) is comprised of the most recent "HC_Hreqave" handover measurements which are in measurement bins (1) through (HC_Hreqave) and all Samples are derived from a number of measurement values equal to "HC_Hreqave".

Handover control decision epochs occur each handover measurement epoch unless the T_Hand_RQD timer interval has not passed since the last handover. Each handover measurement epoch the value that was in measurement bin(HC_Hreqt) is shifted out of the decision window; the values that were in bins (1) through (HC_Hreqt -1) are shifted one position to fill bins (2) through (HC_Hreqt); and the newly received measurement epoch value fills measurement bin (1). When the next algorithm decision epoch occurs, and after the sliding window procedures are completed, the current HC_Hreqt measurement bin values are averaged together, HC_Hreqave at a time, to form the P_HC algorithm samples current decision epoch.

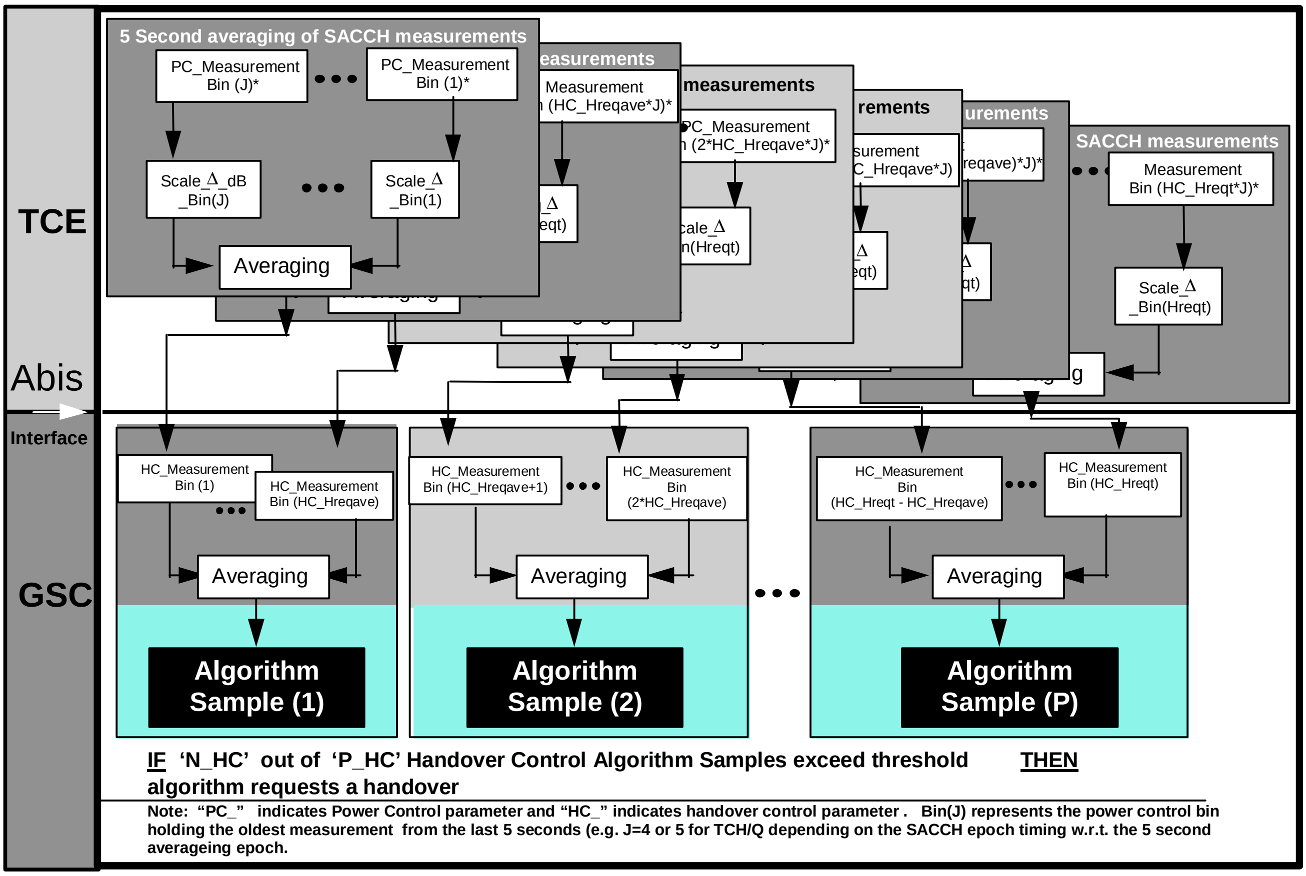

Figure 5-1: Handover Algorithm Decision Window

5.3.2 Handover Control: Averaging of Measurement Bin Values to form Algorithm Samples

In order to generate an "algorithm sample", Hreqave handover measurement bin values" are averaged together. The gateway GSC shall be capable of pre-processing the measurement bin values by unweighted averaging.

