3GPP TSG R1#7(99) a68

3G TS 25.224 V1.0.1~~0~~ (1999-07~~4~~)

Technical Specification

3rd Generation Partnership Project (3GPP);
Technical Specification Group Radio Access Network;
Physical Layer Procedures (TDD);
(3G TS 25.224 version 1.0.1~~0~~)

Reference

DTS/TSG<name abbv>-0<WG no><spec no> U

Keywords

<keyword[, keyword]>

3GPP

Postal address

3GPP support office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00
Fax: +33 4 93 65 47 16

Internet

http://www.3gpp.org

Contents

Foreword

This Technical Specification has been produced by the 3GPP.

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of this TS, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version 3.y.z

where:

x the first digit:
  1 presented to TSG for information;
  2 presented to TSG for approval;
  3 Indicates TSG approved document under change control.
y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
z the third digit is incremented when editorial only changes have been incorporated in the specification;

1 Scope

The present document describes the Physical Layer Procedures in the TDD 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.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

3 Definitions, Symbols and Abbreviations

3.1 Definitions

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

<defined term>: <definition>.

3.2 Symbols

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

<symbol>	<Explanation>

3.3 Abbreviations

<Editor’s note: This section covers TDD relevant abbreviations only.>

BCCH	Broadcast Control Channel
BCH	Broadcast Channel
DCA	Dynamic Channel Allocation
FACH	Forward Access Channel
NRT	Non-Real Time
ODMA	Opportunity Division Multiple Access
TPC	Transmit Power Control
RACH	Random Access Channel
RT	Real Time
RU	Resource Unit

SCH	Synchronisation Channel
UE	User Equipment
VBR	Variable Bit Rate

4 Physical layer procedures (TDD)

4.1 General

4.2 Synchronisation of NodeBs and ODMA Relays

4.2.1 Synchronisation of TDD NodeBs

In several scenarios, there is a need to synchronise Node Bs in order to optimise system capacity. One example is a scenario for coordinated operation with overlapping coverage areas of the cells, i.e. there is contiguous coverage for a certain area.

Several alternatives can be used to synchronise Node Bs. The 3GPP TS25~~1~~.2xx specification shall provide the means for Node B synchronisation by an air interface protocol.

< Editors note: The specification of this Node B synchronisation protocol is for further study and depends on required synchronisation accuracy. The protocol shall fulfil the following requirements:

- *Reliability and stability*
- *Low implementation effort*
- *Minimum impact on air interface traffic capacity.*

For example the two schemes below are considered in WG1:

1. *For Node B synchronisation via the air interface a special burst, the network synchronisation burst, is used. This burst is sent on a predetermined TS at regular intervals. During the reception of the network synchronisation burst in a cell the transmission in this cell has to be switched off. The Node Bs receive this burst and adjust their frame timing accordingly.*
2. *Node Bs are synchronised by means of receiving other cells Physical Synchronisation Channel (PSCH). >*

4.2.1.1 Inter-system-synchronisation

<Editors Note: to be determined>

4.2.2 Synchronisation of ODMA Relays

Due to the relatively short range of transmissions, the inclusion of ODMA does not impose any additional guard period or frame synchronisation requirements over those discussed above for standard TDD.

Any potential overlap caused by relay transmissions will be localised to a node and its neighbours by the ODMA protocol.

The inclusion of ODMA could relax the guard period requirements when relaying between nodes (not involving the BS) since neighbouring UEs are regarded as relay opportunities and any communications between neighbours (on an ODCH) could be synchronised further

4.3 Transmitter Power Control

4.3.1 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.

Table -1: TPC characteristics

	Uplink	**Downlink**
Dynamic range	80 dB	30 dB
Power control rate	Variable Closed loop: 100-800 cycles/sec. Open loop: 1-7 slots delay (2 slot SCH) 1-14~~5~~ slots delay (1 slot SCH)	Variable closed loop: 100-800 cycles/sec.
Step size	[1 ... 3] dB	[1 ... 3] dB
Remarks	All figures are without TPC decoding and received power measurements.	within one timeslot the powers of all active codes may be balanced to within a range of [20] dB

- All codes within one timeslot allocated to the same bearer service use the same transmission power.
- In case of one user with simultaneous RT and NRT bearer service, the closed loop power control is used both for RT and NRT bearer service. However, depending on the current services different power levels are used.

