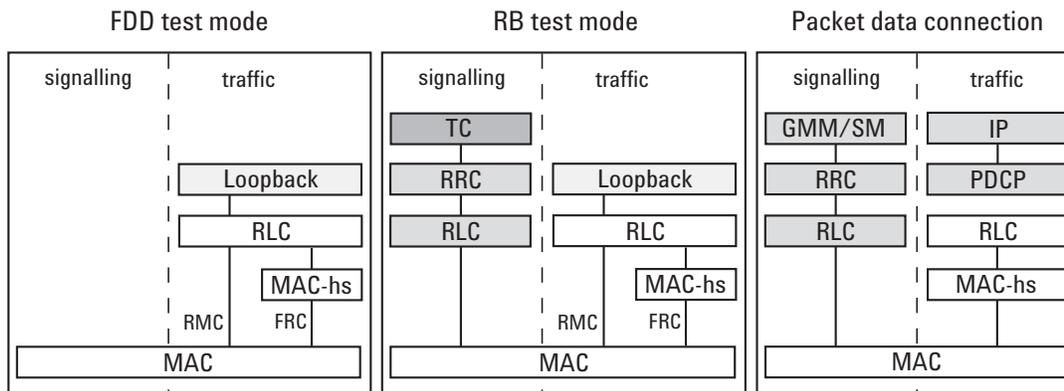


Introduction

The W-CDMA applications in the Agilent 8960 test set are being evolved to include HSDPA test functionality. This paper contrasts the various HSDPA connection types and provides details of the test set's HSDPA frequency division duplex (FDD) test mode and HSDPA measurements.

Test Set Connection Types

There are several types of connections available in the test set; each involving different protocol entities and layers, and varying amounts of signaling. Three main connection types are discussed below: FDD test mode, RB (radio bearer) test mode, and packet data connection.



FDD test mode

FDD test mode is an Agilent-proprietary test mode. It is based on the 3GPP RB test mode, but without Layer 3 signaling. FDD test mode allows you to test the parametric performance of your user equipment's (UE's) transmitter and receiver without upper layer signaling.

In FDD test mode, the test set does not send any signaling information on the downlink. Rather, it continuously generates a downlink signal and searches for a corresponding uplink signal. The UE must synchronize to the downlink signal and send an appropriate uplink signal, which the test set uses to measure the UE's transmitter and receiver performance. Any changes to the UE configuration must be accomplished by directly sending commands to the UE from a system controller through a proprietary digital interface.

RB test mode

RB test mode uses signaling to establish a Layer 3 test control connection between the test set and UE, allowing you to test the parametric performance of your UE's transmitter and receiver.

In RB test mode, the test set provides signaling to establish a connection with the UE. The test set can use Layer 3 commands to alter the UE's uplink radio bearer configuration. The test set measures the uplink signal to determine the UE's transmitter and receiver performance.

