3GPP TSG-RAN WG1 Meeting 19th
Las Vegas, U.S.A, Feb 27 – Mar 2, 2001

Tdoc R1-01-0267

Agenda item: **REL-4 CRs**

Source: **Samsung and Nokia**

Title: **TS 25.214 CR, Addition of power control during gated DPCCH transmission to TS 25.214**

Document for: **Approval**

Introduction

This contribution introduces the CR for addition of power control during gated DPCCH transmission to TS 25.214 which is based on TR 25.840 "Terminal Power Saving Features" v2.2.0 (R1-01-0296).

Summary of Changes

In section 5.1.2.1 of current TS 25.214, it is defined that the previous value of DPCCH power shall be that used in the last slot before the transmission gap when the compressed mode is activated. Similarly, gated DPCCH transmission is added as another case that requires different definition of previous value of DPCCH power as follows:

- When gated DPCCH transmission is used, the previous value shall be that used in the last slot transmitted.

Secondly, the uplink power control of gated DPCCH transmission is explained in new section 5.1.2.7.

Thirdly, new section 5.2.1.5 describes the downlink power control of gated DPCCH transmission.

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CHANGE REQUEST

✍	**25.214**	**CR**	**CR-0152**	✍ rev	**-**	✍ Current version:	**3.5.0** ✍

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Proposed change affects: ✍ (U)SIM [ ] ME/UE [X] Radio Access Network [X] Core Network [ ]

Title: ✍	Addition of power control during gated DPCCH transmission to TS 25.214		
Source: ✍	Samsung and Nokia		
Work item code: ✍	RlnImp-TPS	***Date:*** ✍	March 2, 2001
Category: ✍	**B**	***Release:*** ✍	REL-4
	Use one of the following categories: ***F*** *(essential correction)* ***A*** *(corresponds to a correction in an earlier release)* ***B*** *(Addition of feature),* ***C*** *(Functional modification of feature)* ***D*** *(Editorial modification)* Detailed explanations of the above categories can be found in 3GPP TR 21.900.		*Use one of the following releases:* *2 (GSM Phase 2)* *R96 (Release 1996)* *R97 (Release 1997)* *R98 (Release 1998)* *R99 (Release 1999)* *REL-4 (Release 4)* *REL-5 (Release 5)*

Reason for change: ✍	Addition of power control during gated DPCCH transmission in order to include gated DPCCH transmission in REL-4 specification.
Summary of change: ✍	- In section 5.1.2.1, gating is added as another case that uses different definition of previous value of DPCCH power similar to that of compressed mode. - The explanation of uplink power control of gating is added in new section 5.1.2.7. - The explanation of downlink power control of gating is added in new section 5.2.1.5.
Consequences if not approved: ✍	Results in degradation of power control when gated DPCCH transmission is used.

Clauses affected: ✍	5.1.2.1, 5.1.2.7 (new section), 5.2.1.5 (new section)	
Other specs Affected: ✍	[ ] Other core specifications [ ] Test specifications [ ] O&M Specifications	✍
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 subclause.

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, subclause 5.1.2.5 applies also for the RACH message part, with the differences that:

- $?_c$ is the gain factor for the control part (similar to DPCCH);
- $?_d$ 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 the uplink transmit power control procedure simultaneously controls 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 subclause 5.1.2.5 using the gain factors signalled to the UE using higher layer signalling.

The operation of the inner power control loop, described in sub clause 5.1.2.2, adjusts the power of the DPCCH and DPDCHs by 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.

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 DPCCH power with respect to its previous value is derived by the UE and is denoted by $?_{DPCCH}$ (in dB). The previous value of DPCCH power shall be that used in the previous slot, except in the event of an interruption in transmission due to the use of compressed mode and due to the use of gated DPCCH transmission. When compressed mode is used, ~~when~~ the previous value shall be that used in the last slot before the transmission gap. When gated DPCCH transmission is used, the previous value shall be that used in the last slot transmitted.

During the operation of the uplink power control procedure the UE transmit power shall not exceed a maximum allowed value which is the lower out of the maximum output power of the terminal power class and a value which may be set by higher layer signalling.

Uplink power control shall be performed while the UE transmit power is below the maximum allowed output power.

The provisions for power control at the maximum allowed value and below the required minimum output power (as defined in [7]) are described in sub-clause 5.1.2.6.

5.1.2.2 Ordinary transmit power control

5.1.2.2.1 General

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 TPC commands and transmit 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 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. Which of these two algorithms is used is determined by a UE-specific higher-layer parameter, "PowerControlAlgorithm", and is under the control of the UTRAN. If "PowerControlAlgorithm" indicates "algorithm1", then the layer 1 parameter PCA shall take the value 1 and if "PowerControlAlgorithm" indicates "algorithm2" then PCA shall take the value 2.

If PCA has the value 1, Algorithm 1, described in subclause 5.1.2.2.2, shall be used for processing TPC commands.

If PCA has the value 2, Algorithm 2, described in subclause 5.1.2.2.3, shall be used for processing TPC commands.

The step size $?_{TPC}$ is a layer 1 parameter which is derived from the UE-specific higher-layer parameter "TPC-StepSize" which is under the control of the UTRAN. If "TPC-StepSize" has the value "dB1", then the layer 1 parameter $?_{TPC}$ shall take the value 1 dB and if "TPC-StepSize" has the value "dB2", then $?_{TPC}$ shall take the value 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 with a step of $?_{DPCCH}$ (in dB) which is given by:

$?_{DPCCH} = ?_{TPC} ? TPC\_cmd$.

5.1.2.2.1.1 Out of synchronisation handling

After 160 ms after physical channel establishment (defined in [5]), the UE shall control its transmitter according to a downlink DPCCH quality criterion as follows:

- The UE shall shut its transmitter off when the UE estimates the DPCCH quality over the last 160 ms period to be worse than a threshold Q_{out}. Q_{out} is defined implicitly by the relevant tests in [7].

- The UE can turn its transmitter on again when the UE estimates the DPCCH quality over the last 160 ms period to be better than a threshold Q_{in}. Q_{in} is defined implicitly by the relevant tests in [7]. When transmission is resumed, the power of the DPCCH shall be the same as when the UE transmitter was shut off.

