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Contents

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1 Scope

The present document describes spreading and modulation for UTRA Physical Layer FDD mode.

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.
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[1] 3GPP TS 25.201: "Physical layer - general description".

[2] 3GPP TS 25.211: "Physical channels and mapping of transport channels onto physical channels (FDD)."

[3] 3GPP TS 25.101: "UE Radio transmission and Reception (FDD)".

[4] 3GPP TS 25.104: "UTRA (BS) FDD; Radio transmission and Reception".

[5] 3GPP TS 25.308: "UTRA High Speed Downlink Packet Access (HSDPA); Overall description".

[6] 3GPP TS 25.214: "Physical layer procedures (FDD)".

[7] 3GPP TS 25.212: "Multiplexing and channel coding (FDD)".

3 Symbols, abbreviations and definitions

3.1 Symbols

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

$C_{ch,SF,n}$:	n:th channelisation code with spreading factor SF
$C_{pre,n,s}$:	PRACH preamble code for *n*:th preamble scrambling code and signature *s*
$C_{sig,s}$:	PRACH signature code for signature *s*
$S_{dpch,n}$:	*n*:th DPCCH/DPDCH uplink scrambling code
$S_{r\text{-}pre,n}$:	*n*:th PRACH preamble scrambling code
$S_{r\text{-}msg,n}$:	*n*:th PRACH message scrambling code
$S_{dl,n}$:	DL scrambling code
C_{psc}:	PSC code
$C_{ssc,n}$:	n:th SSC code

3.2 Abbreviations

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

16QAM	16 Quadrature Amplitude Modulation
4PAM	4 Pulse Amplitude Modulation
64QAM	64 Quadrature Amplitude Modulation
8PAM	8 Pulse Amplitude Modulation

AICH	Acquisition Indicator Channel
BCH	Broadcast Channel
CCPCH	Common Control Physical Channel
CLTD	Closed Loop Transmit Diversity
CPICH	Common Pilot Channel
DCH	Dedicated Channel
DPCH	Dedicated Physical Channel
DPCCH	Dedicated Physical Control Channel
DPCCH2	Dedicated Physical Control Channel 2
DPDCH	Dedicated Physical Data Channel
E-AGCH	E-DCH Absolute Grant Channel
E-DPCCH	E-DCH Dedicated Physical Control Channel
E-DPDCH	E-DCH Dedicated Physical Data Channel
E-HICH	E-DCH Hybrid ARQ Indicator Channel
E-RGCH	E-DCH Relative Grant Channel
E-ROCH	E-DCH Rank and Offset Channel
FDD	Frequency Division Duplex
F-DPCH	Fractional Dedicated Physical Channel
F-TPICH	Fractional Transmitted Precoding Indicator Channel
HS-DPCCH	Dedicated Physical Control Channel (uplink) for HS-DSCH
HS-DPCCH$_2$	Secondary Dedicated Physical Control Channel (uplink) for HS-DSCH, when Secondary_Cell_Enabled is greater than 3
HS-DSCH	High Speed Downlink Shared Channel
HS-PDSCH	High Speed Physical Downlink Shared Channel
HS-SCCH	Shared Control Physical Channel for HS-DSCH
MBSFN	MBMS over a Single Frequency Network
Mcps	Mega Chip Per Second
MICH	MBMS Indication Channel
OVSF	Orthogonal Variable Spreading Factor (codes)
TPI	Transmitted Precoding Indicator
PICH	Page Indication Channel
PRACH	Physical Random Access Channel
PSC	Primary Synchronisation Code
RACH	Random Access Channel
SCH	Synchronisation Channel
S-DPCCH	Secondary Dedicated Physical Control Channel
S-E-DPCCH	Secondary Dedicated Physical Control Channel for E-DCH
S-E-DPDCH	Secondary Dedicated Physical Data Channel for E-DCH
SSC	Secondary Synchronisation Code
SF	Spreading Factor
UE	User Equipment

3.3 Definitions

Activated uplink frequency: For a specific UE, an uplink frequency is said to be activated if the UE is allowed to transmit on that frequency. The primary uplink frequency is always activated when configured while a secondary uplink frequency has to be activated by means of an HS-SCCH order in order to become activated. Similarly, for a specific UE, an uplink frequency is said to be deactivated if it is configured but disallowed by the NodeB to transmit on that frequency.

