3GPP TSG RAN WG1 ***TSGR1#10(00)53***

January 18 – 21, 2000, Beijing, China

Agenda item:

Source: **Philips**

Title: **Correction to application of power control to data channels**

Document for: **Decision**

Introduction

There appear to be some inconsistencies in the description of power control given section 5.1.2 of TS25.214.

As an example we consider the following:

1) Section 5.1.2.5.1 indicates that changes due to inner loop power control are applied on top of gain factors between DPCCH and DPDCH. The gain factors are computed very frame.

2) Section 5.1.2.2.1 indicates that in every slot the power of DPCCH and DPDCH are both changed by delta TPC (or zero if TPC_cmd equals zero).

One potential conflict arises at the frame boundary where there can be a simultaneous change in power of the DPDCH due to both gain factors and inner loop power control, strictly violating 2)

The difficulty seems to arise from the fact that there are several mechanisms which can alter the UE output power, particularly in compressed mode.

The proposed solution is to modify the text in section 5.1.2 to make the inner loop power control operate specifically on the DPCCH. The relative power of the DPDCH is then be determined by the gain factors. Then the relative scaling of DPDCH due to gain factors would be applied on top of changes made (e.g. by the inner loop power control) to the power of DPCCH. The following changes are included in the CR.

- Moving of features which apply to inner loop power control in general to section 5.1.2.1
- Defining power control to act on the DPCCH, with DPDCH power determined by the gain factors
- Introducing a new variable Δ_{DPCCH} which is the DPCCH power change
- Introducing a new variable Δ_{PILOT} which is the change in power due to a change in number of pilot bits in compressed mode
- Changes resulting from using the above variables
- Introducing a more precise specification of behaviour in the case of reaching power limits
- Modifications to improve consistency with above changes
- Various editorial improvements

This CR may need further refinement, and could therefore be a basis for further discussion.

3GPP TSG RAN WG1 Meeting #10
Beijing, China, Jan 18 - 21, 2000

Document R1-00-53
e.g. for 3GPP use the format TP-99xxx
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25.214	**CR**	**50**	Current Version:	3.1.0

GSM (AA.BB) or 3G (AA.BBB) specification number ↑ *↑ CR number as allocated by MCC support team*

For submission to:	TSG-RAN #7	for approval	X	strategic		*(for SMG use only)*
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Proposed change affects: *(at least one should be marked with an X)*	(U)SIM		ME	X	UTRAN / Radio	X	Core Network	

Source:	Philips	**Date:**	2000-01-14
Subject:	Corrections to uplink power control in compressed mode		
Work item:			

Category:	F	Correction	X	**Release:**	Phase 2	
	A	Corresponds to a correction in an earlier release			Release 96	
(only one category	B	Addition of feature			Release 97	
shall be marked	C	Functional modification of feature			Release 98	
with an X)	D	Editorial modification			Release 99	X
					Release 00	

Reason for change:	
Clauses affected:	5.1 Uplink power control

Other specs affected:	Other 3G core specifications		→ List of CRs:	
	Other GSM core specifications		→ List of CRs:	
	MS test specifications		→ List of CRs:	
	BSS test specifications		→ List of CRs:	
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Other comments:	

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5 Power control

5.1 Uplink power control

5.1.1 PRACH

5.1.1.1 General

The power control during the physical random access procedure is described in clause 6. The setting of power of the message control and data parts is described in the next sub-clause.

5.1.1.2 Setting of PRACH control and data part power difference

The message part of the uplink PRACH channel shall employ gain factors to control the control/data part relative power similar to the uplink dedicated physical channels. Hence, section 5.1.2.45 applies also for the RACH message part, with the differences that:

- b_c is the gain factor for the control part (similar to DPCCH),
- b_d is the gain factor for the data part (similar to DPDCH),
- no inner loop power control is performed.

5.1.2 DPCCH/DPDCH

5.1.2.1 General

The initial uplink DPCCH transmit power is set by higher layers. Subsequently tThe uplink transmit power control procedure simultaneously controls simultaneously the power of a DPCCH and its corresponding DPDCHs (if present). The relative transmit power offset between DPCCH and DPDCHs is determined by the network and is computed according to sub clause 5.1.2.5 using the gain factors signalled to the UE using higher layer signalling.

