**TSG-RAN Working Group 1 meeting #18** *TSGR1(01)0160*
Boston, USA, Jan. 15 - 18, 2001

**Agenda Item:** AH21

**Source:** Siemens AG

**To:** TSG RAN WG1

**Title:** Transmission of TPC commands in 1.28Mcps TDD

**Document for:** Decision

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# 1. Summary

The TPC is utilised to command a TX power adjustment for transmission power control. In 3.84 Mcps TDD, TPC information is not transmitted as L1 signal on the downlink. In 1.28 Mcps TDD, the TPC information is transmitted once per 5 ms sub-frame in the downlink and in the uplink. Each time slot and CCTrCH is controlled independently.

# 2. Introduction

In 3.84 Mcps TDD option, the TPC command is not used in the downlink. However the TPC is utilised in 1.28 Mcps in both uplink and downlink to command a TX power adjustment of 1 or 2 or 3 dB. The default step size is signalled by the network by means of system information that is broadcast in the cell. The TPC information (if applied) is to be transmitted directly after the SS information in downlink and uplink. Figure 1 shows the position of the TPC in a burst. The TPC, as one of L1 signals, is to be transmitted once per 5 ms sub-frame.

The step size can be adjusted during call setup or readjusted during the call.

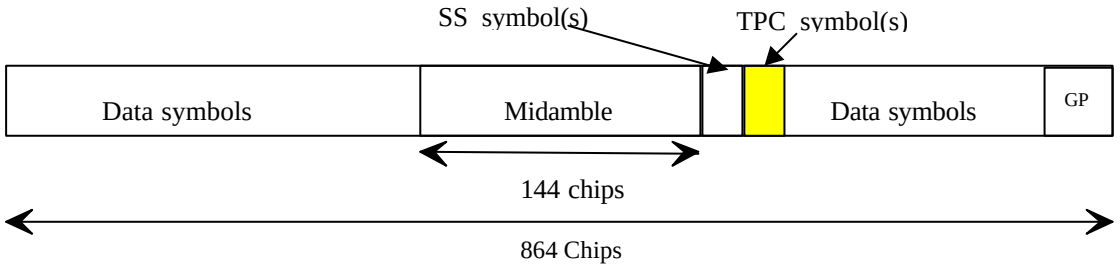


*Figure 1 TPC information in a burst in downlink and uplink*

For the number of layer 1 symbols per channelisation code there are 3 possibilities configurable for each channelisation code during the call setup:

?? one SS and one TPC symbol
?? no SS and no TPC symbols
?? 16/SF SS and 16/SF TPC symbols

So, in case 3, when SF=1, there are 16 TPC symbols which correspond to 32 bits (for QPSK) and 48 bits (for 8PSK).

For every user the TPC information is to be transmitted at least once per 5ms sub-frame. If applied, transmission of TPC is done in the data parts of the traffic burst and it can be transmitted using the first allocated channelisation code and the first allocated timeslot (according to the order in the higher layer allocation message). Other allocations (more

than one TPC transmission in one sub-frame) of TPC are also possible. The TPC is spread with the same spreading factor (SF) and spreading code as the data parts of the respective physical channel.

Each of the TPC symbols for uplink power control in the DL will be associated with an UL time slot and an UL CCTrCH depending on the number of allocated UL time slots and UL CCTrCHs and the allocated TPC symbols in the DL.

For the downlink power control the situation is vice versa. Each of the TPC symbols for downlink power control in the UL will be associated with a DL time slot and a DL CCTrCH depending on the number of allocated DL time slots and DL CCTrCHs and the allocated TPC symbols in the UL.

In case a UE has

- more than one channelisation code

and/or

- channelisation codes being of lower spreading factor than 16 and using 16/SF SS and 16/SF TPC symbols,

the TPC commands for each UL(DL) time slot CCTrCH pair (all channelisation codes on that time slot belonging to the same time slot and CCTrCH pair have the same TPC command) will be distributed to the following rules:

1. The UL(DL) time slots and CCTrCH pairs the TPC commands are intended for will be numbered form the first to the last UL(DL) time slot and CCTrCH pair allocated to the regarded UE (starting with 0). The number of a time slot and CCTrCH pair is smaller then the number of another time slot and CCTrCH pair within the same time slot if its spreading code with the lowest SC number according to the following table has a lower SC number then the spreading code with the lowest SC number of the other time slot and CCTrCH pair.

