# ETSI TS 125 214 V3.1.1 (2000-01)

*Technical Specification*

**Universal Mobile Telecommunications System (UMTS);**
**Physical layer procedures (FDD)**
**(3G TS 25.214 version 3.1.1 Release 1999)**

Reference

DTS/TSGR-0125214U

Keywords

UMTS

***ETSI***

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# Foreword

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# Foreword

This Technical Specification has been produced by the 3GPP.

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# 1 Scope

The present 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, the latest version applies.

[1] TS 25.211: "Physical channels and mapping of transport channels onto physical channels (FDD)"

[2] TS 25.212: "Multiplexing and channel coding (FDD)"

[3] TS 25.213: "Spreading and modulation (FDD)"

[4] TS 25.215: "Physical layer – Measurements (FDD)"

# 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 |
| DTX | Discontinuous Transmission |
| 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 synchronisation

The 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 4.3.2 and 4.3.3 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 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 5.2.1, 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.

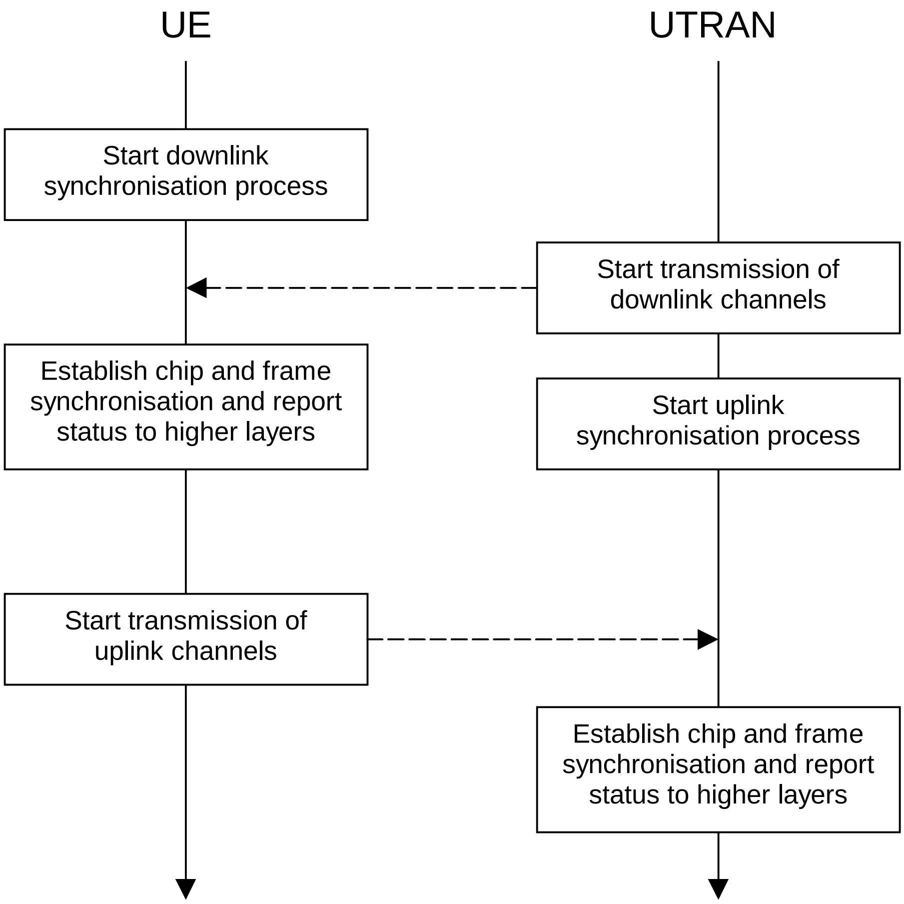



**Figure 1: Synchronisation establishment flow for dedicated channels: uplink dedicated channel not existing**

### 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 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.

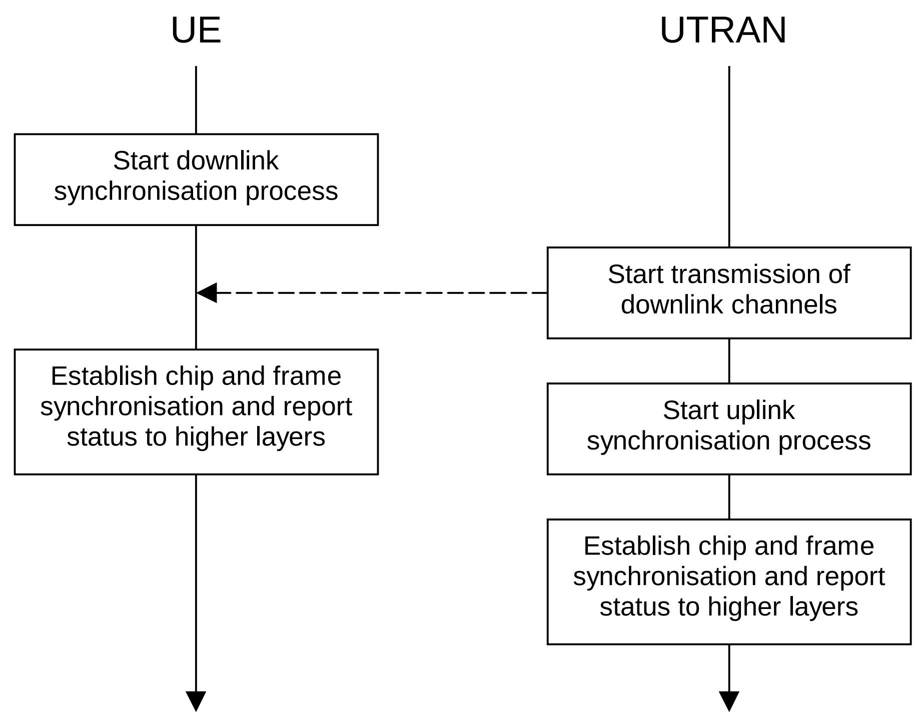



**Figure 2: Synchronisation establishment flow for dedicated channels: uplink dedicated channel already existing**

### 4.3.4 Transmission timing adjustments

During a connection the UE may adjust its DPDCH/DPCCH transmission time instant.