The normal operation of inner power control loop,- described in sub clause 5.1.2.2,adjusts the power of the DPCCH and DPDCHs by with the same amount, provided there are no changes in gain factors. Additional adjustments to the power of the DPCCH associated with the use of compressed mode are described in sub clause 5.1.2.3. The relative transmit power offset between DPCCH and DPDCHs is determined by the network and signalled to the UE using higher layer signalling.

Any change in the uplink DPCCH transmit power shall take place immediately before the start of the pilot field on the DPCCH. The change in power with respect to its previous value is denoted by Δ_{DPCCH} (in dB). The previous value shall be that used in the previous slot except in the event of an interruption in transmission due to the use of compressed mode when the previous value shall be that used in the last slot before the transmission gap.

During the operation of the uplink power control procedure UE transmit power shall be within the allowed range and shall not exceed the maximum allowed transmission power of the terminal power class or any lower limit which may be set by higher layer signalling.

5.1.2.2 Ordinary transmit power control

5.1.2.2.1 General

The initial uplink transmit power is set by higher layers.

~~By means of higher layer signalling, a maximum transmission power for uplink inner-loop power control may be set to a lower value than what the terminal power class is capable of. Power control shallbe performed within the allowed range.~~

The uplink inner-loop power control adjusts the UE transmit power in order to keep the received uplink signal-to-interference ratio (SIR) at a given SIR target, SIR_{target}.

The serving cells (cells in the active set) should estimate signal-to-interference ratio SIR_{est} of the received uplink DPCH.~~ .~~The serving cells should then generate~~s~~ TPC commands and transmit~~s~~ the commands once per slot according to the following rule: if $SIR_{est} > SIR_{target}$ then the TPC command to transmit is "0", while if $SIR_{est} < SIR_{target}$ then the TPC command to transmit is "1".

Upon reception of one or more TPC commands in a slot, the UE shall derive~~s~~ a single TPC command, TPC_cmd, for each slot, combining multiple TPC commands if more than one is received in a slot. Two algorithms shall be supported by the UE for deriving a TPC_cmd, as described in subclauses 5.1.2.2.2 and 5.1.2.2.3. Which of these two algorithms is used is an UE-specific parameter and is under the control of the UTRAN.

The step size Δ_{TPC} is a UE specific parameter, under the control of the UTRAN that can have the values 1 dB or 2 dB.

After deriving of the combined TPC command TPC_cmd using one of the two supported algorithms, the UE -shall adjust the transmit power of the uplink DPCCH~~dedicated physical channels~~ with a step of Δ_{DPCCH}~~TPC~~ (in dB) which is given by:

$$\Delta_{DPCCH} = \Delta_{TPC} \times TPC\_cmd$$

~~according to the TPC command. If TPC_cmd equals 1 then the transmit power of the uplink DPCCH and uplink DPDCHs shall be increased by Δ_{TPC} dB. If TPC_cmd equals -1 then the transmit power of the uplink DPCCH and uplink DPDCHs shall be decreased by Δ_{TPC} dB. If TPC_cmd equals 0 then the transmit power of the uplink DPCCH and uplink DPDCHs shall be unchanged.~~

~~Any power increase or decrease shall take place immediately before the start of the pilot field on the DPCCH.~~

5.1.2.2.1.1 Out of synchronisation handling

The UE shall monitor the active link, or links in case of soft handover, to determine if the link is out-of-synchronisation or not. Depending on the situation the UE may use for example CPICH or pilot symbol patterns or combination there off to determine the link synchronisation status.

If N_out_synch_frames_1 frames that have passed have been found to be out-of-synchronisation for all links, the UE shall turn off uplink transmission. The value for N_out_synch_frames_1 is given by the higher layers.

If N_out_synch_frames_2 is detected to be out-of-synchronisation, the UE shall maintain the the value of TPC_cmd as zero ~~output power level, controlled by inner loop power control, constant~~ while out-of-synchronisation state lasts or until N_out_synch_frames_1 reached when the transmission shall be turned off. The TPC command sent in the uplink shall be set as "1" during the period of out-of-synchronisation.

5.1.2.2.2 Algorithm 1 for processing TPC commands

5.1.2.2.2.1 Derivation of TPC_cmd when only one TPC command is received in each slot

When a UE is not in soft handover, only one TPC command will be received in each slot. In this case, the value of TPC_cmd is derived as follows:

- If the received TPC command is equal to 0 then TPC_cmd for that slot is –1.
- If the received TPC command is equal to 1, then TPC_cmd for that slot is 1.

