TSG RAN1#5 (99)478

3GPP RAN 25.214 V2.0.0 (1999-10)

Technical Specification

3rd Generation Partnership Project (3GPP);
Technical Specification Group (TSG)
Radio Access Network (RAN);
Working Group 1 (WG1);
Physical layer procedures (FDD)

3GPP

Contents

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< Editor's note: To be filled in. >

Foreword

This specification has been produced within the Third Generation Partnership Project (3GPP), and has been elaborated by the TSG RAN WG1 working group, as a part of the work in defining and describing Layer 1 of the Universal Mobile Terrestrial Radio Access (UTRA).

This specification describes the physical layer procedures in UTRA/FDD.

1   Scope

This document specifies and establishes the characteristics of the physicals layer procedures in the FDD mode of UTRA.

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.

- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1]   Reference 1

3   Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following definitions apply:

<defined term>: <definition>.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

<symbol>   <Explanation>

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ASC	Access Service Class
AP	Access Preamble
BCH	Broadcast Channel
CCPCH	Common Control Physical Channel
CD	Collision Detection
CPCH	Common Packet Channel
DCH	Dedicated Channel
DPCCH	Dedicated Physical Control Channel
DPCH	Dedicated Physical Channel
DPDCH	Dedicated Physical Data Channel
FACH	Forward Access Channel
MUI	Mobile User Identifier
PCH	Paging Channel
PCPCH	Physical Common Packet Channel
PI	Paging Indication
PRACH	Physical Random Access Channel
RACH	Random Access Channel
SCH	Synchronisation Channel
SIR	Signal-to-Interference Ratio
SSDT	Site Selection Diversity TPC
TPC	Transmit Power Control
UE	User Equipment

4 Synchronisation procedures

4.1 Cell search

During the cell search, the UE searches for a cell and determines the downlink scrambling code and common channel frame synchronisation of that cell. How cell search is typically done is described in Annex C.

4.2 Common physical channel synchronisationThe radio frame timing of all common physical channels can be determined after cell search. The P-CCPCH radio frame timing is found during cell search and the radio frame timing of all common physical channel are related to that timing as described in 25.211.

4.3 DPCCH/DPDCH synchronisation

4.3.1 General

The synchronisation of the dedicated physical channels can be divided into two cases:

- when a downlink dedicated physical channel and uplink dedicated physical channel shall be set up at the same time;

- or when a downlink dedicated physical channel shall be set up and there already exist an uplink dedicated physical channel.

The two cases are described in subclauses 5.5.1 and 5.5.2 respectively.

4.3.2   No existing uplink dedicated channel

The assumption for this case is that a DPCCH/DPDCH pair shall be set up in both uplink and downlink, and that there exist no uplink DPCCH/DPDCH already. This corresponds to the case when a dedicated physical channel is initially set up on a frequency.

The synchronization establishment procedures of the dedicated physical channel are described below. The synchronization establishment process flow is shown in Figure 1.

a)   UTRAN starts the transmission of downlink DPCCH/DPDCHs. The DPDCH is transmitted only when there is data to be transmitted to the UE.

b)   The UE establishes downlink chip synchronization and frame synchronization based on the CPICH timing and timing offset information notified from UTRAN. Frame synchronization can be confirmed using the Frame Synchronization Word. Successful frame synchronization is confirmed and reported to the higher layers when S_R successive frames have been confirmed to be frame synchronized. Otherwise, frame synchronization failure is reported to the higher layers.

c)   The UE starts the transmission of the uplink DPCCH/DPDCHs at a frame timing exactly T_0 chips after the frame timing of the received downlink DPCCH/DPDCH. The DPDCH is transmitted only when there is data to be transmitted. The UE immediately starts inner-loop power control as described in sections 5.1.2 and 5.2.3, i.e. the transmission power of the uplink DPCCH/DPDCH follows the TPC commands generated by UTRAN, and the UE performs SIR estimation to generate TPC commands transmitted to UTRAN.

d)   UTRAN establishes uplink channel chip synchronization and frame synchronization. Frame synchronization can be confirmed using the Frame Synchronization Word. Successful frame synchronization is confirmed and reported to the higher layers when S_R successive frames have been confirmed to be frame synchronized. Otherwise, frame synchronization failure is reported to the higher layers.

```
                      UE                            Network
                       |                               |
        ┌──────────────┴──────────────────┐            |
        │ Start down link synchronization  │            |
        │ establishment process.            │            |
        └──────────────┬──────────────────┘            |
                       |                               |
                       |◄═══════════════════  ┌────────┴──────────────────────────┐
                       |                       │ Start the transmission of down     │
                       |                       │ link channels.                     │
                       |                       └────────┬──────────────────────────┘
                       |                       ┌────────┴──────────────────────────┐
                       |                       │ Start up link synchronization      │
                       |                       │ establishment process.             │
                       |                       └────────┬──────────────────────────┘
        ┌──────────────┴──────────────────┐            |
        │ Establish chip synchronization   │            |
        │ and confirm frame synchronization.│           |
        └──────────────┬──────────────────┘            |
        ┌──────────────┴──────────────────┐            |
        │ Inform upper layer of frame       │            |
        │ synchronization confirmation      │            |
        └──────────────┬──────────────────┘            |
        ┌──────────────┴──────────────────┐            |
        │ Start the transmission of uplink  │═════════►  |
        │ channels.                         │            |
        └──────────────┬──────────────────┘            |
                       |                       ┌────────┴──────────────────────────┐
                       |                       │ Establish chip synchronization     │
                       |                       │ and confirm frame synchronization. │
                       |                       └────────┬──────────────────────────┘
                       |                       ┌────────┴──────────────────────────┐
                       |                       │ Transmission power of down link    │
                       |                       │ channel follow the TPC bits         │
                       |                       │ transmitted by UE.up link.          │
                       |                       └────────┬──────────────────────────┘
                       |                       ┌────────┴──────────────────────────┐
                       |                       │ Inform synchronization confirmation│
                       |                       │ to upper layer                     │
                       |                       └────────┬──────────────────────────┘
                       |                               |
```

Figure 1 : Synchronization establishment flow of dedicated channels

4.3.3   With existing uplink dedicated channel

The assumption for this case is that there already exist DPCCH/DPDCHs in the uplink, and a corresponding dedicated physical channel shall be set up in the downlink. This corresponds to the case when a new cell has been added to the active set in soft handover and shall begin its downlink transmission.

At the start of soft handover, the uplink dedicated physical channel transmitted by the UE, and the downlink dedicated physical channel transmitted by the soft handover source cell continues transmitting as usual.

The synchronisation establishment flow upon intra/inter-cell soft handover is described in Figure 2.

a)   The UE starts the chip synchronisation establishment process of downlink channels from the handover destination. The uplink channels being transmitted shall continue transmission as before.

b)   UTRAN starts the transmission of the downlink DPCCH/DPDCH at a frame timing such that the frame timing received at the UE will be within $T_0 \pm [148]$ chips prior to the frame timing of the uplink DPCCH/DPDCH at the UE. UTRAN then starts the synchronization establishment process of the uplink DPCCH/DPDCH transmitted by the UE. Frame synchronization can be confirmed using the Frame Synchronization Word. Successful frame synchronization is confirmed and reported to the higher layers

when S_R successive frames have been confirmed to be frame synchronized. Otherwise, frame synchronization failure is reported to the higher layers.
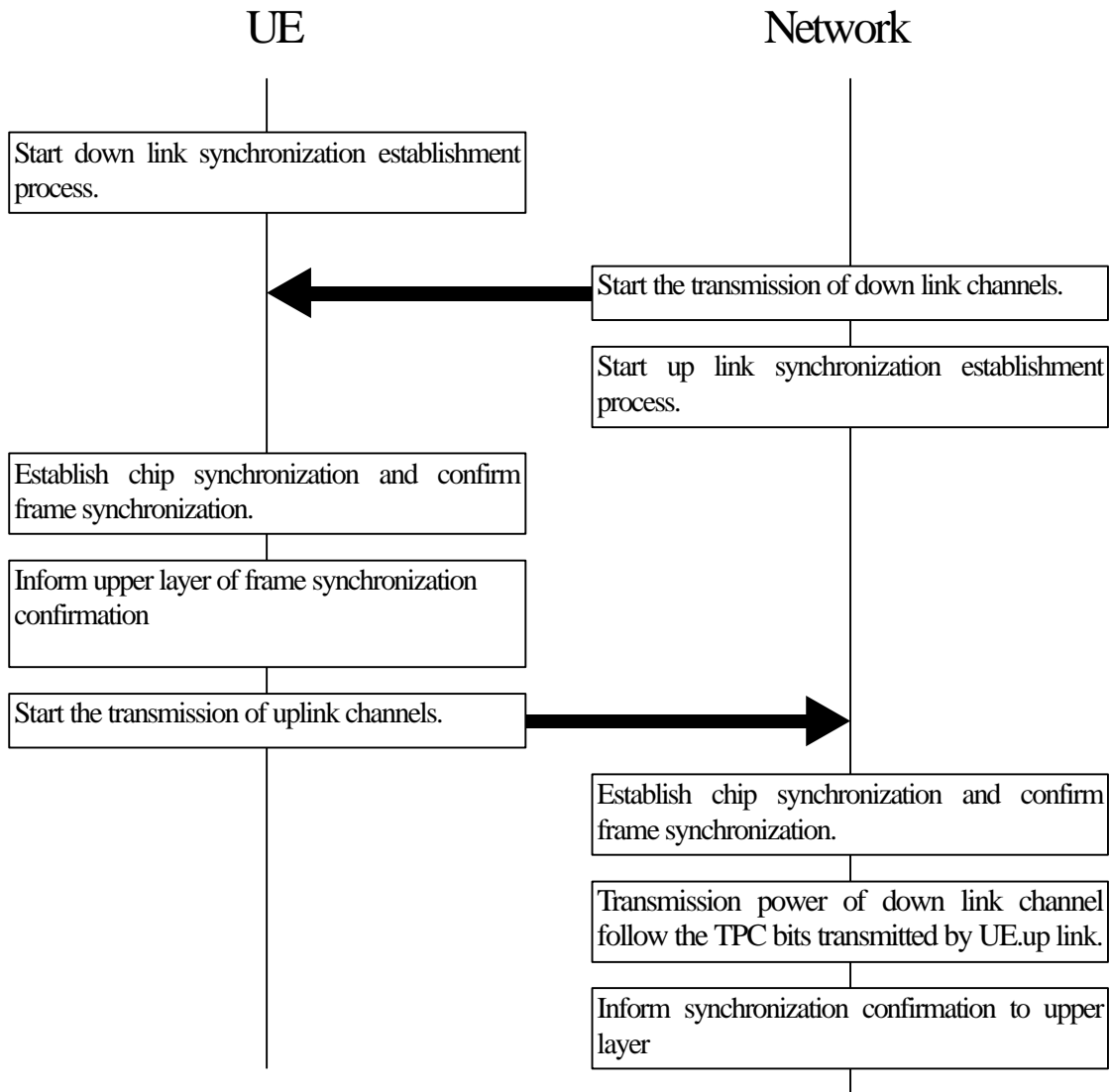
c) Based on the handover destination CPICH reception timing, the UE establishes chip synchronisation of downlink channels from handover destination cell. Frame synchronization can be confirmed using the Frame Synchronization Word. Successful frame synchronization is confirmed and reported to the higher layers when S_R successive frames have been confirmed to be frame synchronized. Otherwise, frame synchronization failure is reported to the higher layers.