If the receive timing for any downlink DPCCH/DPDCH in the current active set has drifted, so the time between reception of the downlink DPCCH/DPDCH in question and transmission of uplink DPCCH/DPDCH lies outside the valid range, L1 shall inform higher layers of this, so that the network can be informed of this and downlink timing can be adjusted by the network.

NOTE: The maximum rate of uplink TX time adjustment, and the valid range for the time between downlink DPCCH/DPDCH reception and uplink DPCCH/DPDCH transmission in the UE is to be specified by RAN WG4.

# 5 Power control

## 5.1 Uplink power control

### 5.1.1 PRACH

#### 5.1.1.1 General

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

#### 5.1.1.2 Setting of PRACH control and data part power difference

The message part of the uplink PRACH channel shall employ gain factors to control the control/data part relative power similar to the uplink dedicated physical channels. Hence, section 5.1.2.4 applies also for the RACH message part, with the differences that:

- $\beta_c$ is the gain factor for the control part (similar to DPCCH),
- $\beta_d$ 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 is set by higher layers.

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

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

The serving cells (cells in the active set) should estimate signal-to-interference ratio $SIR_{est}$ of the received uplink DPCH . The serving cells 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 $\Delta_{TPC}$ 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 $\Delta_{TPC}$ 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 $\Delta_{TPC}$ dB. If TPC_cmd equals -1 then the transmit power of the uplink DPCCH and uplink DPDCHs shall be decreased by $\Delta_{TPC}$ dB. If TPC_cmd equals 0 then the transmit power of the uplink DPCCH and uplink DPDCHs shall be unchanged.

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

##### 5.1.2.2.1.1 Out of synchronisation handling

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

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

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

#### 5.1.2.2.2 Algorithm 1 for processing TPC commands

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

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

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

##### 5.1.2.2.2.2 Combining of TPC commands known to be the same

When a UE is in soft handover, multiple TPC commands may be received in each slot from different cells in the active set. In some cases, the UE has the knowledge that some of the transmitted TPC commands in a slot are the same. This is the case e.g. with receiver diversity or so called softer handover when the UTRAN transmits the same command in all the serving cells the UE is in softer handover with. For these cases, the TPC commands known to be the same 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 conduct a soft symbol decision on each of the power control commands $TPC_i$, where i = 1, 2, …, N and N is the number of TPC commands not known to be the same, that may be the result of a first phase of combination according to subclause 5.1.2.2.2.2.

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

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

#### 5.1.2.2.3 Algorithm 2 for processing TPC commands

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

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

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

The value of TPC_cmd is derived as follows:

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

- Otherwise, TPC_cmd = 0 in the 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 $\gamma$ of all the N temporary power control commands $TPC\_temp_i$:

TPC_cmd(3rd slot) = $\gamma$ ($TPC\_temp_1$, $TPC\_temp_2$, …, $TPC\_temp_N$), 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 $\gamma$:

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

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

Otherwise, TPC_cmd is set to 0.

### 5.1.2.3 Transmit power control in compressed mode

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

In downlink compressed mode, no power control is applied 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 $\Delta_{RESUME}$. The value of $\Delta_{RESUME}$ (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 25.215). The different modes are summarised in table 1.

**Table 1: Power control resume modes during compressed mode**

| Power Resume Mode | Description |
|---|---|
| 0 | $\Delta_{RESUME} = 0$ |
| 1 | $\Delta_{RESUME} = \mathrm{Int}[\delta_{last} / \Delta_{TPCmin}]\ \Delta_{TPCmin}$ |

Here Int[ ] means round to the nearest integer and $\Delta_{TPCmin}$ is the minimum power control step size supported by the UE. $\delta_{last}$ 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:

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

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

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

**Table 2: Power control modes during compressed mode**

| Mode | Description |
|---|---|
| 0 | Ordinary transmit power control (see subclause 5.1.2.2) is applied with step size $\Delta_{TPC}$ |
| 1 | Ordinary transmit power control is applied using algorithm 1 (see subclause 5.1.2.2.2) with step size $\Delta_{RP-TPC}$ 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, power control algorithm 1 is applied with a step size $\Delta_{RP-TPC}$ instead of $\Delta_{TPC}$.

$\Delta_{RP-TPC}$ 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, $\Delta_{RP-TPC}$ is equal to the minimum value of 3 dB and $2\Delta_{TPC}$. If algorithm 2 (section 5.1.2.2.3) is used in normal mode, $\Delta_{RP-TPC}$ is equal to 1 dB.

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

After the recovery period, ordinary transmit power control resumes using the same algorithm and step size as used in normal mode before the transmission gap.

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 5.1.2.2.2.3.1) 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.

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

### 5.1.2.4 Transmit power control in DPCCH power control preamble

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

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

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

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

### 5.1.2.5 Setting of the uplink DPCCH/DPDCH power difference

#### 5.1.2.5.1 General

The uplink DPCCH and DPDCH(s) are transmitted on different codes as defined in section 4.2.1 of TS 25.213. The gain factors $\beta_c$ and $\beta_d$ 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:

- $\beta_c$ and $\beta_d$ are signalled for the TFC, or
- $\beta_c$ and $\beta_d$ 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 $\beta_c$ and $\beta_d$ 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 $\pm\Delta_{TPC}$ dB.