4.3.2 ODMA Power Control

<for further study>

4.3.3 Uplink Control

4.3.3.1 Common Physical Channel

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

$$P_{PRACH} = L_{CCPCH} + I_{BTS} + \text{Constant value}$$

where, P_{PRACH} : transmitter power level in dBm,
L_{CCPCH}: measured path loss in dB (transmit power is broadcasted on BCH),
I_{BTS}: interference signal power level at cell's receiver in dBm, which is broadcasted on BCH
Constant value: This value shall be set via Layer 3 message (operator matter).

4.3.3.2 Dedicated Physical Channel

The initial transmission power is decided in a similar manner as PRACH. After the synchronisation between nodeB and UE is established, the UE transits into open-loop or closed-loop transmitter power control (TPC).

UL Open Loop Power Control:
~~The UE transmit power is set based on the measured path loss in the same way as for the PRACH.~~

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

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

Where, P_{UE} : transmitter power level in dBm,
L_{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 broadcasted on BCH
α: α is a weighting parameter which represents the quality of path loss measurements. α may be a function of the time delay between the uplink time slot and the most recent down link time slot. α is calculated at the UE. An example for calculating α as a function of the time delay is given in Annex 1.SIR_{TARGET}: Target SNR in dB. A higher layer outer loop adjusts the target SIR.
Constant value: This value shall be set via Layer 3 message (operator matter).

UL Closed Loop Power Control:
Closed-loop TPC is based on SIR, and the TPC processing procedures are the same as the FDD mode. During this power control process, the nodeB periodically makes a comparison between the received SIR measurement value and the target SIR value. When the measured value is higher than the target SIR value, TPC bit = „0„. When this is lower than the target SIR value, TPC bit = „1„. At the UE, soft decision on the TPC bits is performed, and when it is judged

as „0„, the mobile transmit power shall be reduced by one power control step, whereas if it is judged as „1„, the mobile transmit power shall be raised by one TPC step. A higher layer outer loop adjusts the target SIR. This scheme allows quality based power control.

When the TPC bit cannot be received due to out-of-synchronisation, the transmission power value shall be kept at a constant value. When SIR measurement cannot be performed for being out-of-synchronisation, the TPC bit shall always be = „1„ during the period of being out-of-synchronisation.

4.3.4 Downlink Control

4.3.4.1 Common Physical Channel

The primary CCPCH transmit power can be changed based on network determination on a slow basis. The exact power of CCPCH is signaled on the BCH on a periodic basis.

4.3.4.2 Dedicated Physical Channel

The initial transmission power of the downlink Dedicated Physical Channel is set by the network. After the initial transmission, the nodeB transits into SIR-based closed-loop TPC as similar to the FDD mode.
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 bit = „0„. When this is lower than the target SIR value, TPC bit = „1„. At the NodeB, soft decision on the TPC bits is performed, and when it is judged as „0„, the transmission power shall be reduced by one step, whereas if judged as „1„, the transmission power shall be raised by one step.
When the TPC bit cannot be received due to out-of-synchronisation, the transmission power value shall be kept at a constant value. When SIR measurement cannot be performed due to out-of-synchronisation, the TPC bit shall always be = „1„ during the period of being out-of-synchronisation.
A higher layer outer loop adjusts the target SIR.

4.4 Timing Advance

4.4.1 Without UL Synchronization

The timing of transmissions from the UE is adjusted according to timing advance values received from the serving nodeB. The initial value for timing advance will be determined in the serving nodeB by measurement of the timing of the PRACH. The required timing advance will be represented as a 8~~[7]~~ bit number ~~[~~(0-255~~127~~)~~]~~ being the multiple of ~~[1.953 μs(= 8~~ 4 chips~~)]~~ which is nearest to the required timing advance. The maximum allowed value may be limited by the operator to a value lower than 255~~[127]~~, if required or the function may be disabled. A UE cannot operate beyond the range set by the maximum value of timing advance.

The serving nodeB will continuously measure the timing of a transmission from the UE and send the necessary timing advance value. On receipt of this value the UE will adjust the timing of its transmissions accordingly in steps of ~~[48]~~ chips. The transmission of TA values is done by means of higher layer messages.