Packet data connection

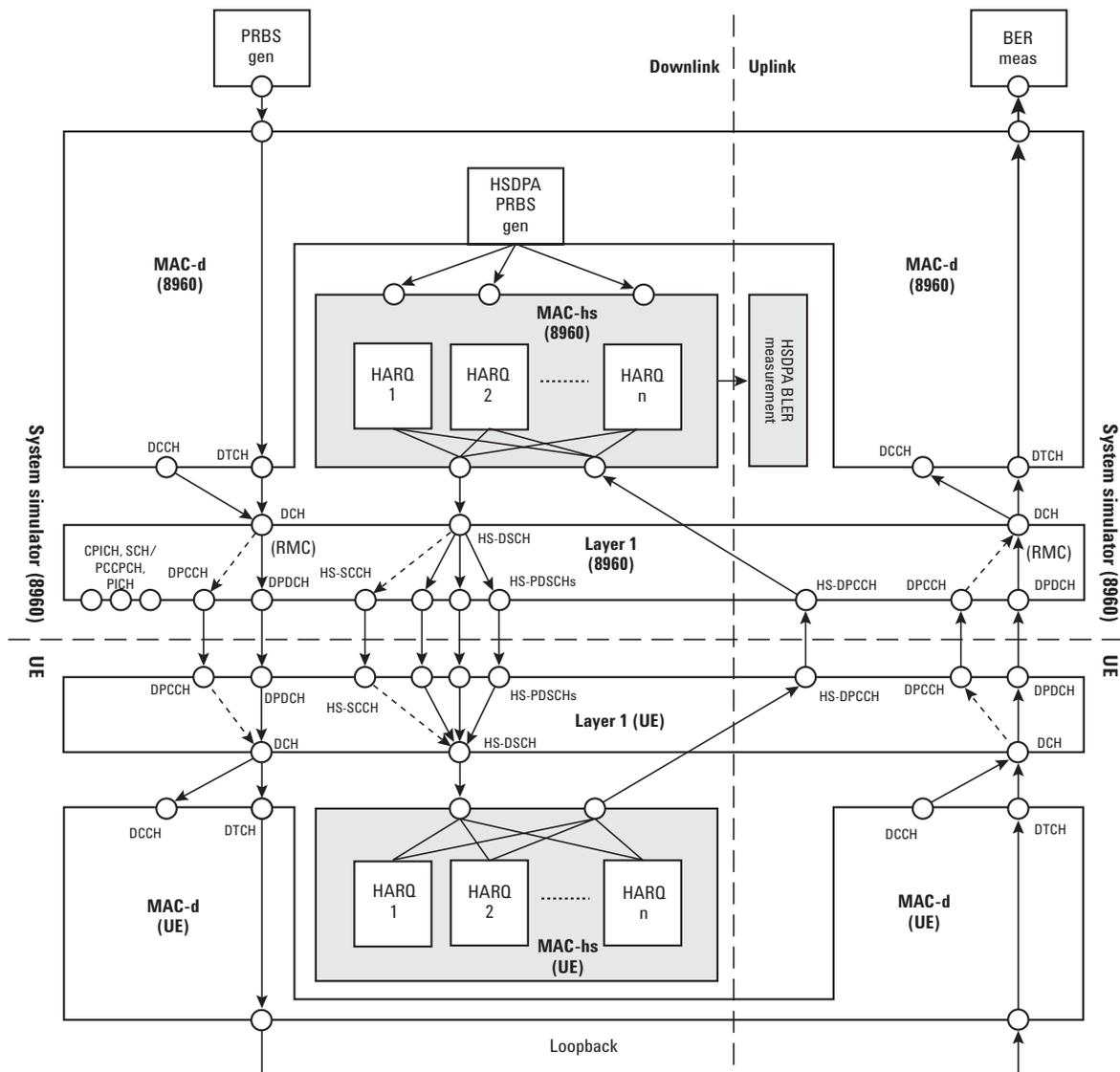
A packet data connection allows you to perform functional verification of your UE to validate real network operation and signaling. The test set provides signaling to establish a packet data connection with the UE, which provides an end-to-end packet-switched data channel over which IP-based applications can transfer data.

FDD Test Mode Details

In (non-HSDPA) FDD test mode, the test set continuously transmits a downlink signal, which consists of a dedicated physical channel (DPCH) configured as a symmetrical reference measurement channel (RMC), CPICH, and SCH/P-CCPCH channels to allow the UE to synchronize to the test set and decode the downlink data, OCNS (as defined in 3GPP TS 34.121 E.3), AWGN if desired, and a PICH channel with fixed data. The UE must be manually configured to transmit the same RMC as is transmitted in the downlink, and to enable (non-HSDPA) receiver testing the UE must loop back the data bits it receives on the RMC from the test set.

The HSDPA FDD test mode implementation in the test set is an extension of the existing (non-HSDPA) FDD test mode. When Channel Type is set to 12.2k RMC + HSDPA, the test set continues to transmit and receive the 12.2k RMC and common channels, but can also be configured to include up to four HS-SCCHs and five HS-PDSCHs (as determined by the FRC Type setting.) When the HSDPA channels are active, the test set generates a six-channel OCNS as defined in 3GPP TS 34.121 E.5, rather than the OCNS defined in E.3.

The test set includes a fully-operational MAC-hs layer (conforming to 3GPP Release 5 December 2004) that contains up to eight active HARQ processes.



