Agilent Technologies

Advanced Design System 2011.01

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HSDPA Design Library

Acknowledgments

Errata The ADS product may contain references to "HP" or "HPEESOF" such as in file names and directory names. The business entity formerly known as "HP EEsof" is now part of Agilent Technologies and is known as "Agilent EEsof". To avoid broken functionality and to maintain backward compatibility for our customers, we did not change all the names and labels that contain "HP" or "HPEESOF" references.

About HSPA plus Design Library

The HSPA Wireless Library is designed for High Speed Packet Access plus(HSPA+), which is an enhancement to 3GPP downlink/uplink and defined in release 7 of 3GPP specification. This design library focuses on the physical layer aspects of HSDPA systems and is intended to be a baseline system for designers to get an idea of what nominal or ideal system performance would be. Evaluations can be made regarding degraded system performance due to system impairments that may include non-ideal component performance.

The transport channels and physical channels defined in previous versions of 3GPP specification s are also supported by HSDPA design library. But they are treated as the accessory channels because HSDPA design library focus on the modeling and test of channels defined in release 5, say HSDPA. The test for the scenario with only 3GPP FDD and without HSDPA can be implemented by 3GPP design library.

3GPP Technical Specifications Supported

3GPP committee updates 3GPP technical specifications every 3 months. Each of 3GPP specification is further classified by features: release '99 (Version 3.xx), release 4 (Version 4.xx), release 5 (Version 5.xx), release 6 (Version 6.xx) and release 7 (Version 7.xx). Basically, the contents defined in lower version specifications typically duplicate the contents from release '99, release 4 and release 5 that are published simultaneously.

The HSPA design library is compliant with 3GPP release 7 technical specifications published in 2008.

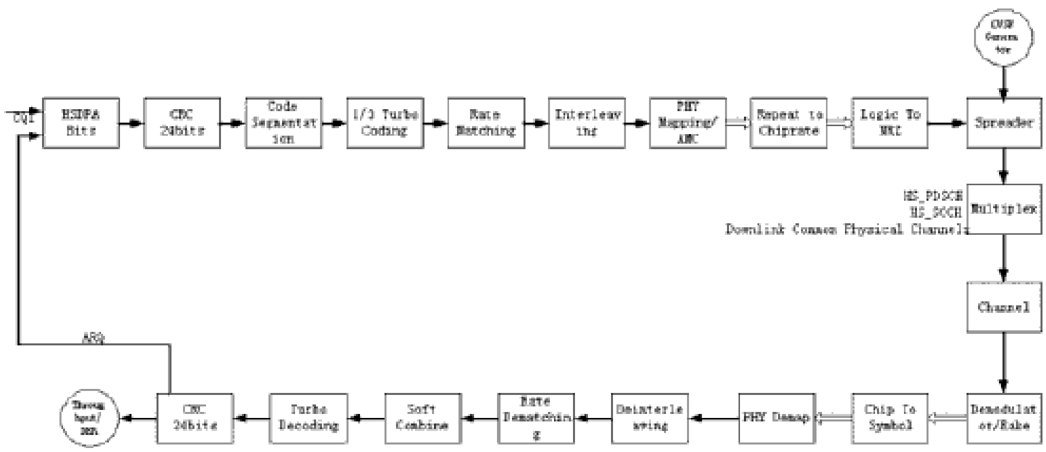
HSDPA design library also reuses some 3GPP design library models in the application level. The technical specifications of those models were published in 2002-03 for release '99 content. The version may be changed if 3GPP design library is updated.

HSDPA Systems

HSDPA offers peak downlink data rates up to 42 Mbps with MIMO and higher order modulation and increases the system capacity for downlink packet data. The increased data rates and improved capacity result in shorter delays for the end-users. This is particularly important for some multimedia applications such as interactive games. The high data rates also benefit streaming and web browsing applications. At the same time, HSDPA is backward-compatible with 3GPP FDD specification.

In the downlink, two new physical channels HS-PDSCH and HS-SCCH are defined for HSDPA; and in the uplink, one new physical channel HS-DPCCH is defined for HSDPA. HS-PDSCH carries downlink data from HS-DSCH, which is the transport channel defined for HSDPA; HS-SCCH carries downlink signalling; and HS-DPCCH carries uplink signalling.