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

#### 5.1.2.5.2 Signalled gain factors

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

#### 5.1.2.5.3 Computed gain factors

The gain factors $\beta_c$ and $\beta_d$ may also be computed for certain TFCs, based on the signalled settings for a reference TFC.

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

Define the variable

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

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

Similarly, define the variable

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

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

The variable $A_j$ is then computed as:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

## 5.1.3 PCPCH

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

### 5.1.3.1 Power control in the message part

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

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

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

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

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

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

### 5.1.3.2 Power control in the power control preamble

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

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

# 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 sub-clauses.

### 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

##### 5.2.1.2.1 General

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 average power of transmitted DPDCH symbols over one timeslot shall not exceed Maximum_DL_Power(dBm), nor shall it be below Minimum_DL_Power (dBm). Transmitted DPDCH symbol means here a complex QPSK symbol before spreading which does not contain DTX.

NOTE: It should still be clarified whether Maximum_DL_Power and Minimum_DL_Power are defined for one code or for one CCTrCH

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.

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.

##### 5.2.1.2.2 Adjustment loop

UTRAN may further employ adjustment loop, in which they change their calculated transmission powers *P(i)* in every slot according to the following equation:

$$P(i+1) = P(i) + S_{INNER}(i) + S_{ADJ}(i)$$

$$S_{ADJ}(i) = \mathrm{sign}\{(1 - r)(P_{REF} - P(i))\}\ \min\{|(1 - r)(P_{REF} - P(i))|, S_{ADJ\_MAX}\}$$

where

*P(i)*: calculated transmission power of UTRAN access point in dBm,

$S_{INNER}(i)$: inner loop control in dB,

$S_{ADJ}(i)$: adjustment loop control in dB,

*sign{x}*: sign function of the value *x*, i.e. +1 when x>0, 0 when x=0, and –1 when x<0,

*r*: convergence coefficient ($0 \leq r \leq 1$),

$P_{REF}$: reference transmission power in dBm,

$S_{ADJ\_MAX}$: maximum power change limit by adjustment loop in dB.

The actual change in the transmitted power level due to the adjustment loop is a value which is the nearest allowed TPC step to $S_{ADJ}(i)$. The parameters, *r*, $P_{REF}$, and $S_{ADJ\_MAX}$ shall be signalled by higher layers. $S_{ADJ\_MAX}$ shall be a multiple of the minimum step size $\Delta_{TPC,min}$ dB.

### 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)<br>0000000(0) | 000(0)<br>000(0) | 000<br>000 |
| b | 1111111(1)<br>1111111(1) | 111(1)<br>111(1) | 111<br>111 |
| c | 0000000(0)<br>1111111(1) | 000(0)<br>111(1) | 000<br>111 |
| d | 1111111(1)<br>0000000(0) | 111(1)<br>000(0) | 111<br>000 |
| e | 0000111(1)<br>1111000(0) | 001(1)<br>110(0) | 001<br>100 |
| f | 1111000(0)<br>0000111(1) | 110(0)<br>001(1) | 110<br>011 |
| g | 0011110(0)<br>0011110(0) | 011(0)<br>011(0) | 010<br>010 |
| h | 1100001(1)<br>1100001(1) | 100(1)<br>100(1) | 101<br>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 subclause5.2.1.2 or 5.2.1.3 in compressed mode.

#### 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 uplink link compressed mode, does not results in excessive levels of puncturing on the coded ID. The acceptable level of puncturing on the coded ID is less than (int)$N_{ID}$/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 with update synchronous. 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 cell state is unchanged 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. 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 5.2.1.2 or 5.2.1.3 in 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 by the same way as specified in 5.2.1.2 or 5.2.1.3 in compressed mode | 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.

## 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 compared to the primary CPICH transmit power by the higher layers.

# 6 Random access procedure

## 6.1 Physical random access procedure

The physical random access procedure described in this section is initiated upon request of a PHY-Data-REQ primitive from the MAC sublayer (cf. TS 25.321).

Before the physical random-access procedure can be initiated, Layer 1 shall receive the following information from the higher layers (RRC) :

- The preamble scrambling code
- The message length in time, either 10 or 20 ms
- The AICH_Transmission_Timing parameter [0 or 1].
- The available signatures and RACH sub-channel groups for each Access Service Class (ASC), where a sub-channel group is defined as a group of some of the sub-channels defined in Section 6.1.1.
- The power-ramping factor Power_Ramp_Step [integer > 0].
- The parameter Preamble_Retrans_Max [integer > 0].
- The initial preamble power Preamble_Initial_Power.
- The set of Transport Format parameters. This includes the power offser $\Delta P_{p\text{-}m}$ between the preamble and the message part for each Transport Format.

Note that the above parameters may be updated from higher layers before each physical random access procedure is initiated.

At each initiation of the physical random access procedure, Layer 1 shall receive the following information from the higher layers (MAC):

- The Transport Format to be used for the PRACH message part.
- The ASC of the PRACH transmission.
- The data to be transmitted (Transport Block Set).

The physical random-access procedure shall be performed as follows:

1 Randomly select the RACH sub-channel group from the available ones for the given ASC. The random function shall be usch that each of the allowed selections is chosen with equal probability.

2 Derive 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 select one uplink 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 select one access slot from the available access slots in the following frame, defined by SFN+1. The random function shall be such that each of the allowed selections is chosen with equal probability.

3 Randomly select a signature from the available signatures for the given ASC. The random function shall be such that each of the allowed selections is chosen with equal probability.

