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1. Introduction

This contribution continues the discussion initiated in [1] of UE performance requirements for HSDPA to be specified in TS25.101 REL-5, and makes proposals for HS-DSCH reference channels and simulation assumptions to permit UE performance specification to commence.

HSDPA introduces new physical layer functionality into REL-5, and a complete performance specification will require careful attention to the following areas:

1. **Multicode operation & higher order modulation** – the UE is required to simultaneously receive multiple (likely up to 15) length-16 spreading codes on the High Speed Physical Downlink Shared Channel (HS-PDSCH), with the exact number of codes limited by the UE capability. Operation with QPSK and 16-QAM is also a WG1 working assumption. Although UE(s) for REL99/REL4 support DL multi-code operation, the current measurement channels are based on single code operation and therefore do not consider performance degradation due to loss of orthogonality in multipath channels when using large numbers of multi-codes. Testing multicode reception in delay spread channel conditions is therefore of fundamental importance for REL-5 HSDPA receivers, especially when using 16-QAM. Further, operation with large numbers of multicode potentially presents additional performance issues for receiver linear and non-linear impairments that should be reflected in an HSDPA-specific sensitivity test.
2. **Hybrid Automatic Repeat Request (HARQ)** – HSDPA UE's are required to support multiple HARQ processes (the exact number is still to be defined in WG1), to soft-combine coded bits from multiple successive transmissions on the same HARQ process, and to transmit a per-TTI acknowledgement (ACK/NACK). Verification of the soft-combining function, and ACK/NACK validation are essential tests.
3. **Incremental redundancy (IR)** – WG1's current working assumption is that IR is the reference HARQ FEC coding model for HS-DSCH¹, although the exact structure of the rate matching,

¹ With Chase combining (where the same codeword is transmitted in each TTI) regarded as a subset of full IR operation.

redundancy version selection, and symbol mapping elements are yet to be agreed. We propose re-sizing ARQ process soft buffer sizes (in Soft Metric Locations, or SML's) to permit IR testing.

4. **C/I Reporting** – WG1's current working assumption is that some form of Transport Format Resource Combination (TFRC) will be reported by the UE, as an indication of the maximum current information rate that the UE can receive (itself a function of C/I, channel type, Doppler frequency etc.) In order to make this reference metric meaningful to each manufacturer's Node-B scheduler, adequate and standardized testing of its performance is essential.
5. **Control Channels** – WG1's working assumptions are that a new shared control channel (the High Speed Shared Control Channel or HS-SCCH), and associated signaling (the associated DPCH-borne High Speed Indicator or HI), are introduced by HSDPA. While the signaling performance of the HI and HS-SCCH are currently under study in WG1, HSDPA performance assessment requires HS-SCCH and HI signaling performance be assessed, ideally in combination with HS-DSCH assessment.

Each of these elements should be assessed using the minimal number of tests, which should in turn be consistent with the current performance methodology in WG4 and T1. Accordingly, it is proposed that a new section be added to TS 25.101 covering HSDPA, addressing the following performance aspects.

- a) A set of HSDPA sensitivity tests,
- b) A set of 'Standard' HSDPA demodulation tests (i.e. tests conducted without use of the HARQ protocol) based on a UE-reported packet erasure analysis². These tests are assessed using the metric of MAC-hs CRC-derived Packet Error Rate (PER) (as opposed to received BLER or BER) versus \hat{I}_{or}/I_{oc} ,
- c) A set of 'HARQ' HSDPA demodulation tests that assess UE soft combining performance when using HARQ plus ACK/NACK and TFRC metric reporting. These tests are assessed according to information bit throughput versus \hat{I}_{or}/I_{oc} ,
- d) An associated informative annex defining measurement channels and physical channels for HSDPA testing.

² Where a 'packet' is defined as the TTI information bit payload comprising all transport blocks covered by the 24-bit MAC-hs CRC.

2. HSDPA Standard Performance Tests

2.1. Test Methodology

These tests are based on packet error rate (PER³) analysis in the absence of HARQ, and are based on Figure 1. The UE receiver attempts demodulation of each signaled HS-DSCH packet and reports – via the UL 12.2kbps reference channel DCCH – a final accumulated PER estimate (where a packet error is declared when the MAC-hs CRC fails). A new packet is transmitted to the UE in each successive active TTI, up to the maximum TTI occupancy consistent with UE capability and timing. The HARQ process number is incremented in each successive active TTI, modulo the UE-defined number of HARQ processes. A single composite PER (i.e. the combination of each process PER) would be reported by the UE via the UL DCCH. A single HS-DPCH transport channel, using a single priority class, and offering an ‘infinite’ queue of packets for transmission would source the information bit sequence.

The proposed set of downlink physical channels present during these tests are as specified in Table 18 (see Section 6 below) which would be added to an informative annex on HSDPA in TS 25.101. Performance assessment would be based on the observed packet error rate (PER) as a function of \hat{I}_{or} / I_{oc} for each of the three (3) HSDPA DL reference channels defined in Section 5, which operate at nominal peak information bit rates of 796kbps, 3540kbps and 7068kbps.