5.1.2.2.2.2 Combining of TPC commands known to be the same

When a UE is in soft handover, multiple TPC commands may be received in each slot from different cells in the active set. In some cases, the UE has the knowledge that some of the transmitted TPC commands in a slot are the same. This is the case e.g. with receiver diversity or so called softer handover when the UTRAN transmits the same command in all the serving cells the UE is in softer handover with. For these cases, the TPC commands known to be the same shall beare combined into one TPC command, to be further combined with other TPC commands as described in subclause 5.1.2.2.2.3.

5.1.2.2.2.3 Combining of TPC commands not known to be the same

In general in case of soft handover, the TPC commands transmitted in the same slot in the different cells may be different.

This subclause describes the general scheme for combination of the TPC commands not known to be the same and then provides an example of such a scheme. It is to be further decided what should be subject to detailed standardisation, depending on final requirements. The example might be considered as the scheme from which minimum requirement will be derived or may become the mandatory algorithm.

5.1.2.2.2.3.1 General scheme

First, the UE shall conduct a soft symbol decision on each of the power control commands TPC_i, where i = 1, 2, …, N and N is the number of TPC commands not known to be the same, that may be the result of a first phase of combination according to subclause 5.1.2.2.2.2.

Then the UE assigns to each of the TPC_i command a reliability figure W_i, where W_i is the soft symbol decision obtained above. Finally, the UE derives a combined TPC command, TPC_cmd, as a function γ of all the N power control commands TPC_i and reliability estimates W_i:

TPC_cmd = γ (W_1, W_2, … W_N, TPC_1, TPC_2, …, TPC_N), where TPC_cmd can take the values 1 or -1.

5.1.2.2.3 Algorithm 2 for processing TPC commands

NOTE: Algorithm 2 makes it possible to emulate smaller step sizes than the minimum power control step specified in section 5.1.2.2.1, or to turn off uplink power control by transmitting an alternating series of TPC commands.

5.1.2.2.3.1 Derivation of TPC_cmd when only one TPC command is received in each slot

When a UE is not in soft handover, only one TPC command will be received in each slot. In this case, the UE shall process received TPC commands on a 5-slot cycle, where the sets of 5 slots shall be aligned to the frame boundaries and there shall be no overlap between each set of 5 slots.

The value of TPC_cmd is derived as follows:

- For the first 4 slots of a set, TPC_cmd = 0.
- For the fifth slot of a set, the UE uses hard decisions on each of the 5 received TPC commands as follows:
- If all 5 hard decisions within a set are 1 then TPC_cmd = 1 in the 5^{th} slot.
  - If all 5 hard decisions within a set are 0 then TPC_cmd = -1 in the 5^{th} slot.
  - Otherwise, TPC_cmd = 0 in the 5^{th} slot.

5.1.2.2.3.2 Combining of TPC commands known to be the same

When a UE is in soft handover, multiple TPC commands may be received in each slot from different cells in the active set. In some cases, the UE has the knowledge that some of the transmitted TPC commands in a slot are the same. This is the case e.g. with receiver diversity or so called softer handover when the UTRAN transmits the same command in all the serving cells the UE is in softer handover with. For these cases, the TPC commands known to be the same are combined into one TPC command, to be processed and further combined with any other TPC commands as described in subclause 5.1.2.2.3.3.

5.1.2.2.3.3 Combining of TPC commands not known to be the same

In general in case of soft handover, the TPC commands transmitted in the same slot in the different cells may be different.

This subclause describes the general scheme for combination of the TPC commands not known to be the same and then provides an example of such scheme. It is to be further decided what should be subject to detailed standardisation, depending on final requirements. The example might be considered as the scheme from which minimum requirement will be derived or may become the mandatory algorithm.

5.1.2.2.3.3.1 General scheme

The UE shall make a hard decision on the value of each TPC_i, where i = 1, 2, …, N and N is the number of TPC commands not known to be the same, that may be the result of a first phase of combination according to subclause 5.1.2.2.3.2..

The UE shall follow this procedure for 3 consecutive slots, resulting in N hard decisions for each of the 3 slots.

The sets of 3 slots shall be aligned to the frame boundaries and there shall be no overlap between each set of 3 slots.