The timing of the processing shall be controlled by parameters, set by O&M, as follows:

a) RXLEV_XX, RXQUAL_XX and TXPWR_XX (XX = DL or UL):

For every connection, and for both forward and return links, at least the last 32 pre-processed measurement reports shall be stored. A pre-processed measurement report is the scaled, 5-second-average of the values evaluated by the MES and gateway during SACCH multiframe cycles occurring during the 5-second period and reported to the Gateway Station Controller by the TCE for each active connection. Every 5 seconds, the gateway station controller shall average the pre-processed measurement reports as defined by the parameters, Hreqave and Hreqt, applicable to each respective measurement category (e.g., RXLEV_XX), and this creates a new "algorithm sample". The number of SACCH measurement reports averaged, by the TCE, to form the pre-processed measurement, during the 5-second averaging period, will depend upon the bearer rate SACCH cycle period and the number of valid SACCH reports received during the 5 second period. The average shall be performed against the actual number of valid SACCH measurement reports received by the TCE during the 5-second averaging period. For forward link measurement reports which depend upon successful return link SACCH decoding, at least 2 valid SACCH measurement reports must be successfully decoded during the 5-second period in order to yield a valid pre-processed measurement report. If less than 2 valid SACCH measurement reports are received, the forwarded 5-second averaged value shall be marked by the TCE as an "invalid" forward link pre-processed measurement.

b) HC_Hreqave and HC_Hreqt:

The value of HC_Hreqt is defined by O&M, for each gateway, to determine the averaging of reported pre-processed measurements. HC_Hreqt is determined by the configured values of HC_Hreqave and P_HC where:

- HC_Hreqt = (HC_Hreqave) x (P_HC).

HC_Hreqave: defines the period over which an algorithm sample is produced, for threshold comparison, in terms of the number of handover measurement cycles, i.e. the number of pre-processed measurement reports contributing to each algorithm sample. (Reference figure 5-1).

HC_Hreqt: is the total number of preprocessed measurements that must be maintained to comprise an "algorithm decision window" for threshold comparison.

HC_Hreqave measurement values are averaged together to form a single algorithm sample and an algorithm decision window is comprised of "P_HC" algorithm samples.

The gateway shall support values of Hreqave and P_HC such that:

- 0 < HC_Hreqave ≤ 32 and 0 < P_HC ≤ 32;

  where: HC_Hreqave x P_HC ≤ 32.

5.4 Threshold Parameter Descriptions

All threshold parameters for handover control shall be configured by the gateway operator and shall be configurable as a function of MES classmark. The RXLEV_XX_H and RXQUAL_XX_H parameters have two settings for each UL and DL direction. One setting for MES classmark = 1 (fixed terminals i.e., Gaussian Channels) and the second for MES classmark >1 (mobile terminals with classmark = 2, 3, or 4 i.e., Rician Channels). The TXPWR_XX_H parameter has 4 settings for each UL and DL direction. One for each MES classmark = 1, 2, 3, and 4. The threshold parameter descriptions and usage are provided below:

RXLEV_XX_H (XX = DL or UL): This parameter sets the threshold value for received signal strength on the Forward link (or Downlink (DL)) and on the Return link (or Uplink (UL)). It shall be configured as a real number in "dBm" in the range and step size as specified in clause 5.6 (See tables 5-3 through 5-6). The interface value sent via O&M to the algorithm processor shall be an integer number representing a row in the referenced tables and the configured real number value is the value from the table corresponding to the row number which was passed.