UE

diversity handover
destination network

Start down link chip sync. establishment process

Start down link transmission

Down link chip synchronization established

Start up link chip synchronization establishment process

Frame synchronization confirmation

Up link chip synchronization established

Frame synchronization confirmation

Inform upper layer of frame synchronization confirmation

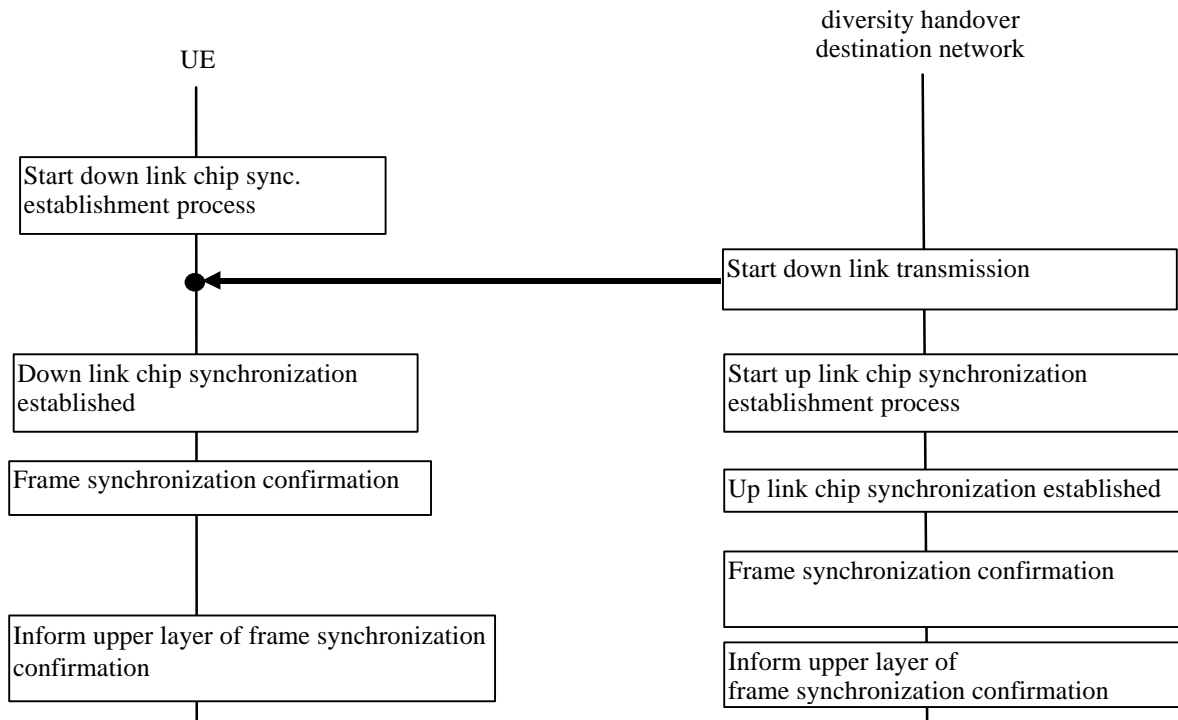Inform upper layer of frame synchronization confirmation

Figure 2 : Synchronization establishment flow upon intra/inter-cell soft handover

During a connection, in some cases the UE is allowed to change its transmission timing. When the UE is not in soft handover or in soft handover with cells that all are known to have the same timing reference, the UE may adjust its DPDCH/DPCCH transmission time instant. <Note: maximum rate of the adjustment should be specified in R4> Otherwise, the UE may not adjust its DPDCH/DPCCH transmission time instant.

5 Power control

5.1 Uplink power control

5.1.1 PRACH

5.1.1.1 General

The transmitter power of UE shall be calculated by following equation:

$P_{RACH} = L_{Perch} + I_{BTS} + \text{Constant value}$
where,

P_{RACH}: transmitter power level in dBm,

L_{Pearch}: measured path loss in dB,

I_{BTS}: interference signal power level at BTS in dBm, which is broadcasted on BCH,

Constant value: This value shall be designated via Layer 3 message (operator matter).

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

-   $\boldsymbol{b_c}$ is the gain factor for the control part (similar to DPCCH),

-   $\boldsymbol{b_d}$ 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 uplink 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. The relative transmit power offset between DPCCH and DPDCHs is determined by the network and signalled to the UE using higher layer signalling.

5.1.2.2   Ordinary transmit power control

5.1.2.2.1   General

The initial uplink transmit power to use is decided using an open-loop power estimate, similar to the random access procedure. *< Editor's note: This needs to be elaborated, how is the estimate derived? >*

The maximum transmission power at the maximum rate of DPDCH is designated for uplink and control must be performed within this range. *< Editor's note: The necessity of this range needs to be confirmed. >* The maximum transmit power value of the inner-loop TPC is set by the network using higher layer signalling.

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 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".

Upon reception of one or more TPC commands in a slot, the UE derives 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 dedicated physical channels with a step of Δ_{TPC} dB 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

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 are 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 estimate the signal-to-interference ratio PC_SIR_i on each of the power control commands TPC_i, where $i = 1, 2, \ldots, N$ 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 a function β of PC_SIR_i, $W_i = \beta(PC\_SIR_i)$. 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 $= \gamma (W_1, W_2, \ldots W_N, TPC_1, TPC_2, \ldots, TPC_N)$, where TPC_cmd can take the values 1 or -1.

5.1.2.2.2.3.2   Example of the scheme

A particular example of the scheme is obtained when using the following definition of the functions β and γ:

For β: the reliability figure W_i is set to 0 if $PC\_SIR_i < PC\_thr$, otherwise W_i is set to 1. This means that the power control command is assumed unreliable if the signal-to-interference ratio of the TPC commands is lower than a minimum value PC_thr.

For γ: if there is at least one TPC_i command, for which $W_i = 1$ and $TPC_i = 0$, or if $W_i = 0$ and $TPC_i = 0$ for all N TPC_i commands, then TPC_cmd is set to 1, otherwise TPC_cmd is set to 1. Such a function γ means that the power is decreased if at least one cell for which the reliability criterion is satisfied asks for a power decrease.

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 5th slot.

    - If all 5 hard decisions within a set are 0 then TPC_cmd = -1 in the 5th slot.

    - Otherwise, TPC_cmd = 0 in the 5th 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(3rd slot) = γ (TPC_temp$_1$, TPC_temp$_2$, …, TPC_temp$_N$), where TPC_cmd(3rd 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 $\dfrac{1}{N}\sum_{i=1}^{N} TPC\_temp_i > 0.5$.

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

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 during transmission gaps, since no downlink TPC command 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 is stopped during transmission gaps.

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 Δ_{RESUME}. The value of Δ_{RESUME} (in dB) 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 25.231). 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	$\Delta_{\text{RESUME}} = \text{Int}[\boldsymbol{d}_{\text{last}} / \Delta_{\text{TPCmin}}] \, \Delta_{\text{TPCmin}}$

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:

$$\boldsymbol{d}_{last} = 0.9375 \boldsymbol{d}_{previous} - 0.96875 TPC\_cmd_{last}\Delta_{TPC}$$

$$\boldsymbol{d}_{previous} = \boldsymbol{d}_{last}$$

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

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 25.231). The different modes are summarised in the Table 2:

Table 2 : Power control modes during compressed mode.

Mode	Description
0	Ordinary transmit power control is applied with step size Δ_{TPC}
1	Ordinary transmit power control is applied with step size $\Delta_{\text{RP-TPC}}$ 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).

For mode 1, during RPL slots after each transmission gap, called the recovery period, the same power control algorithm is applied but with a step size $\Delta_{\text{RP-TPC}}$ instead of Δ_{TPC}.

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

If algorithm 2 (section 5.1.2.2.3) is being used in normal mode, the sets of slots over which the TPC commands are processed (in section 5.1.2.2.3.1) 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 there will be no change in transmit power level for those sets of slots.

5.1.2.4 Setting of the uplink DPCCH/DPDCH power difference

5.1.2.4.1 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:

- $\boldsymbol{b}_c$ and $\boldsymbol{b}_d$ are signalled for the TFC, or

- $\boldsymbol{b}_c$ and $\boldsymbol{b}_d$ 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 $\boldsymbol{b}_c$ and $\boldsymbol{b}_d$ 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 output power shall be performed by the UE, so that the output DPCCH power follows the inner loop power control with power steps of $\pm\Delta_{\mathrm{TPC}}$ dB.

5.1.2.4.2 Signalled gain factors

When the gain factors $\boldsymbol{b}_c$ and $\boldsymbol{b}_d$ are signalled by higher layers for a certain TFC, the signalled values are used directly for weighting of DPCCH and DPDCH(s).

5.1.2.4.3 Computed gain factors

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

Let $\boldsymbol{b}_{c,ref}$ and $\boldsymbol{b}_{d,ref}$ denote the signalled gain factors for the reference TFC. Further, let $\boldsymbol{b}_{c,j}$ and $\boldsymbol{b}_{d,j}$ denote the gain factors used for the TFC in the j:th radio frame.

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 TFC used in the j:th frame.