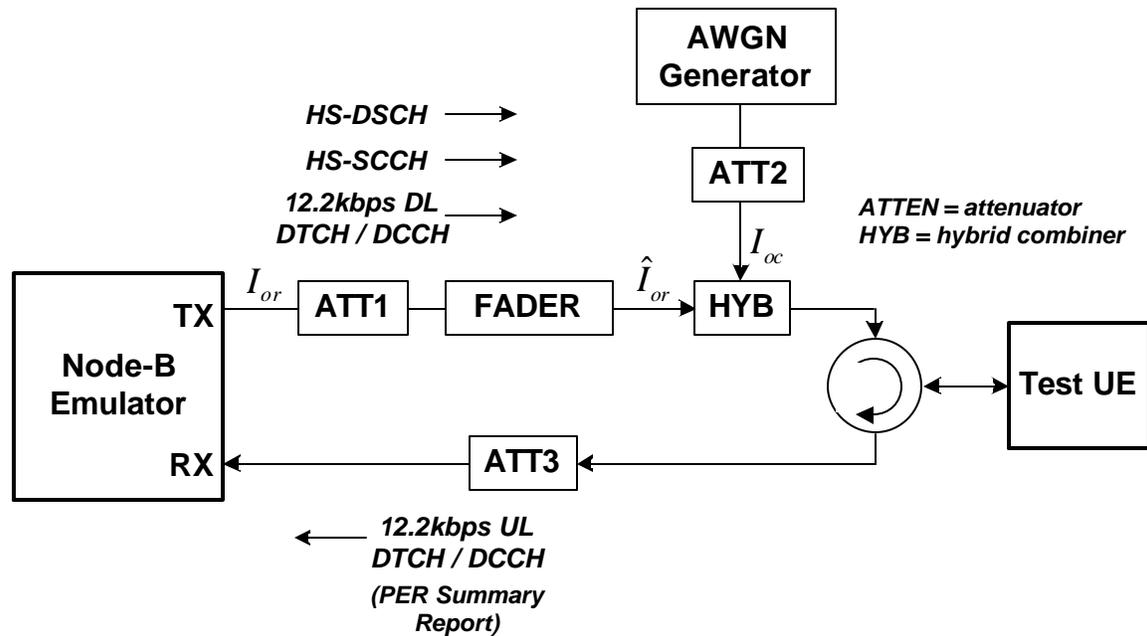


Figure 1. UE Test Configuration – Standard tests.

³ Where a ‘packet’ is defined as the information bit payload of each per-TTI transmission, and a packet error is the event where any constituent bit in the TTI is in error, including the CRC.

2.2. Associated DL DPCH Testing

Given the extensive data set already available for 12.2kbps reference channel operation, we propose that reference channel be used as the associated DL DPCH (without power control) for HSDPA testing, and also as the associated UL DPCH (for transport of PER statistics, and to which the uplink HS-DPCCH channel – used for ACK/NACK and TFRC signaling – is attached). Since we expect only a minor degradation in DL DPCH performance whatever the adopted method of HI insertion into the DL DPCH⁴, existing TS 25.101 specifications for 12.2kbps DPCH performance (E_c / I_{or}) are adopted, *after appropriate modification for the change in \hat{I}_{or} needed for HS-DSCH demodulation*. The specified relative level of the punctured HI symbol(s) (with respect to the DL DPCH pilot field) is currently under study, and will be proposed in a future contribution.

2.3. Control Channel Testing

Since correct packet reception is conditional on successful signaling on the associated DL DPCH as well as the HS-SCCH, the proposed Standard tests also assess downlink signaling performance. One possible approach would be to configure the associated DPCH and HS-SCCH received power levels so that signal error events are negligible. This does not, however, verify a) efficient operation of the DL DPCH during HS-DSCH reception, and b) efficient demodulation of the HI and HS-SCCH signaling fields.

Concerning HS-SCCH operation, it seems essential that we test both the function of the DPCH HI *both* as an indicator of HS-DPCH data availability addressed to the UE under test, *and* a pointer towards the appropriate HS-SCCH channel (WG1's current working assumption is that the UE is required to demodulate at most 4 HS-SCCH's, regardless of the number defined in the cell). Accordingly, we propose that that while only a single HS-SCCH be transmitted by the host Node-B (and hence occupy only a single OVSF code in the code tree⁵, and a single power allocation in the DL test physical channel definition) the UE be advised that 4 HS-SCCH's are active, with each potentially signaling to the UE under test.

2.4. Channel Modeling

Inter-chip interference during multicode reception, even at high \hat{I}_{or} / I_{oc} levels, can significantly impair conventional RAKE receiver operation. Further, as stated above, receiver sensitivity assessment during multicode reception can be affected by linear and non-linear receiver impairments that would not normally be an issue at larger spreading factors.

Accordingly, tests are specified for three different channel conditions, specifically:

- a) Static environment (also for receiver sensitivity analysis),
- b) TS 25.101 Table B.1 Case 3 (4 ray, 120km/h),

⁴ *DPDCH and TFCI puncturing have both been suggested in WG1.*

⁵ *The HS-SCCH spreading factor is currently under discussion in WG1, with a spreading factor of 128 or 256 being most likely to be adopted.*

c) TS 25.101 Table B.1 Case 4 (2 ray, 3km/h).

Two multipath cases are required for the following reasons. First, the relatively low Doppler frequency specified by Case 4 verifies UE performance meets the requirement of TR 25.858 ([4], Informative Annex A) that system operation should be optimized for Doppler frequencies consistent with urban operation (i.e. urban operation implies a delay spread channel). Second, TR 25.858 requires that, although not optimal, HSDPA operation should still be possible at higher Doppler frequencies, and this is accomplished by the Case 3 (120km/h) test. Moreover, the potential loss of SNR for some channel estimation techniques at higher Doppler frequencies make such a test desirable.⁶

2.5. OCNS

The use of OCNS would certainly be a valid approach in HSDPA assessment, especially since mixed voice and HS-DSCH operation is envisaged. It appears to add little, however, to the functional assessment of HSDPA receiver performance, since HS-PDSCH demodulation already assesses multicode operation, and so is neglected here.

2.6. PER Requirements

Most HSDPA simulations (system and link level) offered to WG1 have focused on a 10% PER requirement for a first transmission, and this is reflected here. In some circumstances, however, low-delay HS-DSCH operation is also anticipated and so we propose a further requirement that 1% PER operation be achievable, as a means of verifying that receiver performance does not ‘floor’ (i.e. PER remains flat as a function of \hat{I}_{or}/I_{oc}) and therefore precludes low-delay operation.

2.7. Standard Test Specifications

In the tests below, the primary performance requirement is that the HS-DSCH PER requirement is satisfied for the given \hat{I}_{or}/I_{oc} . As a secondary test of efficient DL DPCH demodulation, a DPCH performance requirement (i.e. $DPCH_E_c/I_{or}$) is also specified.

