TSG-RAN Working Group 1 meeting #19
Las Vegas, USA
27th February – 2nd March 2001

TSGR1#19(01)0358

Agenda item: AH 99

Source: Siemens

Title: CR 25.224-046r2: Corrections of TDD power control sections

Document for: Decision

The TDD open loop power control for the uplink is desribed in 25.331 and partly also in 25.224. This is an unnecessary duplication. It is proposed to remove the description completely in 25.224 and to include just a hint, that the open loop power control is desribed in 25.331. The CR is accompanied by a corresponding CR in WG2 adding some details of the open loop power control in 25.331 that were just covered in 25.224.

In addition to this, the description of the general power control limits in uplink and downlink is clarified. It is also proposed to improve the behaviour, if the maximum Node B transmit power is exceeded. It is specified so far, that in this case only the DPCH is scaled, so that the resulting transmit power is equal to the maximum Node B transmit power. However, it is beneficial to reduce also the transmit power of the PDSCH in this case.

Furtermore, a possible structure for the power control is given in the informative annex. This includes a description of the term "inner power control", which is used at some places in the specification.

3GPP TSG-RAN WG1 Meeting #18 **R1-01-0358**
Las Vegas, USA, 27th February – 2nd March 2001

CR-Form-v3

CHANGE REQUEST

25.224	**CR 046**	rev	**2**	Current version:	**3.5.0**

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ✍ symbols.*

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

Title:	Corrections of TDD power control sections
Source:	Siemens
Work item code:	
Date:	28 Feb. 2001
Category:	**F**
Release:	R99

Use one of the following categories:
F *(essential correction)*
A *(corresponds to a correction in an earlier release)*
B *(Addition of feature),*
C *(Functional modification of feature)*
D *(Editorial modification)*
Detailed explanations of the above categories can be found in 3GPP TR 21.900.

Use one of the following releases:
2 (GSM Phase 2)
R96 (Release 1996)
R97 (Release 1997)
R98 (Release 1998)
R99 (Release 1999)
REL-4 (Release 4)
REL-5 (Release 5)

Reason for change:	The description of the open loop power control is given in 25.224 and 25.331. This is an unnecessary duplication. Also, the general power control limits are described insufficiently and the behaviour, if the maximum Node B transmit power is exceeded, is not optimal.
Summary of change:	This CR removes the description of the open loop power control in 25.224 and clarifies the description of the general power control limits. It is also proposed to scale not only the DPCH, but also the PDSCH, if the maximum Node B transmit power is exceeded. In addition to this a description of a possible power control structure is given in the informative annex. Some minor clarifications are also proposed to remove potential ambiguities.
Consequences if not approved:	The actual specification is not optimal with respect to the behaviour at the downlink power control limit. With respect to the other points mentioned above, the actual specification could lead to misunderstandings.

Clauses affected:	4.2, Annex A
Other specs affected:	[ ] Other core specifications [ ] Test specifications [ ] O&M Specifications
Other comments:	

How to create CRs using this form:

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4.2 Transmitter Power Control

4.2.1 General Parameters

Power control is applied for the TDD mode to limit the interference level within the system thus reducing the intercell interference level and to reduce the power consumption in the UE.

All codes within one timeslot allocated to the same CCTrCH use the same transmission power, in case they have the same spreading factor.

Table 1~~1~~: Transmit Power Control characteristics

	Uplink	Downlink
Power control rate	Variable 1-7 slots delay (2 slot SCH) 1-14 slots delay (1 slot SCH)	Variable, with rate depending on the slot allocation.
TPC Step size	--	1dB or 2 dB or 3 dB~~1, 2, 3 dB~~
Remarks	All figures are without processing and measurement times	Within one timeslot the powers of all active codes may be balanced to within a range of 20 dB

4.2.2 Uplink Control

4.2.2.1 General Limits

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

Uplink power control shall be performed while the total UE transmit power is below the maximum allowed output power. In some cases the total UE transmit power in a timeslot after uplink power control calculation might exceed the maximum allowed output power. In these cases the calculated transmit power of all uplink physical channels in this timeslot shall be scaled by the same amount in dB before transmission. The total UE transmission power used shall be the maximum allowed output power.

The UTRAN may not expect the UE to be capable of reducing its total transmit power below the minimum level specified in [2].