The variable A_j is then computed as:

$$A_j = \frac{\boldsymbol{b}_{d,ref}}{\boldsymbol{b}_{c,ref}} \cdot \sqrt{\frac{K_j}{K_{ref}}} \,.$$

The gain factors for the TFC in the j:th radio frame are then computed as follows:

If $A_j > 1$, then $\boldsymbol{b}_{d,j} = 1.0$ and $\boldsymbol{b}_{c,j} = \lfloor 1/A_j \rfloor$, where $\lfloor \bullet \rfloor$ means rounding to closest lower quantized β-value.

If $A_j \leq 1$, then $\boldsymbol{b}_{d,j} = \lceil A_j \rceil$ and $\boldsymbol{b}_{c,j} = 1.0$, 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.

5.2 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.

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.

5.2.1.2 Ordinary transmit power control

The downlink inner-loop power control adjusts the network transmit power in order to keep the received downlink SIR at a given SIR target, SIR_{target}. A higher layer outer loop adjusts SIR_{target} independently for each connection.

The UE should estimate the received downlink DPCCH/DPDCH power of the connection to be power controlled. Simultaneously, the UE should estimate the received interference. The obtained SIR estimate SIR_{est} is then used by the UE to generate TPC commands according to the following rule: if $SIR_{est} > SIR_{target}$ then the TPC command to transmit is "0", requesting a transmit power decrease, while if $SIR_{est} < SIR_{target}$ then the TPC command to transmit is "1", requesting a transmit power increase.

When the UE is not in soft handover the TPC command generated is transmitted in the first available TPC field in the uplink DPCCH.

When the UE is in soft handover it should 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.

As a response to the received TPC commands, UTRAN may adjust the downlink DPCCH/DPDCH power. The transmitted DPCCH/DPDCH power may not exceed Maximum_DL_Power, nor may it be below Minimum_DL_Power.

< Note: It should be clarified with WG3 if Maximum_DL_Power and Minimum_DL_Power are given as absolute values or relative. >

< Note: It is not clear to what extent the UTRAN response to the received TPC commands should be specified. Until this has been clarified, the text in the paragraph below should be seen as an example of UTRAN behaviour. >

Changes of power shall be a multiple of the minimum step size $\Delta_{TPC,min}$ dB. It is mandatory for UTRAN to support $\Delta_{TPC,min}$ of 1 dB, while support of 0.5 dB is optional.

< Note: It needs to be clarified if an upper limit on the downlink power step should be specified. >

'When SIR measurements cannot be performed due to downlink out-of-synchronisation, the TPC command transmitted shall be set as "1" during the period of out-of-synchronisation.

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, i.e. TPC commands should be generated based on the estimated received SIR.

The UTRAN behaviour during compressed mode is not specified. As an example, the algorithm can be similar to uplink power control in downlink compressed mode as described in sub-clause 5.1.2.3.

In downlink compressed mode or in simultaneous downlink and uplink compressed mode, the transmission of downlink DPCCH and DPDCH(s) is stopped.

5.2.1.4   Site selection diversity transmit power control

5.2.1.4.1   General

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

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	0000000(0)	00000
b	111111111111111	1111111(1)	11111
c	000000001111111	0000111(1)	00011
d	111111110000000	1111000(0)	11100
e	000011111111000	0011110(0)	00110
f	111100000000111	1100001(1)	11001
g	001111000011110	0110011(0)	01010
h	110000111100001	1001100(1)	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	0000000(0)	000(0)	000
	0000000(0)	000(0)	000
b	1111111(1)	111(1)	111
	1111111(1)	111(1)	111
c	0000000(0)	000(0)	000
	1111111(1)	111(1)	111
d	1111111(1)	111(1)	111
	0000000(0)	000(0)	000
e	0000111(1)	001(1)	001
	1111000(0)	110(0)	100
f	1111000(0)	110(0)	110
	0000111(1)	001(1)	011
g	0011110(0)	011(0)	010
	0011110(0)	011(0)	010
h	1100001(1)	100(1)	101
	1100001(1)	100(1)	101

ID must be terminated within a frame. If FBI space for sending a given ID cannot be obtained within a frame, hence if the entire ID is not transmitted within a frame but must be split over two frames, the last bit(s) of the ID is(are) punctured. The relating bit(s) to be punctured are shown with brackets in Table 3 and Table 4.

5.2.1.4.2 TPC procedure in UE

The TPC procedure of the UE in SSDT is identical to that described in subclause 5.2.3.2.

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 two conditions are fulfilled simultaneously:

- the received primary ID code does not match with the own ID code,

- and the received uplink signal quality satisfies a quality threshold, Qth, a parameter defined by the network.

Otherwise the cell recognises its state as primary.

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. Period of primary cell update depends on the settings of 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 as the same way specified in 5.2.3.2 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 5.2.3.1. 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 by the same way as specified in 5.2.3.2	Switched off
primary		= P1

5.2.2 Power Control with DSCH

The DSCH 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.

6 Random access procedure

6.1 RACH Random Access Procedure

Before the random-access procedure is executed, the UE should acquire the following information from the BCH :

- The preamble spreading code(s) / message scrambling code(s) used in the cell

- The available signatures , and RACH sub-channel(s) groups for each ASC, where a sub-channel group is defined as a group of some of the sub-channels defined in Table 7, and is indicated by upper layer.

- The available spreading factors for the message part

- The uplink interference level in the cell

- The primary CCPCH transmit power level

- The AICH transmission timing parameter as defined in 25.211.

- The power offset ΔP_{p-m} between preamble and the message part.

- The power offsets ΔP_0 (power step when no acquisition indicator is received, step 7.3) and ΔP_1 (power step when negative acquisition is received, see step 8.3)

The random-access procedure is:

1.   The UE randomly selects a preamble spreading code from the set of available spreading codes. The random function is TBD.

2.   The UE sets the preamble transmit power to the value P_{RACH} given in Section 5.1.1. [*Editor's note: Here it is assumed that the initial power back-off is included in the "Constant Value" of 5.1.1*]

3.   The UE implements the dynamic persistence algorithm by:

   3.1   Monitor the broadcast channel (BCH).

   3.2   Read the current persistence factor, *N*, from the BCH.

   3.3   If *N = 0*, the UE proceeds to step 4. Otherwise, the UE generate an integer uniform random variable R in the interval [*0, 1, ..., $2^N - 1$*].

   3.4   If the outcome of the random draw *R = 0*, the UE proceeds to step 4. Otherwise, the UE defers the transmission of the message for one frame and repeats step 3.

4   The UE:

   4.1   Randomly selects the RACH sub-channel group from the available ones for its ASC, The random function, for selecting the RACH sub-channel group from the available ones is TBD.

   4.2   Derives the available access slots in the next two frames, defined by SFN and SFN+1 in the selected RACH sub-channel group with the help of SFN and Table 7. Randomly selects one access slot from the available access slots in the next frame, defined by SFN, if there is one available. If there is no access slot available in the next frame, defined by SFN then, randomly selects one access slot from the available access slots in the following frame, defined by SFN+1. Random function is TBD.

   4.3   Randomly selects a signature from the available signatures within the ASC given by higher layers. Random function is TBD.

5   The UE sets the Preamble Retransmission Counter to Preamble_Retrans_Max (value TBD).

6   The UE transmits its preamble using the selected uplink access slot, signature, and preamble transmission power..

7   If the UE does not detect the positive or negative acquisition indicator corresponding to the selected signature in the downlink access slot corresponding to the selected uplink access slot, the UE:

   7.1   Selects a new uplink access slot, as next available access slot, i.e. next slot in the sub-channel group used, as selected in 4.1

   7.2   Randomly selects a new signature from the available signatures within the ASC given by higher layers. Random function is TBD.

   7.3   Increases the preamble transmission power with the specified offset ΔP_0.

   7.4   Decrease the Preamble Retransmission Counter by one.

   7.5   If the Preamble Retransmission Counter > 0, the UE repeats from step 6 otherwise an error indication is passed to the higher layers and the random-access procedure is exited.

8.   If the UE detects the negative acquisition indicator corresponding to the selected signature in the downlink access slot corresponding to the selected uplink access slot, the UE:

   8.1   Selects a new uplink access slot as in 7.1

   8.2   Randomly selects a new signature from the available signatures within the ASC given by higher layers. Random function is TBD.

   8.3   Modifies the preamble transmission power with the specified offset ΔP_1.

   8.4   Repeats from step 6

9.   The UE transmits its random access message three or four uplink access slots after the uplink access slot of the last transmitted preamble depending on the AICH transmission timing parameter. Transmission power of the random access message is modified from that of the last transmitted preamble with the specified offset ΔP_{p-m}.

10. An indication of successful random-access transmission is passed to the higher layers.

Dynamic persistence is provided for managing interference and minimising delay by controlling access to the RACH channel. The system will publish a dynamic persistence value on the BCH, the value of which is dependent on the estimated backlog of users in the system.

Table 7 : The available access slots for different RACH sub-channels

	Sub-channel Number											
Frame number	0	1	2	3	4	5	6	7	8	9	10	11
SFN modulo 8=0	0	1	2	3	4	5	6	7				
SFN modulo 8=1	12	13	14						8	9	10	11
SFN modulo 8=2				0	1	2	3	4	5	6	7	
SFN modulo 8=3	9	10	11	12	13	14						8
SFN modulo 8=4	6	7					0	1	2	3	4	5
SFN modulo 8=5			8	9	10	11	12	13	14			
SFN modulo 8=6	3	4	5	6	7					0	1	2

SFN modulo 8=7						8	9	10	11	12	13	14

6.2 CPCH Access Procedures

For each CPCH physical channel in a CPCH set allocated to a cell the following physical layer parameters are included in the System Information message:

- UL Access Preamble (AP) scrambling code.

- UL Access Preamble signature set

- The Access preamble slot sub-channels group

- AP- AICH preamble channelization code.

- UL Collision Detection(CD) preamble scrambling code.

- CD Preamble signature set

- CD preamble slot sub-channels group

- CD-AICH preamble channelization code.

- CPCH UL scrambling code.

- CPCH UL channelization code. (variable, data rate dependant)

- DPCCH DL channelization code.([512] chip)

    Note : There may be some overlap between the AP signature set and CD signature set if they correspond to the same scrambling code.

The following are access, collision detection/resolution and CPCH data transmission parameters:

Power ramp-up, Access and Timing parameters (Physical layer parameters)

1. N_AP_retrans_max = Maximum Number of allowed consecutive access attempts (retransmitted preambles) if there is no AICH response. This is a CPCH parameter and is equivalent to Preamble_Retrans_Max in RACH.