Parameter	Unit	Test 1	Test 2	Test 3
Phase Reference		P-CPICH		
I_{oc}	dBm	-60		
Reference channel	kbps	796	3540	7068

Table 1 - Standard test parameters for HS-DSCH in static environment

⁶ This can result, for example, from the use of an FIR channel estimator, where the increased Doppler frequency bandwidth at higher UE velocities leads to increased estimator bandwidth and reduced estimate SNR.

Test Number	$\frac{DPCH - E_c}{I_{or}}$ (dB)	\hat{I}_{or} / I_{oc} (dB)	PER
1	TBD	TBD	10^{-1}
	TBD	TBD	10^{-2}
2	TBD	TBD	10^{-1}
	TBD	TBD	10^{-2}
3	TBD	TBD	10^{-1}
	TBD	TBD	10^{-2}

Table 2 – Standard test requirements for HS-DSCH in static environment

Parameter	Unit	Test 4	Test 5	Test 6
Phase Reference		P-CPICH		
I_{oc}	dBm	-60		
Reference channel	kbps	796	3540	7068

Table 3 - Standard test parameters for HS-DSCH in multipath (Case 3)

Test Number	$\frac{DPCH - E_c}{I_{or}}$ (dB)	\hat{I}_{or} / I_{oc} (dB)	PER
4	TBD	TBD	10^{-1}
	TBD	TBD	10^{-2}
5	TBD	TBD	10^{-1}
	TBD	TBD	10^{-2}
6	TBD	TBD	10^{-1}
	TBD	TBD	10^{-2}

Table 4 – Standard test requirements for HS-DSCH in multipath (Case 3)

Parameter	Unit	Test 7	Test 8	Test 9
Phase Reference		P-CPICH		
I_{oc}	dBm	-60		
Reference channel	kbps	796	3540	7068

Table 5 - Standard test parameters for HS-DSCH in multipath (Case 4)

Test Number	$\frac{DPCH_E_c}{I_{or}}$ (dB)	\hat{I}_{or} / I_{oc} (dB)	PER
7	TBD	TBD	10^{-1}
	TBD	TBD	10^{-2}
8	TBD	TBD	10^{-1}
	TBD	TBD	10^{-2}
9	TBD	TBD	10^{-1}
	TBD	TBD	10^{-2}

Table 6 – Standard test requirements for HS-DSCH in multipath (Case 4)

3. HSDPA HARQ Performance Tests

The HSDPA Standard performance tests specified above do not exercise critical aspects of HSDPA receiver operation, including Incremental Redundancy (IR), soft combining under HARQ protocol control, and TFRC reporting accuracy.

One approach to HARQ testing would be to neglect the TFRC report, disable IR (i.e. enforce Chase HARQ combining) and assess throughput based on ACK/NACK-controlled re-transmission of the reference channels used for the Standard tests. This has the disadvantage that it does not however, assess the TFRC and IR aspects, which we consider to be essential test items. While the problem of TFRC report verification could be addressed by comparing TFRC reports against a given test stimulus in a separate test, an alternative approach would be to define, at the test Node-B, a simplified reference Adaptive Modulation

Controller (AMC)^{7,8} function capable of accepting as input⁹ the UL ACK/NACK signaling data and TFRC reports, and then – constrained by the UE capability under test – deliver a test sequence of packets. The test requirement would then be expressed as mean information bit throughput (kbps) as a function of \hat{I}_{or} / I_{oc} , conditioned on the definition of the standard AMC. This approach has the advantage that the HARQ/IR and TFRC assessment are bundled into a small number of relatively comprehensive tests. The disadvantages lie in the obvious difficulty of specifying a standard AMC, and the fact that a specific point of failure in the test process (e.g. TFRC, HARQ etc.) would not be easily identifiable.

While we prefer the latter option, we propose for the present that throughout testing (see Figure 2) be performed by providing only ACK/NACK signaling to the AMC function, and restricting the AMC function to use the Standard reference channels defined above, with the exception that the number of ARQ processes are modified so that the number of Soft Metric Locations (SML's – i.e. UE binary coded symbol log-likelihood ratio storage locations) available to each process is increased, permitting testing of IR. Additionally, for now, we propose that TFRC reporting must be assessed in a separate test (which is FFS). The modified set of reference channels for HARQ testing appear in Section 5.

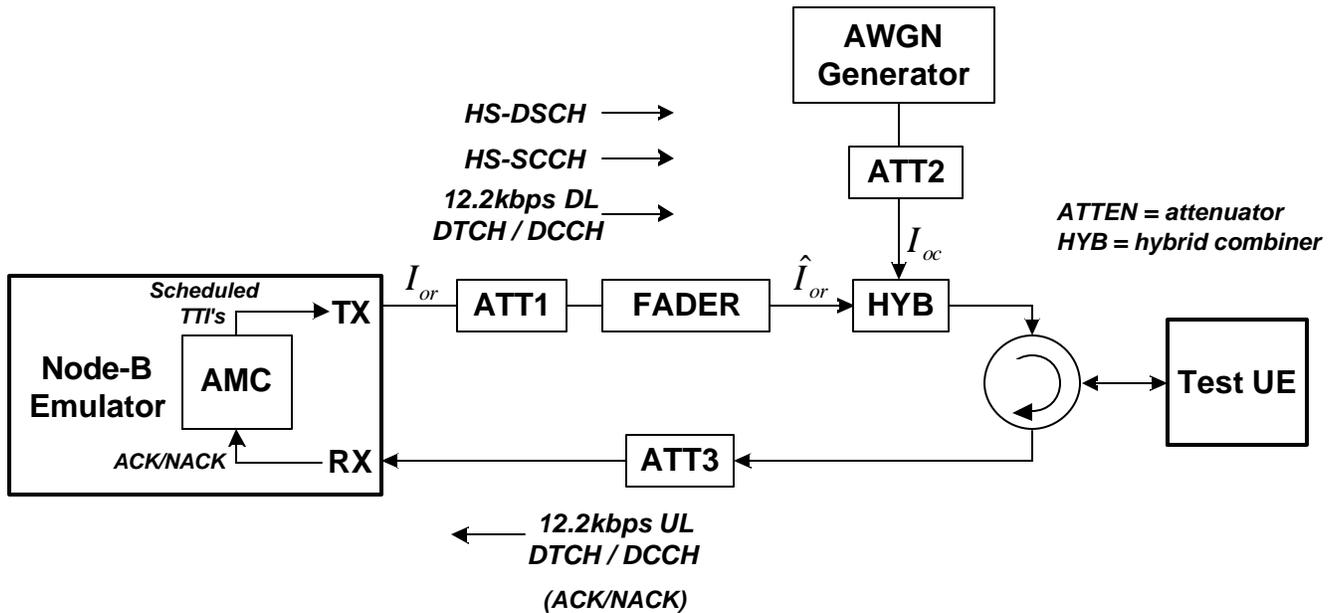


Figure 2. UE Test Configuration – HARQ tests.