~~By means of higher layer signalling, the Maximum_Allowed_UL_TX_ power for uplink may be set to a value lower than what the terminal power class is capable of. The total transmit power shall not exceed the allowed maximum. If this would be the case, then the transmit power of all uplink physical channels in a timeslot is reduced by the same amount in dB.~~

4.2.2.2 PRACH

The transmit power for the PRACH is set by higher layers based on open loop power control as described in [15].

4.2.2.3 DPCH, PUSCH

The transmit power for DPCH and PUSCH is set by higher layers based on open loop power control as described in [15].

4.2.2.3.1 Gain Factors

Two or more transport channels may be multiplexed onto a CCTrCH as described in [9]. ~~-~~These transport channels undergo rate matching which involves repetition or puncturing. ~~-~~This rate matching affects the transmit power required to obtain a particular E_b/N_0. Thus, the transmission power of the CCTrCH shall be weighted by a gain factor ? .

There are two ways of controlling the gain factors for different TFC's within a CCTrCH transmitted in a radio frame:

- ? is signalled for the TFC, or
- ? is computed for the TFC, based upon the signalled settings for a reference TFC.

Combinations of the two above methods may be used to associate ? values to all TFC's in the TFCS for a CCTrCH. The two methods are described in sections 4.2.2.3.1.1 and 4.2.2.3.1.2 respectively. Several reference TFC's for several different CCTrCH's may be signalled from higher layers.

The weight and gain factors may vary on a radio frame basis depending upon the current SF and TFC used. The setting of weight and gain factors is independent of any other form of power control. ~~-~~That means that the transmit power P_{UL} is calculated according to the formula given in [15] ~~below in section 4.2.2.3.2~~ and then the weight and gain factors are applied on top of that, cf. [10].

4.2.2.3.1.1 Signalled Gain Factors

When the gain factor $?_j$ is signalled by higher layers for a certain TFC, the signalled values are used directly for weighting DPCH~~(s)~~ or PUSCH within a CCTrCH. Exact values are given in [10].

4.2.2.3.1.2 Computed Gain Factors

The gain factor $?_j$ may also be computed for certain TFCs, based on the signalled settings for a reference TFC:

Let $?_{ref}$ denote the signalled gain factor for the reference TFC. Further, let $?_j$ denote the gain factor used for the j-th TFC.

Define the variable: $K_{ref} ? \underset{i}{?} RM_i ?N_i$

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

Similarly, define the variable $K_j ? \underset{i}{?} RM_i ?N_i$

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

Moreover, define the variable $L_{ref} ? \underset{i}{?} \frac{1}{SF_i}$

where SF_i is the spreading factor of DPCH or PUSCH i and the sum is taken over all DPCH or PUSCH i used in the reference TFC.

Similarly, define the variable $L_j ? \underset{i}{?} \frac{1}{SF_i}$

where the sum is taken over all DPCH or PUSCH i used in the j-th TFC.

Then the variable A_j, called the nominal power relation for TFC j, is computed as:

$$A_j ? \sqrt{\frac{L_j}{L_{ref}}} ? \sqrt{\frac{K_{ref}}{K_j}}$$

The gain factors $?_j$ for the j-th TFC are then computed as follows:

- If $A_j > 1$, then $?_j$ is the largest quantized ?-value, for which the condition $?_j ? 1 / A_j$ holds.
- If $A_j ? 1$, then $?_j$ is the smallest quantized ?-value, for which the condition $?_j ? 1 / A_j$ holds.

The quantized ?-values are given in [10].

4.2.2.3.2 Power Control Loop

After the synchronisation between UTRAN and UE is established, the UE transits into open-loop transmitter power control (TPC).

The power setting for each uplink DPCH in one CCTrCH shall be calculated by the following equation:

$P_{UL} = ? L_{P\text{-}CCPCH} + (1-?) L_0 + I_{BTS} + SIR_{TARGET} + \text{Constant value}$

where

P_{UL}: Power setting in dBm, cf. section "Combination of physical channels in uplink" in [10]; This value corresponds to a particular CCTrCH (due to CCTrCH-specific SIR_{TARGET}) and a particular timeslot (due to possibly timeslot specific ? and I_{BTS}).

$L_{P\text{-}CCPCH}$: Measure representing path loss in dB (reference transmit power is broadcast on BCH).

L_0: Long term average of path loss in dB.

I_{BTS}: Interference signal power level at cell's receiver in dBm, which is broadcast on BCH.

?: ? is a weighting parameter which represents the quality of path loss measurements. ? may be a function of the time delay between the uplink time slot and the most recent down link time slot containing a beacon channel, see [8]. ? shall be calculated autonomously at the UE, subject to a maximum allowed value which shall be signalled by higher layers. An example for calculating ? as a function of the time delay is given in annex A.1.