2. $P_{RACH} = P_{CPCH}$ = Initial open loop power level for the first CPCH access preamble sent by the UE.

[RACH/CPCH parameter]

3. ΔP_0 = Power step size for each successive CPCH access preamble.

[RACH/CPCH parameter]

4. ΔP_1 = Power step size for each successive RACH/CPCH access preamble in case of negative AICH. A timer is set upon receipt of a negative AICH. This timer is used to determine the period after receipt of a negative AICH when ΔP_1 is used in place of ΔP_0.

[RACH/CPCH parameter]

5. T_{cpch} = CPCH transmission timing parameter: This parameter is identical to PRACH/AICH transmission timing parameter.

[RACH/CPCH parameter]

Note : It is FFS if ΔP_0 for the CPCH access may be different from ΔP_0 for the RACH access as defined in section 6.1.

The CPCH -access procedure in the physical layer is:

1) The UE MAC function selects a CPCH transport channel from the channels available in the assigned CPCH set The CPCH channel selection includes a dynamic persistence algorithm (similar to RACH) for the selected CPCH channel.

2) The UE MAC function builds a transport block set for the next TTI using transport formats which are assigned to the logical channel with data to transmit. The UE MAC funtion sends this transport block set to the UE PHY function for CPCH access and uplink transmission on the selected CPCH transport channel3) The UE sets the preamble transmit power to the value $P_{CPCH\_}$ which is supplied by the MAC layer for initial power level for this CPCH access attempt.

4) The UE sets the AP Retransmission Counter to N_AP_Retrans_Max (value TBD).

5) The UE randomly selects a CPCH-AP signature from the signature set for this selected CPCH channel. The random function is TBD.

6)The UE Derives the available CPCH-AP access slots in the next two frames, defined by SFN and SFN+1 in the AP access slot sub-channel group with the help of SFN and **Table 7** in section 6.1. The UE randomly selects one access slot from the available access slots in the next frame, defined by SFN, if there is one available. If there is no access slot available in the next frame, defined by SFN then, randomly selects one access slot from the available access slots in the following frame, defined by SFN+1. Random function is TBD

7) The UE transmits the AP using the MAC supplied uplink access slot, signature, and initial preamble transmission power.

8)If the UE does not detect the positive or negative acquision indicator corresponding to the selected signature in the downlink access slot corresponding to the selected uplink access slot, the UE:

   a   Selects the next uplink access slot from among the access slots in the CPCH-AP sub-channel group, as selected in 4.1. There must be a minimum distance of three or four access slots from the uplink access slot in which the last preamble was transmitted depending on the CPCH/AICH transmission timing parameter. [NOTE: Use of random function here to select access slot is FFS for RACH and CPCH.].

   b)   Increases the preamble transmission power with the specified offset ΔP . Power offset ΔP_0 s is used unless the negative AICH timer is running, in which case ΔP_1 is used instead..

   c)   Decrease the Preamble Retransmission Counter by one.

   dd) If the Preamble Retransmission Counter < 0, the UE aborts the access attempt and sends a failure message to the MAC layer.

9) If the UE detects the AP-AICH_nak (negative acquisition indicator) corresponding to the selected signature in the downlink access slot corresponding to the selected uplink access slot, the UE aborts the access attempt and sends a failure message to the MAC layer. The UE sets the negative AICH timer to indicate use of ΔP_1 use as the preamble power offset until timer expiry

10) Upon reception of AP-AICH, the access segment ends and the contention resolution segment begins. In this segment, the UE randomly selects a CD signautre from the signature set and also select one-CD access slot sub-channel from the CD sub-channel group supported in the cell.and transmits a CD Preamble, then waits for a CD-AICH from the Node B.

11) If the UE does not receive a CD-AICH in the designated slot, the UE aborts the access attempt and sends a failure message to the MAC layer.

12) If the UE receives a CD-AICH in the designated slot with a signature that does not match the signature used in the CD Preamble, the UE aborts the access attempt and sends a failure message to the MAC layer.

13) 9. If the UE receives a CD-AICH with a matching signature, the UE transmits the power control preamble $\tau_{cd\text{-}p\text{-}pc\text{-}p}$ ms later as measured from initiation of the CD Preamble. . The transmission of the message portion of the burst starts immediately after the power control preamble.

14) During CPCH Packet Data transmission, the UE and UTRAN perform inner-loop power control on both the CPCH UL and the DPCCH DL.

15) If the UE detects loss of DPCCH DL during transmission of the power control preamble or the packet data, the UE halts CPCH UL transmission, aborts the access attempt and sends a failure message to the MAC layer.

16) If the UE completes the transmission of the packet data, the UE sends a success message to the MAC layer.

7. Procedures in Packet Data Transfer

7.1 Rapid Initialization of DCH for Packet Data Transfer

A rapid initialization procedure for establishing a DCH is defined to support bursting packet data transfer. The rapid initialization may be invoked for downlink packet data transfer on the DSCH or uplink packet data transfer on the DCH. The procedure may also be invoked to resume a recently discontinued DCH connection.

7.1.1 Rapid Initialization of DCH for Packet Data Transfer using DSCH

The synchronization of the DSCH/DCH pair may be expedited so that data transmission using DSCH can commence in slightly over 10 ms following the FACH burst assigning the TFCI using DCH. Figure 3shows the timing diagram of RACH/FACH to DCH/DCH+DSCH state transition. The parameter T_A specifies the RACH/FACH response time. The parameters T_B, T_C and T_D are referenced relative to the FACH frame. T_B specifies the time period when the downlink DPCCH is started. The parameter T_C specifies the period at which the UE will start the uplink DPCCH. Finally, T_D specifies the period that the DCH will be stable and the first frame of data may arrive. The parameters T_B, T_C, and T_D have the following relationship:

$$T_B < T_C << T_D$$

$$T_D = T_B + N_{slots}*0.666$$

where N_{slots} is a positive integer.

In order to initialise fast uplink link power control loop, searcher and channel estimator at the Node B, the UE will adhere to the following:

- The transmission of uplink link DPCCH will start at N_{slots} slots (1 to 15 slots) prior to the scheduled downlink packet data transmission using DSCH.

- The DPCCH will be transmitted with an additional negative power offset P_{offset} from the computed open loop estimate.

- The initial power control step size for transmitting the DPCCH will be set at P_{step} (typically: 2dB).

- The UE will revert back to the normal power control (PC) step size upon the receipt of the first down power control command during the uplink DPCCH transmission phase,

- The step size always goes back to its nominal setting in the beginning of DSCH transmission

The parameters T_B, T_C, T_D , N_{slots}, P_{offset} and P_{step} may be negotiated with each individual UE or broadcast by the system so that the transition from RACH/FACH to DCH/DCH+DSCH sub-state is optimised.

7.1.2   Rapid Initialization of DCH for Uplink Packet Data Transfer

The synchronization of the DCH may also be expedited for the transfer of uplink packet data.. Figure 4 shows the same parameters T_B, T_C, and T_D applied to an uplink packet data transfer. The UE, upon detecting data in its queue, transmits a RACH with measurement report. After the UTRAN assigns the DCH via the FACH message, the downlink DPCCH is started after a time period T_B. The UE then begins transmission of the uplink DPCCH for reasons as outlined in section 7.3.4 at time period T_C. T_C is measured relative to the FACH transmit timing. Finally, the UE begins transmitting the data on the DPDCH after the period. The procedure for starting the uplink DPCCH transmission will be similar to Section 7.3.4.1

7.1.3   Resumption of DCH for Downlink or Uplink Packet Data Transfer

The synchronization of the DCH technique may be used to resume a DCH/DCH+DSCH connection that has been dropped for a short period.. This is applicable for packet data transfer using DSCH or uplink DPDCH or bi-directional data transfer using DSCH/Uplink DPDCH. Figure 5 shows the case where the DCH has been discontinued based on an inactivity timer T_E. The UTRAN, upon detecting data in the queue, may resume the DCH operation provided the period T_E has not elapsed. Typically T_E is set to 1000msec.
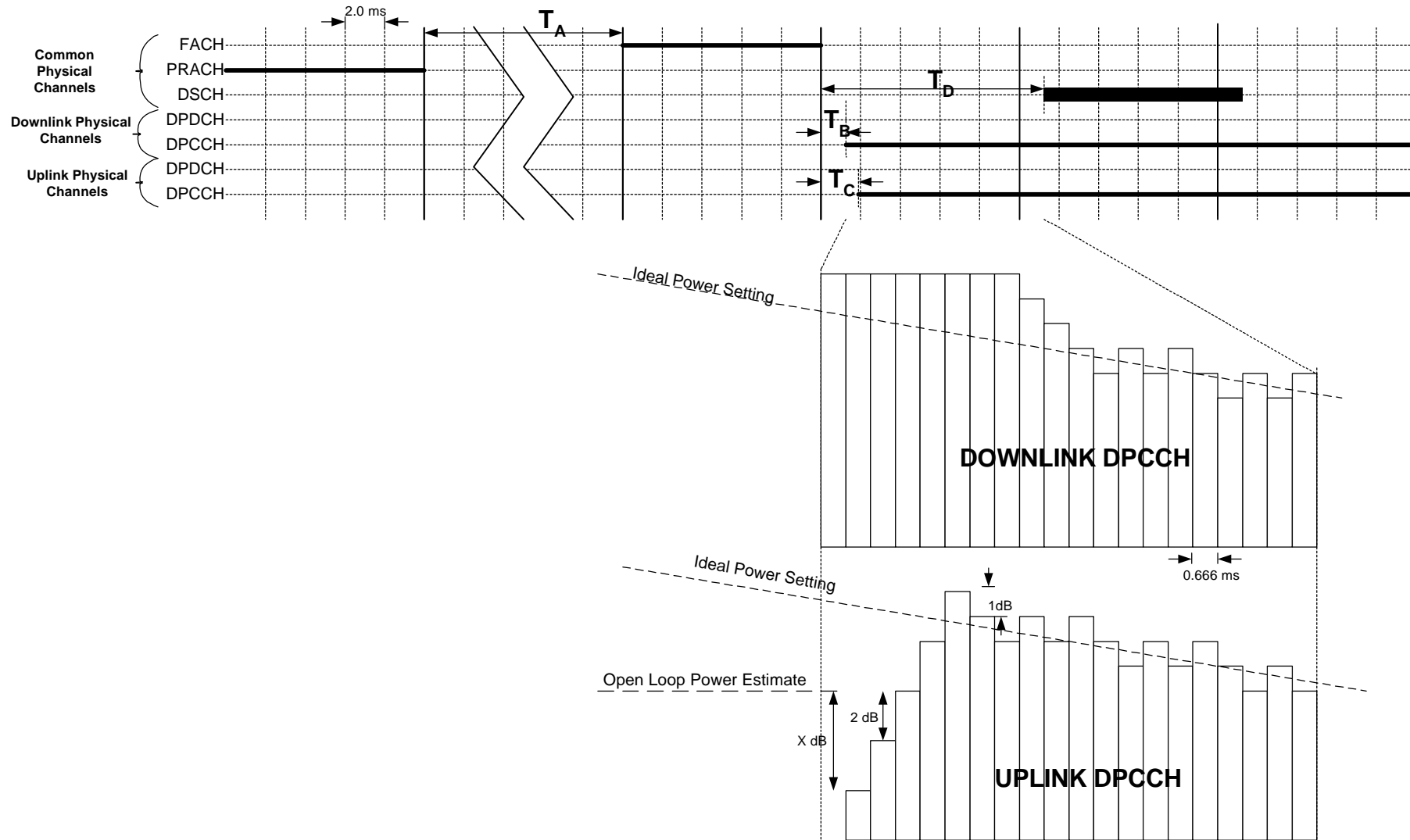
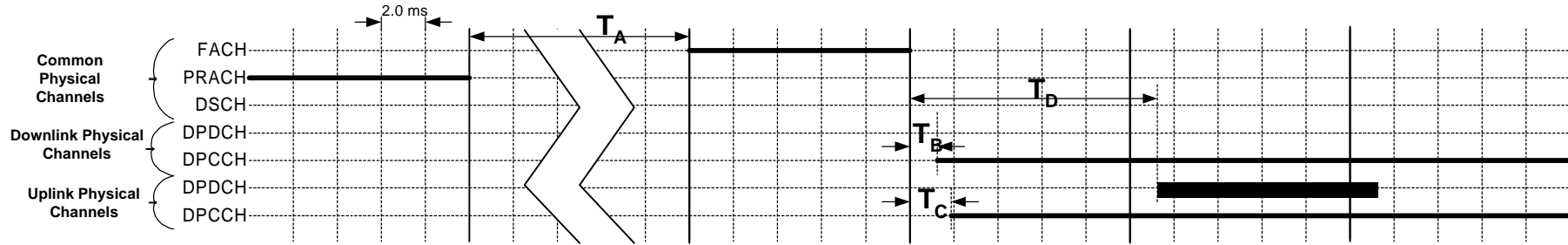**Figure 3 : Rapid Initialization of DCH for packet data transfer over the DSCH.**