The **HSDPA Downlink transmitter and receiver structure block diagram** for HS-PDSCH is shown below:



Specifications for HS-DSCH and HS-PDSCH

HSDPA HS-DSCH physical layer categories are shown **FDD HS-DSCH physical layer categories** in the table below:

HS-DSCH category	**Maximum number of HS-DSCH codes received**	**Minimum inter-TTI interval**	**Maximum number of bits of an HS-DSCH transport block received within an HS-DSCH TTI NOTE 1**	**Total number of soft channel bits**	**Supported modulations without MIMO operation**	**Supported modulations simultaneous with MIMO operation**
Category 1	5	3	7298	19200	QPSK, 16QAM	Not applicable (MIMO not supported)
Category 2	5	3	7298	28800		
Category 3	5	2	7298	28800		
Category 4	5	2	7298	38400		
Category 5	5	1	7298	57600		
Category 6	5	1	7298	67200		
Category 7	10	1	14411	115200		
Category 8	10	1	14411	134400		
Category 9	15	1	20251	172800		
Category 10	15	1	27952	172800		
Category 11	5	2	3630	14400	QPSK	
Category 12	5	1	3630	28800		
Category 13	15	1	35280	259200	QPSK, 16QAM, 64QAM	
Category 14	15	1	42192	259200		
Category 15	15	1	23370	345600	QPSK, 16QAM	
Category 16	15	1	27952	345600		
Category 17 NOTE 2	15	1	35280	259200	QPSK, 16QAM, 64QAM	N/A
			23370	345600	N/A	QPSK, 16QAM
Category 18 NOTE 3	15	1	42192	259200	QPSK, 16QAM, 64QAM	N/A
			27952	345600	N/A	QPSK, 16QAM

For any category, in addition to the requirements in Table 5.1a, an HS-SCCH less capable UE shall allocate 24960 raw channel bits for HS-SCCH less operation in order to buffer the last 13 subframes and 13599 soft channel bits to receive 3 parallel HARQ processes.
UE Categories 1 to 4 and Category 11 do not support HS-DSCH reception in CELL_FACH, CELL_PCH or URA_PCH states.

UEs of Category 13 are only required to support code rates up to 0.823 when 64QAM is used, which is represented by a limitation in the maximum value of Ki. in the transport block calculation in Reference \10]. For other modulation formats, this restriction does not apply.

UEs of Category 15 are only required to support code rates up to 0.823 for 16QAM when two transport blocks are received in the same TTI, which is represented by a limitation in the maximum value of Ki. in the transport block calculation in Reference [10]. For other modulation formats or when a single transport block is received, this restriction does not apply.

A UE that supports categories greater or equal to category 13, also supports E-DPDCH. A UE that supports categories greater or equal to category 13, also supports MAC-ehs. UEs of categories 13, 15, or 17 also support category 9 when MAC-ehs is configured. UEs of categories 14, 16, or 18 also support category 10 when MAC-ehs is configured.

NOTE 1: Depending on the HS-DSCH configuration, the indicated maximum number of bits of an HS-DSCH transport block does not have to correspond exactly to an entry in the transport block size table to be applied Reference [10].

NOTE 2: A UE of category 17 supports the physical capabilities of categories 13 and 15, but not simultaneously. The first row of category 17 in table 5.1a specifies the capabilities when MIMO is not configured and the capabilities of category 13 apply, the second row specifies the capabilities when MIMO is configured and the capabilities of category 15 apply.

NOTE 3: A UE of category 18 supports the physical capabilities of categories 14 and 16, but not simultaneously. The first row of category 18 in table 5.1a specifies the capabilities when MIMO is not configured and the capabilities of category 14 apply, the second row specifies the capabilities when MIMO is configured and the capabilities of category 16 apply.