The data source for the HARQ processes is a single PRBS generator operating at the MAC-d level. Each time a HARQ process is ready to transmit a new block it requests a single MAC-d block from the PRBS generator. If MAC-hs Header is set to Present, the size of the requested MAC-d block matches the MAC-hs transport block size minus the MAC-hs header. If MAC-hs header is set to Data, the MAC-d block matches the MAC-hs transport block size (which is determined by the FRC Type setting.) The MAC-d block from the PRBS generator is pure data; it does not contain any MAC-d header information (nor does it include any headers from upper layers.)

When a HARQ process transmits a block of data on the HS-DSCH transport channel, the test set's Layer 1 transmits an associated HS-SCCH physical control channel. This carries HARQ process information (new data indicator, TFRI, etc.) and HS-PDSCH physical channel configuration information (modulation type, number of codes, etc.) for that HS-DSCH transport block. This allows the UE to correctly receive the HS-PDSCHs and transmit appropriate acknowledgement information on its HS-DPCCH.

The test set schedules new blocks and retransmissions based on the acknowledge/negative acknowledge (ACK/NACK) information on the uplink HS-DPCCH. If a NACK is received and the block has not been retransmitted more than the Number of Transmissions setting allows, the HARQ process retransmits the block using the next redundancy version (RV) from the RV Sequence list. If a NACK is received and the block has been retransmitted the maximum number of allowed times, or if an ACK is received, the MAC-hs layer transmits a new block using the first RV in the list. If the expected HS-DPCCH transmission is not received on the uplink at the appropriate time, the test set reacts according to the statDTX Reception Behavior setting. The test set records the number of ACKs, NACKs, and statDTXs for use by the HSDPA BLER measurement.

During TTIs where data is not transmitted to the UE (i.e. when inter-TTI is greater than one), the test set transmits dummy data using the Alternate H-RNTI.

Test Set Configuration

As there is no Layer 3 signaling between the test set and UE, you must use proprietary control mechanisms to directly configure the UE to match the test set's HSDPA configuration. This configuration is based on the following test set settings:

HS-SCCH, HS-PDSCH, and H-RNTI configuration

- HS-SCCH1-4: State, level, channelization code
- HS-PDSCHs: Sum of levels, channelization codes (you can specify the channelization code of the first HS-PDSCH, the others are assigned to the adjacent channelization codes)
- FRC Type: H-Set 1-3 (QPSK and 16QAM), 4-5 (QPSK)

- Primary H-RNTI: Identifier used on HS-SCCH1 to transmit information to the UE under test
- Alternate H-RNTI: Identifier used on HS-SCCH2-4 and when the test set is transmitting information on HS-SCCH1 that is not directed to the UE under test

MAC-hs parameters

- Number of Transmissions: The number of times a MAC-hs HARQ process will attempt to transmit a particular data block (one to eight)
- RV Sequence: Indicates the sequence of RV parameters to be used by the test for block transmissions. You may specify up to eight integer values (between zero and seven), but the number of RV parameters actually used by the test set is determined by the Number of Transmissions setting
- MAC-hs Transmit Window Size: This setting is only used when MAC-hs Header is set to Present. It can be set to 4, 6, 8, 12, 16, 24, or 32 MAC-hs PDUs
- HS-DSCH Data Pattern: Data pattern sent in each HS-DSCH transport block (CCITT PRBS15, CCITT PRBS9, all zeros, all ones, incrementing, alternating)
- MAC-hs Header
 - Present: When MAC-hs Header is set to Present, each MAC-hs block contains a valid MAC-hs header formatted with the following values:

VF = 0	Queue ID = 0	TSN = [incrementing]	SID ₁ = 0	N ₁ = 1	F = 0
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The TSN field is incremented each time a new block is sent by a HARQ process.