Configured uplink frequency: For a specific UE, an uplink frequency is said to be configured if the UE has received all relevant information from higher layers in order to perform transmission on that frequency.

Primary uplink frequency: If a single uplink frequency is configured for the UE, then it is the primary uplink frequency. In case more than one uplink frequency is configured for the UE, then the primary uplink frequency is the frequency on which the E-DCH corresponding to the serving E-DCH cell associated with the serving HS-DSCH cell is transmitted. The association between a pair of uplink and downlink frequencies is indicated by higher layers.

Secondary uplink frequency: A secondary uplink frequency is a frequency on which an E-DCH corresponding to a serving E-DCH cell associated with a secondary serving HS-DSCH cell is transmitted. The association between a pair of uplink and downlink frequencies is indicated by higher layers.

4 Uplink spreading and modulation

4.1 Overview

Spreading is applied to the physical channels. It consists of two operations. The first is the channelisation operation, which transforms every data symbol into a number of chips, thus increasing the bandwidth of the signal. The number of chips per data symbol is called the Spreading Factor (SF). The second operation is the scrambling operation, where a scrambling code is applied to the spread signal.

With the channelisation, data symbols on so-called I- and Q-branches are independently multiplied with an OVSF code. With the scrambling operation, the resultant signals on the I- and Q-branches are further multiplied by complex-valued scrambling code, where I and Q denote real and imaginary parts, respectively.

4.2 Spreading

4.2.1 Dedicated physical channels

The possible combinations of the maximum number of respective dedicated physical channels which may be configured simultaneously for a UE in addition to the DPCCH are specified in table 0. The actual UE capability may be lower than the values specified in table 0; the actual dedicated physical channel configuration is indicated by higher layer signalling. The actual number of configured DPDCHs, denoted $N_{max\text{-}dpdch}$, is equal to the largest number of DPDCHs from all the TFCs in the TFCS. $N_{max\text{-}dpdch}$ is not changed by frame-by-frame TFCI change or temporary TFC restrictions.

Table 0: Maximum number of simultaneously-configured uplink dedicated channels

	DPDCH	HS-DPCCH	E-DPDCH	E-DPCCH	S-E-DPDCH	S-E-DPCCH
Case 1	6	1	-	-	-	-
Case 2	1	1	2	1	-	-
Case 3	-	1 on the primary uplink frequency, 0 on any secondary uplink frequency	4 per uplink frequency	1 per uplink frequency	-	-
Case 4	1	2	2	1	-	-
Case 5	-	2 on the primary uplink frequency, 0 on any secondary uplink frequency	4 per uplink frequency	1 per uplink frequency	-	-
Case 6	-	2	4	1	4	1
Case X	1 on the primary uplink frequency	2 on the primary uplink frequency, 0 on any secondary uplink frequency	2 on the primary uplink frequency, 4 on the secondary uplink frequency	1 per uplink frequency	-	-

Figure 1 illustrates the principle of the spreading of uplink dedicated physical channels (DPCCH, DPDCHs, HS-DPCCH, DPCCH2, E-DPCCH, E-DPDCHs, S-E-DPCCH). Figure 1.1 illustrates the principle of the spreading of uplink S-DPCCH and S-E-DPDCHs.

In case of BPSK modulation , the binary input sequences of all physical channels are converted to real valued sequences, i.e. the binary value "0" is mapped to the real value +1, the binary value "1" is mapped to the real value –1, and the value "DTX" (HS-DPCCH only) is mapped to the real value 0.

In case of 4PAM modulation, the binary input sequences of all E-DPDCH and S-E-DPDCH physical channels are converted to real valued sequences, i.e. a set of two consecutive binary symbols n_k, n_{k+1} (with k mod 2 = 0) in each binary sequence is converted to a real valued sequence following the mapping described in Table 0A.