4 Set the Preamble Retransmission Counter to Preamble_Retrans_Max.

5 Set the preamble transmission power to Preamble_Initial_Power.

6 Transmit a preamble using the selected uplink access slot, signature, and preamble transmission power.

7 If no positive or negative acquisition indicator corresponding to the selected signature is detected in the downlink access slot corresponding to the selected uplink access slot:

7.1 Select a new uplink access slot as next available access slot, i.e. next access slot in the sub-channel group used, as selected in 1

7.2 Randomly selects a new signature from the available signatures within the given ASC. The random function shall be such that each of the allowed selections is chosen with equal probability.

7.3 Increase the preamble transmission power by $\Delta P_0$ = Power_Ramp_Step [dB].

7.4 Decrease the Preamble Retransmission Counter by one.

7.5 If the Preamble Retransmission Counter > 0 then repeat from step 6. Otherwise pass L1 status ("No ack on AICH") to the higher layers (MAC) and exit the physical random access procedure.

8 If a negative acquisition indicator corresponding to the selected signature is detected in the downlink access slot corresponding to the selected uplink access slot, pass L1 status ("Nack on AICH received") to the higher layers (MAC) and exit the physical random access procedure.

9 Transmit the 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 $\Delta P_{p\text{-}m}$.

10 Pass L1 status "RACH message transmitted" to the higher layers and exit the physical random access procedure.

### 6.1.1 RACH sub-channels

A RACH sub-channel defines a sub-set of the total set of access slots. There are a total of 12 RACH sub-channels. RACH sub-channel #i (i = 0, …, 11) consists of the following access slots:

- Access slot #i transmitted in parallel to P-CCPCH frames for which SFN mod 8 = 0 or SFN mod 8 = 1.
- Every $12^{th}$ access slot relative to this access slot.

The access slots of different RACH sub-channels are also illustrated in Table 7.

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

| | Sub-channel Number | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SFN modulo 8 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 0 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | | |
| 1 | 12 | 13 | 14 | | | | | | 8 | 9 | 10 | 11 |
| 2 | | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| 3 | 9 | 10 | 11 | 12 | 13 | 14 | | | | | | 8 |
| 4 | 6 | 7 | | | | | 0 | 1 | 2 | 3 | 4 | 5 |
| 5 | | | 8 | 9 | 10 | 11 | 12 | 13 | 14 | | | |
| 6 | 3 | 4 | 5 | 6 | 7 | | | | | 0 | 1 | 2 |
| 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) $\Delta P_0$ = Power step size for each successive CPCH access preamble.

   [RACH/CPCH parameter]

4) $\Delta P_1$ = 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 $\Delta P_1$ is used in place of $\Delta P_0$.

   [RACH/CPCH parameter]

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

   [RACH/CPCH parameter]

6) $L_{pc\text{-}preamble}$ = Length of power control preamble (0 or 8 slots)

   [CPCH parameter]

NOTE: It is FFS if $\Delta P_0$ for the CPCH access may be different from $\Delta P_0$ 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 channel.

3) 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 acquisition 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 $\Delta P$ . Power offset $\Delta P_0$ s is used unless the negative AICH timer is running, in which case $\Delta P_1$ is used instead..

   c) Decrease the Preamble Retransmission Counter by one.

   d) 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 $\Delta P_1$ 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) 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

# 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.

For the closed loop mode 1 different (orthogonal) dedicated pilots symbols in the DPCCH are sent on the 2 different antennas. For closed loop mode 2 the same dedicated pilot symbols in the DPCCH are sent on both antennas.

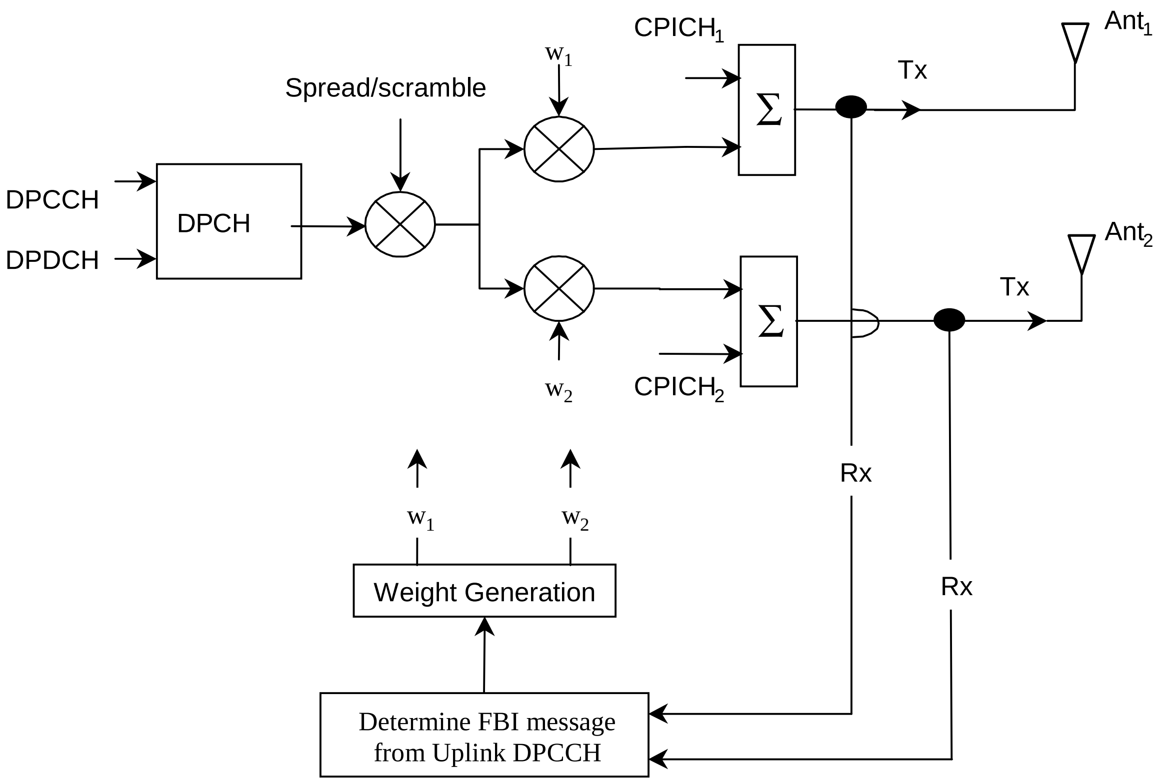



**Figure 6: The generic downlink transmitter structure to support closed loop mode transmit diversity for DPCH transmission**

There are two closed loop modes whose characteristics are summarized in the table 8. The use of the modes is controlled via higher layer signalling.