- Data: The header space is filled with HS-DSCH Data Pattern data
- statDTX Reception Behavior: You can configure how the test set responds to a statDTX from the UE (the options are as defined in 3GPP TS 34.121 Table 9.2.1.2)
 - Handle as ACK: The test set transmits a new block from the MAC-hs transmit queue using the first entry in the RV sequence and resets the transmission counter to one. If you would like the test set to continuously transmit new data regardless of the uplink HS-DPCCH presence (to allow you to measure BER in an external program, for example), set statDTX Reception Behavior to Handle as ACK, set Number of Transmissions to 1, HS-DSCH Data Pattern to CCITT PRBS15 or CCITT PRBS9, and MAC-hs Header to Data.
 - Handle as NACK: If the transmission counter is less than the Number of Transmissions setting, the test set transmits the same block using the next entry in the RV sequence and increments the transmission counter by one. (If the transmission counter equals the Number of Transmissions setting, then the Handle as ACK process is followed instead.)
 - Handle as statDTX: The test set transmits the same block using the same entry in the RV sequence and does not increment the transmission counter.

HSDPA Test Requirements Overview

Tests for the new HSDPA UE performance requirements are currently being drafted by 3GPP RAN WG5. As of the June 2005 release of 34.121, several tests have been drafted, but there remains a number of issues still to be resolved including the exact composition of the test signals. The main UE transmitter and receiver tests under development include:

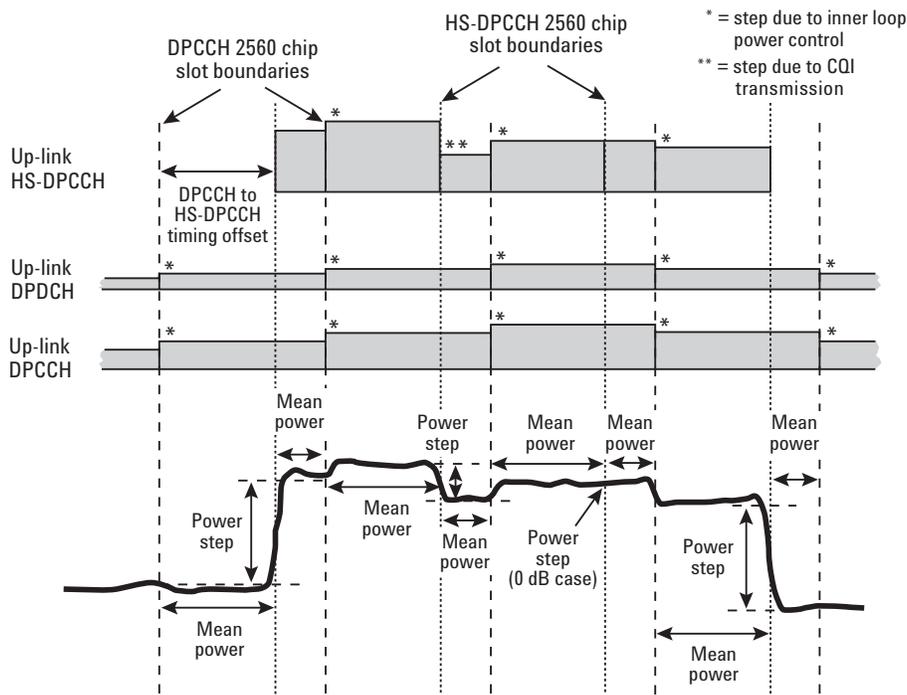
- 3GPP TS 34.121 5.2A Maximum Output Power with HS-DPCCH
- 3GPP TS 34.121 5.7A HS-DPCCH (Transmit ON/OFF Power)
- 3GPP TS 34.121 5.9A Spectrum Emission Mask with HS-DPCCH
- 3GPP TS 34.121 5.10A Adjacent Channel Leakage Power Ratio (ACLR) with HS-DPCCH
- 3GPP TS 34.121 5.13.1A Error Vector Magnitude (EVM) with HS-DPCCH
- 3GPP TS 34.121 6.3A Maximum Input Level for HS-PDSCH Reception (16QAM)

The addition of the new uplink HS-DPCCH code channel to the existing UL DPCH adds complexity to the power versus time profile of the UE, and is worthy of further explanation.