5.1.2.2.1.2 TPC command generation on downlink during RL initialisation

When commanded by higher layers the TPC commands sent on a downlink radio link from Node Bs that have not yet achieved uplink synchronisation shall follow a pattern as follows:

If higher layers indicate by "First RLS indicator" that the radio link is part of the first radio link set sent to the UE

- a value 'n' is obtained from the parameter "DL TPC pattern 01 count" passed by higher layers,

- the TPC pattern shall consist of n instances of "01" plus one instance of "1",

- the TPC pattern continuously repeat but shall be forcibly re-started at the beginning of each frame where CFN mod 4 = 0.

else

- The TPC pattern shall consist of all "1".

The TPC pattern shall terminate once uplink synchronisation is achieved.

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 shall be 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 from radio links of the same radio link set

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 when the radio links are in the same radio link set. For these cases, the TPC commands fromthe same radio link set shall be 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 from radio links of different radio link sets

This subclause describes the general scheme for combination of the TPC commands from radio links of different radio link sets.

First, the UE shall conduct a soft symbol decision W_i on each of the power control commands TPC_i, where i = 1, 2, …, N, where N is greater than 1 and is the number of TPC commands from radio links of different radio link sets, that may be the result of a first phase of combination according to subclause 5.1.2.2.2.2.

Finally, the UE derives a combined TPC command, TPC_cmd, as a function ? of all the N soft symbol decisions W_i:

- TPC_cmd = ? $(W_1, W_2, \ldots W_N)$, where TPC_cmd can take the values 1 or -1.

The function ? shall fulfil the following criteria:

If the N TPC_i commands are random and uncorrelated, with equal probability of being transmitted as "0" or "1", the probability that the output of ? is equal to 1 shall be greater than or equal to $1/(2^N)$, and the probability that the output of ? is equal to -1 shall be greater than or equal to 0.5. Further, the output of ? shall equal 1 if the TPC commands from all the radio link sets are reliably “1”, and the output of ? shall equal –1 if a TPC command from any of the radio link sets is reliably “0”.

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 subclause 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 shall be 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 from radio links of the same radio link set

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 when the radio links are in the same radio link set. For these cases, the TPC commands from radio links of the same radio link set shall be 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 from radio links of different radio link sets

This subclause describes the general scheme for combination of the TPC commands from radio links of different radio link sets.

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 from radio links of different radio link sets, 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 5 consecutive slots, resulting in N hard decisions for each of the 5 slots.

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 zero for the first 4 slots. After 5 slots have elapsed, the UE shall determine the value of TPC_cmd for the fifth slot in the following way:

The UE first determines one temporary TPC command, TPC_temp_i, for each of the N sets of 5 TPC commands as follows:

- If all 5 hard decisions within a set are "1", TPC_temp_i = 1.
- If all 5 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 fifth slot, TPC_cmd, as a function ? of all the N temporary power control commands TPC_temp_i:

TPC_cmd(5^{th} slot) = ? (TPC_temp_1, TPC_temp_2, …, TPC_temp_N), where TPC_cmd(5^{th} slot) can take the values 1, 0 or –1, and ? is given by the following definition:

- TPC_cmd is set to 1 if $\frac{1}{N} \overset{N}{\underset{i?1}{?}} TPC\_temp_i \; ? \; 0.5$.
- TPC_cmd is set to -1 if $\frac{1}{N} \overset{N}{\underset{i?1}{?}} TPC\_temp_i \; ? \; ?0.5$.

Otherwise, TPC_cmd is set to 0.

5.1.2.3 Transmit power control in compressed mode

In compressed mode, some frames are compressed and contain transmission gaps. The uplink power control procedure is as specified in clause 5.1.2.2, using the same UTRAN supplied parameters for Power Control Algorithm and step size ($?_{TPC}$), but with additional features which aim to recover as rapidly as possible a signal-to-interference ratio (SIR) close to the target SIR after each transmission gap.

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 TPC commands and transmit the commands once per slot, except during downlink transmission gaps, according to the following rule: if $SIR_{est} > SIR_{cm\_target}$ then the TPC command to transmit is "0", while if $SIR_{est} < SIR_{cm\_target}$ then the TPC command to transmit is "1".

SIR_{cm_target} is the target SIR during compressed mode and fulfils

$SIR_{cm\_target} = SIR_{target} + ?_{PILOT} + ?SIR1\_coding + ?SIR2\_coding$,

where ? SIR1_coding and ? SIR2_coding are computed from uplink parameters DeltaSIR1, DeltaSIR2, DeltaSIRafter1, DeltaSIRafter2 signaled by higher layers as:

- ? SIR1_coding = DeltaSIR1 if the start of the first transmission gap in the transmission gap pattern is within the current uplink frame.
- ? SIR1_coding = DeltaSIRafter1 if the current uplink frame just follows a frame containing the start of the first transmission gap in the transmission gap pattern.
- ? SIR2_coding = DeltaSIR2 if the start of the second transmission gap in the transmission gap pattern is within the current uplink frame.
- ? SIR2_coding = DeltaSIRafter2 if the current uplink frame just follows a frame containing the start of the second transmission gap in the transmission gap pattern.
- ? SIR1_coding = 0 dB and ? SIR2_coding = 0 dB in all other cases.

And $?_{PILOT}$ is defined below.

In case several compressed mode patterns are used simultaneously, ? SIR1_coding and ? SIR2_coding offsets are computed for each compressed mode pattern and all ? SIR1_coding and ? SIR2_coding offsets are summed together.

In compressed mode, compressed frames may occur in either the uplink or the downlink or both. In uplink compressed frames, the transmission of uplink DPDCH(s) and DPCCH shall both be stopped during transmission gaps.

Due to the transmission gaps in compressed frames, there may be missing TPC commands in the downlink. If no downlink TPC command is transmitted, the corresponding TPC_cmd derived by the UE shall be set to zero.