**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, $\phi$, 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, $\underline{w}$, that maximises

$$P=\underline{w}^H H^H H \underline{w} \qquad (1)$$

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,

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

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.

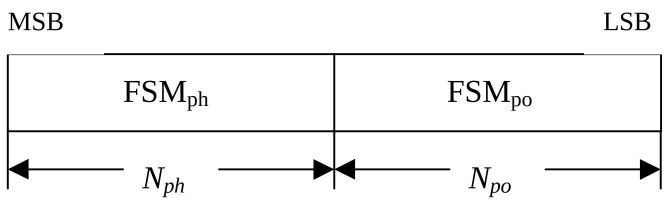



**Figure 7: Format of feedback signalling message. $FSM_{po}$ transmits the power setting and $FSM_{ph}$ the phase setting**

The adjustments are made by the UTRAN Access Point at the beginning of the downlink DPCCH pilot field. The downlink slot in which the adjustment is done is signaled to L1 of UE by higher layers. Two possibilities exist:

1. When feedback command is transmitted in uplink slot $i$, which is transmitted in a chip offset limited to 1024 ± 148 chips when compared to received downlink slot $j$, the adjustment is done at the beginning of the pilot field of the downlink slot ($j$+1) mod 15, or

2. When feedback command is transmitted in uplink slot $i$, which is transmitted in a chip offset limited to 1024 ± 148 chips when compared to received downlink slot $j$, the adjustment is done at the beginning of the pilot field of the downlink slot ($j$+2) mod 15.

## 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:

$$S^1_{CPICH}(t) = a_1(t)e^{j\phi_1(t)} \qquad (2)$$

$$S^2_{CPICH}(t) = a_2(t)e^{j\phi_2(t)} \qquad (3)$$

where,

$S^1_{CPICH}(t)$ = common pilot signal from antenna 1

$a_1(t)$ = time varying amplitude of the $S^1_{CPICH}(t)$

$\phi_1(t)$ = time varying phase of the $S^1_{CPICH}(t)$

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

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

$\phi_2(t)$ = time varying phase of the $S^2_{CPICH}(t)$

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

$$S^2_{CPICH}(t) = a_2(t)e^{j\phi_2(t)}e^{j\phi_r(t)} \qquad (4)$$

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

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

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

$$\begin{aligned} \frac{-\pi}{2} < \phi \le \frac{\pi}{2} \quad &\Rightarrow \quad \phi_Q = 0 \\ \frac{\pi}{2} < \phi \le \frac{3\pi}{2} \quad &\Rightarrow \quad \phi_Q = \pi \end{aligned} \qquad (6)$$

If $\phi_Q = 0$, a command '0' is send to UTRAN using the $FSM_{ph}$ field. Correspondingly, if $\phi_Q = \pi$, 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, $\phi_i$ ,, and received feedback command for each UL slot.

**Table 9: Feedback commands and corresponding phase adjustments, $\phi_i$, for the slots *i* of the UL radio frame**

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

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

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

where,

$$\phi_i \in \{0, \pi, \pi/2, -\pi/2\} \quad (8)$$

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

$$w_1 = 1 \quad (9)$$

### 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. $\phi_i$ from slot 14 is not used:

$$w_2 = \frac{\cos(\phi_{13}^{j-1}) + \cos(\phi_0^{j})}{\sqrt{2}} + j \frac{\sin(\phi_{13}^{j-1}) + \sin(\phi_0^{j})}{\sqrt{2}} \quad (10)$$

where,

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

$\phi_0^{j}$ = 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:

$$w_2 = \frac{\cos(\pi/2) + \cos(\phi_0)}{\sqrt{2}} + j \frac{\sin(\pi/2) + \sin(\phi_0)}{\sqrt{2}} \quad (11)$$

where,

$\phi_0$ = 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, $\phi_i$, 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 $\phi_i$ 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 $\phi_i$ 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. 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 |

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, where, in this figure $b_i$ (0<i<3) are the bits of the FSM (from table 10 and table 11) 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 table 10 and table 11. 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).