The value of TPC_cmd is zero for the first 2 slots. After 3 slots have elapsed, the UE shall determine the value of TPC_cmd for the third slot in the following way:

The UE first determines one temporary TPC command, TPC_temp_i, for each of the N sets of 3 TPC commands as follows:

- If all 3 hard decisions within a set are "1", $TPC\_temp_i = 1$
- If all 3 hard decisions within a set are "0", $TPC\_temp_i = -1$
- Otherwise, $TPC\_temp_i = 0$

Finally, the UE derives a combined TPC command for the third slot, TPC_cmd, as a function γ of all the N temporary power control commands TPC_temp_i:

$TPC\_cmd(3^{rd}\ slot) = \gamma\ (TPC\_temp_1, TPC\_temp_2, \ldots, TPC\_temp_N)$, where $TPC\_cmd(3^{rd}$ slot) can take the values 1, 0 or –1.

5.1.2.2.3.3.2 Example of the scheme

A particular example of the scheme is obtained when using the following definition of the function γ:

TPC_cmd is set to 1 if $\frac{1}{N}\sum_{i=1}^{N} TPC\_temp_i > 0.5$.

TPC_cmd is set to -1 if $\frac{1}{N}\sum_{i=1}^{N} TPC\_temp_i < -0.5$.

Otherwise, TPC_cmd is set to 0.

5.1.2.3 Transmit power control in compressed mode

The aim of uplink power control in downlink or/and uplink compressed mode is to recover as fast as possible a signal-to-interference ratio (SIR) close to the target SIR after each transmission gap.

In downlink compressed mode, ~~no power control is applied~~ TPC_cmd is zero during transmission gaps, since no downlink TPC commands are~~is~~ sent. ~~Thus, the transmit powers of the uplink DPDCH(s) and DPCCH are not changed during the transmission gaps.~~

In simultaneous downlink and uplink compressed mode, the transmission of uplink DPDCH(s) and DPCCH shall be ~~is~~ stopped during transmission gaps.

In compressed mode the uplink DPCCH may have a different number of pilot bits per slot in a compressed frame (i.e. one containing a transmission gap) compared with a normal frame. A change in the transmit power of the uplink DPCCH would be needed in order to compensate for the change in the total pilot energy. Therefore at the start of each slot the UE shall derive the value of a power offset Δ_{PILOT}. If the number of pilot bits per slot is different from its value in the most recently transmitted slot $\Delta_{PILOT} = 10\text{Log}_{10}(N_{pilot,prev}/N_{pilot,curr})$ (dB), where $N_{pilot,prev}$ is the previous number of pilot bits per slot , and $N_{pilot,curr}$ is the current number of pilot bits per slot. Otherwise Δ_{PILOT} is zero.

~~The initial transmit power of each uplink DPDCH and DPCCH after the transmission gap is equal to the power before the gap, but with an offset~~ The UE shall derive a power offset Δ_{RESUME} for use in the first slot after a transmission gap. The value of Δ_{RESUME} (in dB) shall be~~is~~ determined according to the Power Resume Mode (PRM). The PRM is a UE specific parameter, which is signalled by the network with the other parameters of the downlink compressed mode (see TS 25.215). The different modes are summarised in table 1.

Table 1: Power control resume modes during compressed mode

Power Resume Mode	Description
0	$\Delta_{RESUME} = 0$
1	$\Delta_{RESUME} = \text{Int}[d_{last} / \Delta_{TPCmin}]\ \Delta_{TPCmin}$

Here Int[ ] means round to the nearest integer and Δ_{TPCmin} is the minimum power control step size supported by the UE. δ_{last} is the power offset computed at the last slot before the transmission gap according to the following recursive relations, which are, executed every slot during uplink transmission:

$$d_{last} = 0.9375 d_{previous} - 0.96875 TPC\_cmd_{last} \Delta_{TPC}$$
$$d_{previous} = d_{last}$$

TPC_cmd is the power control command executed by the UE in the last slot before the transmission gap. $\delta_{previous}$ is the power offset computed for the previous slot. The value of $\delta_{previous}$ shall be initialised to zero when a DCH is activated, or during the first slot after a transmission gap.