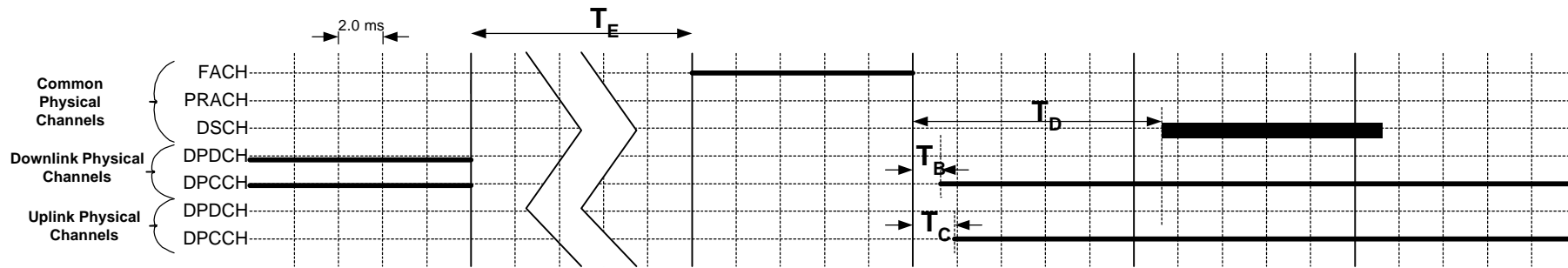**Figure 4 : Rapid initialization of the DCH for transfer of uplink packet data.**

Figure 5 : Resumption of the DCH for transmission of downlink packet data.

8 Closed loop mode transmit diversity

The general transmitter structure to support closed loop mode transmit diversity for DPCH transmission is shown in Figure 6. Channel coding, interleaving and spreading are done as in non-diversity mode. The spread complex valued signal is fed to both TX antenna branches, and weighted with antenna specific weight factors w_1 and w_2. The weight factors are complex valued signals (i.e., $w_i = a_i + jb_i$), in general.

The weight factors (actually the corresponding phase adjustments in closed loop mode 1 and phase/amplitude adjustments in closed loop mode 2) are determined by the UE, and signalled to the UTRAN access point (=cell transceiver) using the D-bits of the FBI field of uplink DPCCH.
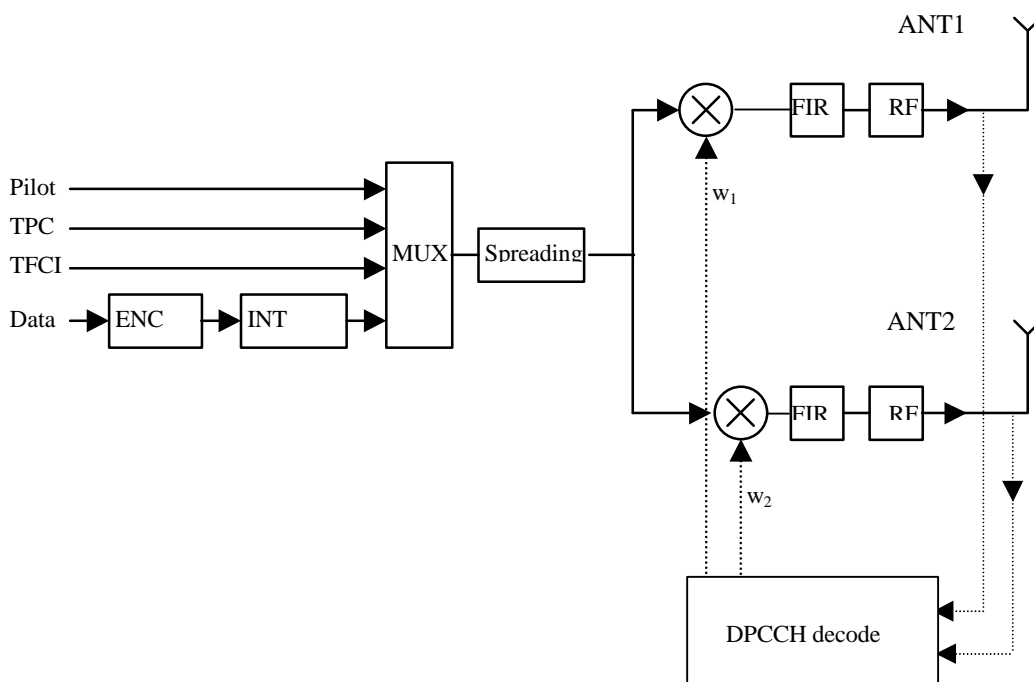

Figure 6 : The generic downlink transmitter structure to support closed loop mode transmit diversity for DPCH transmission (UTRAN Access Point)

There are two closed loop modes whose characteristics are summarized in the Table 8. The use of the modes is controlled by the UTRAN access point.

Table 8 : Summary of number of feedback information bits per slot, N_{FBD}, feedback command length in slots, N_W, feedback command rate, feedback bit rate, number of phase bits, N_{ph}, per signalling word, number of amplitude bits, N_{po}, per signalling word and amount of constellation rotation at UE for the two closed loop modes.

Closed loop mode	N_{FBD}	N_W	Update rate	Feedback bit rate	N_{po}	N_{ph}	Constellation rotation
1	1	1	1500 Hz	1500 bps	0	1	$\pi/2$
2	1	4	1500 Hz	1500 bps	1	3	N/A

8.1 Determination of feedback information

The UE uses the Common PIlot CHannel (CPICH) to separately estimate the channels seen from each antenna.

Once every slot, the UE computes the phase adjustment, f, and for mode 2 the amplitude adjustment that should be applied at the UTRAN access point to maximise the UE received power. In non-soft handover case, that can be accomplished by e.g. solving for weight vector, w, that maximises

$$P = \underline{w}^H H^H H \underline{w} \tag{1}$$

where

$$H = [\underline{h}_1 \ \underline{h}_2 \ ...]$$

and where the column vectors $\underline{h}_i$ and h_2 represent the estimated channel impulse responses for the transmission antennas 1 and 2, of length equal to the length of the channel impulse response. The elements of w correspond to the phase and amplitude adjustments computed by the UE.

During soft handover or SSDT power control, the antenna weight vector, $\underline{w}$ can be, for example, determined so as to maximise the criteria function,

$$P = \underline{w}^H (H_1^H H_1 + H_2^H H_2 + \cdots) \underline{w} \tag{2}$$

where H_i is an estimated channel impulse response for BS#i. In regular SHO, the set of BS#i corresponds to the active set. With SSDT, the set of BS#i corresponds to the primary base station(s).

The UE feeds back to the UTRAN access point the information on which phase/power settings to use. Feedback Signalling Message (FSM) bits are transmitted in the portion of FBI field of uplink DPCCH slot(s) assigned to FB Mode Transmit Diversity, the FBI D field (see 25.211). Each message is of length $N_W = N_{po} + N_{ph}$ bits and its format is shown in the Figure 7. The transmission order of bits is from MSB to LSB, i.e. MSB is transmitted first. FSM_{po} and FSM_{ph} subfields are used to transmit the power and phase settings, respectively.
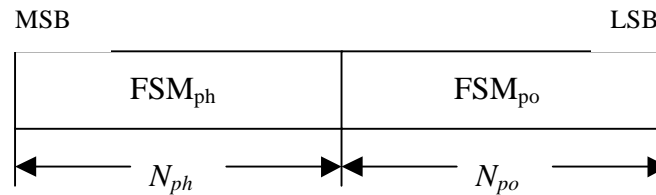
Figure 7 : Format of feedback signalling message. FSM_{po} transmits the power setting and FSM_{ph} the phase setting.

The adjustments are made by the UTRAN Access Point at the beginning of the downlink DPCCH pilot field.