SIR_{TARGET}: Target SIR in dB. A higher layer outer loop adjusts the target SIR.

Constant value: This value shall be set by higher Layer (operator matter). and is broadcast on BCH.

If the midamble is used in the evaluation of $L_{P\text{-}CCPCH}$ and L_0, and the Tx diversity scheme used for the P-CCPCH involves the transmission of different midambles from the diversity antennas, the received power of the different midambles from the different antennas shall be combined prior to evaluation of these variables.

4.2.2.3.23 Out of synchronisation handling

As stated in 4.2.3.3, the association between TPC commands sent on uplink DPCH and PUSCH, with the power controlled downlink DPCH and PDSCH is signaled by higher layers. In the case of multiple DL CCTrCHs it is possible that an UL CCTrCH will provide TPC commands to more than one DL CCTrCH.

In the second phase of synchronisation evaluation, as defined in 4.4.2.1.2, the UE shall shut off the transmission of an UL CCTrCH if the following criteria are fulfilled for any one of the DL CCTrCHs commanded by its TPC:

- The UE estimates the received dedicated channel burst quality over the last 160 ms period to be worse than a threshold Q_{out}, and in addition, no special burst, as defined in 4.5, is detected with quality above a threshold, Q_{sbout}. Q_{out} and Q_{sbout} are defined implicitly by the relevant tests in [2]. If the UE detects the beacon channel reception level [10 dB] above the handover triggering level, then the UE shall use a 320 ms estimation period for the burst quality evaluation and for the Special Burst detection window.

UE shall subsequently resume the uplink transmission of the CCTrCH if the following criteria are fulfilled:

- The UE estimates the received dedicated CCTrCH burst reception quality over the last 160 ms period to be better than a threshold Q_{in} or the UE detects a burst with quality above threshold Q_{sbin} and TFCI decoded to be that of the Special Burst. Q_{in} and Q_{sbin} are defined implicitly by the relevant tests in [2]. If the UE detects the beacon channel reception level [10 dB] above the handover triggering level, then the UE shall use a 320 ms estimation period for the burst quality evaluation and for the Special Burst detection window.

4.2.3 Downlink Control

4.2.3.1 P-CCPCH

The Primary CCPCH transmit power is set by higher layer signalling and can be changed based on network conditionsdetermination on a slow basis. The -reference transmit power of the P-CCPCH is broadcast on BCH or individually signalled to each UEsignalled on the BCH.

4.2.3.2 S-CCPCH, PICH

The relative transmit power of the Secondary CCPCH and the PICH compared to the P-CCPCH transmit power are set by higher layer signalling. The PICH power offset relative to the P-CCPCH reference power is signalled on the BCH.

4.2.3.3 SCH

The SCH transmit power is set by higher layer signalling [16]. The value is given relative to the power of the P-CCPCH.

4.2.3.43 DPCH, PDSCH

The initial transmission power of the downlink DPCH and the PDSCH is set by the network. After the initial transmission, the UTRAN transits into SIR-based inner loop power control.

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

The initial transmission power of the downlink DPCH and the PDSCH shall be set by the network. If associated uplink CCTrCHs for TPC commands are signalled to the UE by higher layers (mandatory for a DPCH), the network shall transit into inner loop power control after the initial transmission. The UE shall then generate TPC commands to control the network transmit power and send them in the TPC field of the associated uplink CCTrCHs. An example on how to derive the TPC commands and the definition of the inner loop power control are given in Annex A.1. A TPC command sent in an uplink CCTrCH controls all downlink DPCHs or PDSCHs to which the associated downlink CCTrCH is mapped to.

The association between TPC commands sent on uplink DPCH and PUSCH, with the power controlled downlink DPCH and PDSCH is signalled by higher layers.

In the case that no associated downlink data is scheduled within 15 timeslots before the transmission of a TPC command then this is regarded as a transmission pause. The TPC commands in this case shall be derived from measurements on the P-CCPCH. An example solution for the generation of the TPC command for this case is given in Annex A 12.

Each TPC command shall always be based on all associated downlink transmissions received since the previous related TPC command. Related TPC commands are defined as TPC commands associated with the same downlink CCTrCHs. If there are no associated downlink transmissions between two or more uplink transmissions carrying related TPC commands, then these TPC commands shall be identical and they shall be regarded by the UTRAN as a single TPC command. This rule applies both to the case where the TPC commands are based on measurements are based on a on the associated CCTrCH or, in the case of a transmission pause, on the P-CCPCH.