The HS-DPCCH is not always transmitted continuously. Rather, slot 0 of the HS-DPCCH sub-frame contains ACK/NACK information,

or no signal if the UE was not scheduled for a transmission or if the UE failed to decode the HS-SCCH of a scheduled transmission. Slots 1 and 2 may or may not contain the channel quality indicator (CQI). The presence of CQI data is determined by the CQI repetition factor specified by the network; it is independent of the scheduling of the data packets and associated ACK/NACK transmissions. The power levels the UE must use for ACK, NACK, and CQI transmissions is signaled to the UE by the network, and are independent of one another. Thus, the power of the HS-DPCCH may differ greatly between slots.

The UE's composite power is simultaneously controlled by inner loop power control (via TPC commands). These power changes (which occur on DPCH slot boundaries) may or may not be aligned to the HS-DPCCH slot boundary power changes because the uplink DPCH may be offset in time from the fixed position of the uplink HS-DPCCH. The downlink and uplink DPCH timing offset is controlled by the τ_{DPCH} parameter in 0.1 slot (256 chip) increments. For example, when $\tau_{DPCH}=0$, the uplink DPCH will be 0.1 slot behind the uplink HS-DPCCH. This timing offset adds further complexity as the UE's composite power may differ even within a slot. This is shown in the following diagram from 3GPP TS 25.101 Figure 6.6:



The power step due to HS-DPCCH transmission is the difference between the mean powers transmitted before and after an HS-DPCCH slot boundary. The mean power evaluation period excludes a 25 μ s period before and after any DPCCH or HS-DPCCH slot boundary.

HSDPA Measurements in the 8960 Test Set

The test set includes several measurements capable of testing an uplink HSDPA signal. The UE must be able to decode the test set's HS-SCCH and use the information on that channel to decode the corresponding HS-PDSCHs. The UE must also transmit a valid HS-DPCCH on the uplink which includes ACK/NACK data derived from the HS-DSCH decode.

When Channel Type is set to an RMC that does not include HSDPA, the full suite of test set measurements is available.

When Channel Type is set to 12.2k RMC + HSDPA, the following measurements are available:

Table 1. HSDPA measurements

Measurement	3GPP performance requirement
Transmitter measurements	
Channel power	3GPP TS 34.121 5.2A Maximum Output Power with HS-DPCCH 3GPP TS 34.121 5.7A HS-DPCCH (Transmit ON/OFF Power)
Spectrum emission mask	3GPP TS 34.121 5.9A Spectrum Emission Mask with HS-DPCCH
Adjacent channel leakage ratio	3GPP TS 34.121 5.10A Adjacent Channel Leakage Power Ratio (ACLR) with HS-DPCCH
Dynamic power analysis	3GPP TS 34.121 5.2A Maximum Output Power with HS-DPCCH 3GPP TS 34.121 5.7A HS-DPCCH
Coming soon:	
Waveform quality	3GPP TS 34.121 5.13.1A Error Vector Magnitude (EVM) with HS-DPCCH
Receiver measurements	
HSDPA BLER	3GPP TS 34.121 6.3A Maximum Input Level for HS-PDSCH Reception (16QAM)

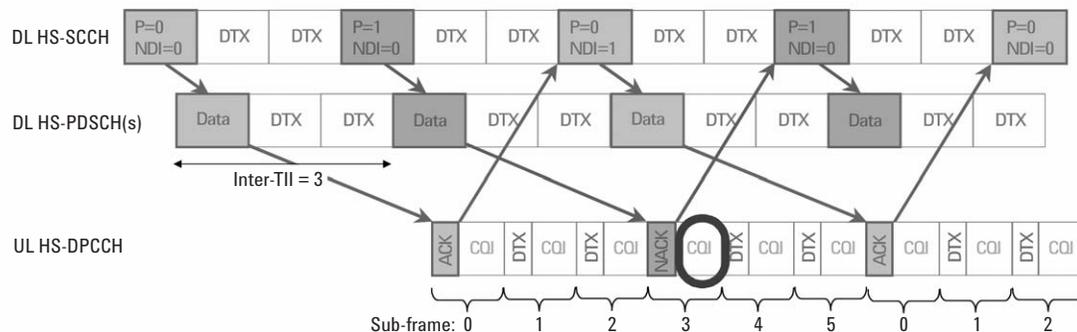
Also available: Audio Generator, Audio Analyzer, Spectrum Monitor, and Frequency Stability.