In the full-up configuration of the algorithm, "*handover requests*" shall be determined by RXQUAL_XX_H threshold comparisons and "*handover request type"* shall be determined by the RXLEV_XX_H threshold comparisons. If a handover request is declared because RXQUAL_XX_H is exceeded, then the handover request type shall be Basic Rate - Normal Mode Speech, if RXLEV_xx_H is not exceeded, and Basic Rate - Robust Mode Speech, if RXLEV_XX_H is exceeded. The configured value of RXLEV_XX_H increases as you go from Row # 1 to Row # 31 in tables 5-3 through 5-6. When RXLEV_XX_H is configured to a non-zero value, then exceeding an RXLEV_XX_H threshold shall be declared if N_HC out of P_HC RXLEV_XX algorithm samples are less than the configured RXLEV_XX_H value. The higher (less negative) the configured value of RXLEV_XX_H the more likely the RXLEV algorithm samples break threshold and thus, the more likely a handover request type will be set to Robust Mode Speech. In the limit, if RXLEV_XX_H is set to its highest "non-zero" reporting value (Row # 31 from tables 5-3 through 5-6), then all reported values of RXLEV will be below threshold and all handover requests will result in a handover request type of Robust Mode Speech. Particular RXLEV_XX_H settings will achieve specific optional algorithm configurations as described below:

a) Dynamically determined Handover Request Type:

This requires the full-up configuration capability. A RXLEV_XX_H threshold must be selected as the trigger threshold for dynamic selection of a Robust Mode Speech handover. When the TXPWR_XX_H and RXQUAL_XX_H thresholds are exceeded, then the algorithm shall dynamically determine the handover request type. The handover type shall be Basic Rate - Normal Mode Speech when the RXLEV_XX_H threshold is not exceeded (i.e. review of P RXLEV samples has not found N samples below RXLEV_XX_H) and it shall be Basic Rate - Robust Mode Speech when the RXLEV_XX_H threshold is exceeded (i.e. N out of P RXLEV samples are below RXLEV_XX_H). In this configuration, the handover request type shall default to Robust Mode if the handover_count reaches Max_Handover.

b) Fixed number of Regular Handover attempts prior to a final handover to Robust Mode:

The algorithm shall be configured to attempt a fixed number of Normal Mode Speech handovers before trying a Robust Mode handover. This is the same configuration as for "Dynamic Handover Request Type Determination" except RXLEV_XX_H threshold is set to its lowest, non-zero, value (i.e. its Row # 1 value from tables 5-3 through 5-6). This value will always be less than the RXLEV samples and therefore the handover algorithm will always request a Normal Mode handover whenever the TXPWR_XX_H and RXQUAL_XX_H thresholds are exceeded. The number of regular handovers, before a Robust Mode handover, is set by selection of the Max_Handover parameter since the algorithm shall request a Robust Mode handover when the handover count reaches Max_Handover.

c) Immediate handover to Robust mode (TCH/HRS):

The algorithm shall be configured to perform a single Robust Mode handover, after exceeding the TXPWR_XX_H and RXQUAL_XX_H thresholds, by setting RXLEV_XX_H to its highest settable value (i.e. row #31 value from tables 5-3 through 5-6). This will guarantee that all RXLEV values are below threshold and therefore the first time the TXPWR_XX_H and RXQUAL_XX_H thresholds are exceeded shall trigger a Robust Mode handover request. Once the Robust Mode handover is successfully completed, no further handovers are requested/implemented.

d) Turning off the Robust Handover Capability:

Turning off robust mode handovers shall be achievable by setting the RXLEV_XX_H threshold = 0,0 (Row # 0) and setting the Lost_meas_flag = 0. Setting RXLEV_XX_H=0,0 acts as a flag which turns off threshold comparisons on RXLEV algorithm samples. This means that no matter what the actual RXLEV algorithm sample value, the threshold comparison process shall not declare any RXLEV_XX_H threshold exceeded. If no RXLEV threshold is exceeded then all handover requests will be for Normal Mode handovers. In order to completely turn off all Robust Mode handovers, the Lost_meas_flag parameter must be configured to '0' in conjunction with RXLEV_H = 0,0 so that no robust handover is requested due to unrecovered SACCH measurement reports.

RXQUAL-XX-H (XX = DL or UL): This parameter sets the threshold value for received signal quality on the Forward link (or Downlink (DL)) and on the Return link (or Uplink (UL)). It shall be configured as a real decimal value measuring BER with range and step size as specified in clause 5.6 (See tables 5-3 through 5-6). The interface value sent via O&M to the algorithm processor shall be an integer number representing a row in the referenced tables and the configured real number value is the value from the table corresponding to the row number which was passed.