Compressed and non-compressed frames in the uplink DPCCH may have a different number of pilot bits per slot. 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 $?_{PILOT}$. If the number of pilot bits per slot in the uplink DPCCH is different from its value in the most recently transmitted slot, $?_{PILOT}$ (in dB) shall be given by:

$$?_{PILOT} = 10Log_{10} (N_{pilot,prev}/N_{pilot,curr});$$

where $N_{pilot,prev}$ is the number of pilot bits in the most recently transmitted slot , and $N_{pilot,curr}$ is the number of pilot bits in the current slot. Otherwise, including during transmission gaps in the downlink, $?_{PILOT}$ shall be zero.

Unless otherwise specified, in every slot during compressed mode the UE shall adjust the transmit power of the uplink DPCCH with a step of $?_{DPCCH}$ (in dB) which is given by:

?

$$?_{DPCCH} = ?_{TPC} ? TPC\_cmd + ?_{PILOT.}$$

At the start of the first slot after an uplink or downlink transmission gap the UE shall apply a change in the transmit power of the uplink DPCCH by an amount $?_{DPCCH}$ (in dB), with respect to the uplink DPCCH power in the most recently transmitted uplink slot, where:

?

$$?_{DPCCH} = ?_{RESUME} + ?_{PILOT.}$$

The value of $?_{RESUME}$ (in dB) shall be determined by the UE according to the Initial Transmit Power mode (ITP). The ITP is a UE specific parameter, which is signalled by the network with the other compressed mode parameters (see [4]). The different modes are summarised in table 1.

Table 1: Initial Transmit Power modes during compressed mode

Initial Transmit Power mode	Description
0	$?_{RESUME} = ?_{TPC} ? TPC\_cmd_{gap}$
1	$?_{RESUME} = ?_{last}$

In the case of a transmission gap in the uplink, TPC_cmd_{gap} shall be the value of TPC_cmd derived in the first slot of the uplink transmission gap, if a downlink TPC_command is transmitted in that slot. Otherwise TPC_cmd_{gap} shall be zero.

$?_{last}$ shall be equal to the most recently computed value of $?_i$. $?_i$ shall be updated according to the following recursive relations, which shall be executed in all slots in which both the uplink DPCCH and a downlink TPC command are transmitted, and in the first slot of an uplink transmission gap if a downlink TPC command is transmitted in that slot:

$$?_i \; ? \; 0.9375?_{i?1} \; ? \; 0.96875 TPC\_cmd_i ?_{TPC} k_{sc}$$
$$?_{i?1} \; ? \; ?_i$$

where: TPC_cmd_i is the power control command derived by the UE in that slot;

$k_{sc} = 0$ if additional scaling is applied in the current slot and the previous slot as described in sub-clause 5.1.2.6, and $k_{sc} = 1$ otherwise.

$?_{i-1}$ is the value of $?_i$ computed for the previous slot. The value of $?_{i-1}$ shall be initialised to zero when the uplink DPCCH is activated, and also at the end of the first slot after each uplink transmission gap, and also at the end of the first slot after each downlink transmission gap. The value of $?_i$ shall be set to zero at the end of the first slot after each uplink transmission gap.

After a transmission gap in either the uplink or the downlink, the period following resumption of simultaneous uplink and downlink DPCCH transmission is called a recovery period. RPL is the recovery period length and is expressed as a number of slots. RPL is equal to the minimum value out of the transmission gap length and 7 slots. If a transmission gap is scheduled to start before RPL slots have elapsed, then the recovery period shall end at the start of the gap, and the value of RPL shall be reduced accordingly.

During the recovery period, 2 modes are possible for the power control algorithm. The Recovery Period Power control mode (RPP) is signalled with the other compressed mode parameters (see [4]). The different modes are summarised in the table 2:

Table 2: Recovery Period Power control modes during compressed mode

Recovery Period power control mode	Description
0	Transmit power control is applied using the algorithm determined by the value of PCA, as in subclause 5.1.2.2 with step size $?_{TPC}$.
1	Transmit power control is applied using algorithm 1 (see subclause 5.1.2.2.2) with step size $?_{RP-TPC}$ during RPL slots after each transmission gap.

For RPP mode 0, the step size is not changed during the recovery period and ordinary transmit power control is applied (see subclause 5.1.2.2), using the algorithm for processing TPC commands determined by the value of PCA (see sub clauses 5.1.2.2.2 and 5.1.2.2.3).

For RPP mode 1, during RPL slots after each transmission gap, power control algorithm 1 is applied with a step size $?_{RP-TPC}$ instead of $?_{TPC}$, regardless of the value of PCA. Therefore, the change in uplink DPCCH transmit power at the start of each of the RPL+1 slots immediately following the transmission gap (except for the first slot after the transmission gap) is given by:

? $$?_{DPCCH} = ?_{RP-TPC} ? \; TPC\_cmd + ?_{PILOT}$$

$?_{RP-TPC}$ is called the recovery power control step size and is expressed in dB. If PCA has the value 1, $?_{RP-TPC}$ is equal to the minimum value of 3 dB and $2?_{TPC}$. If PCA has the value 2 , $?_{RP-TPC}$ is equal to 1 dB.

After the recovery period, ordinary transmit power control resumes using the algorithm specified by the value of PCA and with step size $?_{TPC}$.

If PCA has the value 2 , the sets of slots over which the TPC commands are processed shall remain aligned to the frame boundaries in the compressed frame. For both RPP mode 0 and RPP mode 1, if the transmission gap or the recovery period results in any incomplete sets of TPC commands, TPC_cmd shall be zero for those sets of slots which are incomplete.

5.1.2.4 Transmit power control in DPCCH power control preamble

An UL DPCCH power control preamble is a period of UL DPCCH transmission prior to the start of the uplink DPDCH. The DL DPCCH shall also be transmitted during an uplink power control preamble.

The length of the uplink power control preamble is a higher layer parameter signalled by the network as defined in [5]. The UL DPDCH shall not commence before the end of the power control preamble.

During the uplink power control preamble the change in uplink DPCCH transmit power shall be given by:

? $$?_{DPCCH} = ?_{TPC} \; ? \; TPC\_cmd.$$

During the power control preamble TPC_cmd is derived according to algorithm 1 as described in sub clause 5.1.2.2.1, regardless of the value of PCA.