When TDD to TDD handover takes place the UE shall transmit in the new cell with timing advance TA adjusted by the relative timing difference Δt between the new and the old cell:

$$TA_{new} = TA_{old} + 2.\Delta t$$

4.4.2 With UL Synchronization

With UL Synchronization, the timing advance is sub-chip granular and with high accuracy in order to enable synchronous CDMA in the UL. The required timing advance will be represented as a multiple of 1/8 chips.
The serving nodeB will continuously measure the timing of a transmission from the UE and send the necessary timing advance value. On receipt of this value the UE will adjust the timing of its transmissions accordingly in steps of ±/8 chips. The transmission of TA values is ffs.

4.5 Synchronisation and Cell Search Procedures

4.5.1 Cell Search

During the initial cell search, the UE searches for a cell. It then determines the midamble, the downlink scrambling code and frame synchronisation of that cell. The initial cell search uses the Physical Synchronisation Channel (PSCH) described in S1.21. The generation of synchronisation codes is described in S1.23

This initial cell search is carried out in three steps:

Step 1: Slot synchronisation

During the first step of the initial cell search procedure the UE uses the primary synchronisation code c_p to acquire slot synchronisation to the strongest cell. Furthermore, frame synchronisation with the uncertainty of 1 out of 2 is obtained in this step. A single matched filter (or any similar device) is used for this purpose, that is matched to the primary synchronisation code which is common to all cells. The procedure is according to the description for the FDD mode in S1.14.

Step 2: Frame synchronisation and code-group identification

The Step 2 is described for the case where PSCH and CCPCH are in timeslot k and k+8 with k=0…6~~7~~.

During the second step of the initial cell search procedure, the UE uses the sequence of Secondary Synchronisation Codes to find frame synchronisation and identify one of 32 code groups. Each code group is linked to a specific t_{Offset}, thus to a specific frame timing, and is containing 4 specific scrambling codes. Each scrambling code is associated with a specific short and long basic midamble code.

The detection of secondary synchronisation sequence is done by correlating the received signal at the positions of the Secondary Synchronisation Code with all possible sequences of Secondary Synchronisation Codes, similar to FDD Mode. After four frames a sequence of eight codes is available providing all necessary information described above. Nevertheless, it should be noted that due to the special coding already three codes show the sequence unambiguously, i.e. a UE can determine the whole sequence when three codes have been received.

Step 3: Scrambling code identification

During the third and last step of the initial cell-search procedure, the UE determines the exact basic midamble code and the accompanying scrambling code used by the found cell. They are identified through correlation over the CCPCH with all four midambles of the code group identified in the second step . Thus the third step is a one out of four decision. This step is taking into account that the CCPCH containing the BCH is transmitted using the first spreading code ($a_{Q=16}^{(h=1)}$ in figure 2 of S1.23 section ‘6.2 Spreading Codes’) and using the first midamble $\mathbf{m}^{(1)}$ (derived from basic midamble code $\mathbf{m}_P$, cf. S1.21 section ‘7.2.3 Training sequences for spread bursts’). Thus CCPCH code and midamble can be immediately derived when knowing scrambling code and basic midamble code.

4.6 ODMA Relay Probing

This section describes the probe-response procedure used by ODMA nodes to detect neighbours which may be used as relays during a call.

4.6.1 Initial Mode Probing

The initial mode probing procedure is activated by a UE when it is switched on and has no information about its surroundings. In this case the UE will synchronise with the ODMA Random Access Channel (ORACH) which is used by all UEs to receive and broadcast system routing control information and data. The UE begins a probing session by periodically broadcasting a probe packet on the ORACH. The broadcast probe includes the current neighbour list for the UE which will initially be empty. If a neighbouring UE, UE*a*, receives the broadcast packet it will register the UE as a neighbour and send an addressed response probe. The response probe is transmitted at random to avoid contention with other UEs and typically one response is sent for every *n* broadcast probes received from a particular UE.

The next time the UE transmits a broadcast probe the neighbour list will have one new entry, *UEa*, and an associated quality indicator (a weighted factor based on the received signal strength of the response probe). It is through this basic mechanism that each UE builds a neighbour list.