HSDPA Component Libraries Overview

HSDPA supports following components as mentioned below:

- **Multiplexers & Coders Components:**
    - CRC
    - Bit scrambling
    - Turbo coding for HS-DSCH
    - Convolutional coding for HS-SCCH
    - Rate matching
    - Interleaving
    - STTD encoding
    - Physical channel mapping
    - Spreading
- **Demultiplexers & Decoders Components:**
    - Physical channel demapping
    - STTD decoding
    - Turbo decoding
    - Deinterleaving
    - CRC decoding
- **Measurement Components:**
    - Throughput measurement
    - EVM measurement
- **Receiver Components:**
    - Rake receiver for HSDPA downlink
    - Baseband receiver for HSDPA downlink
    - RF receiver for HSDPA downlink
- **Signal Source Components:**
    - Bit signal source with HARQ and AMC functionality
    - HS-PDSCH signal source with FEC
    - HS-PDSCH signal source without FEC
    - HS-SCCH signal source
    - HSDPA baseband signal source
    - HSDPA RF signal source

Design Examples

The RF characteristics can be measured using the HSDPA design library. RF measurements for user equipment (UE) are defined in Reference [5]; test methods are described in Reference [8]. For base station (BS), the RF characteristics are defined in Reference [6]; test methods are described in Reference [7].

- The HSDPA_BS_Tx_wrk workspace shows base station transmitter performance measurements. Designs for these measurements include:
  - BS_Tx_ACLR
  - BS_Tx_CCDF
  - BS_Tx_EVM
  - BS_Tx_MaxPower
  - BS_Tx_OccupiedBW
  - BS_Tx_Pk_Code_Error
  - BS_Tx_Spec_Emission
  - BS_Tx_VSA
- The HSDPA_UE_Rx_wrk workspace shows user equipment receiver performance. Designs for these measurements include:
  - UE_Rx_Demodulation_Hset1_PA3_QPSK
  - UE_Rx_Demodulation_Hset2_PB3_16QAM
  - UE_Rx_Demodulation_Hset3_VA30_16QAM
  - UE_Rx_Demodulation_Hset4_PB3_QPSK
  - UE_Rx_Demodulation_Hset5_VA120_QPSK
  - UE_Rx_Demodulation_Hset6_PA3_16QAM
  - UE_Rx_HSSCCH_Detection_TS1_PA3
  - UE_Rx_MaxLevel

Glossary of Terms

3GPP	third generation partnership project
ACLR	adjacent channel leakage power ratio
AWGN	additive white Gaussian noise
CCDF	complementary cumulative distribution function
DCH	dedicated channel
DPDCH	dedicated physical data channel
HS-DSCH	high speed downlink shared channel
HS-PDSCH	high speed physical downlink shared channel
HS-SCCH	shared control channel for HS-DSCH
HS-DPCCH	dedicated physical control channel (uplink) for HS-DSCH
EVM	error vector magnitude
FDD	frequency division duplex
FEC	forward error correction
HSDPA	high speed downlink packet access
HSUPA	high speed uplink packet access
PA	power amplifier
PER	packet error rate
QPSK	quadrature phase shift keying
RF	radio frequency
RX	receive or receiver
TTI	transmission timing interval
TX	transmit or transmitter

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.10.0, May 2008.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2008.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 7.6.0, Sept. 2008.
4. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 7.9.0, May 2008.
5. 3GPP Technical Specification TS 25.101, "UE Radio transmission and Reception (FDD)," Version 7.13.0, Sept. 2008.
6. 3GPP Technical Specification TS 25.104, "UTRA (BS) FDD: Radio transmission and Reception," Version 7.10.0, Mar. 2008.
7. 3GPP Technical Specification TS 25.141, "Base station conformance test," Version 7.11.0, Mar. 2008.
8. 3GPP Technical Specification TS 34.121, "Radio transmission and reception (FDD)," Version 7.5.0, June 2007.
9. 3GPP Technical Specification TS 25.306, "UE Radio Access capabilities," Version 7.8.0, Sept. 2008.
10. 3GPP Technical Specification TS 25.321, "Medium Access Control (MAC) protocol specification". Version 7.7.0, Dec. 2008.

HSDPA Base Station Transmitter Design Examples

The HSDPA_BS_Tx_wrk workspace shows base station transmitter measurement characteristics including maximum output power, occupied bandwidth, complementary cumulative distribution function (CCDF), spectrum emission, adjacent channel leakage power ratio (ACLR), EVM and peak code domain error and code domain power measurement. The downlink frequency band is set at 2110 to 2170 MHz and the signal sources are the test models defined in 25.141.