At the start of the first slot after a transmission gap UE shall apply a change in the transmit power of the uplink DPCCH by an amount Δ_{DPCCH} (in dB), with respect to the DPCCH power in the slot before the gap, where

$$\Delta_{DPCCH} = \Delta_{PILOT} + \Delta_{RESUME}$$

After each transmission gap, 2 modes are possible for the power control algorithm. The power control mode (PCM) is fixed and signalled with the other parameters of the downlink compressed mode (see TS 25.215). The different modes are summarised in the table 2:

Table 2: Power control modes during compressed mode

Mode	Description
0	Ordinary transmit power control (see subclause 5.1.2.2) is applied with step size Δ_{TPC}
1	Ordinary transmit power control is applied using algorithm 1 (see subclause 5.1.2.2.2) with step size Δ_{RP-TPC} during RPL slots after each transmission gap.

For mode 0, the step size is not changed and the ordinary transmit power control is ~~still~~ applied ~~during compressed mode~~ (see subclause 5.1.2.2), using the same algorithm for processing TPC commands as in normal mode (see section 5.1.2.2.2 and 5.1.2.2.3)~~.~~and the change in uplink DPCCH transmit power (except for the first slot after the transmission gap) is given by

$$\Delta_{DPCCH} = \Delta_{TPC} \times TPC\_cmd + \Delta_{PILOT}$$

For mode 1, during RPL slots after each transmission gap, called the recovery period, power control algorithm 1 is applied with a step size Δ_{RP-TPC} instead of Δ_{TPC}, and the change in uplink DPCCH transmit power (except for the first slot after the transmission gap) is given by.

$$\Delta_{DPCCH} = \Delta_{RP-TPC} \times TPC\_cmd + \Delta_{PILOT}$$

Δ_{RP-TPC} is called recovery power control step size and is expressed in dB. If algorithm 1 (section 5.1.2.2.2) is used in ordinary transmit power control normal mode, Δ_{RP-TPC} is equal to the minimum value of 3 dB and $2\Delta_{TPC}$. If algorithm 2 (section 5.1.2.2.3) is used in ordinary transmit power control in normal mode, Δ_{RP-TPC} is equal to 1 dB.

RPL is called recovery period length and is expressed in number of slots. RPL is fixed and equal to the minimum value of TGL and 7 slots.

After the recovery period, ordinary transmit power control resumes using the same algorithm and step size as used in normal mode before the transmission gap .and the change in uplink DPCCH transmit power is given by:-

$$\Delta_{DPCCH} = \Delta_{TPC} \times TPC\_cmd + \Delta_{PILOT}$$

If algorithm 2 (section 5.1.2.2.3) is being used in ordinary transmit power control normal mode, the sets of slots over which the TPC commands are processed (in section 5.1.2.2.2.3.1) shall remain aligned to the frame boundaries in the compressed frame. In both mode 0 or mode 1, if the transmission gap or the recovery period results in any incomplete sets of TPC commands, no TPC_temp_i command will be determined for those sets of slots which are incomplete, and TPC_cmd, shall be zero and there will be no change in transmit power level for those sets of slots.

During compressed mode and the recovery period after compressed mode, regardless of the offset Δ_{RESUME} and the step size Δ_{RP-TPC}, the UE transmit power shall not exceed the maximum allowed transmission power set by higher layer signalling.

5.1.2.4 Transmit power control in DPCCH power control preamble

A power control preamble may be used for initialisation of a DCH. Both the UL and DL DPCCHs shall be transmitted during the uplink power control preamble. The UL DPDCH shall not commence before the end of the power control preamble.

The length of the power control preamble is a UE-specific parameter signalled by the network, and can take the values 0 slots or 8 slots.

The inner power control loop acts on the UL DPCCH during the preamble in the same way as described in section 5.1.2.2.1.

The details of power control used during the power control preamble differ from that used afterwards After the first slot of the power control preamble the initial change in uplink DPCCH transmit power is given by

$$\Delta_{DPCCH} = \Delta_{TPC-init} \times TPC\_cmd$$

control step size used in the power control preamble differs from that used after the preamble in the following way. TPC_cmd is derived according to algorithm 1 as described in sub clause 5.1.2.2.1, regardless of the algorithm to be used in ordinary power control after the preamble.

If algorithm 1 is to be used after the preamble to calculate the value of TPC_cmd, then the initial step size in the power control preamble is $\Delta_{TPC-init}$, where $\Delta_{TPC-init}$ is equal to the minimum value out of 3 dB and $2\Delta_{TPC}$. If algorithm 2 is to be used after the preamble to calculate the value of TPC_cmd, then initially in the power control preamble algorithm 1 is used with a step size $\Delta_{TPC-init}$ isof 2dB. In either case, the power control algorithm and step size revert to those used for the main part of the transmission as soon as the sign of TPC_cmd reverses for the first time, or at the end of the power control preamble if the power control preamble ends first.