As indicated above, "*handover requests*" shall be determined by RXQUAL_XX_H threshold comparisons and "*handover request type*" shall be determined by the RXLEV_XX_H threshold comparisons. A handover request shall be declared only if RXQUAL_XX_H is exceeded. The configured value of RXQUAL_XX_H decreases as you go from Row # 1 to Row # 31 in tables 5-3 through 5-6. When RXQUAL_XX_H is configured to a non-zero value, then exceeding an RXQUAL_XX_H threshold shall be declared if N_HC out of P_HC RXQUAL_XX algorithm samples are greater (i.e., higher BER) than the configured RXQUAL_XX_H value. The lower the configured value of RXQUAL_XX_H (i.e., less bit errors allowed) the more likely the RXQUAL algorithm samples break threshold and thus, the more likely a handover request will be declared. In the limit, if RXQUAL_XX_H is set to its lowest "non-zero" reporting value (Row # 31 from tables 5-3 through 5-6), then almost all reported values of RXQUAL will be above threshold and handover requests will be declared on almost every 5 second sample reading. Setting RXQUAL_XX_H = 0,0 (Row # 0 in tables 5-3 through 5-6) shall be a condition that functions as a flag which turns off threshold comparisons on RXQUAL algorithm samples. This means that no matter what the actual RXQUAL algorithm sample value, the threshold comparison process shall not declare any RXQUAL_XX_H threshold exceeded. Since "*handover requests*" are only initiated by exceeding an RXQUAL_XX_H threshold, setting RXQUAL-XX_H = 0,0 results in turning off all handover actions.

TXPWR_XX_H (XX = DL or UL): This parameter sets the threshold value for transmit power levels on the Forward link (or Downlink (DL)) and on the Return link (or Uplink (UL)). It shall be configured as a real number in "dBm" in the range and step size as specified in clause 5.6 (See tables 5-7 and 5-8). The interface value sent via O&M to the algorithm processor shall be an integer number representing a row in the referenced tables and the configured real number value is the value from the table corresponding to the row number which was passed.

The handover threshold comparison process shall be initiated only by exceeding a TXPWR_XX_H threshold. The configured value of TXPWR_XX_H decreases with increasing row number in tables 5-7 and 5-8. When TXPWR_XX_H is configured to a non-zero value, then exceeding a TXPWR threshold shall be declared if N_HC out of P_HC TXPWR_XX algorithm samples are greater than the configured TXPWR_XX_H value. The greater the configured value of TXPWR_XX_H, the less likely the TXPWR algorithm samples will break threshold and thus the less likely a handover assessment will be performed for a given connection. In the limit, if TXPWR_XX_H is set to its highest "non-zero" value then nearly all reported values of TXPWR will be below threshold, and only those connections averaging this maximum power level will be assessed for handover. Setting TXPWR_XX_H = 0,0 shall be a condition that functions as a flag to turn off threshold comparisons on TXPWR algorithm samples. It means TXPWR_XX_H threshold is always exceeded no matter what the actual TXPWR algorithm sample value. Since RXLEV_XX and RXQUAL_XX threshold comparisons are only performed when TXPWR_XX_H threshold is exceeded, TXPWR_XX_H = 0,0 is a flag which turns off the transmit power constraint limiting the number of connections to be evaluated for handovers.

5.5 Operator Configurable Algorithm Parameter Descriptions

All algorithm configuration parameters for handover control shall be configured by the gateway operator and shall be configurable at a gateway level (i.e. one configurable value is used for all connections within the gateway). The threshold parameter descriptions and usage are provided below:

HC_Hreqave: This parameter defines the period, over which an algorithm sample is produced, in terms of the number of handover measurement cycles, i.e. the number of "5-second TCE averaged SACCH cycle measurement reports" contributing to each algorithm sample. (Reference figure 5-1 in clause 5.3).

If HC_Hreqave is set to its lower limit of 1, then each of the P_HC algorithm samples will represent a 5-second average of the SACCH cycle measurements during that period. The variability of the algorithm sample values will average out effects having a decorrelation time shorter than 5 seconds. As the value of HC_Hreqave is increased up to its limit of 32, the increased averaging of measurement reports will average out effects with increasing decorrelation times.