- Designs for these measurements include:
    - Maximum power measurements: **BS_Tx_MaxPower**
    - Occupied bandwidth measurements: **BS_Tx_OccupiedBW**
    - Complementary cumulative distribution function measurements: **BS_Tx_CCDF**
    - Transmitter spectrum emissions measurements: **BS_Tx_Spec_Emission**
    - Adjacent channel leakage power measurements in frequency domain: **BS_Tx_ACLR**
    - Transmitter EVM measurements: **BS_Tx_EVM**
    - Transmitter peak code domain error measurements: **BS_Tx_Pk_Code_Error**
    - Connect with VSA 89600 software and show the results of VSA 89600 software: **BS_Tx_VSA**
- Variables used in these designs are listed in the **Variable parameter** table detailed below:

Parameter Name	Description	Default Value
SamplePerChip	Samples per chip	8
ChipsPerSlot	Chips per slot	2560
NumSlotMeasured	Number of slots to be measured	Depends on measurements
StartSlot	The first slot to be measured	0
TimeStart	Start point for timed measurement	(1+StartSlot)*667e-6
TimeStep	Time step	1/(3840000*SamplesPerChip)
TimeStop	Stop point for timed measurement	(1+StartSlot+NumSlotMeasured)*667e-6
FilterLength	Filter length in terms of samples	16
RF_Freq	RF frequency	2140 (MHz)
SignalPower	Signal power	Depends on measurement

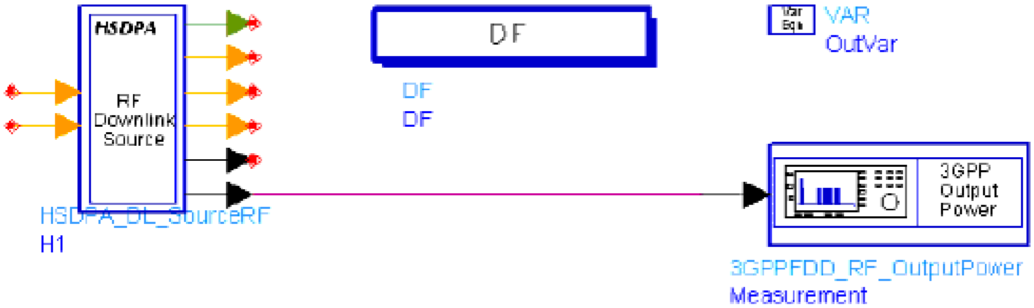
Maximum Power Measurements

Design: BS_Tx_MaxPower design
Features:

- maximum power measurement
- HSDPA signal or test model 1 can be used as the signal sourceHSDPA signal or test model 1 can be used as the signal source
- synchronized slot measurement

Description:
BS_Tx_MaxPower measures the maximum power of downlink signal. Normally, the base station maximum output power must remain within +2dB and -2dB of the manufacturer's rated power.

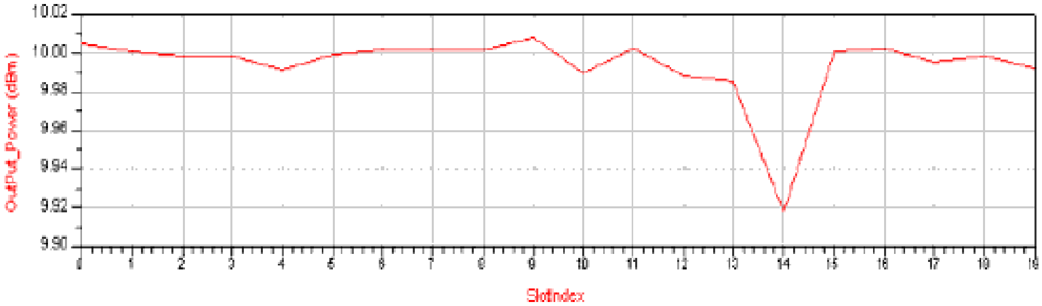
The schematic for this design is shown below:



HSDPA_DL_SourceRF can output 3GPP TestModel1 signal. This signal consists of 16/32/64 DPCH channels, one PICH channel, one primary CPICH channel and one PCCPCH+SCH channel. The PICH channel and DPCH channels are transmitted after different time offsets. When OutputMode = Ramp, the output power will reach its preset value after all channels are transmitted. Meaningful maximum power is reached after 15 slots.