⁷ The Adaptive Modulation Controller (AMC) is a derivative of the scheduling function envisaged at the MAC-hs, with the obvious modification that only a single UE is being addressed.

⁸ EGPRS has previously adopted throughput as a method of assessing receiver performance in an IR/HARQ mode – see Section 6.7 of 3GPP TS 05.05 [5].

⁹ In the interests of simplicity, DL DPCH transmit power is not used as input to the proposed reference AMC..

The HARQ tests would be subject to the same TS 25.101 multipath channels as for the Standard tests – i.e. Cases 3 and 4 (no static environment HARQ test is proposed). The UL DPCH would be delivered to the test Node-B at a signal level consistent with zero error rate ACK/NACK signaling and TFRC reporting (see Section 6.2). The parameters and requirements for HARQ testing follow. These would be inserted into the new HSDPA-specific section of TS 25.101. The resulting test configuration appears in Figure 2.

3.1. HARQ Test Specification

As stated above, the AMC function for HARQ testing is under study. This section specifies measured throughput as a function of \hat{I}_{or}/I_{oc} for each capability class (which are yet to be defined in WG1 – the classes below are included as examples).

Parameter	Unit	All Capability Classes
Phase Reference		P-CPICH
I_{oc}	dBm	-60

Table 7 - HARQ test parameters for HS-DSCH in multipath environment (Cases 3 and 4)

Test Number	UE Capability Class	$\frac{DPCH - E_c}{I_{or}}$ (dB)	\hat{I}_{or}/I_{oc} (dB)	Throughput (kbps)
10	384 kbps	TBD	TBD	TBD
		TBD	TBD	TBD
11	768 kbps	TBD	TBD	TBD
		TBD	TBD	TBD
12	2048 kbps	TBD	TBD	TBD
		TBD	TBD	TBD
13	7200 kbps	TBD	TBD	TBD
		TBD	TBD	TBD
14	10800 kbps	TBD	TBD	TBD
		TBD	TBD	TBD

Table 8 – HARQ test requirements for HS-DSCH in multipath environment (Case 3)

Test Number	UE Capability Class	$\frac{DPCH - E_c}{I_{or}}$ (dB)	\hat{I}_{or} / I_{oc} (dB)	Throughput (kbps)
15	384 kbps	TBD	TBD	TBD
		TBD	TBD	TBD
16	768 kbps	TBD	TBD	TBD
		TBD	TBD	TBD
17	2048 kbps	TBD	TBD	TBD
		TBD	TBD	TBD
18	7200 kbps	TBD	TBD	TBD
		TBD	TBD	TBD
19	10800 kbps	TBD	TBD	TBD
		TBD	TBD	TBD

Table 9 – HARQ test requirements for HS-DSCH in multipath environment (Case 4)

4. HSDPA Sensitivity Tests

We do not expect significant HSDPA-specific requirements (beyond those of Section 7 of 25.101) in areas such as maximum input signal level, adjacent channel selectivity, blocking, spurious response, spurious emission and intermodulation.

It is proposed, however, that an additional reference sensitivity level test be added for HSDPA. This is motivated by the observation that the existing reference sensitivity level test is not simply an estimate of the receiver noise figure. Rather, it reflects receiver “front-end” imperfections, including linear impairments (such as receiver chip matched filter mismatch) and non-linear impairments [such as non-linear ADC quantization effects, I/Q conversion errors (amplitude and phase) etc.] Since HS-PDSCH can operate at higher data rates than previously defined for R’99, using a relatively high number of length-16 multicodes (as many as 15) and therefore at a relatively high code packing density (the ratio of the number of codes to the code length), we believe that the performance of the receiver front-end operating at minimum signal levels should be re-verified for HS-PDSCH operation.

Accordingly, we propose that the Standard tests defined above (Section 2.7, Tests 1-3) for the static channel be repeated, except that rather than setting I_{oc} to -60dBm , the receiver sensitivity level would be measured. The resulting requirements are specified in Table 10 for a common PER of 0.1.

As above, the DL associated channel performance is assessed to verify that sensitivity performance is maintained during HS-PDSCH reception.

Parameter	Unit	Test 20	Test 21	Test 22
$\frac{DPCH_E_c}{I_{or}}$	dB	TBD	TBD	TBD
\hat{I}_{or}	dBm	TBD	TBD	TBD
Reference channel (Standard)	kbps	796	3540	7068

Table 10 - Test parameters for HSDPA reference sensitivity

5. HSDPA Reference Channels

5.1. HS-DSCH Reference Channels

Three (3) reference HS-PDSCH DL channels are proposed for the Standard tests. They are summarized in Table 11. Each reference channel also has a companion HARQ reference channel case, for use in HARQ testing where the number of SML's available to each process is increased to permit IR testing.

The TTI for all reference channels is 2ms (as specified in [4]), and the HS-PDSCH CRC length is 24 bits. As required for HSDPA, a single transport channel is transmitted per TTI, and in fact only a single HS-DSCH transport channel (with only one priority class) is defined for each test. Also, in the interests of simplicity, a single transport block size of 98 bytes (784 bits) is proposed for all reference channels (from the perspective of receiver performance verification, there appears to be little benefit in varying the transport block size, or seeking the spectral efficiency improvements that might accompany such adjustments in practice).