2. The commanding TPC symbols on all DL(UL) CCTrCHs allocated to one UE are numbered consecutively starting with zero according to the following rules:

   a) The numbers of the TPC commands of a regarded DL time slot are lower than those of DL time slots being transmitted after that time slot

   b) Within a DL (UL) time slot the numbers of the TPC commands of a regarded channelisation code are lower than those of channelisation codes having a higher spreading code number

   The spreading code number is defined by the following table: (see TS 25.223)

| SC number | SF (Q) | Walsh code number (k) |
|---|---|---|
| 0 | 16 | $\mathbf{c}_{Q?16}^{(k?1)}$ |
| | ... | |
| 15 | 16 | $\mathbf{c}_{Q?16}^{(k?16)}$ $\mathbf{c}_{Q?16}^{(k?15)}$ |
| 16 | 8 | $\mathbf{c}_{Q?8}^{(k?1)}$ |
| | … | |
| 23 | 8 | $\mathbf{c}_{Q?8}^{(k?8)}$ |
| 24 | 4 | $\mathbf{c}_{Q?4}^{(k?1)}$ |
| | … | |
| 27 | 4 | $\mathbf{c}_{Q?4}^{(k?4)}$ |
| 28 | 2 | $\mathbf{c}_{Q?2}^{(k?1)}$ |

| | | |
|---|---|---|
| 29 | 2 | $\mathbf{c}_{Q?2}^{(k?2)}$ |
| 30 | 1 | $\mathbf{c}_{Q?1}^{(k?1)}$ |

Note: Spreading factors 2-8 are not used in DL

c) Within a channelisation code numbers of the TPC commands are lower than those of TPC commands being transmitted after that time

The following equation is used to determine the UL time slot which is controlled by the regarded TPC symbol in the DL:

$$UL_{pos} ? (SFN'?N_{UL\_TPCsymbols} ? TPC_{DLpos}) \bmod (N_{ULslot}),$$

where

$UL_{pos}$ is the number of the controlled uplink time slot and CCTrCH pairs.

SFN' is the system frame number counting the sub-frames. The system frame number of the radio frames (SFN) can be derived from SFN' by

SFN=SFN' div 2, where div is the reminder free division operation.

$N_{UL\_PCsymbols}$ is the number of UL TPC symbols in a sub-frame.

$TPC_{DLpos}$ is the number of the regarded UL TPC symbol in the DL within the sub-frame.

$N_{ULslot}$ is the number of UL slots and CCTrCH pairs in a frame.

For the TPC symbols in the UL the corresponding equation applies:

$$DL_{pos} ? (SFN'?N_{DL\_TPCsymbols} ? TPC_{ULpos}) \bmod (N_{DLslot})$$

In the following two examples of the association of UL TPC commands to UL time slots are shown:

**Table 1 Two examples of the association of DL TPC commands to UL uplink time slots with $N_{ULslot}$=3**

Case 1: $N_{UL\_TPCsymbols}$=2; Case 2: $N_{UL\_TPCsymbols}$=4

| Sub-Frame Number | Case 1 (2 UL TPC symbols) | | The order of the served UL time slot and CCTrCH pairs (UL time slot and CCTrCH number) | Case 2 (4 UL TPC symbols) | |
|---|---|---|---|---|---|
| | The order of UL TPC symbols | | | The order of UL TPC symbols | |
| SFN'=0 | (1st $UL_{pos}$=0) | 0 | 0 (TS3) | 0 | (1st $UL_{pos}$=0) |
| | | 1 | 1 (TS4) | 1 | |
| | | | 2 (TS5) | 2 | |
| | | | 0 (TS3) | 3 | |
| SFN'=1 | (1st $UL_{pos}$=2) | 0 | 0 (TS3) | 0 | (1st $UL_{pos}$=1) |
| | | 1 | 1 (TS4) | 1 | |
| | | | 2 (TS5) | 2 | |
| | | | 0 (TS3) | 3 | |
| | | | 1 (TS4) | | |
| SFN'=2 | (1st $UL_{pos}$=1) | 0 | 0 (TS3) | 0 | (1st $UL_{pos}$=2) |
| | | 1 | 1 (TS4) | 1 | |
| | | | 2 (TS5) | 2 | |
| | | | 0 (TS3) | 3 | |
| | | | 1 (TS4) | | |
| | | | 2 (TS5) | | |
| . | . | | . | . | |
| . | . | | . | . | |
| . | . | | . | . | |

# 3. Proposal

We propose to add following paragraphs in the working CR for TS25.221 as the description of the transmission of TPC commands in the 1.28Mcps TDD.

---------- Beginning of text proposal for working CR for 25.221 ----------

## 6.2.2.2 Transmission of TPC

The burst type for dedicated channels provides the possibility for transmission of TPC in uplink and downlink.