4.6.2 Idle Mode Probing

The Idle Mode Probing procedure is activated when the UE has synchronised with the ORACH but is not transmitting data. This procedure is the same as that described above after ORACH synchronisation.

The ODMA Idle Mode Probing procedure controls the rate of probing on the ORACH to reduce interference levels and regulate power consumption. The procedure is governed by a state machine, which consists of the following states: full probing, duty maintained probing, and relay prohibited. Each state defines the number of probing opportunities within one N multiframe, and a probing activity parameter *K* which is the ratio of probe transmission time to probe monitoring time.

Full probing

Full probing is the case where probing is allowed on every ORACH timeslot within an *N* multiframe. The UE_R will probe on the ORACH at a rate defined by the probing activity parameter *K*.

Duty Maintained probing

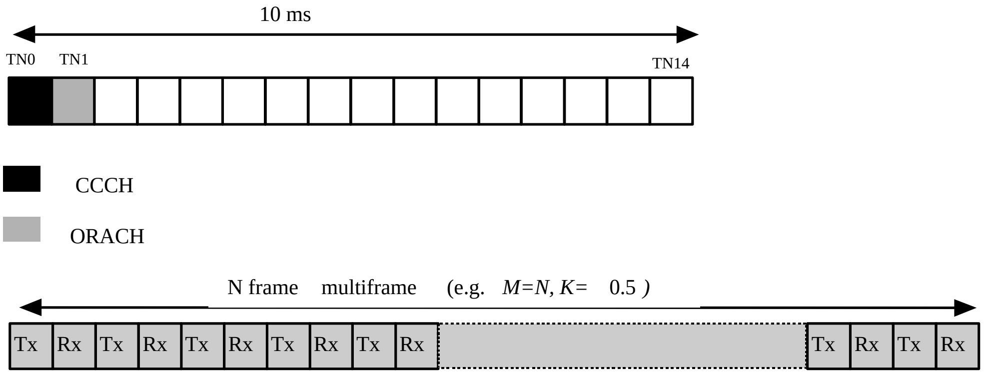
The duty maintained probing is the case where probing is allowed on *M* slots of an *N* multiframe. The UE_R will probe on the *M* ORACH slots in an *N* multiframe at a rate defined by the probing activity parameter *K*.

Relay Prohibited

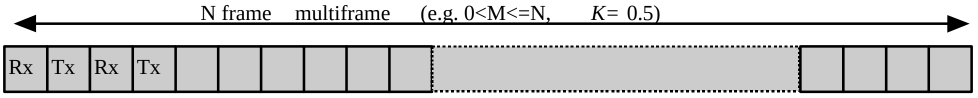
In this mode the UE_R would cease all of its ODMA probing activities and will fall into standard TDD or FDD operation.

The probing activity levels for given state machines are illustrated in Figure 2 for a system with an ORACH for M slots per N × 16 multiframe.

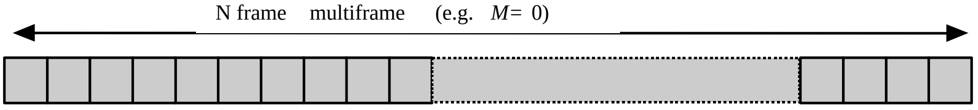
Note that the distribution of probing opportunities within a multiframe may not necessarily be consecutive and located at the beginning of a multiframe.



(a) Full probing



(b) Duty maintained probing - example



(c) Relay prohibited

Figure 3: Probing state machines and mechanism.

4.6.3 Active Mode Probing

The Active Mode Probing procedure is activated when the UE has synchronised with the ORACH and is transmitting data.
With ODMA, data may be relayed on either the ODMA Random Access Channel (ORACH) or the ODMA dedicated transport channel (ODCH), depending on the volume of data to be sent. When a UE has small amounts of data to send it may transmit an addressed probe response packet on the ORACH at an interval proportional to air interface modem rate, R_{CCH}, and is defined by *Probe_timer_1*. This interval also defines the broadcast probe interval, *Probe_timer_2*, which is typically five times longer than *Probe_timer_1*. Every time an UE transmits a response probe containing data on the ORACH, it may be received, but not acknowledged, by third party neighbour UEs, and provides an implicit indication of activity. In this instance broadcast probes are not necessary and *Probe_timer_2* is reset after every addressed probe transmission. Only when an UE has no data to send is it necessary to transmit a broadcast probe every *Probe_timer_2* seconds to register its active status with its neighbours.