The number of transport blocks is varied to create the 3 Standard reference channels of Table 11, with each channel characterized by a progressively larger number of allocated physical channel codes, code rate and information bit rate. The number of information bits per TTI scales roughly with the UE capability classes (such as those proposed in [3]) – the 796kbps reference channel is applicable to low-capability devices, while the 3540kbps is applicable to capability classes 2048kbps and above, and the 7068kbps reference channel is applicable to both the 7200kbps and 10800kbps classes of [3].

Reference Chan. Label	Num. TrBlks / TTI	TrBlk Set Size	Num. Inf. Bits / TTI (inc CRC)	Num. Code Blks / TTI	Tot. Num. Coded Bits / TTI	Num. Phy. Codes	Mod'n	Code Rate	Peak Inf. Bit Rate (kbps)
796 kbps	2	1568	1592	1	3840	4	QPSK	0.41	796
3540 kbps	9	7056	7080	2	9600	5	16-QAM	0.74	3540
7068 kbps	18	14112	14136	3	19200	10	16-QAM	0.74	7068

Table 11 - Summary of proposed reference channels for HSDPA standard testing.

5.2. HS-DSCH Reference Measurement Channel (796 kbps)

The parameters for the Standard and HARQ 796 kbps HS-DSCH reference measurement channels are specified in Table 14 and Table 15. The channel coding is shown for information in Figure 3 and Figure 4.

Parameter	Unit	Value
Peak Inf. Bit Rate	kbps	796
Number of HARQ Processes	Processes	2
Transport Block Size	Bits	784
Transport Block Set Size	Bits	1568
Number Code Blocks	Blocks	1
Binary Coded Bits Per TTI	Bits	3840
Number of SML's per HARQ Proc.	SML's	3840
Inst. Coding Rate		0.41
Final Coding Rate		0.41
Number of Physical Channel Codes	Codes	4
Modulation		QPSK

Table 12 - 796 kbps Standard HS-DSCH reference measurement channel.

Parameter	Unit	Value
Peak Inf. Bit Rate	kbps	796
Number of HARQ Processes	Processes	2
Transport Block Size	Bits	784
Transport Block Set Size	Bits	1568
Number Code Blocks	Blocks	1
Binary Coded Bits Per TTI	Bits	3840
Number of SML's per HARQ Proc.	SML's	4788
Inst. Coding Rate		0.41
Final Coding Rate		0.33
Number of Physical Channel Codes	Codes	4
Modulation		QPSK

Table 13 - 796 kbps HARQ HS-DSCH reference measurement channel.

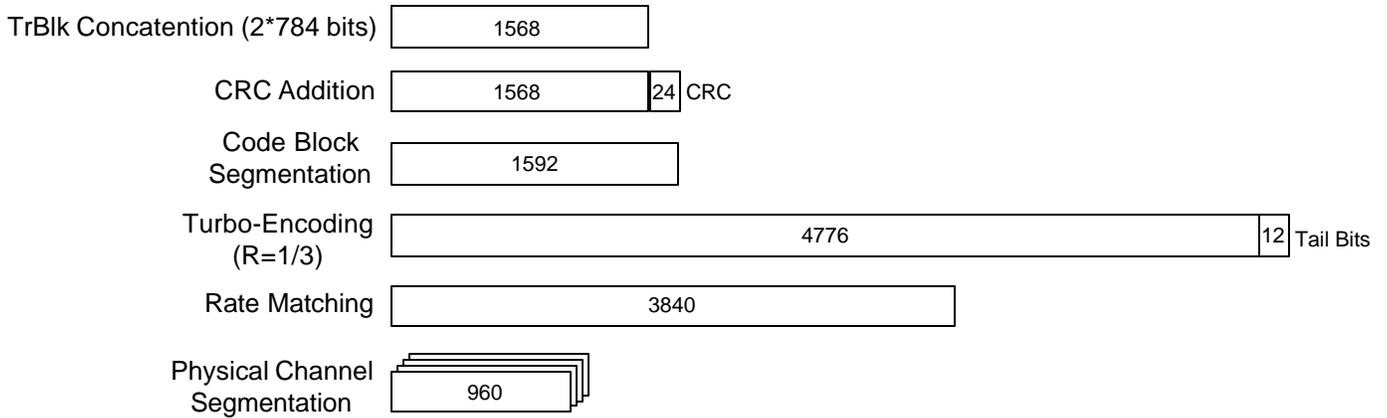


Figure 3. Coding for 796 kbps Standard HS-DSCH reference measurement channel.

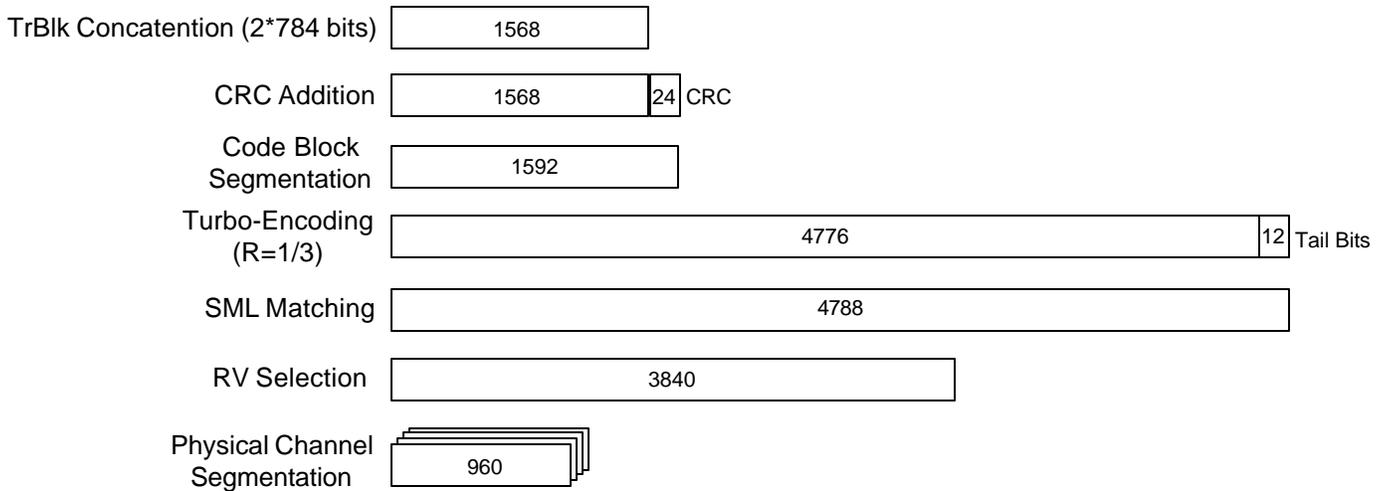


Figure 4. Coding for 796 kbps HARQ HS-DSCH reference measurement channel.