The transmission of TPC is done in the data parts of the traffic burst. Hence the midamble structure and length is not changed. The TPC information is to be transmitted directly after the SS information, which is transmitted after the midamble. Figure XX shows the position of the TPC command in a traffic burst.

For every user the TPC information is to be transmitted at least once per 5ms sub-frame. If applied, transmission of TPC is done in the data parts of the traffic burst and it can be transmitted using the first allocated channelisation code and the first allocated timeslot (according to the order in the higher layer allocation message). Other allocations (more than one TPC transmission in one sub-frame) of TPC are also possible. The TPC is spread with the same spreading factor (SF) and spreading code as the data parts of the respective physical channel.

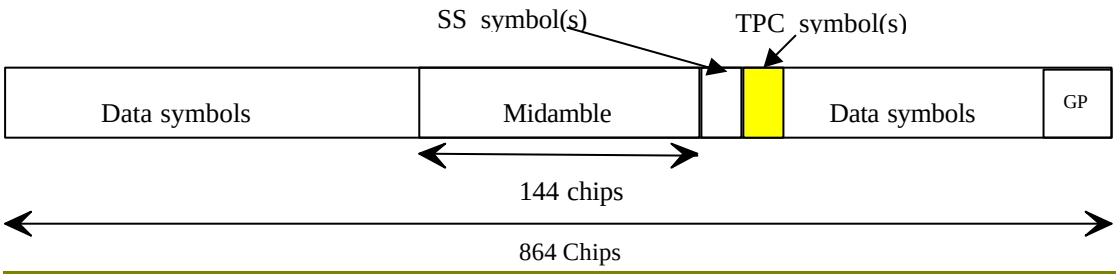


*Figure X: TPC information in a burst in downlink and uplink*

For the number of layer 1 symbols per channelisation code there are 3 possibilities configurable for each channelisation code during the call setup:

?? one SS and one TPC symbol

?? no SS and no TPC symbols

?? 16/SF SS and 16/SF TPC symbols

So, in case 3, when SF=1, there are 16 TPC symbols which correspond to 32 bits (for QPSK) and 48 bits (for 8PSK).

In the following the uplink is described only. For the description of the downlink, downlink (DL) and uplink (UL) have to be interchanged.

Each of the TPC symbols for uplink power control in the DL will be associated with an UL time slot and an UL CCTrCH pair. This association varies with

?? ~~depending on~~ the number of allocated UL time slots and UL CCTrCHs on these time slots (time slot and CCTrCH pair) and

?? the allocated TPC symbols in the DL.

~~For the downlink power control the situation is vice versa. Each of the TPC symbols for downlink power control in the UL will be associated with a DL time slot and a DL CCTrCH depending on the number of allocated DL time slots and DL CCTrCHs and the allocated TPC symbols in the UL.~~

In case a UE has

- more than one channelisation code

and/or

- channelisation codes being of lower spreading factor than 16 and using 16/SF SS and 16/SF TPC symbols.

the TPC commands for each UL ~~(DL)~~ time slot CCTrCH pair (all channelisation codes on that time slot belonging to the same time slot and CCTrCH pair have the same TPC command) will be distributed to the following rules:

3. The UL ~~(DL)~~ time slots and CCTrCH pairs the TPC commands are intended for will be numbered form the first to the last UL ~~(DL)~~ time slot and CCTrCH pair allocated to the regarded UE (starting with 0). The number of a time slot and CCTrCH pair is smaller then the number of another time slot and CCTrCH pair within the same time slot if its spreading code with the lowest SC number according to the following table has a lower SC number then the spreading code with the lowest SC number of the other time slot and CCTrCH pair.

4. The commanding TPC symbols on all DL ~~(UL)~~ CCTrCHs allocated to one UE are numbered consecutively starting with zero according to the following rules:

   a) The numbers of the TPC commands of a regarded DL time slot are lower than those of DL time slots being transmitted after that time slot

   b) Within a DL ~~(UL)~~ time slot the numbers of the TPC commands of a regarded channelisation code are lower than those of channelisation codes having a higher spreading code number