5.1.2.5 Setting of the uplink DPCCH/DPDCH power difference

5.1.2.5.1 General

The uplink DPCCH and DPDCH(s) are transmitted on different codes as defined in section 4.2.1 of TS 25.213. The gain factors β_c and β_d may vary for each TFC. There are two ways of controlling the gain factors of the DPCCH code and the DPDCH codes for different TFCs in normal (non-compressed) frames:

- b_c and b_d are signalled for the TFC, or
- b_c and b_d is computed for the TFC, based on the signalled settings for a reference TFC.

Combinations of the two above methods may be used to associate b_c and b_d values to all TFCs in the TFCS. The two methods are described in sections 5.1.2.4.2 and 5.1.2.4.3 respectively. Several reference TFCs may be signalled from higher layers.

The gain factors may vary on radio frame basis depending on the current TFC used. Further, the setting of gain factors is independent of the inner loop power control. ~~This means that at the start of a frame, the gain factors are determined and the inner loop power control step is applied on top of that.~~

~~Appropriate scaling~~ of the The UE shall scale the ~~output~~ total transmit power of the DPCCH and DPDCH(s) ~~shall be performed by the UE~~, sucho that the ~~output~~ DPCCH output power follows the changes required by the ~~inner loop~~ power control procedure.with power adjustmentssteps of Δ_{DPCCH} ~~$\pm\Delta_{TPC}$~~ dB, unless this would result in a . UE transmit power outside the allowed range. In this case the UE shall scale the total transmit power so that it is equal to the maximum or minimum allowed power, whichever limit is nearer.

The gain factors during compressed frames are based on the gain factors defined in normal frames, as specified in 5.1.2.5.4.

5.1.2.5.2 Signalled gain factors

When the gain factors b_c and b_d are signalled by higher layers for a certain TFC, the signalled values are used directly for weighting of DPCCH and DPDCH(s).

5.1.2.5.3 Computed gain factors

The gain factors b_c and b_d may also be computed for certain TFCs, based on the signalled settings for a reference TFC.

Let $b_{c,ref}$ and $b_{d,ref}$ denote the signalled gain factors for the reference TFC. Further, let $b_{c,j}$ and $b_{d,j}$ denote the gain factors used for the j:th TFC. Also let L_{ref} denote the number of DPDCHs used for the reference TFC and L_j denote the number of DPDCHs used for the j:th TFC.

Define the variable

$$K_{ref} = \sum_i RM_i \cdot N_i \ ,$$

where RM_i is the semi-static rate matching attribute for transport channel i (defined in TS 25.212 section 4.2.7), N_i is the number of bits output from the radio frame segmentation block for transport channel i (defined in TS 25.212 section 4.2.6.1), and the sum is taken over all the transport channels i in the reference TFC.

Similarly, define the variable

$$K_j = \sum_i RM_i \cdot N_i \ ,$$

where the sum is taken over all the transport channels i in the j:th TFC.

The variable A_j is then computed as:

$$A_j = \frac{b_{d,ref}}{b_{c,ref}} \cdot \sqrt{\frac{L_{ref}}{L_j}} \sqrt{\frac{K_j}{K_{ref}}} .$$

The gain factors for the *j*:th TFC are then computed as follows:

If $A_j > 1$, then $b_{d,j} = 1.0$ and $b_{c,j} = \lfloor 1/A_j \rfloor$, where $\lfloor \bullet \rfloor$ means rounding to closest lower quantized β–value. Since $b_{c,j}$ may not be set to zero, if the above rounding results in a zero value, $b_{c,j}$ shall be set to the lowest quantized amplitude ratio of 0.0667 as specified in TS 25.213.

If $A_j \leq 1$, then $b_{d,j} = \lceil A_j \rceil$ and $b_{c,j} = 1.0$, where $\lceil \bullet \rceil$ means rounding to closest higher quantized β-value.

The quantized β-values is defined in TS 25.213 section 4.2.1, table 1.