3GPPFDD_RF_OutputPower measures the average power of the specified slots. The average period is one slot; SlotNum specifies the number of slots to be measured. Test signals are aligned at the specified slot boundary to ensure that the power average is based on a single slot.

Simulation Results:
The figure below shows the performance of maximum output power.



Benchmark:

- Hardware Platform: Pentium IV 2.2GHz, 1 GB memory

- Software Platform: Windows 2000, ADS 2005A
- Data Points: 20 slots
- Simulation Time: approximately 16 seconds

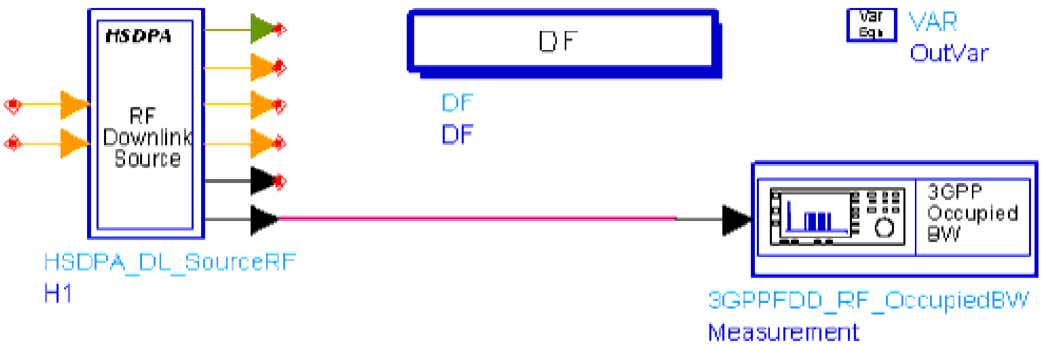
Occupied Bandwidth Measurements

Design: BS_Tx_OccupiedBW Design

Features:

- occupied bandwidth measurement
- HSDPA signal or test model 1 can be used as the signal source
- synchronized slot measurement

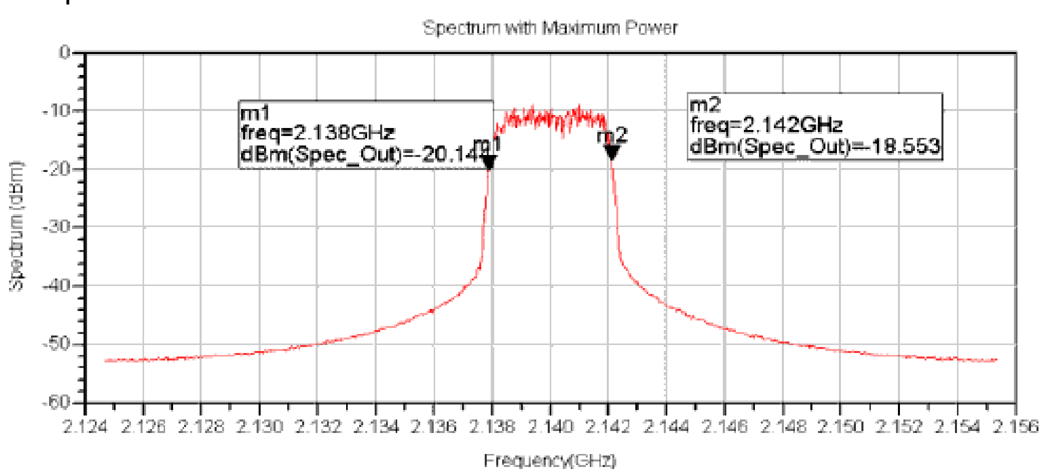
Description:
BS_Tx_OccupiedBW measures the occupied bandwidth of downlink signal. The schematic is shown below:



Occupied bandwidth is a measure of the bandwidth containing 99% of the integrated power for the transmitted spectrum and is centered on the assigned frequency. The occupied bandwidth must be less than 5 MHz based on a chip rate of 3.84 Mcps.

HSDPA_DL_SourceRF can output 3GPP TestModel1 signal. This signal consists of 16/32/64 DPCH channels, one PICH channel, one primary CPICH channel and one PCCPCH+SCH channel. The PICH channel and DPCH channels are transmitted after different time offsets. When OutputMode = Ramp, the output power will reach its preset value after all channels are transmitted. Meaningful maximum power is reached after 15 slots. Carrier frequency is set to 2140 MHz in this design.