Ordinary power control (see subclause 5.1.2.2), with the power control algorithm determined by the value of PCA and step size $?_{TPC,}$ shall be used after the end of the uplink power control preamble.

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 subclause 4.2.1 of [3]. The gain factors $?_c$ and $?_d$ 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:

?? $?_c$ and $?_d$ are signalled for the TFC, or

?? $?_c$ and $?_d$ 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 $?_c$ and $?_d$ values to all TFCs in the TFCS. The two methods are described in subclauses 5.1.2.5.2 and 5.1.2.5.3 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.

After applying the gain factors, the UE shall scale the total transmit power of the DPCCH and DPDCH(s), such that the DPCCH output power follows the changes required by the power control procedure with power adjustments of $?_{DPCCH}$ dB, subject to the provisions of sub-clause 5.1.2.6.

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

5.1.2.5.2 Signalled gain factors

When the gain factors $?_c$ and $?_d$ are signalled by higher layers for a certain TFC, the signalled values are used directly for weighting of DPCCH and DPDCH(s). The variable A_j, called the nominal power relation is then computed as:

$$A_j \; ? \; \frac{?_d}{?_c}.$$

5.1.2.5.3 Computed gain factors

The gain factors $?_c$ and $?_d$ may also be computed for certain TFCs, based on the signalled settings for a reference TFC.

Let $?_{c,ref}$ and $?_{d,ref}$ denote the signalled gain factors for the reference TFC. Further, let $?_{c,j}$ and $?_{d,j}$ 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

$$K_{ref} ? \underset{i}{?} RM_i ?N_i ;$$

where RM_i is the semi-static rate matching attribute for transport channel *i* (defined in [2] subclause 4.2.7), N_i is the number of bits output from the radio frame segmentation block for transport channel *i* (defined in [2] subclause 4.2.6.1), and the sum is taken over all the transport channels *i* in the reference TFC.

<u>Similarly, define the variable</u>

$$K_j ? \underset{i}{?} RM_i ?N_i ;$$

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

The variable A_j, called the nominal power relation is then computed as:

$$A_j ? \frac{?_{d,ref}}{?_{c,ref}} ?\sqrt{\frac{L_{ref}}{L_j}}\sqrt{\frac{K_j}{K_{ref}}} .$$

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

- If $A_j > 1$, then $?_{d,j} ? 1.0$ and $?_{c,j}$ is the largest quantized $?$ -value, for which the condition $?_{c,j} ? 1 / A_j$ holds. Since $?_{c,j}$ may not be set to zero, if the above rounding results in a zero value, $?_{c,j}$ shall be set to the lowest quantized amplitude ratio of 1/15 as specified in [3].
- If $A_j ? 1$, then $?_{d,j}$ is the smallest quantized $?$ -value, for which the condition $?_{d,j} ? A_j$ holds and $?_{c,j} ? 1.0$.

The quantized ?-values are defined in [3] subclause 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 nominal power relation used in normal (non-compressed) frames for that TFC. Let A_j denote the nominal power relation for the *j*:th TFC in a normal frame. Further, let $?_{c,C,j}$ and $?_{d,C,j}$ denote the gain factors used for the *j*:th TFC when the frame is compressed. The variable $A_{C,j}$ is computed as:

$$A_{C,j} ? A_j ?\sqrt{\frac{15?N_{pilot,C}}{N_{slots,C} ?N_{pilot,N}}} ;$$

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 $?_{d,C,j} ? 1.0$ and $?_{c,C,j}$ is the largest quantized $?$ -value, for which the condition $?_{c,C,j} ? 1 / A_{C,j}$ holds. Since $?_{c,C,j}$ may not be set to zero, if the above rounding results in a zero value, $?_{c,C,j}$ shall be set to the lowest quantized amplitude ratio of 1/15 as specified in [3].

If $A_{C,j} ? 1$, then $?_{d,C,j}$ is the smallest quantized $?$ -value, for which the condition $?_{d,C,j} ? A_{C,j}$ holds and $?_{c,C,j} ? 1.0$.

The quantized ?-values are defined in [3] subclause 4.2.1, table 1.

5.1.2.6 Maximum and minimum power limits

In the case that the total UE transmit power (after applying DPCCH power adjustments and gain factors) would exceed the maximum allowed value, the UE shall apply additional scaling to the total transmit power so that it is equal to the maximum allowed power. This additional scaling shall be such that the power ratio between DPCCH and DPDCH remains as required by sub-clause 5.1.2.5.

When transmitting on a DPCH the UE is not required to be capable of reducing its total transmit power below the minimum level required in [7]. However, it may do so, provided that the power ratio between DPCCH and DPDCH remains as specified in sub clause 5.1.2.5. Some further regulations also apply as follows: In the case that the total UE transmit power (after applying DPCCH power adjustments and gain factors) would be at or below the total transmit power in the previously transmitted slot and also at or below the required minimum power specified in [7], the UE may apply additional scaling to the total transmit power, subject to the following restrictions:

- The total transmit power after applying any additional scaling shall not exceed the required minimum power, nor the total transmit power in the previously transmitted slot;
- The magnitude of any reduction in total transmit power between slots after applying any additional scaling shall not exceed the magnitude of the calculated power reduction before the additional scaling.

In the case that the total UE transmit power in the previously transmitted slot is at or below the required minimum power specfied in [7] and the DPCCH power adjustment and gain factors for the current slot would result in an increase in total power, then no additional scaling shall be used (i.e. power control shall operate as normal).

If the UE applies any additional scaling to the total transmit power as described above, this scaling shall be included in the computation of any DPCCH power adjustments to be applied in the next transmitted slot.

5.1.2.7 Power Control in Gated DPCCH Transmission

5.1.2.7.1 General

During gating, the change in uplink transmit power shall be given by:

? ?$_{DPCCH}$ = ?$_{TPC}$? TPC_cmd.

During gating, TPC_cmd is derived according to algorithm 1 without explicit signalling, regardless of the power control algorithm used before gating is initiated, with the modification to support gating. The required modification is as follows: UE derives TPC_cmd based on the TPC command(s) received in the switched-on downlink time slot and adjusts its transmission power in the first available switched-on uplink time slot. The change in uplink transmit power shall take place immediately before the start of the pilot field on the uplink DPCCH.