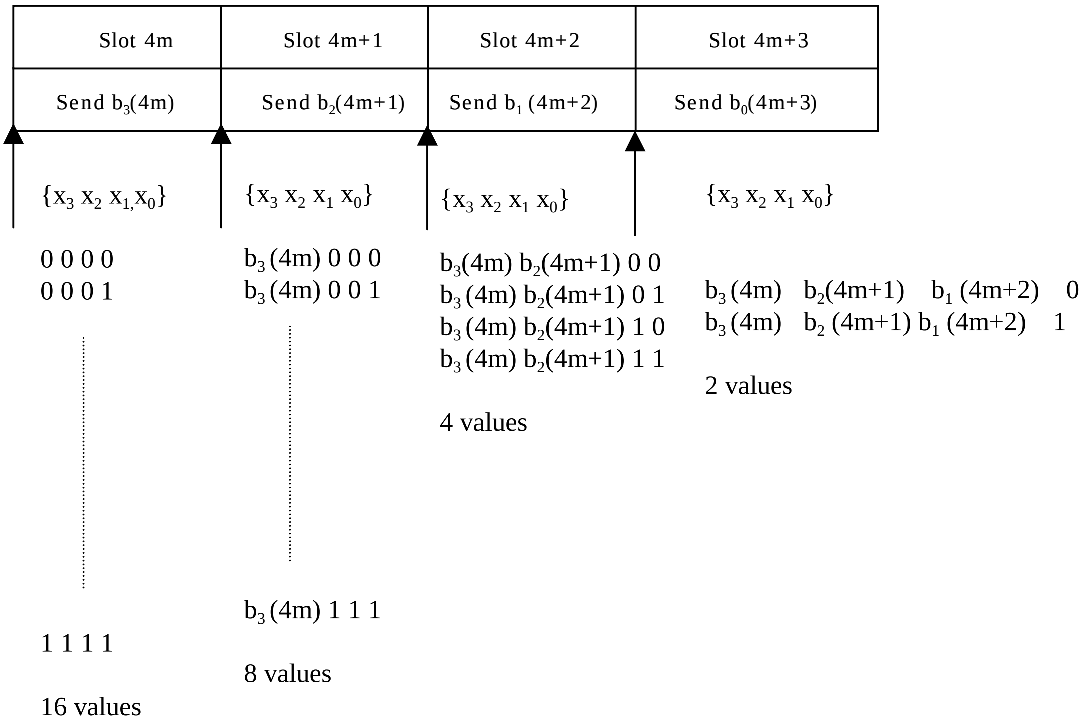



**Figure 8: Progressive Refinement at the UE for closed loop mode 2**

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 table 10 and table 11. 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 **z** are used to determine the phase and amplitude adjustments as defined by table 10 and table 11, 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:

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

## 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)<br>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 normal mode

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

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.

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 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 table 13. 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 |

### 8.3.3.2 Both downlink and uplink in compressed mode

During both downlink and uplink compressed mode, the UTRAN and the UE performs the functions of recovery after compressed mode as described in the previous section 8.3.3.1

# 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.

# 10 Idle Periods for IPDL Location method.

To support time difference measurements that need to be made for location services there needs to be Idle Periods created in the DownLink (IPDL) during which time all channels from a node B are temporally seized. During these Idle Periods the visibility of neighbour basestations from the UE is improved thus allowing the measurements to be performed.

The Idle Periods are arranged in a predetermined pseudo random fashion according to higher layer parameters, these parameters are used by layer 1 to arrange and use these Idle Periods. Idle Periods differ from compressed mode in that they are shorter in duration, all channels are silent simultaneously, and no attempt is made to prevent data loss.

In general there are two modes for these Idle Periods:

- Continuous mode, and
- Burst mode

In continuous mode the Idle Periods are active all the time. In burst mode the Idle Periods are arranged in bursts where each burst contains enough Idle Periods to allow a UE to make sufficient measurements for its location to be calculated. The bursts are separated by a period where no Idle Periods occur.

## 10.1 Parameters of IPDL

The follow parameters are signalled to the UE via higher layers:

**IP_Status:** This is a logic value that indicates if the Idle Periods are arranged in continuous or burst mode.

**IP_Spacing:** The number of 10ms frames between the start of a frame that contains an Idle Period and the next frame that contains an Idle Period. (Note that there is at most one Idle Period in a frame)

**IP_Length:** The length of the Idle Periods, expressed in symbols of the CPICH.

**IP_offset:** A cell specific offset (can be used to synchronise Idle Periods from different sectors within a node B).

**Seed:** A seed for a pseudo random number generator.

Additionally in the case of burst mode operation the following parameters are also communicated to the UE.

**Burst_Start:** The SFN where the first burst of Idle Periods starts.

**Burst_Length:** The number of Idle Periods in a burst of Idle Periods.

**Burst_Freq:** The number of frames of the primary CPICH between the start of a burst and the start of the next burst.

## 10.2 Calculation of Idle Period Position

The position of the $x^{th}$ Idle Period relative to the start of a burst, expressed in symbols of the CPICH, is given by the formula (assuming the Idle Periods are indexed from 1, i.e. the first Idle Period is x=1 etc):

$$x * IP\_Spacing * 150 + rand(x \bmod 64) \bmod Max\_dev + IP\_offset$$

$$\begin{aligned} where: \quad & Max\_dev = 150 - IP\_Length, \\ & rand(n) = (106 * rand(n-1) + 1283) \bmod 6075, \qquad and \\ & rand(0) = Seed \end{aligned}$$

Continuous mode can be considered as a specific case of the burst mode with just one burst spanning the whole SFN cycle. Note also that x will be reset to x=1 for the first idle period in a SFN cycle for both continuous and burst modes and will also, in the case of burst mode, be reset for the first Idle Period in every burst.

Figure 10.1 below illustrates the Idle Periods for the Burst Mode case.