Simulation Results:
The signal power density spectrum is obtained using the spectrum analyzer. The figure below shows the signal power density spectrum. A marker is placed to identify the occupied bandwidth.



Benchmark:

- Hardware Platform: Pentium IV 2.2GHz, 1 GB memory
- Software Platform: Window 2000, ADS 2005A
- Data Points: 1 slot
- Simulation Time: 8 seconds

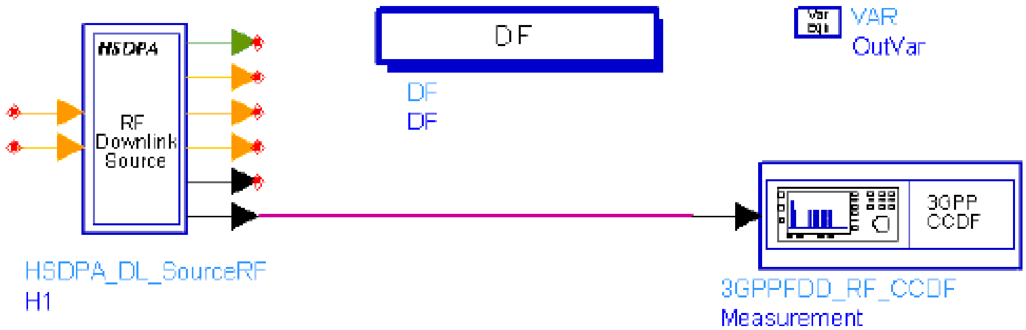
Complementary Cumulative Distribution Function Measurements

Design: BS_Tx_CCDF Design

Features:

- CCDF measurement
- HSDPA signal or test model 1 can be used as the signal source
- synchronized slot measurement

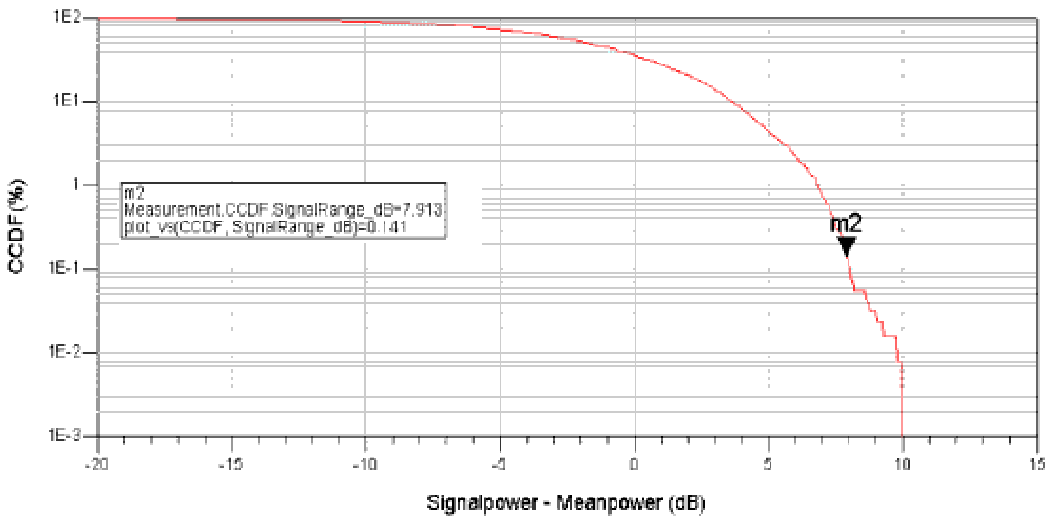
Description:
BS_Tx_CCDF measures the CCDF of a downlink signal. The schematic is shown below:



HSDPA_DL_SourceRF can output 3GPP TestModel1 signal. This signal consists of 16/32/64 DPCH channels, one PICH channel, one primary CPICH channel and one PCCPCH+SCH channel. The PICH channel and DPCH channels are transmitted after different time offsets. When OutputMode = Ramp, the output power will reach its preset value after all channels are transmitted. Meaningful maximum power is reached after 15 slots.

Carrier frequency is set to 2140 MHz in this design.