5.1.2.5.4 Setting of the uplink DPCCH/DPDCH power difference in compressed mode

The gain factors used during a compressed frame for a certain TFC are calculated from the gain factors used in normal (non-compressed) frames for that TFC. Let $b_{c,j}$ and $b_{d,j}$ denote the gain factors for the *j*:th TFC in a normal frame. Further, let $b_{c,C,j}$ and $b_{d,C,j}$ denote the gain factors used for the *j*:th TFC when the frame is compressed. The variable $A_{C,j}$ is computed as:

$$A_{C,j} = \frac{b_{d,j}}{b_{c,j}} \cdot \sqrt{\frac{15 \cdot N_{pilot,C}}{N_{slots,C} \cdot N_{pilot,N}}} ,$$

where $N_{pilot,C}$ is the number of pilot bits per slot when in compressed mode, and $N_{pilot,N}$ is the number of pilot bits per slot in normal mode. $N_{slots,C}$ is the number of slots in the compressed frame used for transmitting the data.

The gain factors for the *j*:th TFC in a compressed frame are computed as follows:

If $A_{C,j} > 1$, then $b_{d,C,j} = 1.0$ and $b_{c,C,j} = \lfloor 1/A_{C,j} \rfloor$, where $\lfloor \bullet \rfloor$ means rounding to closest lower quantized β–value. Since $b_{c,j}$ may not be set to zero, if the above rounding results in a zero value, $b_{c,j}$ shall be set to the lowest quantized amplitude ratio of 0.0667 as specified in TS 25.213.

If $A_{C,j} \leq 1$, then $b_{d,C,j} = \lceil A_{C,j} \rceil$ and $b_{c,C,j} = 1.0$, where $\lceil \bullet \rceil$ means rounding to closest higher quantized β-value.

The quantized β-values is defined in TS 25.213 section 4.2.1, table 1.

~~Appropriate scaling of the output power shall be performed by the UE, so that the output DPCCH power follows the inner loop power control with power steps of $\pm\Delta_{TPC}$ dB ($\pm\Delta_{RP-TPC}$ dB during the recovery period) with an additional power offset during a compressed frame of $N_{pilot,N} / N_{pilot,C}$.~~

5.1.3 PCPCH

This section describes the power control procedures for the PCPCH. The CPCH access procedure is described in section 6.2.

5.1.3.1 Power control in the message part

The uplink inner-loop power control adjusts the UE transmit power in order to keep the received uplink signal-to-interference ratio (SIR) at a given SIR target, SIR_{target}, which is set by the higher layer outer loop.

The network should estimate the signal-to-interference ratio SIR_{est} of the received PCPCH . The network then generates TPC commands and transmits the commands once per slot according to the following rule: if $SIR_{est} > SIR_{target}$ then the TPC command to transmit is "0", while if $SIR_{est} < SIR_{target}$ then the TPC command to transmit is "1".

The UE derives a TPC command, TPC_cmd, for each slot. Two algorithms shall be supported by the UE for deriving a TPC_cmd, as described in subclauses 5.1.2.2.2.1 and 5.1.2.2.3.1. Which of these two algorithms is used is a higher-layer parameter under the control of the UTRAN.

The step size Δ_{TPC} is a higher-layer parameter under the control of the UTRAN, that can have the values 1 dB or 2 dB.

After deriving the TPC command TPC_cmd using one of the two supported algorithms, the UE shall adjust the transmit power of the uplink PCPCH with a step of Δ_{TPC} dB according to the TPC command. If TPC_cmd equals 1 then the transmit power of the uplink PCPCH shall be increased by Δ_{TPC} dB. If TPC_cmd equals -1 then the transmit power of the uplink PCPCH shall be decreased by Δ_{TPC} dB. If TPC_cmd equals 0 then the transmit power of the uplink PCPCH shall be unchanged.

Any power increase or decrease shall take place immediately before the start of the pilot field on the PCPCH control channel.

5.1.3.2 Power control in the power control preamble

The UE commences the power control preamble using the same power level as was used for the CD preamble.

The initial power control step size used in the power control preamble differs from that used in the message part: if inner loop power control algorithm 1 is to be used in the message part, then the initial step size in the power control preamble is $\Delta_{TPC-init}$, where $\Delta_{TPC-init}$ is equal to the minimum value out of 3 dB and $2\Delta_{TPC}$, where Δ_{TPC} is the power control step size used for the message part. If inner loop power control algorithm 2 is to be used in the message part, then inner loop power control algorithm 1 is used initially in the power control preamble, with a step size of 2dB. In either case, the power control algorithm and step size revert to those used for the message part as soon as the sign of the TPC commands reverses for the first time.