8.2 Closed loop mode 1

UE uses the CPICH transmitted both from antenna 1 and antenna 2 to calculate the phase adjustment to be applied at UTRAN access point to maximize the UE received power. The received CPICH can be denoted as:

$$S_{CPICH}^1(t) = a_1(t)e^{jf_1(t)} \tag{2}$$

$$S_{CPICH}^2(t) = a_2(t)e^{jf_2(t)} \tag{3}$$

where,

$$S_{CPICH}^1(t) = \text{common pilot signal from antenna 1}$$

$$a_1(t) = \text{time varying amplitude of the } S_{CPICH}^1(t)$$

$$f_1(t) = \text{time varying phase of the } S_{CPICH}^1(t)$$

$S^2_{CPICH}(t)$ = common pilot signal from antenna 2 (diversity antenna)

$a_2(t)$ = time varying amplitude of the $S^2_{CPICH}(t)$

$f_2(t)$ = time varying phase of the $S^2_{CPICH}(t)$

Before solving for the optimum phase adjustment, the S^2_{CPICH} is rotated as follows:

$$S^2_{CPICH}(t) = a_2(t)e^{jf_2(t)}e^{jf_r(t)} \tag{4}$$

The rotation angle, $f_r(t)$, which is applied before solving for phase adjustment to be signaled in uplink slot i, is defined as:

$$f_r(t) = \begin{cases} 0, & i = 0,2,4,6,8,10,12,14 \\ \dfrac{p}{2}, & i = 1,3,5,7,9,11,13 \end{cases} \tag{5}$$

After rotation of the S^2_{CPICH} by $f_r(t)$, UE calculates the optimum phase adjustment, f, which is then quantized into f_Q having two possible values as follows:

$$\begin{aligned} \frac{-p}{2} < f \le \frac{p}{2} &\Rightarrow f_Q = 0 \\ \frac{p}{2} < f \le \frac{3p}{2} &\Rightarrow f_Q = p \end{aligned} \tag{6}$$

If $f_Q = 0$, a command '0' is send to UTRAN using the FSM_{ph} field. Correspondingly, if $f_Q = \pi$, command '1' is send to UTRAN using the FSM_{ph} field.

Due to rotation of the constellation at UE the UTRAN interprets the received commands according to Table 9 which shows the mapping between phase adjustment, f_i,, and received feedback command for each UL slot.

Table 9 : Feedback commands and corresponding phase adjustments, f_i, for the slots i of the UL radio frame.

FSM_{ph}	f_i														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0	0	$\pi/2$	0	$\pi/2$	0	$\pi/2$	0	$\pi/2$	0	$\pi/2$	0	$\pi/2$	0	$\pi/2$	0
1	π	$-\pi/2$	π	$-\pi/2$	π	$-\pi/2$	π	$-\pi/2$	π	$-\pi/2$	π	$-\pi/2$	π	$-\pi/2$	π

The weight vector, w_2, is then calculated by sliding window averaging the received phases over 2 consecutive slots. Algorithmically, w_2 is calculated as follows:

$$w_2 = \frac{\sum_{i=n-1}^{n} \cos(f_i)}{\sqrt{2}} + j\frac{\sum_{i=n-1}^{n} \sin(f_i)}{\sqrt{2}} \tag{7}$$

where,

$$f_i \in \{0, p, p/2, -p/2\} \tag{8}$$

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For antenna 1, the weight vector, w_1, is always:

$$w_1 = 1 \tag{9}$$

8.2.1 Mode 1 end of frame adjustment

In closed loop mode 1 at frame borders the sliding window averaging operation is slightly modified. Upon reception of the FB command for slot 0 of the next frame, the average is calculated based on the command for slot 13 of the previous frame and the command for slot 0 of the next frame, i.e. f_i from slot 14 is not used:

$$w_2 = \frac{\cos(\boldsymbol{f}_{13}^{j-1}) + \cos(\boldsymbol{f}_0^{j})}{\sqrt{2}} + j\,\frac{\sin(\boldsymbol{f}_{13}^{j-1}) + \sin(\boldsymbol{f}_0^{j})}{\sqrt{2}} \tag{10}$$

where,

$\boldsymbol{f}_{13}^{j-1}$ = phase adjustment from frame j-1, slot 13

$\boldsymbol{f}_0^{j}$ = phase adjustment from frame j, slot 0

8.2.2 Mode 1 normal initialization

For the first frame of transmission UE determines the feedback commands in a normal way and sends them to UTRAN.

Having received the first FB command the UTRAN calculates the w_2 as follows:

$$w_2 = \frac{\cos(\boldsymbol{p}/2) + \cos(\boldsymbol{f}_0)}{\sqrt{2}} + j\,\frac{\sin(\boldsymbol{p}/2) + \sin(\boldsymbol{f}_0)}{\sqrt{2}} \tag{11}$$

where,

$\boldsymbol{f}_0$ = phase adjustment from slot 0 of the first frame

8.2.3 Mode 1 operation during compressed mode

8.2.3.1 Downlink in compressed mode and uplink in normal mode

When downlink is in compressed mode but uplink is operating normally (i.e. not compressed) the UTRAN continues it's Tx diversity related functions in the same way as in non-compressed downlink mode.

If UE continues to calculate the phase adjustments based on the received CPICH from antennas 1 and 2 during the idle downlink slots there is no difference in UE operation when compared to non-compressed downlink operation.

If during the compressed downlink transmission there are uplink slots for which no new estimate of the phase adjustment has been calculated the following rules are applied in UE when determining the feedback command:

1. If no new estimate of phase adjustment, f_i, exist corresponding to the feedback command to be send in uplink slot i:

   If $1 < i < 15$

       the feedback command sent in uplink slot i-2 is used

   else if $i = 0$

       the feedback command sent in uplink slot 14 of previous frame is used

else if $i = 1$

the feedback command sent in uplink slot 13 of previous frame is used

end if

2. When transmission in downlink is started again in downlink slot N_{Last+1} the UE must resume calculating new estimates of the phase adjustment. The feedback command corresponding to the first new estimate of f_i must be send in the uplink slot which is transmitted 1024 chips in offset from the downlink slot N_{Last+1}.

8.2.3.2   Both downlink and uplink in compressed mode

During the uplink idle slots no FB commands are sent from UE to UTRAN. When transmission in downlink is started again in downlink slot N_{Last+1} the UE must resume calculating new estimates of the phase adjustment. The feedback command corresponding to the first new estimate of f_i must be send in the uplink slot which is transmitted 1024 chips in offset from the downlink slot N_{Last+1}.

The UTRAN continues to update the weight vector, w_2, until the uplink enters the compressed mode and no more FB commands are received. When the transmission in downlink resumes in slot N_{Last+1}, the value of w_2 calculated after receiving the last FB command before uplink entered the compressed mode is applied to antenna 2 signal.

After UE resumes transmission in uplink and sends the first FB command the new value of w_2 is calculated as follows:

S_1 = {0, 2, 4, 6, 8, 10, 12 14}
S_2 = {1, 3, 5, 7, 9, 11, 13}

i = number of uplink slot at which the transmission resumes
j = number of uplink slot at which the last FB command was send before uplink entered compressed mode

do while ($i \in S_1$ and $j \in S_1$) or ($i \in S_2$ and $j \in S_2$)
    j = j-1
    if j < 0
        j = 14
    end if
end do

calculate w_2 based on FB commands received in uplink slots i and j

8.3 Closed loop mode 2

In closed loop mode 2 there are 16 possible combinations of phase and amplitude adjustment from which the UE selects and transmits the FSM according to Table 10 and Table 11**Error! Reference source not found.Error! Reference source not found.**. As opposed to closed loop Mode 1, no constellation rotation is done at UE and no filtering of the received weights is performed at the UTRAN.

Table 10 : FSM$_{po}$ subfield of closed loop mode 2 signalling message.

FSM$_{po}$	Power_ant1	Power_ant2
0	0.2	0.8
1	0.8	0.2

Table 11 : FSM$_{ph}$ subfield of closed loop mode 2 signalling message.

FSM$_{ph}$	Phase difference between antennas (degrees)
000	180

001	-135
011	-90
010	-45
110	0
111	45
101	90
100	135

When $N_{po}=0$, equal power is applied to each antenna.

To obtain the best performance, progressive updating is performed at both the UE and the UTRAN Access point. Every slot time, the UE refines its choice of FSM, from the set of weights allowed given the previously transmitted bits of the FSM. This is shown in Figure 8**Error! Reference source not found.**, where, in this figure b_i (0<i<3) are the bits of the FSM (from **Error! Reference source not found.** and **Error! Reference source not found.**) from the MSB to the LSB and m=0, 1, 2, 3 (the end of frame adjustment given section 8.3.1 is not shown here).

At the beginning of a FSM to be transmitted, the UE chooses the best FSM out of the 16 possibilities. Then the UE starts sending the FSM bits from the MSB to the LSB in the portion of FBI field of the uplink DPCCH during 4 (FSM message length) slots. Within the transmission of the FSM the UE refines its choice of FSM. This is defined in the following. :

Define the 4 bits of FSM, which are transmitted from slot number k to k+3, as $\{b_3(k)\ b_2(k+1)\ b_1(k+2)\ b_0(k+3)\}$, where k=0, 4, 8, 12. Define also the estimated received power criteria defined in Equation 1 for a given FSM as $p(\{x_3, x_2\ x_1\ x_0\})$, where $\{x_3\ x_2\ x_1\ x_0\}$ is one of the 16 possible FSMs which defines an applied phase and amplitude offset according to **Error! Reference source not found.** and **Error! Reference source not found.**. The $b_i()$ and x_i are 0 or 1.

The bits transmitted during the m'th FSM of the frame, where m=0,1,2,3, are then given by

$b_3(4m)=X_3$ from the $\{X_3\ X_2\ X_1\ X_0\}$ which maximises $p(\{x_3\ x_2\ x_1\ x_0\})$ over all x_3,x_2,x_1,x_0 (16 possible combinations);

$b_2(4m+1)=X_2$ from the $\{b_3(4m)\ X_2\ X_1\ X_0\}$ which maximises $p(\{b_3(4m)\ x_2\ x_1\ x_0\})$ over all x_2,x_1,x_0 (8 possible combinations);

$b_1(4m+2)=X_1$ from the $\{b_3(4m)\ b_2(4m+1)\ X_1\ X_0\}$ which maximises $p(\{b_3(4m)\ b_2(4m+1)\ x_1\ x_0\})$ over all x1,x0 (4 possible combinations);

$b_0(4m+3)=X_0$ from the $\{b_3(4m)\ b_2(4m+1)\ b_1(4m+2)\ X_0\}$ which maximises $p(\{b_3(4m)\ b_2(4m+1)\ b_1(4m+2)\ x_0\})$ over x_0 (2 possible combinations).