Transmitter measurements

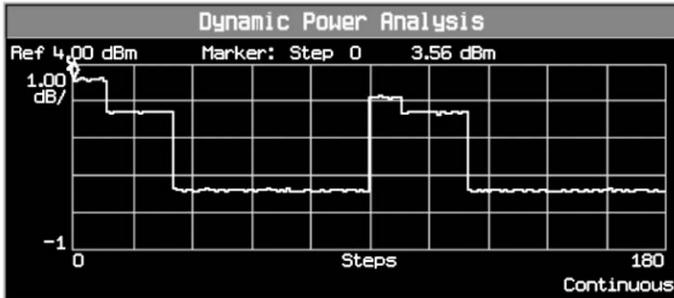
The transmitter measurements rely on the use of the new HS-DPCCH Trigger Source selection and HS-DPCCH Trigger Alignment setting. These settings allow you to specify the HS-DPCCH HARQ sub-frame to which the measurement interval is aligned (by default the measurement interval is aligned to the uplink HS-DPCCH sub-frame for HARQ0). Additionally, you can specify a Trigger Delay of up to ± 12 ms to position the measurement interval within any sub-frame. The Channel Power and Dynamic Power Analysis measurements feature a Measurement Interval setting that can be set as small as 10 μ s to allow measurements of sub-slot intervals.

For example, to measure the Channel Power of the CQI transmission circled below (the CQI data in the sub-frame corresponding to HARQ1 when inter-TTI interval=3), set HS-DPCCH Trigger Alignment to Subframe 3, set Trigger Delay to 666.7 μ s (one timeslot) and Measurement Interval to 1.333 μ s (two timeslots).

Note also if you set HS-DPCCH Trigger Alignment to subframe 1, 2, 4, or 5 (in this example these are the subframes in which the uplink HS-DPCCH is not transmitting) you can perform standard W-CDMA measurements on just the RMC portion of the uplink signal to reduce your overall (W-CDMA and HSDPA) UE test time.



The Dynamic Power Analysis measurement's Step Length can be set as low as 10 μ s to allow evaluation of up to 200 0.1 slot intervals (steps).

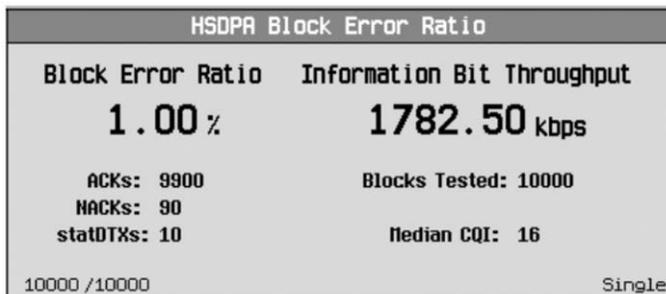


While on an HSDPA channel you can also route the downlink HARQ0 trigger to the rear panel to enable additional UE measurements using external test equipment.

Receiver measurements

You can set the Number of Blocks to Test for the HSDPA BLER measurement between 1 and 99000 blocks. The HSDPA BLER measurement returns the following:

- Block Error Ratio: As specified in 3GPP TS 34.121 F.6.3.2
- Information Bit Throughput (R) in kb/s
- Number of ACKs counted
- Number of NACKs counted
- Number of statDTXs counted
- Blocks Tested
- Median CQI



To speed testing of both the HSDPA and W-CDMA functionality in your UE, you can run HSDPA Block Error Ratio concurrently with the (W-CDMA) Loopback BER or Block Error Ratio measurements.

Conclusion

The 8960's HSDPA FDD test mode allows you to test the parametric performance of your UE's transmitter and receiver without the overhead of upper layer signaling. For production test engineers developing test plans for W-CDMA and HSDPA devices, the 8960 provides the most complete test functionality for 3GPP TS 34.121 sections 5 and 6, with fast, accurate, and repeatable results.

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