5.3. HS-DSCH Reference Measurement Channel (3540 kbps)

The parameters for the Standard and HARQ 3540 kbps HS-DSCH reference measurement channels are specified in Table 14 and Table 15. The channel coding is shown for information in Figure 5 and Figure 6.

Parameter	Unit	Value
Peak Inf. Bit Rate	kbps	3540
Number of HARQ Processes	Processes	6
Transport Block Size	Bits	784
Transport Block Set Size	Bits	7056
Number Code Blocks	Blocks	2
Binary Coded Bits Per TTI	Bits	9600
Number of SML's per HARQ Proc.	SML's	9600
Inst. Coding Rate		0.74
Final Coding Rate		0.74
Number of Physical Channel Codes	Codes	5
Modulation		16-QAM

Table 14 - 3540 kbps Standard HS-DSCH reference measurement channel.

Parameter	Unit	Value
Peak Inf. Bit Rate	kbps	3540
Number of HARQ Processes	Processes	3
Transport Block Size	Bits	784
Transport Block Set Size	Bits	7056
Number Code Blocks	Blocks	2
Binary Coded Bits Per TTI	Bits	9600
Number of SML's per HARQ Proc.	SML's	19200
Inst. Coding Rate		0.74
Final Coding Rate		0.37
Number of Physical Channel Codes	Codes	5
Modulation		16-QAM

Table 15 - 3540 kbps HARQ HS-DSCH reference measurement channel.

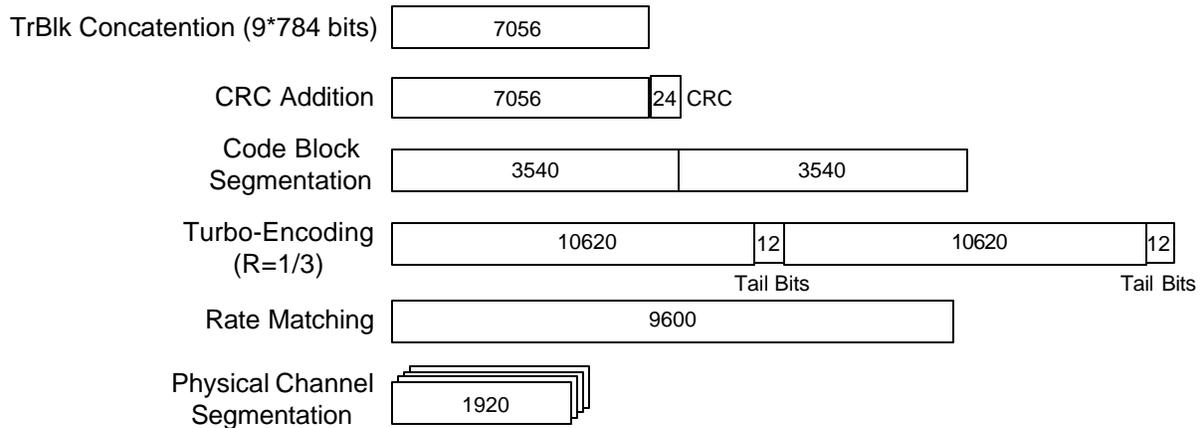


Figure 5. Coding for 3540 kbps Standard HS-DSCH reference measurement channel.

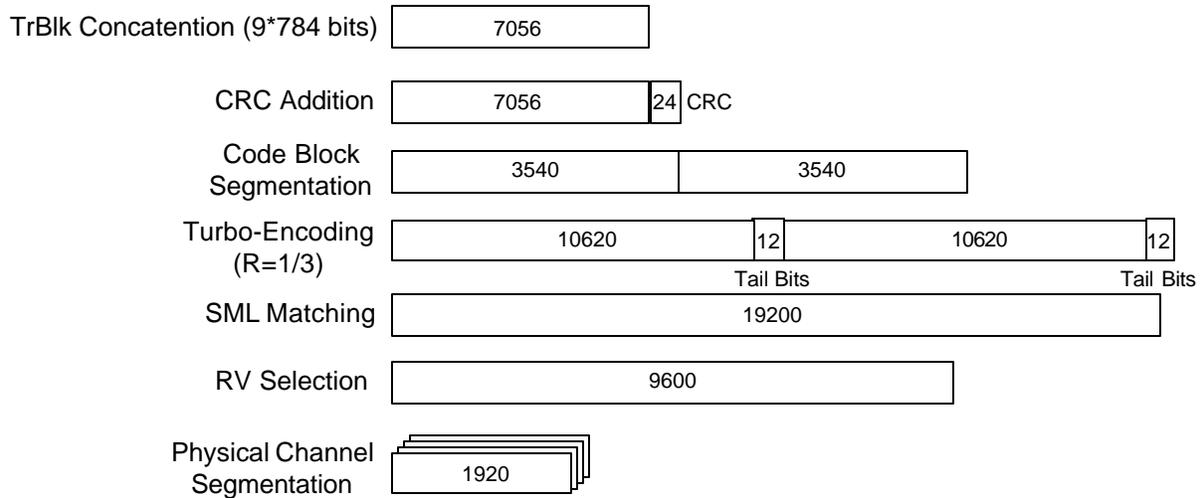


Figure 6. Coding for 3540 kbps HARQ HS-DSCH reference measurement channel.

5.4. HS-DSCH Reference Measurement Channel (7068 kbps)

The parameters for the Standard and HARQ 7068 kbps HS-DSCH reference measurement channels are specified in Table 16 and Table 17. The channel coding is shown for information in Figure 7 and Figure 8.