P_HC and N_HC: P_HC represents the number of algorithm samples which are to be evaluated at each decision epoch and N_HC represents the number of algorithm samples which must break threshold before exceeding a threshold is declared. If P_HC is set to 1 then N_HC must also be 1 and each decision is made based on a single algorithm sample. (Note that a single algorithm sample could represent the averaging of measurement reports over a range of 5 seconds to 32 x 5 seconds as described above for the usage of HC_Hreqave). As P_HC is increased, the number of samples to be evaluated increases and the threshold decisions depend upon the configured value of N_HC.

Setting values of N_HC = P_HC means that all samples in the decision window must exceed threshold before exceeding a threshold is declared. Setting values of N_HC < P_HC allows exceeding a threshold to be declared even when some of the samples are not breaking threshold. If the channel environment and HC_Hreqave setting cause the algorithm samples to have little variation then both N_HC=P_HC and N_HC < P_HC will tend to make similar decisions with the N_HC< P_HC condition having a quicker reaction time. If the channel environment and HC_Hreqave setting cause the algorithm samples to have a high degree of variability, then the N_HC < P_HC condition will be more likely to declare exceeding a threshold than the N_HC = P_HC condition with increasing probability as N_HC << P_HC.

T_Hand_RQD: This parameter defines the minimum required time interval (in seconds) between successive handovers on the same connection. The fidelity of this parameter is 5 seconds corresponding to the averaging and reporting interval for pre-processed measurement reports. At the lowest value of 0, the algorithm shall allow successive handovers to occur at each 5 second interval decision epoch. At its upper bound of 5, the algorithm shall wait until 30 seconds has transpired since the last successful handover before it will allow the algorithm to request another handover on a given connection.

Max_Handover: This parameter represents the maximum number "normal handovers" for the same connection (where "normal handover" is defined as a handover to an equivalent bearer rate channel on different frequency/timeslot). Each time that a "normal handover" occurs for a given connection, the handover control algorithm shall increment a handover counter by 1. When the handover counter value reaches the configured value of "Max_Handover", the handover control algorithm shall no longer assess the connection for handovers.

If the Robust handover capability is "active" (i.e., RXLEV_XX_H is not 0,0), a special condition shall exist when the handover counter reaches "Max_Handover - 1" (Robust Handover is defined as a handover with a change in bearer rate and channel encoding i.e., Basic Rate - Normal Mode Speech is handed over to Basic Rate - Robust Mode Speech). This condition shall be such that if the algorithm decides that another handover is necessary and the handover counter is one less than the Max_Handover value, then the requested handover type shall be a Robust handover irrespective of the RXLEV threshold comparison result. However, if the Robust handover capability is disabled (i.e., RXLEV_XX_H = 0,0) then the handover request shall be for a normal handover irrespective of the RXLEV threshold comparison result.

Irrespective of the current value of the handover counter, if the RXQUAL and RXLEV threshold comparisons result in a request for a Robust handover, the Handover Counter shall be set equal to the configured Max_Handover value and the connection shall no longer be assessed for handovers.

Lost_Meas_Flag: This parameter is a flag, which defines how the algorithm will react to lost measurements. If the SACCH messages are not properly received by the TCE during any 5-second handover control measurement interval then the TCE shall mark the handover control measurement report as "invalid" for that measurement period. If the Lost_Meas_Flag = 0 then the algorithm shall preclude handover assessment for that connection until the handover control algorithm decision window is refreshed with valid data. However, if the Lost_Meas_Flag is set to 1, then the algorithm shall immediately request a Robust handover when an invalid measurement report is received.

Max_HC_Proc_Load: This parameter is functionally equivalent to and implemented as the GSC Congestion_Step parameter, which defines a threshold percentage of GSC processing capacity. Once the GSC processing load reaches the configured Congestion_Step Threshold of the GSC processor capacity, the algorithm shall no longer request handovers for any connections. When the processing load drops back down below this configured threshold then handover requests shall resume.

5.6 RXLEV / RXQUAL Threshold Menu Tables

The following tables are the threshold menu tables, which shall be stored in the GSC and used for the selection of handover thresholds. The thresholds, as a function of Traffic Channel Mode (TCM) and MES Classmark, are configured, by the gateway operator, by entering integer valued row numbers. The implemented threshold setting for RXLEV_XX_H, RXQUAL_XX_H, and TXPWR_XX_H are the real numbered values referenced by the corresponding row numbers in the threshold menu tables (see tables 5-3 through 5-8). The operator enters a separate integer row number for each threshold. The menus, in tables 5-3 through 5-6, provide the operator with insight into the relationship between RXLEV and RXQUAL.