After gating is terminated, UE resumes its original power control algorithm, which had been used before gating was initiated, without explicit signalling.

The uplink power control procedure during gating is described in detail in the following subclauses 5.1.2.7.2 and 5.1.2.7.3.

5.1.2.7.2 Uplink and downlink gated DPCCH transmission

In the case that the gating is enabled for both uplink and downlink, the uplink power control operations are as follows. The serving cells shall generate the TPC commands based on the uplink switched-on time slot that is transmitted with the latest updated transmit power, and shall transmit the new TPC commands on the first available downlink switched-on time slot that is assigned for transmitting updated TPC command. In the case of embedded data period in downlink, the newly generated TPC command is repeatedly transmitted in the downlink switched-on time slots before the next downlink switched-on time slot that is assigned for transmitting updated TPC command.

UE shall adjust the transmit power in the switched-on uplink time slot in response to the latest updated downlink TPC commands. In the case of embedded data period in uplink, the uplink transmit power shall remain constant until the next updated downlink TPC commands are received.

5.1.2.7.3 Downlink only gated DPCCH transmission

In the case that the gating is enabled only for the downlink, then the uplink power control operations are as follows. The serving cells shall generate the TPC commands based on the uplink time slot that is transmitted with the latest updated transmit power, and shall transmit the new TPC commands on the first available downlink switched-on time slot that is assigned for transmitting updated TPC command. In the case of embedded data period in downlink, the newly generated TPC command is repeatedly transmitted in the downlink switched-on time slots before the next downlink switched-on time slot that is assigned for transmitting updated TPC command.

UE shall adjust the transmit power in response to the latest updated downlink TPC commands. And the uplink transmit power shall remain constant until the next updated downlink TPC commands are received.

5.1.3 PCPCH

5.1.3.1 General

The power control during the CPCH access procedure is described in clause 6.2. The inner loop power control for the PCPCH is described in the following sub-clauses.

5.1.3.2 Power control in the message part

The uplink transmit power control procedure simultaneously controls the power of a PCPCH control part and its corresponding PCPCH data part. The relative transmit power offset between the PCPCH control part and the PCPCH data part 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, with the difference that:

- $?_c$ is the gain factor for the PCPCH control part (similar to DPCCH);
- $?_d$ is the gain factor for the PCPCH data part (similar to DPDCH).

The gain factors are applied as shown in sub clause 4.2.3.2 of [3].

The operation of the inner power control loop adjusts the power of the PCPCH control part and PCPCH data part by the same amount, provided there are no changes in gain factors.

Any change in the uplink PCPCH control part transmit power shall take place immediately before the start of the pilot field on the control part of the message part. The change in PCPCH control part power with respect to its value in the previous slot is derived by the UE and is denoted by $?_{PCPCH-CP}$ (in dB).

During the operation of the uplink power control procedure the UE transmit power shall not exceed a maximum allowed value which is the lower out of the maximum output power of the terminal power class and a value which may be set by higher layer signalling.

Uplink power control shall be performed while the UE transmit power is below the maximum allowed output power.

The provisions for power control at the maximum allowed value and below the required minimum output power (as defined in [7]) are described in sub-clause 5.1.2.6.

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 should then generate TPC commands and transmit 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. Which of these two algorithms is used is determined by a higher-layer parameter, "PowerControlAlgorithm", and is under the control of the UTRAN. If "PowerControlAlgorithm" indicates "algorithm1", then the layer 1 parameter PCA shall take the value 1 and if "PowerControlAlgorithm" indicates "algorithm2" then PCA shall take the value 2.

If PCA has the value 1, Algorithm 1, described in subclause 5.1.2.2.2, shall be used for processing TPC commands.

If PCA has the value 2, Algorithm 2, described in subclause 5.1.2.2.3, shall be used for processing TPC commands.

The step size $?_{TPC}$ is a layer 1 parameter which is derived from the higher-layer parameter "TPC-StepSize" which is under the control of the UTRAN. If "TPC-StepSize" has the value "dB1", then the layer 1 parameter $?_{TPC}$ shall take the value 1 dB and if "TPC-StepSize" has the value "dB2", then $?_{TPC}$ shall take the value 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 control part with a step of $?_{PCPCH-CP}$ (in dB) which is given by:

$?_{PCPCH-CP} = ?_{TPC}$? TPC_cmd

5.1.3.3 Power control in the power control preamble

A PCPCH power control preamble is a period when both the UL PCPCH control part and the associated DL DPCCH are transmitted prior to the start of the uplink PCPCH data part.

The length of the power control preamble is a higher layer parameter, $L_{pc-preamble}$ (see section 6.2), and can take the value 0 slots or 8 slots. The uplink PCPCH data part shall not commence before the end of the power control preamble.

If $L_{pc-preamble} > 0$, the details of power control used during the power control preamble differ from the ordinary power control which is used afterwards. After the first slot of the power control preamble the change in uplink PCPCH control part transmit power shall initially be given by:

$?_{PCPCH-CP} = ?_{TPC-init}$? TPC_cmd

If the value of PCA is 1 then $?_{TPC-init}$ is equal to the minimum value out of 3 dB and $2?_{TPC}$.

If the value of PCA is 2 then $?_{TPC-init}$ is equal to 2dB.

TPC_cmd is derived according to algorithm 1 as described in sub clause 5.1.2.2.2, regardless of the value of PCA.

Power control as defined for the message part (see sub-clause 5.1.3.2), with the power control algorithm determined by the value of PCA and step size $?_{TPC,}$ shall be used 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.

5.2 Downlink power control

The transmit power of the downlink channels is determined by the network. In general the ratio of the transmit power between different downlink channels is not specified and may change with time. However, regulations exist as described in the following subclauses.

Higher layer power settings shall be interpreted as setting of the total power, i.e. the sum of the power from the two antennas in case of transmit diversity.