Slot 4m	Slot 4m+1	Slot 4m+2
Send $b_3(4m)$	Send $b_2(4m+1)$	Send $b_1(4m+2)$

$\{x_3\ x_2\ x_1 x_0\}$ $\{x_3\ x_2\ x_1\ x_0\}$ $\{x_3\ x_2\ x_1\ x_0\}$ $\{x_3\ x_2\ x_1\ x_0\}$

0 0 0 0 $b_3(4m)$ 0 0 0 $b_3(4m)\ b_2(4m+1)$ 0 0

0 0 0 1 $b_3(4m)$ 0 0 1 $b_3(4m)\ b_2(4m+1)$ 0 1 $b_3(4m)\ \ b_2(4m+1)\ \ b_1(4m+2)\ \ 0$

                                       $b_3(4m)\ b_2(4m+1)$ 1 0 $b_3(4m)\ \ b_2(4m+1)\ b_1(4m+2)\ \ 1$

                                       $b_3(4m)\ b_2(4m+1)$ 1 1   2 values

                                       4 values
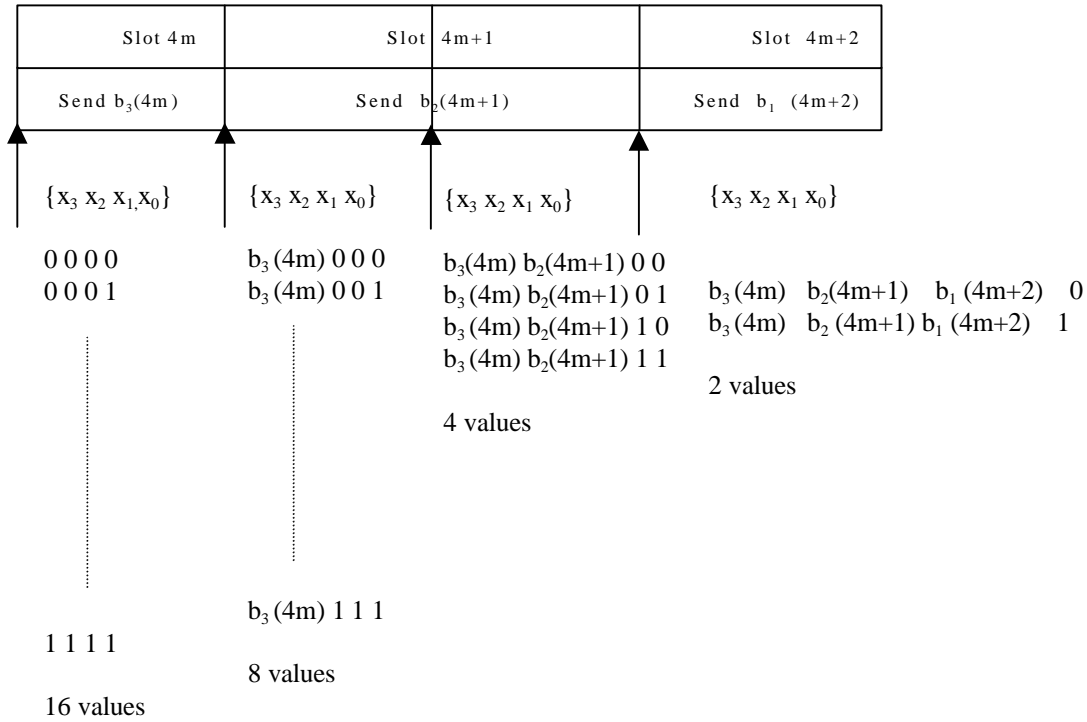
$b_3(4m)$ 1 1 1

1 1 1 1   8 values

16 values

Figure 8 : Progressive Refinement at the UE for closed loop mode 2.

Every slot time the UTRAN constructs the FSM from the most recently received bits for each position in the word and applies the phase and amplitude as defined by **Error! Reference source not found.** and **Error! Reference source not found.**. More precisely, the UTRAN operation can be explained as follows. The UTRAN maintains a register $\mathbf{z}=\{z_3\ z_2\ z_1\ z_0\}$, which is updated every slot time according to $z_i=b_i(ns)$ (i=0:3,ns=0:14). Every slot time the contents of register $\mathbf{z}$ are used to determine the phase and amplitude adjustments as defined by **Error! Reference source not found.** and **Error! Reference source not found.**, with $FSM_{ph}=\{z_3\ z_2\ z_1\}$ and $FSM_{po}=z_0$.

Special procedures for initialisation and end of frame processing are described below.

The weight vector, *w*, is then calculated as:

$$\underline{w} = \begin{bmatrix} \sqrt{power\_ant1} \\ \sqrt{power\_ant2}.\exp(j\boldsymbol{p}.phase\_diff/180) \end{bmatrix} \quad (6)$$

8.3.1 Mode 2 end of frame adjustment

The FSM must be wholly contained within a frame. To achieve this an adjustment is made to the last FSM in the frame where the UE only sends the FSM_{ph} subfield, and the Node B takes the amplitude bit FSM_{po} of the previous FSM.

8.3.2 Mode 2 normal Initialisation

For the first frame of transmission using closed loop mode 2, the operation is as follows.

The UE starts sending the FSM message in slot 0 in the normal way, refining its choice of FSM in slots 1 to 3 from the set of weights allowed given the previously transmitted bits of the FSM.

During the reception of the first three FSM bits (that is before the full four bits are received), the UTRAN Access Point initialises its transmissions as follows. The power in both antennas is set to 0.5. The phase offset applied between the antennas is updated according to the number and value of FSM_{ph} bits received as given in Table 12.

Table 12 : FSM_{ph} normal initialisation for closed mode 2.

FSM_{ph}	Phase difference between antennas (degrees)
- - -	180 (normal initialisation) or held from previous setting (slotted mode recovery)
0 - -	180
1 - -	0
0 0 -	180
0 1 -	-90
1 1 -	0
1 0 -	90
0 0 0	180
0 0 1	-135
0 1 1	-90
0 1 0	-45
1 1 0	0
1 1 1	45
1 0 1	90
1 0 0	135

This operation applies in both the soft handover and non soft handover cases.

8.3.3   Mode 2 operation during compressed mode

8.3.3.1   Downlink in compressed mode and uplink in compressed mode

When the downlink is in compressed mode and the uplink is in normal mode, the closed loop mode 2 functions are described in 8.3.3.1 below.

When the UE is NOT listening to the CPICH from antennas 1 and 2 during the idle downlink slots, the UE sends the last FSM bits calculated before entering in the uplink compressed mode.

8.3.3.2   Both downlink and uplink in compressed mode

For recovery after compressed mode, UTRAN Access Point sets the power in both antennas to 0.5 until a FSM_{po} bit is received. Until the first FSM_{ph} bit is received and acted upon, UTRAN uses the phase offset, which was applied before the transmission interruption (Table 12). Normal initialisation of FSM_{ph} (Table 12) occurs if the uplink signalling information resumes at the beginning of a FSM period (that is if signalling resumes in slots 0,4,8,12). If the uplink signalling does not resume at the beginning of a FSM period, the following operation is performed.

In each of the remaining slots of the partial FSM period, and for the first slot of the next full FSM period, the UE sends the first (i.e. MSB) bit of the FSM_{ph} message, and at the UTRAN access point the phase offset applied between the antennas is updated according to the number and value of FSM_{ph} bits received as given in **Error! Reference source not found.**. Initialisation then continues with the transmission by the UE of the remaining FSM_{ph} bits and the UTRAN operation according to Table 12.

Table 13 : FSMph subfield of FB mode 2 compressed mode recovery period

FSM_{ph}	Phase difference between antennas (degrees)
-	held from previous setting
0	180
1	0

9 Uplink synchronous transmission

9.1 General

<Note: This scheme is not a base-line implementation capability.>

UplinkSynchronous Transmission Scheme(USTS) is an alternative technology applicable for low mobility terminals. USTS can reduce uplink intra-cell interference by means of making a cell receive orthogonalized signals from UEs. To orthogonalize receiving signals from UEs,

- the same scrambling code is allocated to all dedicated physical channels in a cell,

- different channelization codes are allocated to all dedicated physical channels across all UEs in a cell and the spreading factor and code number of channelization code are delivered from network to each UE

- the channelization codes for DPDCH and DPCCH in a UE are chosen from either upper half part or the lower half part of the OVSF code tree in a UE to reduce peak to average power ratio,

- additional scrambling codes can be allocated if all channelization codes are occupied, and

- the signal transmission time of each UE is adjusted.

The spreading and modulation scheme for USTS is same as section 4 of TS 25.213. In case of USTS, the long scrambling code described in section 4.3.2.2. of TS 25.213 is used. However, this long scrambling code is not UE specific, but cell specific. In order to generate the cell specific long scrambling code, the initial loading value of PN generator is determined by the network

The channelization codes are Orthogonal Variable Spreading Factor (OVSF) codes that preserve the orthogonality between USTS uplink channels of different rates and spreading factors.

The transmission time control is carried out by two steps. The first step is initial synchronization and the second is tracking.

1) Initial synchronization: Adjust transmission time through the initial timing control message over FACH

2) Tracking Process (Closed Loop Timing control): Adjust the transmission time through the Time Alignment Bit (TAB) over DPCCH.

9.2 Initial synchronisation

- When the cellreceives signal from UE over RACH, cell measures the difference in time between the received timing and the reference time in the unit of 1/8 chip duration..

- The message for initial synchronization, which contains the difference in time, is delivered to UE via FACH.

- UE adjust its transmission time according to the message.

9.3 Tracking process

- Cell periodically compares the reference time with received signal timing from UE.

- When the received timing is earlier than the reference time, Time Alignment Bit (TAB) = "0". When this is later than the reference time, TAB = "1".

- TAB replaces the TPC bit every timing control period of 20 msecand the last TPC bit of every two frames is replaced by TAB.

- At the UE, hard decision on the TAB shall be performed, and when it is judged as "0", the transmission time shall be delayed by 1/8 chip, whereas if it is judged as "1", the transmission time shall be advanced by 1/8 chip.