In case of 8PAM modulation, the binary input sequences of all E-DPDCH and S-E-DPDCH physical channels are converted to real valued sequences, i.e. a set of three consecutive binary symbols n_k, n_{k+1}, n_{k+2} (with k mod 3 = 0) in each binary sequence is converted to a real valued sequence following the mapping described in Table 0B.

Table 0A: Mapping of E-DPDCH and S-E-DPDCH with 4PAM modulation

n_k, n_{k+1}	Mapped real value
00	0.4472
01	1.3416
10	-0.4472
11	-1.3416

Table 0B: Mapping of E-DPDCH and S-E-DPDCH with 8PAM modulation

n_k, n_{k+1}, n_{k+2}	Mapped real value
000	0.6547
001	0.2182
010	1.0911
011	1.5275
100	-0.6547
101	-0.2182
110	-1.0911
111	-1.5275

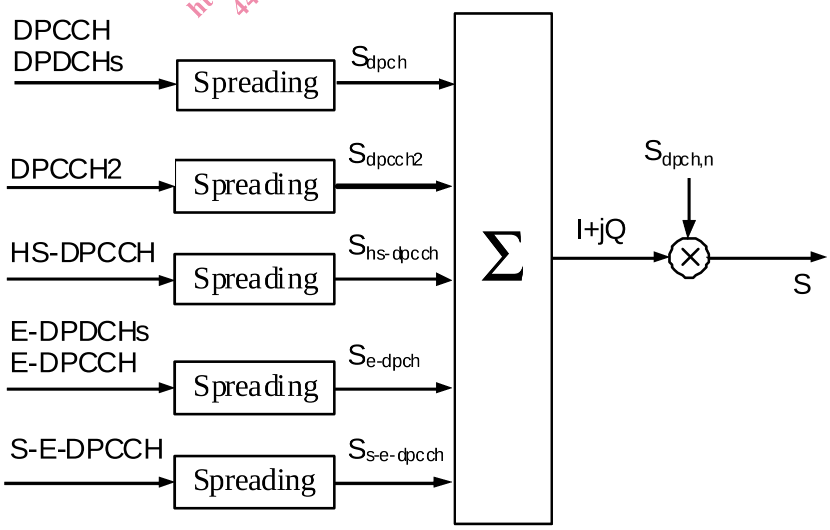

Figure 1: Spreading for uplink dedicated channels

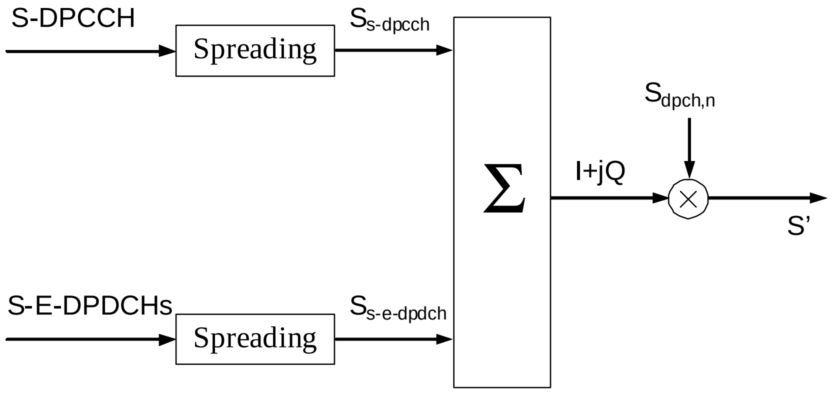

Figure 1.1: Spreading for uplink S-DPCCH and S-E-DPDCHs

The spreading operation is specified in subclauses 4.2.1.1 to 4.2.1.4 for each of the dedicated physical channels; it includes a spreading stage, a weighting stage, and an IQ mapping stage. In the process, the streams of real-valued chips on the I and Q branches are summed; this results in a complex-valued stream of chips for each set of channels.