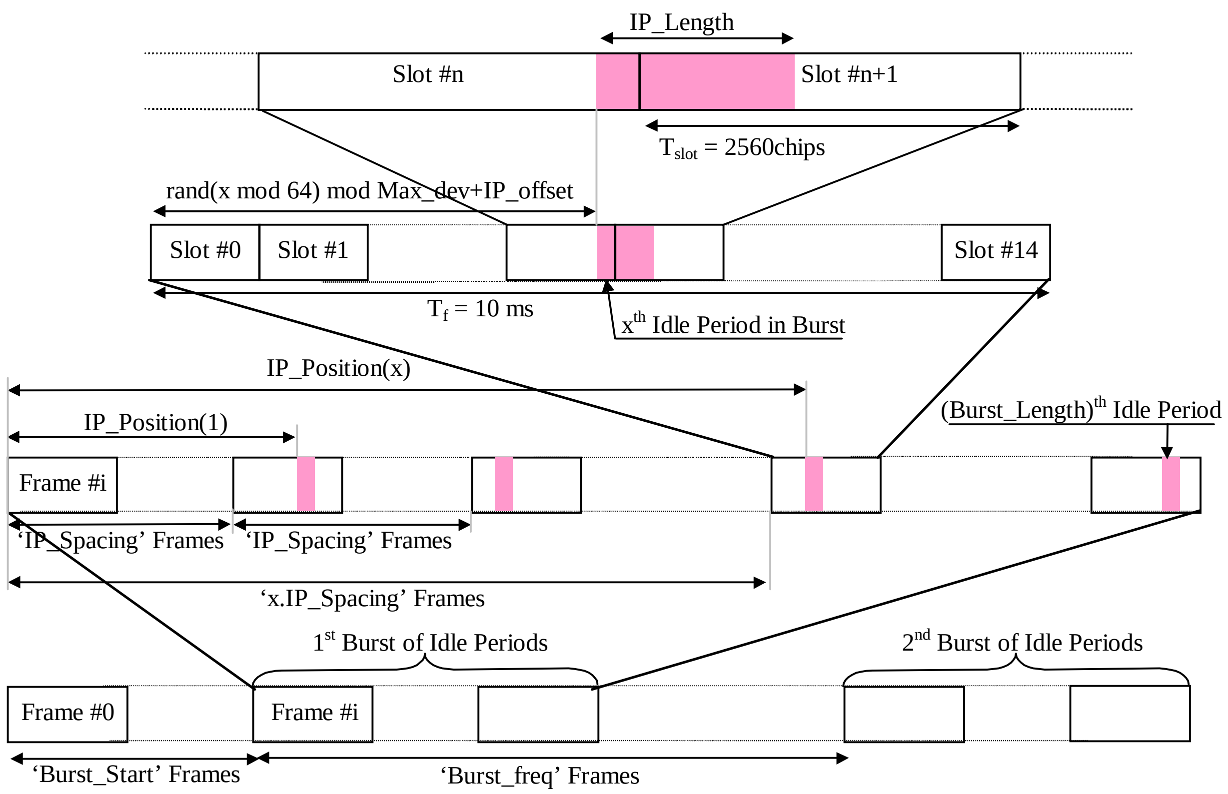



**Figure 10.1: Idle Period placement in the case of burst mode operation.**

# 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

$$2\sum_{i=1}^{Npath}\frac{1}{\sigma_i^2}\left\{2\,\mathrm{Re}(\gamma h_{2,i}^{(d)} h_{2,i}^{(p)^*})\right\} > \ln\left(\frac{\bar{p}(\phi_{Rx}=\pi)}{\bar{p}(\phi_{Rx}=0)}\right)$$

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

Similarly consider

$$-2\sum_{i=1}^{Npath}\frac{1}{\sigma_i^2}\left\{2\,\mathrm{Im}(\gamma h_{2,i}^{(d)} h_{2,i}^{(p)^*})\right\} > \ln\left(\frac{\bar{p}(\phi_{Rx}=-\frac{\pi}{2})}{\bar{p}(\phi_{Rx}=\frac{\pi}{2})}\right)$$

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:

$$\sin(\phi_{Tx}) + j\cos(\phi_{Tx}) = \frac{\sum_{i=0}^{1}\sin(x_i)}{2} + j\frac{\sum_{i=0}^{1}\cos(x_i)}{2}$$

where

the $x_i$ values are used corresponding to the current slot and the next slot, except in the case of slot 14 wherein the slot 14 and slot 1 of the next frame values are used.

$h_{2,i}^{(p)}$ 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,

$\gamma^2$ is the DPCH Pilot SNIR/ PCCPCH Pilot SNIR,

$\alpha_i$ are the elements of *w*,

$\sigma_i^2$ 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).

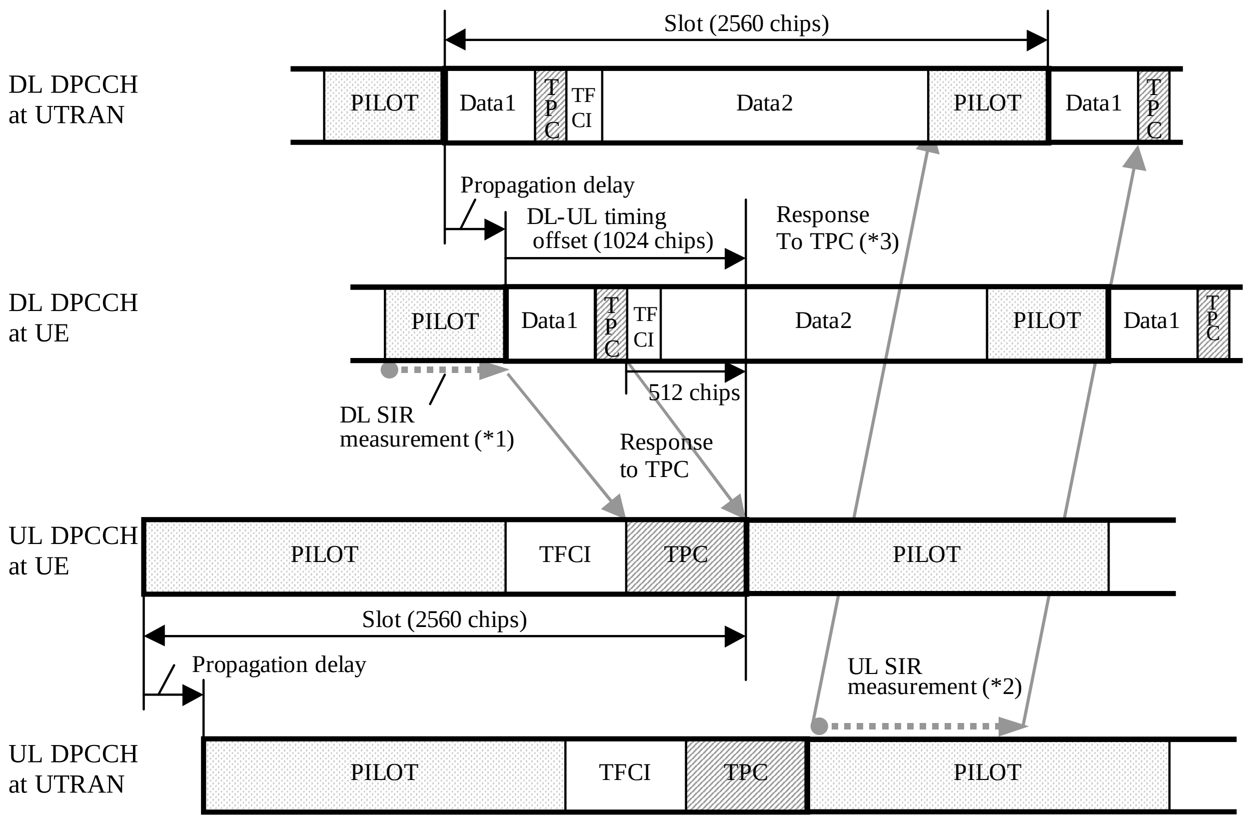
# Annex B (Informative): Power control timing