Parameter	Unit	Value
Peak Inf. Bit Rate	kbps	7068
Number of HARQ Processes	Processes	6
Transport Block Size	Bits	784
Transport Block Set Size	Bits	14112
Number Code Blocks	Blocks	3
Binary Coded Bits Per TTI	Bits	19200
Number of SML's per HARQ Proc.	SML's	19200
Inst. Coding Rate		0.74
Final Coding Rate		0.74
Number of Physical Channel Codes	Codes	10
Modulation		16-QAM

Table 16 - HS-DSCH reference measurement channel (Standard – 7068 kbps)

Parameter	Unit	Value
Peak Inf. Bit Rate	kbps	7068
Number of HARQ Processes	Processes	3
Transport Block Size	Bits	784
Transport Block Set Size	Bits	14112
Number Code Blocks	Blocks	3
Binary Coded Bits Per TTI	Bits	19200
Number of SML's per HARQ Proc.	SML's	38400
Inst. Coding Rate		0.74
Final Coding Rate		0.37
Number of Physical Channel Codes	Codes	10
Modulation		16-QAM

Table 17 - HS-DSCH reference measurement channel (HARQ – 7068 kbps)

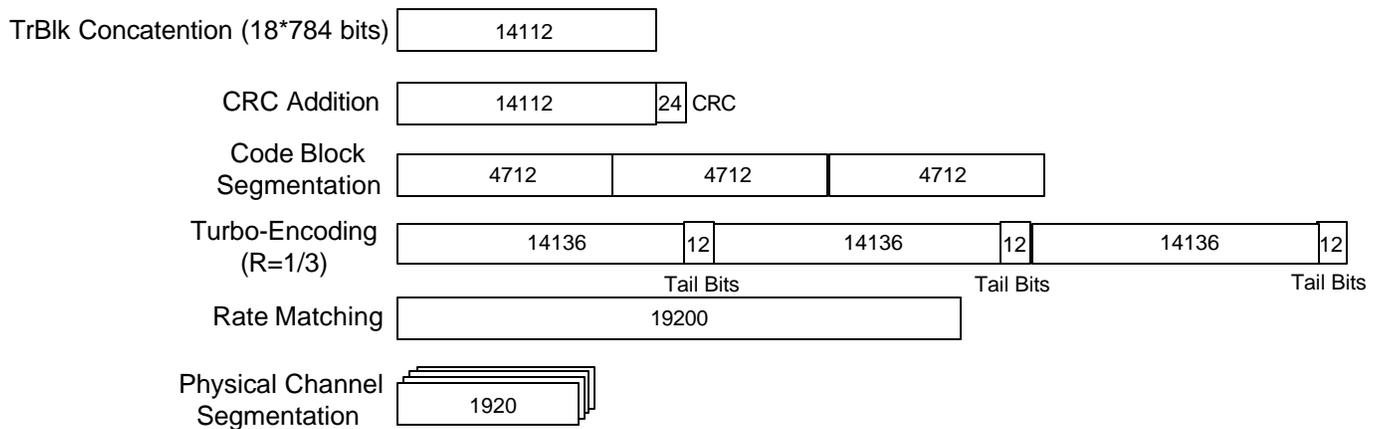


Figure 7. Coding for 7068 kbps Standard HS-DSCH reference measurement channel.

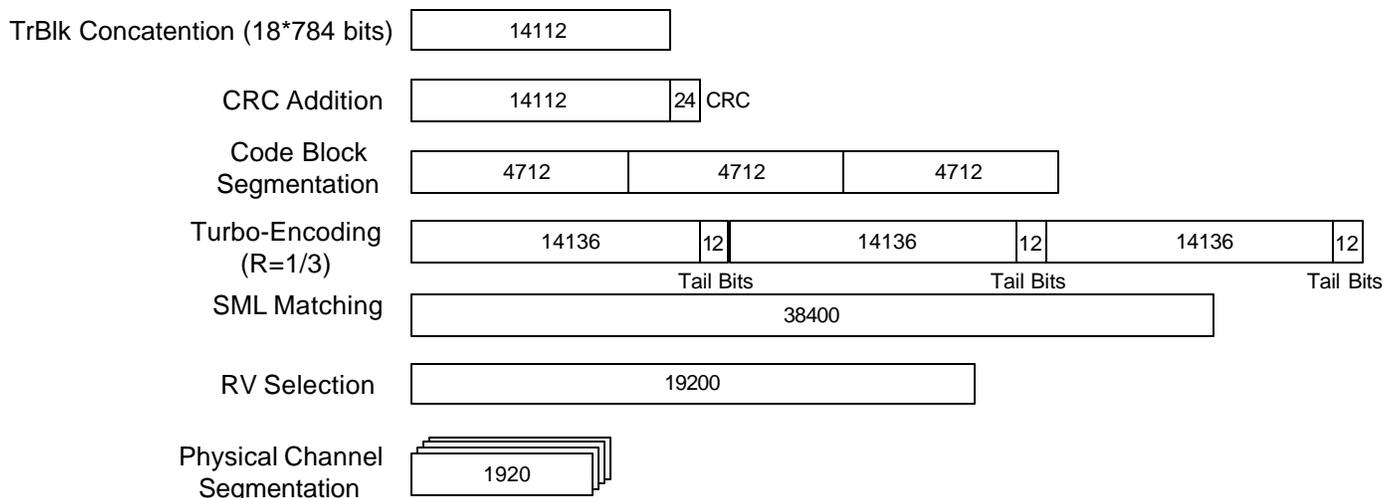


Figure 8. Coding for 7068 kbps HARQ HS-DSCH reference measurement channel.

6. Physical Channels Transmitted During HSDPA Connection

6.1. Downlink Physical Channels

Table 18 proposes the downlink physical channels present during HSDPA testing. Specification of the P-CPICH, P-CCPCH, SCH and PICH physical channels is retained from Table C.3 of 25.101, with random symbols transmitted on the P-CCPCH and PICH. OCNS is not emitted by the test Node-B. Tests using S-CPICH are also neglected, since – although beamforming for HSDPA is expected to be standardized – this again seems to add little to performance tests based on the P-CPICH reference.