As described in figure 1, the resulting complex-valued streams S_{dpch}, S_{dpcch2}, $S_{hs\text{-}dpcch}$, $S_{e\text{-}dpch}$ and $S_{s\text{-}e\text{-}dpcch}$ are summed into a single complex-valued stream which is then scrambled by the complex-valued scrambling code $S_{dpch,n}$ resulting in the complex-valued signal S. As described in Figure 1.1, the resulting complex-valued streams $S_{s\text{-}dpcch}$ and $S_{s\text{-}e\text{-}dpdch}$ are summed into a single complex-valued stream which is scrambled by the same complex-valued scrambling code $S_{dpch,n}$ resulting in the complex-valued signal S'. The scrambling code shall be applied aligned with the radio frames, i.e. the first scrambling chip corresponds to the beginning of a radio frame.

NOTE: Although subclause 4.2.1 has been reorganized in this release, the spreading operation for the DPCCH, DPDCH remains unchanged as compared to the previous release.

4.2.1.1 DPCCH/DPDCH

Figure 1a illustrates the spreading operation for the uplink DPCCH and DPDCHs.

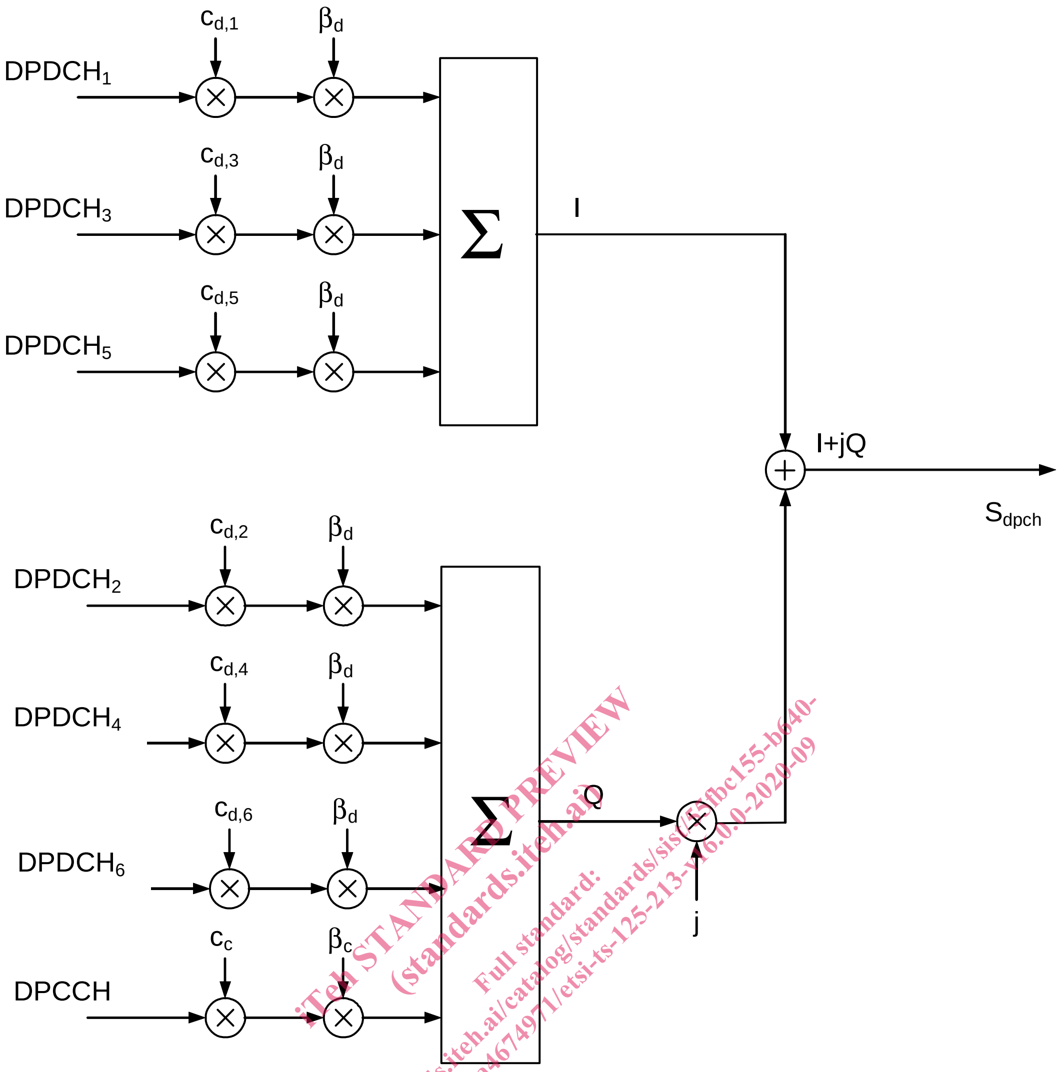

Figure 1A: Spreading for uplink DPCCH/DPDCHs

The DPCCH is spread to the chip rate by the channelisation code c_c. The *n*:th DPDCH called $DPDCH_n$ is spread to the chip rate by the channelisation code $c_{d,n}$.

After channelisation, the real-valued spread signals are weighted by gain factors, β_c for DPCCH, β_d for all DPDCHs.