Table 5-3: Forward Link, Classmark = 1
Signal Strength and Quality Threshold Menu

Row	RXLEV_DL_H (note 1)	RXQUAL_DL_H	Row	RXLEV_DL_H (note 1)	RXQUAL_DL_H
0	0,000 00 (note 2)	0,000 000 00 (note 2)	16	-108,92	0,002 000 00
1	-150,00	0,110 000 00	17	-108,4	0,001 250 00
2	-114,38	0,095 000 00	18	-108,07	0,000 800 00
3	-114,03	0,082 500 00	19	-107,63	0,000 500 00
4	-113,76	0,070 000 00	20	-107,13	0,000 250 00
5	-113,49	0,060 000 00	21	-106,74	0,000 150 00
6	-113,15	0,050 000 00	22	-106,23	0,000 075 00
7	-112,72	0,040 000 00	23	-105,76	0,000 040 00
8	-112,28	0,030 000 00	24	-105,38	0,000 025 00
9	-111,99	0,025 000 00	25	-104,80	0,000 012 50
10	-111,63	0,020 000 00	26	-104,32	0,000 007 00
11	-111,15	0,015 000 00	27	-103,85	0,000 004 00
12	-110,68	0,010 000 00	28	-103,45	0,000 002 50
13	-110,26	0,007 000 00	29	-102,87	0,000 001 25
14	-109,85	0,005 000 00	30	-102,38	0,000 000 70
15	-109,42	0,003 500 00	31	-1,00	0,000 000 40
NOTE 1: RXLEV_DL_H is in units of dBm. NOTE 2: 0,0 is not a real setting but is used as an algorithm flag (see RXLEV_XX_H and RXQUAL_XX_H description).					

Table 5-4: Forward Link, Classmark > 1
Signal Strength and Quality Threshold Menu

Row	RXLEV_DL_H (note 1)	RXQUAL_DL_H	Row	RXLEV_DL_H (note 1)	RXQUAL_DL_H
0	0,000 00 (note 2)	0,000 000 00 (note 2)	16	-109,01	0,008 000 00
1	-150,00	0,115 000 00	17	-108,77	0,007 000 00
2	-114,30	0,100 000 00	18	-108,50	0,006 000 00
3	-114,01	0,090 000 00	19	-108,18	0,005 000 00
4	-113,76	0,080 000 00	20	-107,77	0,004 000 00
5	-113,45	0,070 000 00	21	-107,26	0,003 000 00
6	-113,07	0,060 000 00	22	-106,53	0,002 000 00
7	-112,63	0,050 000 00	23	-106,02	0,001 500 00
8	-112,18	0,040 000 00	24	-105,27	0,001 000 00
9	-111,89	0,035 000 00	25	-104,85	0,000 800 00
10	-111,56	0,030 000 00	26	-104,31	0,000 600 00
11	-111,15	0,025 000 00	27	-103,97	0,000 500 00
12	-110,73	0,020 000 00	28	-103,50	0,000 400 00
13	-110,18	0,015 000 00	29	-102,89	0,000 300 00
14	-109,83	0,012 500 00	30	-102,49	0,000 250 00
15	-109,39	0,010 000 00	31	-1,00	0,000 200 00
NOTE 1: RXLEV_DL_H is in units of dBm. NOTE 2: 0,0 is not a real setting but is used as an algorithm flag (see RXLEV_XX_H and RXQUAL_XX_H description).					

**Table 5-5: Return Link, Classmark = 1
Signal Strength and Quality Threshold Menu**

Row	RXLEV_UL_H (note 1)	RXQUAL_UL_H	Row	RXLEV_UL_ (note 1)	RXQUAL_UL_H
0	0,000 00 (note 2)	0,000 000 0 (note 2)	16	-109,89	0,004 000 00
1	-150,00	0,110 000 00	17	-109,50	0,003 000 00
2	-115,26	0,095 000 00	18	-108,94	0,002 000 00
3	-114,98	0,085 000 00	19	-108,55	0,001 500 00
4	-114,74	0,075 000 00	20	-108,09	0,001 000 00
5	-114,45	0,065 000 00	21	-107,83	0,000 800 00
6	-114,08	0,055 000 00	22	-107,49	0,000 600 00
7	-113,64	0,045 000 00	23	-107,02	0,000 400 00
8	-113,23	0,035 000 00	24	-106,23	0,000 200 00
9	-112,96	0,030 000 00	25	-105,44	0,000 100 00
10	-112,64	0,025 000 00	26	-105,18	0,000 080 00
11	-112,23	0,020 000 00	27	-104,85	0,000 060 00
12	-111,79	0,015 000 00	28	-104,41	0,000 040 00
13	-111,20	0,010 000 00	29	-103,66	0,000 020 00
14	-110,86	0,008 000 00	30	-103,34	0,000 015 00
15	-110,43	0,006 000 00	31	-1,00	0,000 010 00
NOTE 1: RXLEV_UL_H is in units of dBm. NOTE 2: 0,0 is not a real setting but is used as an algorithm flag (see RXLEV_XX_H and RXQUAL_XX_H description).					