In order to avoid overlapping packet transmissions the length of the packet may not exceed the probe timer interval, *Probe_timer_1*. The relationship between the different probe timers is illustrated in Figure 3.

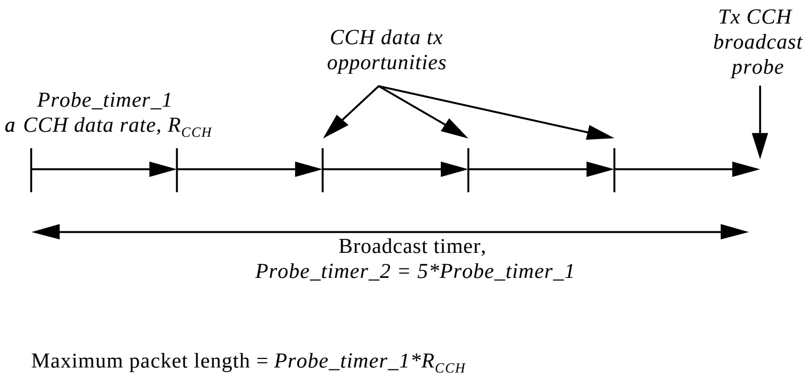


Figure 3: Probe timer relationships.

4.7 Discontinuous transmission (DTX) of Radio Frames

Discontinuous transmission (DTX) is applied in up- and downlink when the total bit rate after transport channel multiplexing differs from the total channel bit rate of the allocated dedicated physical channels.
Rate matching is used in order to fill resource units completely, that are only partially filled with data. In the case that after rate matching and multiplexing no data at all is to be transmitted in a resource unit the complete resource unit is discarded from transmission. This applies also to the case where only one resource unit is allocated and no data has to be transmitted.

<editor's note: It is for ffs, whether the midamble plus possibly TPC and TFCI bits will be continued to be transmitted in certain resource units. For instance transmission can be done acc. to a multiframe pattern. Additional signalling has to ensure, that the other side is informed about DTX.>

4.8 Downlink~~Forward~~ Link Transmit Diversity

Transmit diversity in the forward link provides means to achieve similar performance gains as the mobile-station receiver diversity without the complexity of a second mobile-station receiver. Furthermore, transmit diversity improves the SIR and increases the system capacity. Depending on the mobile station's distance to the base station, its speed, and the asymmetry ratio, selective transmit diversity (STD) can be employed.

With STD, the received signal power of ~~reverse~~ uplink is measured for each of the antennas at the BTS over every single uplink~~reverse link~~ interval (1 slot). The antenna with the highest signal level is used to transmit the ~~forward~~ downlink information for that link during the next interval over which the carrier is used for the downlink~~forward link~~ (1 or more slots). The basis for the gains from this type of diversity is the availability of information on the channel due to the use of the same frequency for ~~reverse~~ uplink and ~~forward~~ downlink. STD is applied only to dedicated physical channels. STD can be applied if the distance between the different transmit antennas is small enough so that the delay profile from each antenna is almost the same.

<Editors Note: Other TX diversity schemes such as schemes for common channels and TXAA are ffs>

Annex 1 – an Example for Calculating α

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

α can be calculated as α = 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 α=1 for a delay of one slot (minimal delay), and α=0 for a delay of 7 slots (maximal delay).

5 History

Document history		
V1.0.0	22.04.1999	First version created based on S1.24 version 2.0.0 at TSG-RAN#3 to reflect the new specification numbering scheme and the status of the document.
V1.0.1	24.07.1999	Modifications due to OHG decision (#853), text proposals at WG1#6: timing advance (#860), UL synchronisation (#941), power control (#A08, modified)

The editor for 25.224 – Physical Layer Procedures (TDD) - is:

Stefan Oestreich
Siemens AG
Tel: +49 89 722 21480, Fax: + 49 89 722 24450, Email: stefan oestreich@icn.siemens.de

This document is written in Microsoft Word 7.0.