Annex A (informative): Antenna verification

In FB mode 1, if channel estimates are taken from the Primary CCPCH, the performance will also suffer if the UE can not detect errors since the channel estimates will be taken for the incorrect phase settings. To mitigate this problem, antenna verification can be done, which can make use of antenna specific pilot patterns of the dedicated physical channel. The antenna verification can be implemented with several different algorithms. A straightforward algorithm can use a 4-hypothesis test per slot. Alternatively, a simplified beam former verification (SBV) requiring only a 2 hypothesis test per slot can be used. If we have orthogonal pilot patterns on the downlink DPCCH we can apply the SBV as follows:

Consider

$$2 \sum_{i=1}^{N_{path}} \frac{1}{s_i^2} \left\{ 2 \operatorname{Re}(\boldsymbol{g} h_{2,i}^{(d)} h_{2,i}^{(p)^*}) \right\} > \ln \left(\frac{\overline{p}(\boldsymbol{f}_{Rx} = \boldsymbol{p})}{\overline{p}(\boldsymbol{f}_{Rx} = 0)} \right)$$

then define the variable x_0 as, $x_0 = 0$ if the above inequality holds good and $x_0 = \pi$ otherwise.
Similarly consider

$$-2 \sum_{i=1}^{N_{path}} \frac{1}{s_i^2} \left\{ 2 \operatorname{Im}(\boldsymbol{g} h_{2,i}^{(d)} h_{2,i}^{(p)^*}) \right\} > \ln \left(\frac{\overline{p}(\boldsymbol{f}_{Rx} = -\dfrac{\boldsymbol{p}}{2})}{\overline{p}(\boldsymbol{f}_{Rx} = \dfrac{\boldsymbol{p}}{2})} \right)$$

then define the variable x_1 as, $x_1 = -\pi/2$ if the above inequality holds good and $x_1 = \pi/2$ oherwise.
Whether x_0 or x_1 is to be calculated for each slot is given by the following table:

Slot	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0

The estimate for the transmitted phase is now obtained as:

$$\sin(_{Tx}) + j \quad _{Tx}) \quad \frac{\sum_{i=} \sin(x_i}{2} + \frac{\cos(x_i}{2}$$

$h_{2,i}^{(p)}$ is the i'th estimated channel tap of antenna 2 using the PCCPCH,

    $h_{2,i}^{(d)}$ is the i'th estimated channel tap of antenna 2 using the DPCCH,

    γ^2 is the DPCH Pilot SNIR/ PCCPCH Pilot SNIR,

    $\boldsymbol{a}_i$ are the elements of $\underline{w}$,

    s_i^2 is the noise plus interference on the i'th path.

In normal operation the *a priori* probability for selected pilot pattern is assumed to be 96% (assuming there are 4% of errors in the feedback channel for power control and antenna selection).

Annex B (Informative): Power control timing

The power control timing described in this annex should be seen as an example on how the control bits have to be placed in order to permit a short TPC delay.

In order to maximise the BTS-UE distance within which one-slot control delay is achieved, the frame timing of an uplink DPCH is delayed by 1024 chips from that of the corresponding downlink DPCH measured at the UE antenna.

Responding to a downlink TPC command, the UE shall change its uplink DPCH output power at the beginning of the first uplink pilot field after the TPC command reception. Responding to an uplink TPC command, BTS shall change its DPCH output power at the beginning of the next downlink pilot field after the reception of the whole TPC command. Note that in soft handover, the TPC command is sent over one slot when DPC_MODE is 0 and over three slots when DPC_MODE is 1. Note also that the delay from the uplink TPC command reception to the power change timing is not specified for BTS. The UE shall decide and send TPC commands on the uplink based on the downlink SIR measurement. The TPC command field on the uplink starts, when measured at the UE antenna, 512 chips after the end of the downlink pilot field. BTS shall decide and send TPC commands based on the uplink SIR measurement. However, the SIR measurement periods are not specified either for UE nor BTS.

Figure B-1 illustrates an example of transmitter power control timings.
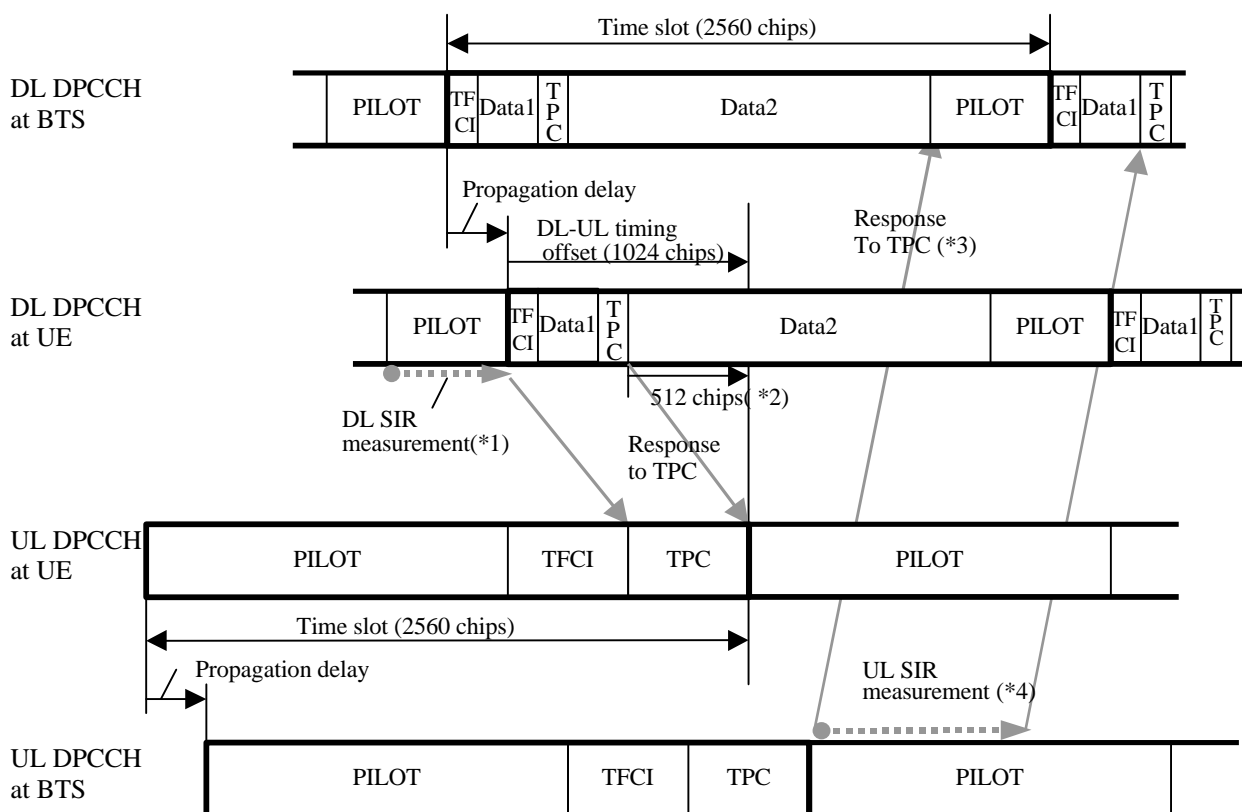
*1,4   The SIR measurement periods illustrated here are examples. Other ways of measurement are allowed to achieve accurate SIR estimation.
*2   Except the case of DL symbol rate=7.5ksps.
*3   If there is not enough time for BTS to respond to the TPC, the action can be delayed until the next slot.

Figure B-1 : Transmitter power control Timing

Annex C (Informative): Cell search procedure

[NOTE: THE TEXT IN THIS SECTION HAS BEEN COPIED FROM SECTION 4.1 WITHOUT REVISION MARKS, AND THEN REVISIONS HAVE BEEN MADE TO SHOW DIFFERENCES IN THE TEXT.]

During the cell search, the UE searches for a cell and determines the downlink scrambling code and frame synchronisation of that cell. The cell search is typically carried out in three steps:

Step 1: Slot synchronisation

During the first step of the cell search procedure the UE uses the SCH's primary synchronisation code to acquire slot synchronisation to a cell. This is typically done with a single matched filter (or any similar device) matched to the primary synchronisation code which is common to all cells. The slot timing of the cell can be obtained by detecting peaks in the matched filter output.

Step 2: Frame synchronisation and code-group identification

During the second step of the cell search procedure, the UE uses the SCH's secondary synchronisation code to find frame synchronisation and identify the code group of the cell found in the first step. This is done by correlating the received signal with all possible secondary synchronisation code sequences, and identifying the maximum correlation value. Since the cyclic shifts of the sequences are unique the code group as well as the frame synchronisation is determined.

Step 3: Scrambling-code identification

During the third and last step of the cell search procedure, the UE determines the exact primary scrambling code used by the found cell. The primary scrambling code is typically identified through symbol-by-symbol correlation over the CPICH with all codes within the code group identified in the second step. After the primary scrambling code has been identified, the Primary CCPCH can be detected.And the system- and cell specific BCH information can be read.

If the UE has received information about which scrambling codes to search for, steps 2 and 3 above can be simplified.

History

Document history		
V0.0.1	1999-02-12	Document created based on ETSI XX.07 V1.3.1 and ARIB Volume 3 ver. 1.0.
V0.1.0	1999-02-26	Version approved by WG1#2. The changes agreed at the meeting to incorporate e.g. ad hoc conclusions not yet included.
V1.0.0	1999-03-04	Version approved by TSG RAN. The changes agreed at the WG1#2 meeting to incorporate e.g. ad hoc conclusions not yet included.
V1.0.1	1999-03-17	Include adhoc conclusions in WG1#2
V1.0.2	1999-03-24	Include adhoc conclusions in WG1#3
V1.1.0	1999-03-25	Version approved by WG1#3.
V2.0.0	1999-04-20	Version approved by WG1#4
V1.0.0	1999-04-23	Version approved by TSG RAN#3
V1.1.0	1999-06-04	Version approved by WG1#5
V1.2.0	1999-08-30	Version approved by WG1#7
V1.3.0	1999-09-03	Version approved by WG1#7
V1.4.0	1999-10-05	Version approved by WG1#7bis
Editors for 3GPP TSG RAN S1.14 are: Takehiro Nakamura NTT DoCoMo R&D Headquarters Tel: +81 468 40 31 90 Mobile: +81 30 20 05 542 Fax: +81 468 40 38 40 E-mail: takehiro@wsp.yrp.nttdocomo.co.jp This document is written in Microsoft Word 97.		