**Table 5-6: Return Link, Classmark > 1
Signal Strength and Quality Threshold Menu**

Row	RXLEV_UL_H (note 1)	RXQUAL_UL_H	Row	RXLEV_UL_ (note 1)	RXQUAL_UL_H
0	0,0000 (note 2)	0,000 000 0 (note 2)	16	-109,93	0,010 000 00
1	-150,00	0,120 000 00	17	-109,47	0,008 000 00
2	-115,43	0,110 000 00	18	-109,05	0,006 500 00
3	-115,15	0,100 000 00	19	-108,70	0,005 500 00
4	-114,88	0,090 000 00	20	-108,32	0,004 500 00
5	-114,61	0,080 000 00	21	-107,84	0,003 500 00
6	-114,27	0,070 000 00	22	-107,54	0,003 000 00
7	-113,86	0,060 000 00	23	-107,19	0,002 500 00
8	-113,43	0,050 000 00	24	-106,76	0,002 000 00
9	-112,93	0,040 000 00	25	-106,18	0,001 500 00
10	-112,62	0,035 000 00	26	-105,36	0,001 000 00
11	-112,25	0,030 000 00	27	-104,90	0,000 800 00
12	-111,85	0,025 000 00	28	-104,33	0,000 600 00
13	-111,39	0,020 000 00	29	-103,97	0,000 500 00
14	-110,90	0,016 000 00	30	-103,53	0,000 400 00
15	-110,45	0,013 000 00	31	-1,00	0,000 300 00
NOTE 1: RXLEV_UL_H is in units of dBm. NOTE 2: 0,0 is not a real setting but is used as an algorithm flag (see RXLEV_XX_H and RXQUAL_XX_H description).					

Table 5-7: Forward Link Transmit Power Threshold Menu

Row	TXPWR_DL_H (note 1)	Row	TXPWR_DL_H (note 1)	Row	TXPWR_DL_H*
0	62,0	16	54,0	32	46,0
1	61,5	17	53,5	33	45,5
2	61,0	18	53,0	34	45,0
3	60,5	19	52,5	35	0,00 (note 2)
4	60,0	20	52,0		
5	59,5	21	51,5		
6	59,0	22	51,0		
7	58,5	23	50,5		
8	58,0	24	50,0		
9	57,5	25	49,5		
10	57,0	26	49,0		
11	56,5	27	48,5		
12	56,0	28	48,0		
13	55,5	29	47,5		
14	55,0	30	47,0		
15	54,5	31	46,5		
NOTE 1: TXPWR_DL_H is in units of dBm. NOTE 2: 0,0 is not a real power setting but is used as an algorithm flag (see TXPWR_XX_H description).					

Table 5-8: Return Link Transmit Power Threshold Menu

Row	TXPWR_UL_H (note 1)	Row	TXPWR_UL_H (note 1)	Row	TXPWR_UL_H*
4	39,0	20	31,0	36	23,0
5	38,5	21	30,5	37	22,5
6	38,0	22	30,0	38	22,0
7	37,5	23	29,5	39	21,5
8	37,0	24	29,0	40	21,0
9	36,5	25	28,5	41	0,0 (note 2)
10	36,0	26	28,0		
11	35,5	27	27,5		
12	35,0	28	27,0		
13	34,5	29	26,5		
14	34,0	30	26,0		
15	33,5	31	25,5		
16	33,0	32	25,0		
17	32,5	33	24,5		
18	32,0	34	24,0		
19	31,5	35	23,5		
NOTE 1: TXPWR_UL_H is in units of dBm. NOTE 2: 0,0 is not a real power setting but is used as an algorithm flag (see TXPWR_XX_H description).					

History

Document history		
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