   The spreading code number is defined by the following table: (see TS 25.223)

| SC number | SF (Q) | Walsh code number (k) |
|---|---|---|
| 0 | 16 | $\mathbf{c}_{Q?16}^{(k?1)}$ |

| | | |
|---|---|---|
| | … | |
| 15 | 16 | $\mathbf{c}_{Q?16}^{(k?16)}$ |
| 16 | 8 | $\mathbf{c}_{Q?8}^{(k?1)}$ |
| | … | |
| 23 | 8 | $\mathbf{c}_{Q?8}^{(k?8)}$ |
| 24 | 4 | $\mathbf{c}_{Q?4}^{(k?1)}$ |
| | … | |
| 27 | 4 | $\mathbf{c}_{Q?4}^{(k?4)}$ |
| 28 | 2 | $\mathbf{c}_{Q?2}^{(k?1)}$ |
| 29 | 2 | $\mathbf{c}_{Q?2}^{(k?2)}$ |
| 30 | 1 | $\mathbf{c}_{Q?1}^{(k?1)}$ |

Note: Spreading factors 2-8 are not used in DL

c) Within a channelisation code numbers of the TPC commands are lower than those of TPC commands being transmitted after that time

The following equation is used to determine the UL time slot which is controlled by the regarded TPC symbol in the DL:

$$UL_{pos} = (SFN' \cdot N_{UL\_TPCsymbols} + TPC_{DLpos}) \bmod (N_{ULslot}) .$$

where

$UL_{pos}$ is the number of the controlled uplink time slot and CCTrCH pairs.

SFN' is the system frame number counting the sub-frames. The system frame number of the radio frames (SFN) can be derived from SFN' by

SFN=SFN' div 2, where div is the reminder free division operation.

$N_{UL\_PCsymbols}$ is the number of UL TPC symbols in a sub-frame.

$TPC_{DLpos}$ is the number of the regarded UL TPC symbol in the DL within the sub-frame.

$N_{ULslot}$ is the number of UL slots and CCTrCH pairs in a frame.

~~For the TPC symbols in the UL the corresponding equation applies:~~

~~$DL_{pos} = (SFN - N_{DL\_TPCsymbols} - TPC_{ULpos}) \bmod (N_{DLslot})$~~

In Annex G two examples of the association of ~~UL~~ TPC commands to ~~UL~~ time slots and CCTrCH pairs~~s~~ are shown.

Coding of TPC:

The relationship between the TPC Bits and the transmitter power control command for QPSK is the same as in the 3.84Mcps TDD cf. [5.2.2.5 'Transmission of TPC'].

The relationship between the TPC Bits and the transmitter power control command for 8PSK is given in table [XX]

**Table XX: TPC Bit Pattern for 8PSK**

| TPC | TPC Bit Pattern | Meaning |
|---|---|---|
| 'Down' | 000 | Decrease Tx Power |
| 'Up' | 110 | Increase Tx Power |

# Annex G (Informative):

# Examples of the association of DL TPC commands to UL uplink time slots for 1.28 Mcps TDD

In the following two examples of the association of UL TPC commands to UL time slots and

**Table X Two examples of the association of DL TPC commands to UL uplink time slots with $N_{ULslot}$=3**

Case 1: $N_{UL\_TPCsymbols}$=2; Case 2: $N_{UL\_TPCsymbols}$=4

| Sub-Frame Number | Case 1 (2 UL TPC symbols) | | The order of the served UL time slot and CCTrCH pairs (UL time slot and CCTrCH number) | Case 2 (4 UL TPC symbols) | |
|---|---|---|---|---|---|
| | The order of UL TPC symbols | | | The order of UL TPC symbols | |
| SFN'=0 | (1st $UL_{pos}$=0) | 0 | 0 (TS3) | 0 | (1st $UL_{pos}$=0) |
| | | 1 | 1 (TS4) | 1 | |
| | | | 2 (TS5) | 2 | |
| | | | 0 (TS3) | 3 | |
| SFN'=1 | (1st $UL_{pos}$=2) | 0 | 0 (TS3) | 0 | (1st $UL_{pos}$=1) |
| | | 1 | 1 (TS4) | 1 | |
| | | | 2 (TS5) | 2 | |
| | | | 0 (TS3) | 3 | |
| | | | 1 (TS4) | | |
| SFN'=2 | (1st $UL_{pos}$=1) | 0 | 0 (TS3) | 0 | (1st $UL_{pos}$=2) |
| | | 1 | 1 (TS4) | 1 | |
| | | | 2 (TS5) | 2 | |
| | | | 0 (TS3) | 3 | |
| | | | 1 (TS4) | | |
| | | | 2 (TS5) | | |
| . . . | . . . | | . . . | . . . | |

CCTrCHs are shown (see 6.2.2.2):

# Annex ~~G~~H (informative):

# Change history

*<No changes will be made in this chapter in this CR, only the numbering has to be changed. >*

---------- End of text proposal for working CR for 25.221 ----------