5.2.1 DPCCH/DPDCH

5.2.1.1 General

The downlink transmit power control procedure controls simultaneously the power of a DPCCH and its corresponding DPDCHs. The power control loop adjusts the power of the DPCCH and DPDCHs with the same amount, i.e. the relative power difference between the DPCCH and DPDCHs is not changed.

The relative transmit power offset between DPCCH fields and DPDCHs is determined by the network The TFCI, TPC and pilot fields of the DPCCH are offset relative to the DPDCHs power by PO1, PO2 and PO3 dB respectively. The power offsets may vary in time. The method for controlling the power offsets within UTRAN is specified in [6]

The power of CCC field in DL DPCCH for CPCH is the same as the power of the pilot field.

5.2.1.2 Ordinary transmit power control

5.2.1.2.1 UE behaviour

The UE shall generate TPC commands to control the network transmit power and send them in the TPC field of the uplink DPCCH. An example on how to derive the TPC commands in given in Annex B.2.

The UE shall check the downlink power control mode (DPC_MODE) before generating the TPC command:

- if DPC_MODE = 0 : the UE sends a unique TPC command in each slot and the TPC command generated is transmitted in the first available TPC field in the uplink DPCCH;
- if DPC_MODE = 1 : the UE repeats the same TPC command over 3 slots and the new TPC command is transmitted such that there is a new command at the beginning of the frame.

The DPC_MODE parameter is a UE specific parameter controlled by the UTRAN.

The UE shall not make any assumptions on how the downlink power is set by UTRAN, in order to not prohibit usage of other UTRAN power control algorithms than what is defined in subclause 5.2.1.2.2.

5.2.1.2.2 UTRAN behaviour

Upon receiving the TPC commands UTRAN shall adjust its downlink DPCCH/DPDCH power accordingly. For DPC_MODE = 0, UTRAN shall estimate the transmitted TPC command TPC_{est} to be 0 or 1, and shall update the power every slot. If DPC_MODE = 1, UTRAN shall estimate the transmitted TPC command TPC_{est} over three slots to be 0 or 1, and shall update the power every three slots.

After estimating the k:th TPC command, UTRAN shall adjust the current downlink power $P(k\text{-}1)$ [dB] to a new power $P(k)$ [dB] according to the following formula:

$P(k) = P(k - 1) + P_{TPC}(k) + P_{bal}(k)$,

where $P_{TPC}(k)$ is the k:th power adjustment due to the inner loop power control, and $P_{bal}(k)$ [dB] is a correction according to the downlink power control procedure for balancing radio link powers towards a common reference power. The power balancing procedure and control of the procedure is described in [6], and an example of how $P_{bal}(k)$ can be calculated is given in Annex B.3.

$P_{TPC}(k)$ is calculated according to the following.

If the value of *Limited Power Raise Used* parameter is 'Not used', then

$$P_{TPC}(k) = \begin{cases} +\Delta_{TPC} & \text{if } TPC_{est}(k) = 1 \\ -\Delta_{TPC} & \text{if } TPC_{est}(k) = 0 \end{cases}, \text{ [dB]}. \quad (1)$$

If the value of *Limited Power Raise Used* parameter is 'Used', then the k:th inner loop power adjustment shall be calculated as:

$$P_{TPC}(k) = \begin{cases} +\Delta_{TPC} & \text{if } TPC_{est}(k) = 1 \text{ and } \Delta_{sum}(k) + \Delta_{TPC} < \text{Power\_Raise\_Limit} \\ 0 & \text{if } TPC_{est}(k) = 1 \text{ and } \Delta_{sum}(k) + \Delta_{TPC} \geq \text{Power\_Raise\_Limit} \\ -\Delta_{TPC} & \text{if } TPC_{est}(k) = 0 \end{cases}, \text{ [dB]} \quad (2)$$

where

$$\Delta_{sum}(k) = \sum_{i = k - \text{DL\_Power\_Averaging\_Window\_Size} + 1}^{k-1} P_{TPC}(i)$$

is the temporary sum of the last *DL_Power_Averaging_Window_Size* inner loop power adjustments (in dB).

For the first (*DL_Power_Averaging_Window_Size* – 1) adjustments after the activation the limited power raise method, formula (1) shall be used instead of formula (2). *Power_Raise_Limit* and *DL_Power_Averaging_Window_Size* are parameters configured in the UTRAN.

The power control step size ?$_{TPC}$ can take four values: 0.5, 1, 1.5 or 2 dB. It is mandatory for UTRAN to support ?$_{TPC}$ of 1 dB, while support of other step sizes is optional.

In addition to the above described formulas on how the downlink power is updated, the restrictions below apply.

In case of congestion (commanded power not available), UTRAN may disregard the TPC commands from the UE.

The average power of transmitted DPDCH symbols over one timeslot shall not exceed Maximum_DL_Power (dB), nor shall it be below Minimum_DL_Power (dB). Transmitted DPDCH symbol means here a complex QPSK symbol before spreading which does not contain DTX. Maximum_DL_Power (dB) and Minimum_DL_Power (dB) are power limits for one channelisation code, relative to the primary CPICH power [6].

5.2.1.3 Power control in compressed mode

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

The UE behaviour is the same in compressed mode as in normal mode, described in subclause 5.2.1.2.

In compressed mode, compressed frames may occur in either the uplink or the downlink or both. In compressed frames, the transmission of downlink DPDCH(s) and DPCCH shall be stopped during transmission gaps.

The power of the DPCCH and DPDCH in the first slot after the transmission gap should be set to the same value as in the slot just before the transmission gap.

In every slot during compressed mode except during downlink transmission gaps, UTRAN shall estimate the k:th TPC command and adjust the current downlink power $P(k-1)$ [dB] to a new power $P(k)$ [dB] according to the following formula:

$$P(k) = P(k - 1) + P_{TPC}(k) + P_{SIR}(k) + P_{bal}(k),$$

where $P_{TPC}(k)$ is the k:th power adjustment due to the inner loop power control, $P_{SIR}(k)$ is the k-th power adjustment due to the downlink target SIR variation, and $P_{bal}(k)$ [dB] is a correction according to the downlink power control procedure for balancing radio link powers towards a common reference power. The power balancing procedure and control of the procedure is described in [6], and an example of how $P_{bal}(k)$ can be calculated is given in Annex B.3.

