TSG-RAN Working Group 4 meeting #6 **TSGR4#6(99) 362**

Queensferry, 26. – 29. July 1999

Agenda Item:

Source: SIEMENS

Title: **UE output power dynamics (TDD)**

Document for: Discussion and Decision

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1. Document scope

In this document the following parameters of TDD-UEs are discussed:

- Open loop power control uplink
  - Open loop tolerance
- Closed loop power control uplink
  - Power control steps
  - Power control steps per second
- Minimum transmit output power

A text proposal for TS 25.102 is attached at the end of this document

2. Introduction

The intent of using power control is to limit the interference level at the receiver and to minimize mobile UEs power consumption.

There have to be defined RF parameters for the following power control procedures:

- Open loop power control
- Closed loop power control

Furthermore, minimum transmit output power for TDD-UE will be defined.

3. General assumptions

- Procedures to control the selection of the actual power control step size have to be defined by WG1
- An important point of view is to achieve FDD-TDD-harmonization.
- FDD-TDD-dual-mode handheld terminals based on a common hardware-platform should be supported.
- In UL and DL the mean power used to transmit a midamble is equal to the transmission power of the sum of the data sections attached to it.

4. Open loop power control

Open loop power control is the capability of the UE transmitter to set its output power to a specified (initial) value suitable for the receiver. The TDD-UE UL output power level will be calculated depending on a measure representing the pathloss, the interference and SIR target at the cell's receiver (both broadcasted on BCH) and an operator defined constant.

Open loop tolerance: Equivalent to FDD mode the open loop tolerance values +/-9dB and +/-12dB are choosen, because there are no implementation specific differences to FDD-UE. Only the time constant of path loss estimation measurement differs to FDD.

Additionally the reciprocity of the channel guarantees a much more accurate estimation of the path loss compared to FDD.

The *minimum* delay of open loop power control is 1 timeslot in scenario of successive alternating UL-TS and DL-TS (for all UL timeslots, a path loss estimation is possible in the DL timeslot immediately before the controlled UL timeslot)

The *maximum* delay of open loop power control are 7 timeslots in the scenario DL/UL = 2/14 (path loss estimation only possible at the DL SCH TSs)

5. Closed loop power control

Closed loop power control is the capability of the UE transmitter to adjust its output power in accordance with the TPC symbols received in the downlink. Closed loop power control is based on SIR measurements at the cell receiver and the corresponding TPC commands generated by the basestation controller.

5.1 Power control steps

The power control step is the step change in the UL transmitter output power in response to a TPC command.

We propose to define fixed step sizes because received TPC commands are not very reliable due to transmission errors. TPC commands tell the UE whether to decrease or to increase the transmission power by one step.

Three different step sizes take into account the different UL/DL-allocation scenarios conceivable in TDD mode. The time in between two DL timeslots is maximum 7 timeslots, in opposite to 1 timeslot (logical) delay in FDD. The maximum possible frequency of TPC commands varies compared to FDD because of channel allocation.

Tolerances:

Experience with GSM-UE technology shows that the implementation of step sizes of 2dB with tolerances of ±1.5dB are possible under normal conditions. The absolute power level tolerances are in the range of ±2dB to ±5dB. For lower power levels the tolerance increases up to the 5dB maximum tolerance. This defines the upper limit for the tolerance due to dualmode GSM-TDD UE's.

For the FDD step size of 1dB the tolerance is specified with ±0.5dB. For a FDD/TDD/GSM multi-mode UE the new upper limit for tolerances is given by ±0.5dB.

The power steps shall form a monotonous sequence. This is reflected by the requirement: "the greatest average rate of change in mean power per 10 steps shall be within the range shown in table x".

From the implementation point of view, the required output power dynamics of 80dB is complicated to realize compared to GSM (35dB dynamics). One exemplary solution might be a switched attenuator in the transmission path of the UE resulting in additional switching transients whenever the range of 50 dB is exhausted. Therefore the tolerance scheme should be relaxed due to implementation desires. This effect should be considered in the test specification by relaxing the tolerances for lower power levels.

5.2 Power control cycles per second

The number of power control cycles per second is the rate of change of the UL transmitter power due to closed loop power control. The number of power control cycles of closed loop power control is:

- Minimum value: 100 cycles/sec. The minimum rate of 100 Hz is to ensure that every frame is power controlled. For instance that is 1 cycle per frame in case of 1 UL-TS and 1 DL-TS per frame (minimum resource scenario).
- Maximum value: 800 cycles/sec. That is the fastest scenario: successive slots are allocated alternating to UL and DL corresponding to 1 cycle each 2 TS (=2x 10ms/14 frames). Due to the new defined odd number of timeslots per frame (15) only 14 TS can form 7 closed cycles.