Four (4) High Speed Shared Control Channels (HS-SCCH's) are specified. As stated previously, signaling and therefore power is only assigned to a single HS-SCCH, but the UE is informed of the presence of 4 HS-SCCH's. Power is not assigned to the other HS-SCCH's.

The HS-SCCH is a broadcast channel, operating without power control. Accordingly, the specified fraction of the test Node-B radiated power level in Table 18 is nominally invariant. Since the HS-SCCH is DTX'd when the UE is not addressed, and since the UE capability may require inactive TTI's to be inserted between active TTI's, the stated power level refers to the power level while the HS-SCCH is not DTX'd.

A single downlink associated DPCH is also specified in Table 18. As stated above, this is the 12.2kbps reference channel transporting HI signaling.

Physical Channel	Parameter	Value	Note
P-CPICH	P-CPICH_Ec/Ior	-10dB	Only P-CPICH specified as phase reference for HS-PDSCH testing (see text). S-CPICH not tested (although expected in practice).
P-CCPCH	P-CCPCH_Ec/Ior	-12dB	As specified in 25.101 – mean power level is shared with SCH.
SCH	SCH_Ec/Ior	-12dB	As specified in 25.101 – mean power level is shared with P-CCPCH – SCH includes P- and S-SCH, with power split between both.
PICH	PICH_Ec/Ior	-15dB	As specified in 25.101.
DPCH	DPCH_Ec/Ior	Test-specific	DPCH is not power controlled, but open-loop power level specified as test requirement.
HS-SCCH_1	HS-SCCH_Ec/Ior	TBD	Specifies fraction of Node-B radiated power transmitted when TTI is active.
HS-SCCH_2	HS-SCCH_Ec/Ior	DTX'd	No signalling scheduled, or power radiated, on this HS-SCCH, but defined at the UE as present.
HS-SCCH_3	HS-SCCH_Ec/Ior	DTX'd	As HS-SCCH_2.
HS-SCCH_4	HS-SCCH_Ec/Ior	DTX'd	As HS-SCCH_2.
HS-PDSCH	HS-PDSCH_Ec/Ior	TBD	Balance of test Node-B transmit power (i.e. Ec/Ior sums to unity).
OCNS		Inactive	Not considered necessary for HS-DSCH testing.

Table 18 – Downlink physical channels transmitted during a connection

6.2. Uplink Physical Channels

It is proposed there should be three (3) physical channels present on the uplink during HSDPA testing, specifically:

1. 12.2kbps associated UL reference channel DPCCH and DPDCH,
2. HS-DPCCH – carrying HS-DSCH ACK/NACK signaling and the TFRC report data [4].

All physical channels should be received at the Node-B at a signal level that ensures zero bit errors in all physical channels.

7. UE Capabilities

WG1 is presently assessing options for UE capability specification [3], and – although those discussions are not complete – it seems likely that not all UE's will be capable of demodulating all of the HS-DSCH reference channels defined above. Accordingly, as stated above, we propose the simple restriction that UE's whose capability (e.g. information bit rate, number of codes supported etc.) is less than a defined reference channel requirement would not be subject to test under that reference channel.

8. Conclusions

The proposals above define specific test procedures for HSDPA UE receiver assessment. We welcome comment from other manufacturers and operators in order to make progress toward the definition of a common set of simulation assumptions for HSDPA. Performance data consistent with the tests and reference channels defined above will be introduced at the next meeting.

9. References

- [1] Motorola, "Evaluation of HSDPA impact to RAN WG4 REL-5 specifications", TSGR4#19(01)1229, Edinburgh, Scotland, Sept. 3-7, 2001
- [2] 3GPP Technical Specification 25.101, "UE Radio Transmission and Reception"
- [3] Motorola, "Revised UE capabilities for HSDPA", TSGR1(01)1016, Sophia Antipolis, France, Nov. 3-5, 2001
- [4] 3GPP TR 25.858, "High Speed Downlink Packet Access: Physical Layer Aspects"
- [5] 3GPP TS 05.05, "Radio transmission and reception"

10. Appendix A - Simulation Assumptions

The simulation assumptions underlying the Standard and HARQ tests outlined above are summarized in Table 19.

Parameter	Assumption
Chip rate	3.84 Mcps
Downlink physical channels and power levels	Section 6.1
HS-DSCH reference channels	796 kbps, 3940 kbps, 7068 kbps
Control channels present	HS-SCCH (4), HI (on DPCH)
OCNS	Not used
Number of OVSF codes	4 (QPSK), 5 (16-QAM), 10 (16-QAM)
UL DPCH reference channel	12.2 kbps
DL DPCH reference channel	12.2 kbps
DL DPCH closed loop power control	Off
HS-DSCH receiver type	Manufacturer specific – conventional RAKE receiver operation in multipath channels even for low numbers of codes appears infeasible – manufacturers should be free to adopt alternative receiver architectures.
Channel estimation	Estimated – when demodulating large numbers of multicodes, and for different Doppler frequencies etc., the effect of practical channel estimation error (i.e. the implementation margin approach) may be difficult to predict.
RX AGC	Off
Number of samples per chip	1
Channel types	Static, Case-3, Case 4
Channel ray mapping	Nearest chip-spaced delay
Number of bits in A/D converter	Floating point simulation
IR coding	To be specified by WG1
HS-DSCH PER target	PER = 10^{-1} , 10^{-2}
Number HS-DSCH transport channels	1
TrCh block size	784
Turbo decoding	MaxLogMap - 8 iterations
I_{oc}	-60 dBm (except for static tests)
P-CCPCH	Random symbols transmitted – ignored by receiver
PICH	Random symbols transmitted – ignored by receiver
DPCH – DTCH	FER = 10^{-2}
DL DPCH HI amplitude (w.r.t DPCH)	TBD
HS-SCCH transmit power level	TBD
HARQ feedback error rate	0%

Table 19 – Simulation assumption summary.