Due to transmission gaps in uplink compressed frames, there may be missing TPC commands in the uplink. If no uplink TPC command is received, $P_{TPC}(k)$ derived by the Node B shall be set to zero. Otherwise, $P_{TPC}(k)$ is calculated the same way as in normal mode (see sub-clause 5.2.1.2.2) but with a step size ?$_{STEP}$ instead of ?$_{TPC}$.

The power control step size ?$_{STEP}$ = ?$_{RP-TPC}$ during RPL slots after each transmission gap and ?$_{STEP}$ = ?$_{TPC}$ otherwise, where:

- RPL is the recovery period length and is expressed as a number of slots. RPL is equal to the minimum value out of the transmission gap length and 7 slots. If a transmission gap is scheduled to start before RPL slots have elapsed, then the recovery period shall end at the start of the gap, and the value of RPL shall be reduced accordingly.⁇

?? ?$_{RP-TPC}$ is called the recovery power control step size and is expressed in dB. ?$_{RP-TPC}$ is equal to the minimum value of 3 dB and 2?$_{TPC}$.

The power offset $P_{SIR}(k)$ = ?P_{curr} - ?P_{prev}, where ?P_{curr} and ?P_{prev} are respectively the value of ?P in the current slot and the most recently transmitted slot and ?P is computed as follows:

?P = max(? P1_compression, …, ? Pn_compression) + ? P1_coding + ? P2_coding

where n is the number of different TTI lengths amongst TTIs of all TrChs of the CCTrCh, where ? P1_coding and ? P2_coding are computed from uplink parameters DeltaSIR1, DeltaSIR2, DeltaSIRafter1, DeltaSIRafter2 signaled by higher layers as:

- ? P1_coding = DeltaSIR1 if the start of the first transmission gap in the transmission gap pattern is within the current frame.

- ? P1coding = DeltaSIRafter1 if the current frame just follows a frame containing the start of the first transmission gap in the transmission gap pattern.

- ? P2_coding = DeltaSIR2 if the start of the second transmission gap in the transmission gap pattern is within the current frame.

- ? P2_coding = DeltaSIRafter2 if the current frame just follows a frame containing the start of the second transmission gap in the transmission gap pattern.

- ? P1_coding = 0 dB and ? P2_coding = 0 dB in all other cases.

and ? Pi_compression is defined by :

- ? Pi_compression = 3 dB for downlink frames compressed by reducing the spreading factor by 2.

- ? Pi_compression = 10 log ($15*F_i$ / ($15*F_i$ - TGL_i)) if there is a transmission gap created by puncturing method within the current TTI of length F_i frames, where TGL_i is the gap length in number of slots (either from one gap or a sum of gaps) in the current TTI of length F_i frames.

- ? Pi_compression = 0 dB in all other cases.

In case several compressed mode patterns are used simultaneously, a ?P offset is computed for each compressed mode pattern and the sum of all ?P offsets is applied to the frame.

5.2.1.4 Site selection diversity transmit power control

5.2.1.4.1 General

Site selection diversity transmit power control (SSDT) is another macro diversity method in soft handover mode. This method is optional in UTRAN.

Operation is summarised as follows. The UE selects one of the cells from its active set to be ‘primary’, all other cells are classed as ‘non primary’. The main objective is to transmit on the downlink from the primary cell, thus reducing the interference caused by multiple transmissions in a soft handover mode. A second objective is to achieve fast site selection without network intervention, thus maintaining the advantage of the soft handover. In order to select a primary cell, each cell is assigned a temporary identification (ID) and UE periodically informs a primary cell ID to the connecting cells. The non-primary cells selected by UE switch off the transmission power. The primary cell ID is delivered by UE to the active cells via uplink FBI field. SSDT activation, SSDT termination and ID assignment are all carried out by higher layer signalling.

5.2.1.4.1.1 Definition of temporary cell identification

Each cell is given a temporary ID during SSDT and the ID is utilised as site selection signal. The ID is given a binary bit sequence. There are three different lengths of coded ID available denoted as "long", "medium" and "short". The network decides which length of coded ID is used. Settings of ID codes for 1-bit and 2-bit FBI are exhibited in table 3 and table 4, respectively.

Table 3: Settings of ID codes for 1 bit FBI

ID label	ID code		
	"long"	"medium"	"short"
a	000000000000000	(0)0000000	00000
b	101010101010101	(0)1010101	01001
c	011001100110011	(0)0110011	11011
d	110011001100110	(0)1100110	10010
e	000111100001111	(0)0001111	00111
f	101101001011010	(0)1011010	01110
g	011110000111100	(0)0111100	11100
h	110100101101001	(0)1101001	10101

Table 4: Settings of ID codes for 2 bit FBI

ID label	ID code (Column and Row denote slot position and FBI-bit position.) "long"	"medium"	"short"
a	(0)0000000 (0)0000000	(0)000 (0)000	000 000
b	(0)0000000 (1)1111111	(0)000 (1)111	000 111
c	(0)1010101 (0)1010101	(0)101 (0)101	101 101
d	(0)1010101 (1)0101010	(0)101 (1)010	101 010
e	(0)0110011 (0)0110011	(0)011 (0)011	011 011
f	(0)0110011 (1)1001100	(0)011 (1)100	011 100
g	(0)1100110 (0)1100110	(0)110 (0)110	110 110
h	(0)1100110 (1)0011001	(0)110 (1)001	110 001

The ID code bits shown in table 3 and table 4 are transmitted from left to right. The ID code(s) are transmitted aligned to the radio frame structure (i.e. ID codes shall be terminated within a frame). If FBI space for sending the last ID code within a frame cannot be obtained, the first bit(s) from that ID code are punctured. The bit(s) to be punctured are shown in brackets in table 3 and table 4.

The alignment of the ID codes to the radio frame structure is not affected by transmission gaps resulting from uplink compressed mode.

5.2.1.4.2 TPC procedure in UE

The UE shall generate TPC commands to control the network transmit power and send them in the TPC field of the uplink DPCCH. An example on how to derive the TPC commands is given in Annex B.2.