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 cell radius 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, the UTRAN access point 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 forUTRAN. 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. The UTRAN access point shall decide and send TPC commands based on the uplink SIR measurement. However, the SIR measurement periods are not specified either for UE nor UTRAN.

Figure B-1 illustrates an example of transmitter power control timings.




1,2 The SIR measurement periods illustrated here are examples. Other ways of measurement are allowed to achieve accurate SIR estimation.

3 If there is not enough time for UTRAN 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

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.

# Annex D (informative): Change history

| Change history | | | | | |
|---|---|---|---|---|---|
| TSG RAN# | Version | CR | Tdoc RAN | New Version | Subject/Comment |
| RAN_05 | - | - | RP-99531 | 3.0.0 | Approved at TSG RAN #5 and placed under Change Control |
| RAN_06 | 3.0.0 | 003 | RP-99686 | 3.1.0 | Flexible timing of UTRAN response to uplink closed loop Tx diversity feedback commands |
| RAN_06 | 3.0.0 | 006 | RP-99686 | 3.1.0 | CPCH power control preamble length |
| RAN_06 | 3.0.0 | 007 | RP-99686 | 3.1.0 | Removal of open loop power control |
| RAN_06 | 3.0.0 | 008 | RP-99687 | 3.1.0 | Power offset of AICH and PICH |
| RAN_06 | 3.0.0 | 009 | RP-99686 | 3.1.0 | Update of Random Access Procedure |
| RAN_06 | 3.0.0 | 010 | RP-99686 | 3.1.0 | oft symbol combining for uplink power control |
| RAN_06 | 3.0.0 | 011 | RP-99685 | 3.1.0 | Clarification of closed loop transmit diversity figure in section 8 and closed loop operation in compressed mode for mode 2 in section 8.3 of TS 25.214 |
| RAN_06 | 3.0.0 | 012 | RP-99686 | 3.1.0 | Uplink power control maximum TX power |
| RAN_06 | 3.0.0 | 013 | RP-99686 | 3.1.0 | Setting of beta values for multi-code |
| RAN_06 | 3.0.0 | 014 | RP-99686 | 3.1.0 | Consolidation of CPCH Power Control Preamble Information |
| RAN_06 | 3.0.0 | 015 | RP-99686 | 3.1.0 | Consolidation of Power Control Information for DCH Initialisation |
| RAN_06 | 3.0.0 | 016 | RP-99686 | 3.1.0 | Uplink power control in compressed mode |
| RAN_06 | 3.0.0 | 018 | RP-99686 | 3.1.0 | Timing for initialisation procedures |
| RAN_06 | 3.0.0 | 021 | RP-99687 | 3.1.0 | 20 ms RACH message length |
| RAN_06 | 3.0.0 | 023 | RP-99684 | 3.1.0 | Maximum Tx Power at uplink compressed Mode |
| RAN_06 | 3.0.0 | 024 | RP-99687 | 3.1.0 | Setting of power in uplink compressed mode |
| RAN_06 | 3.0.0 | 025 | RP-99687 | 3.1.0 | Cleanup of synchronisation procedures |
| RAN_06 | 3.0.0 | 026 | RP-99686 | 3.1.0 | Downlink power control |
| RAN_06 | 3.0.0 | 029 | RP-99687 | 3.1.0 | Out-of-synch handling |
| RAN_06 | 3.0.0 | 030 | RP-99687 | 3.1.0 | State update rule addition to SSDT specification |
| RAN_06 | 3.0.0 | 033 | RP-99687 | 3.1.0 | Uplink TX timing adjustment |
| RAN_06 | 3.0.0 | 036 | RP-99687 | 3.1.0 | Inclusion of idle periods for the IPDL LCS |
| RAN_06 | 3.0.0 | 041 | RP-99686 | 3.1.0 | Revision of power control timing text |
| RAN_06 | 3.0.0 | 042 | RP-99687 | 3.1.0 | Inclusion of adjustment loop in downlink power control |
| - | 3.1.0 | - | - | 3.1.1 | Change history was added by the editor |

# History

| Document history | | |
|---|---|---|
| V3.1.1 | January 2000 | Publication |
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