As a response to the received TPC command, UTRAN may adjust the transmit power. When the TPC command is judged as "down", the transmission power may be reduced by the TPC step sizeone step, whereas if judged as "up", the transmission power may be raised by the TPC step size.one step.

The UTRAN may apply an individual offset to the transmission power in each timeslot according to the downlink interference level at the UE.

The transmission power of one DPCH or PDSCH shall not exceed the limits set by higher layer signalling by means of Maximum_DL_Power (dB) and Minimum_DL_Power (dB). The transmission power is defined as the average power over one timeslot of the complex QPSK symbols of a single DPCH or PDSCH before spreading relative to the power of the P-CCPCH.

During a downlink transmission pause, both UE and Node B shall use the same TPC step size which is signalled by higher layers. the The UTRAN may accumulated the TPC commands received during the pause. TPC commands that shall be regarded as identical may only be counted once. The initial UTRAN transmission power for the first data transmission after the pause may then be set to the sum of -transmission power before the pause and a power offset according to the accumulated TPC commands. Additionally this sum may include a constant set by the operator and a correction term due to uncertainties in the reception of the TPC bits.

The total downlink transmission power at the Node BnodeB within one timeslot shall not exceed Maximum Transmission Power set by higher layer signalling. In case the total power of the sum of all transmissions If the total transmit power of all channels in a timeslot would exceeds this limit, then the transmission power of all downlink DPCHs and PDSCHs shall beis reduced by the same amount in dB. The value for this power reduction is determined, so that the total transmit power of all channels in this timeslot is equal to the maximum transmission power.that allows fulfilling the requirement. The same amount of power reduction is applied to all DPCHs.

A higher layer outer loop adjusts the target SIR.

4.2.3.43.1 Out of synchronisation handling

When the dedicated physical channel out of sync criteria based on the received burst quality is as given in the subclause 4.4.2 then the UE shall set the uplink TPC command = "up". The CRC based criteria shall not be taken into account in TPC bit value setting.

Annex A (informative): Power Control

A.1 An Example for Calculating ?

This annex presents an example for calculating the path loss weighting parameter for open loop power control ? .

? can be calculated as ? = 1-(D-1)/6 where D is the delay, expressed in number of slots, between the uplink slot and the most recent downlink slot. Note that ? =1 for a delay of one slot (minimal delay), and ? =0 for a delay of 7 slots (maximal delay).

A.12 Example Implementation of Downlink Power Control in the UE

The power control may be realized by two cascaded control loops. The outer loop controls the transmission quality, whose reference value is set by higher layers [15], by providing the reference value for the inner loop. This reference value should be the SIR at the UE [15]. The inner loop controls the physical quantity for which the outer loop produces the reference value (e. g. the SIR) by generating TPC commands. This may be done by comparing the measured SIR to its reference value. The measurement of received SIR shall be carried out periodically at the UE. When the measured value is higher than the target SIR value, TPC command = "down". When this is lower than or equal to the target SIR value, TPC command = "up".

In case of a downlink transmission pause on the DPCH or PDSCH, the receive power (RSCP) of the data can no longer be used for inner loop SIR calculations in the UE. In this case v the UE should trace the fluctuations of the pathloss based on the P-CCPCH and use these values instead for generating the TPC commands. This pathloss together with the timeslot ISCP measurement in the data timeslot, which is ongoing, should be used to calculate a virtual SIR value:

$SIR_{virt}(i) = RSCP_{virt}(i)$? $ISCP(i)$,

$RSCP_{virt}(i) = RSCP_0 + L_0 - L(i) + \sum_{k?1}^{i?1} TPC(k)$,

RSCP:	Received signal code power in dBm
ISCP:	Interference signal code power in the DPCH / PDSCH timeslot in dBm
L:	pathloss in dB measured on the P-CCPCH. The same weighting of the long- and short-term pathloss should be used as for uplink open loop power control, see Annex A.1
i:	index for the frames during a transmission pause, 1 ? i ? number of frames in the pause
L_0:	weighted pathloss in the last frame before the transmission pause in dB
$RSCP_0$:	RSCP of the data that was used in the SIR calculation of the last frame before the pause in dBm
TPC (k):	? power control stepsize in dB according to the TPC bit generated and transmitted in frame k, TPC bit "up" = +stepsize, TPC bit "down" = ?stepsize