5.2.1.4.3 Selection of primary cell

The UE selects a primary cell periodically by measuring the RSCP of CPICHs transmitted by the active cells. The cell with the highest CPICH RSCP is detected as a primary cell.

5.2.1.4.4 Delivery of primary cell ID

The UE periodically sends the ID code of the primary cell via portion of the uplink FBI field assigned for SSDT use (FBI S field). A cell recognises its state as non-primary if the following conditions are fulfilled simultaneously:

- the received primary ID code does not match with the own ID code;
- the received uplink signal quality satisfies a quality threshold, Qth, a parameter defined by the network;
- and when the use of uplink compressed mode does not result in excessive levels of puncturing on the coded ID. The acceptable level of puncturing on the coded ID is less than ?N_{ID}/3? symbols in the coded ID, where N_{ID} is the length of the coded ID.

Otherwise the cell recognises its state as primary.

The state of the cells (primary or non-primary) in the active set is updated synchronously. If a cell receives the last portion of the coded ID in uplink slot j, the state of cell is updated in downlink slot $(j+1+T_{os})$ mod 15, where T_{os} is defined as a constant of 2 time slots. The updating of the cell state is not influenced by the operation of downlink compressed mode.

At the UE, the primary ID code to be sent to the cells is segmented into a number of portions. These portions are distributed in the uplink FBI S-field. The cell in SSDT collects the distributed portions of the primary ID code and then detects the transmitted ID. The period of the primary cell update depends on the settings of the code length and the number of FBI bits assigned for SSDT use as shown in table 5.

Table 5: Period of primary cell update

code length	The number of FBI bits per slot assigned for SSDT	
	1	2
"long"	1 update per frame	2 updates per frame
"medium"	2 updates per frame	4 updates per frame
"short"	3 updates per frame	5 updates per frame

5.2.1.4.5 TPC procedure in the network

In SSDT, a non-primary cell can switch off its DPDCH output (i.e. no transmissions).

The cell manages two downlink transmission power levels, P1, and P2. Power level P1 is used for downlink DPCCH transmission power level and this level is updated in the same way with the downlink DPCCH power adjustment specified in 5.2.1.2.2 (for normal mode) and 5.2.1.3 (for compressed mode) regardless of the selected state (primary or non-primary). The actual transmission power of TFCI, TPC and pilot fields of DPCCH is set by adding P1 and the offsets PO1, PO2 and PO3, respectively, as specified in 5.2.1.1. P2 is used for downlink DPDCH transmission power level and this level is set to P1 if the cell is selected as primary, otherwise P2 is switched off. The cell updates P1 first and P2 next, and then the two power settings P1 and P2 are maintained within the power control dynamic range. Table 6 summarizes the updating method of P1 and P2.

Table 6: Updating of P1 and P2

State of cell	P1 (DPCCH)	P2 (DPDCH)
non primary	Updated in the same way with the downlink DPCCH power adjustment specified in 5.2.1.2.2 and 5.2.1.3	Switched off
primary		= P1

5.2.1.5 Power Control in Gated DPCCH Transmission

5.2.1.5.1 General

During gating, DPC_MODE 0 is used without explicit signaling, regardless of the downlink power control mode used before gating is initiated, with the modification to support gating. UE generates TPC command based on the switched-on receive time slot, and the newly generated TPC command is sent in TPC field of the first available switched-on transmit time slot.

After gating is terminated, UE resumes its original downlink power control mode, which had been used before gating was initiated, without explicit signaling.

After estimating the k:th TPC command, UTRAN shall adjust the current downlink power $P(k\text{-}1)$ [dB] to a new power $P(k)$ [dB] according to the following formula:

$P(k) = P(k - 1) + P_{TPC}(k) + P_{bal}(k)$.

The change in downlink transmit power shall take place immediately before the start of the pilot field on the downlink DPCCH.

The downlink power control procedure during gating is described in detail in the following subclauses 5.2.1.5.2 and 5.2.1.5.3.

5.2.1.5.2 Uplink and downlink gated DPCCH transmission

In the case that the gating is enabled for both uplink and downlink, the downlink power control operations are as follows. UE shall generate the uplink TPC command based on the downlink switched-on time slot that is transmitted with the latest updated transmit power, and shall transmit the new TPC command on the first available uplink switched-on time slot that is assigned for transmitting updated TPC command. In the case of embedded data period in uplink, the newly generated TPC command is repeatedly transmitted in the uplink switched-on time slots before the next uplink switched-on time slot that is assigned for transmitting updated TPC command.

UTRAN shall adjust the transmit power in the switched-on downlink time slot in response to the latest updated uplink TPC command. In the case of embedded data period in downlink, the downlink transmit power shall remain constant until the next updated uplink TPC command is received.

5.2.1.5.3 Downlink only gated DPCCH transmission

In the case that the gating is enabled only for the downlink, then the downlink power control operations are as follows. UE shall generate an uplink TPC command based on the downlink switched-on time slot that is transmitted with the latest updated transmit power, and shall transmit the newly generated TPC command repeatedly before receiving the first downlink switched-on time slot that contains the next updated downlink TPC command.

UTRAN shall adjust the transmit power in the switched-on downlink time slot in response to the latest updated uplink TPC command. In the case of embedded data period in downlink, the downlink transmit power shall remain constant until the next updated uplink TPC command is received.

5.2.2 PDSCH

The PDSCH power control can be based on the following solutions, which are selectable, by the network:

- Inner-loop power control based on the power control commands sent by the UE on the uplink DPCCH.
- Slow power control.

5.2.3 AICH

The UE is informed about the relative transmit power of the AICH (measured as the power per transmitted acquisition indicator) compared to the primary CPICH transmit power by the higher layers.

5.2.4 PICH

The UE is informed about the relative transmit power of the PICH (measured as the power over the paging indicators) compared to the primary CPICH transmit power by the higher layers.

5.2.5 S-CCPCH

The TFCI and pilot fields may be offset relative to the power of the data field. The power offsets may vary in time.

5.2.6 CSICH

The UE is informed about the relative transmit power of the CSICH (measured as the power per transmitted status indicator) compared to the primary CPICH transmit power by the higher layers.