6. Minimum transmit output power

The minimum transmission power for TDD UE has been chosen as –44dBm harmonized to FDD with the following background:

- For near UE the minimum coupling loss to the basestation is approximately 60dB. For an UE with 30dBm output power a power level of -30dBm results at the basestation.
- Alternatively, a far UE has to be received by the minimum RX sensitivity level, which is approximately -110dBm.
- It is necessary that both UE will be received at the same power level. The near UE must reduce its power level by the difference of the above calculated –30dBm and the –110dBm.

⇨ the necessary resulting power dynamics is 80dB for UL. This fits our requirements concerning the maximum output power of +36dBm (TDD power class 1): +36dBm – 80dB = -44dBm

7. Conclusions

Open loop tolerance is defined to:

- Normal conditions: ±9dB
- Extreme conditions: ±12dB

One set of **power control step sizes** should be fixed. Three power control step sizes have been proposed:

- 1dB±0.5dB
- 2dB±[1dB]
- 3dB±[1.5dB]

Range of average rate of change in mean power per 10 steps:

minimum	maximum
+/-8dB	+/-12dB
[+/-16dB]	[+/-24dB]
[+/-24dB]	[+/-36dB]

A minimum of 100 and a maximum of 800 **power control steps per second** has been proposed. The number of power control steps per second depends on the channel configuration (UL/DL).

The **minimum transmit output power** has been defined by: -44dBm (root raised cosine with roll-off-factor α=0.22 in 3.84 MHz corresponding to FDD).

8. Definitions and abbreviations:

ACLR Adjacent Channel Leakage Power Ratio

CCPCH Common Control Physical CHannel

DL Downlink

FDD Frequency Division Duplex

PA Power Amplifier

PC Power Class

RF Radio Frequency

RTT Radio Transmission Technique

RX Receiption

SIR Signal-to-Interference level

TDD Time Division Duplex

TS Timeslot

TX Transmission

UE User Equipment

UL Uplink

2G second generation systems (i.e. GSM)

3G third generation systems (i.e. UMTS)

9. References

[1] GSM 05.05 Version 5.2.0, July 1996; Digital cellular telecommunications system (Phase 2+); Radio transmission and reception

[2] TS 25.101v2.1.0 UE Radio Transmission and Reception FDD

[3] TSGR1#5(99)569 OL Power Control and Text Porposal for 25.224 and 25.221

Text Proposal for 25.102

6.4 Output power dynamics

Power control is used to limit the interference level.

6.4.1 Open loop power control

Open loop power control is the ability of the UE transmitter to set~~s~~ its output power to a specified value. For the TDD mode the reciprocity of the channel allows accurate estimation of the required open loop transmit power.

The UE open loop power control error shall be less than ~~[~~+/-9~~]~~dB under normal conditions and +/-12dB under extreme conditions.

6.4.2 Closed loop power control

Closed loop power control is the ability of the UE transmitter to adjust its output power in accordance ~~with~~ to the TPC symbols received in the downlink.

6.4.3 Power control steps

The power control step is the ~~minimum~~ step change in the UL transmitter output power in response to a TPC message. A set of power control steps is defined.

6.4.3.1 Minimum Requirements

The mobile station transmitter shall have the capability of setting power with a step of ~~[~~1, 2, and – 3~~]~~ dB. The tolerance of the transmitter output power and the greatest average rate of change in mean power due to the power control step shall be within the range shown in Table x.

Table x: power control step size tolerance

Step size	tolerance	Range of average rate of change in mean power per 10 steps	
		minimum	maximum
1dB	+/-0.5dB	+/-8dB	+/-12dB

2dB	[+/-1dB]	[+/-16dB]	[+/-24dB]
3dB	[+/-1.5dB]	[+/-24dB]	[+/-36dB]

6.4.4 Power control cycles per second

The maximum and minimum the rate of change for the UL transmitter power control step.

6.4.4.1 Minimum Requirement

The rate of change for the UL transmitter power control step is a s follows: [100 – 800] Hz.

The minimum rate of [100] Hz is to ensure that every frame is power controlled. The maximum rate may differ for open and closed loop power control due to the used frame configuration.

6.4.5 Minimum transmit output power

The minimum controlled output power of the UE is when the power control setting is set to a minimum value. This is when both the closed loop and open loop power control indicates a minimum transmit output power is required.

6.4.5.1 Minimum requirement

The minimum transmit power shall be better than [–44 dBm / 3.84MHz]. measured with a filter that has a rRoot-Rraised Ccosine (RRC) filter response with a roll--off-factor $\alpha = 0.22$ and a bandwidth equal to the chip rate.