The β_c and β_d values are signalled by higher layers or derived as described in [6] 5.1.2.5 and 5.1.2.5C. At every instant in time, at least one of the values β_c and β_d has the amplitude 1.0. The β_c and β_d values are quantized into 4 bit words. The quantization steps are given in table 1.

Table 1: The quantization of the gain parameters

Signalled values for β_c and β_d	Quantized amplitude ratios β_c and β_d
15	1.0
14	14/15
13	13/15
12	12/15
11	11/15
10	10/15
9	9/15
8	8/15
7	7/15
6	6/15
5	5/15
4	4/15
3	3/15
2	2/15
1	1/15
0	Switch off

4.2.1.2 HS-DPCCH

Figure 1B illustrates the spreading operation for the HS-DPCCH when Secondary_Cell_Enabled is less than 4 in case the UE is not configured in MIMO mode with four transmit antennas in any cell, or less than 2 in case the UE is configured in MIMO mode with four transmit antennas in at least one cell. Figure 1B.1 illustrates the spreading operation for the HS-DPCCHs when Secondary_Cell_Enabled is greater than 3 in case the UE is not configured in MIMO mode with four transmit antennas in any cell, or greater than 1 in case the UE is configured in MIMO mode with four transmit antennas in at least one cell..

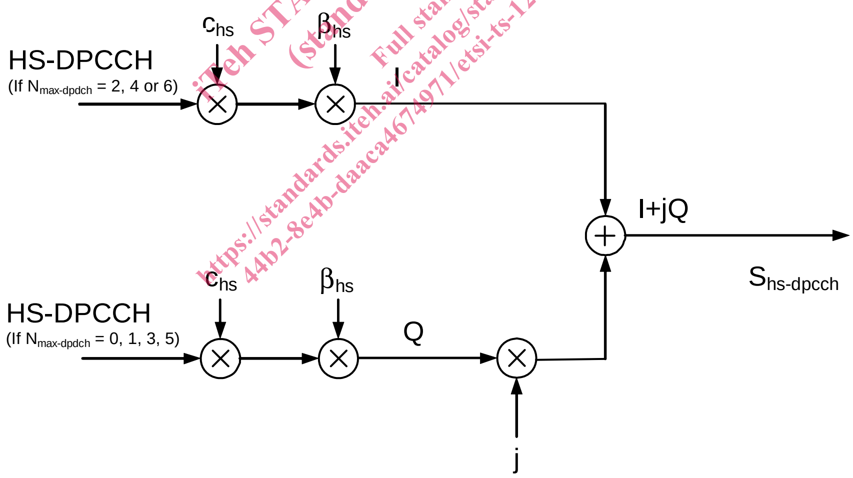

Figure 1B: Spreading for uplink HS-DPCCH when Secondary_Cell_Enabled is less than 4 in case the UE is not configured in MIMO mode with four transmit antennas in any cell, or less than 2 in case the UE is configured in MIMO mode with four transmit antennas in at least one cell