Simulation Results:
The measurement is deployed on 5 slots of a stable signal. The figure below shows the CCDF performance.



Benchmark:

- Hardware Platform: Pentium IV 2.2GHz, 1 GB memory
- Software Platform: Window 2000, ADS 2005A
- Data Points: 5 slots
- Simulation Time: 8 seconds

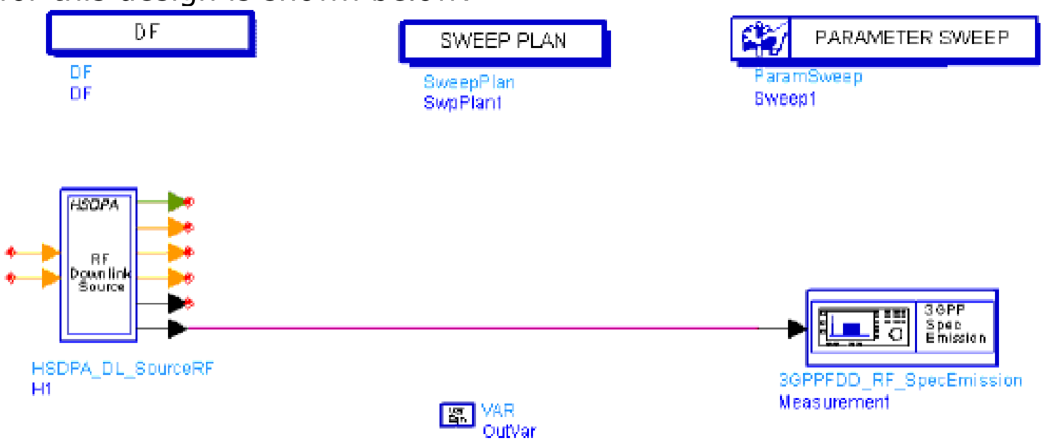
Transmitter Spectrum Emissions Measurements

Design: BS_Tx_Spec_Emission Design

Feature:

- HSDPA signal or test model 1 can be used as the signal source
- Out-of-band power is measured by sweeping the center frequency of the band-pass filter

Description:
BS_Tx_Spec_Emission measures the base station transmitter spectrum emission. Out-of-band emissions are unwanted emissions immediately outside the channel bandwidth resulting from the modulation process and non-linearity in the transmitter. The schematic for this design is shown below:



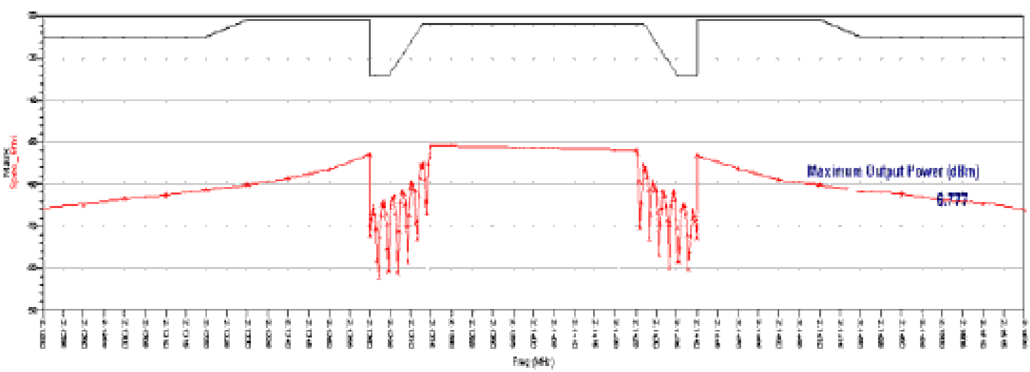
Emissions must not exceed the maximum level specified by the mask in the frequency range with offset from Δf_{min} -12.5 MHz to Δf_{max} 12.5 MHz from the carrier frequency. Mask values are specified in the table below. A sweeper is used to simulate all frequency offsets.

Simulation Results:
The spectrum emission is stored in the sink after 15 slots.

- The Spectrum Emission Mask Values are listed in the table below:

Frequency Offset Δf	**Maximum Level**	**Measurement Bandwidth**
Base Station Maximum Output Power P < 31 dBm		
2.5 ≤ Δf < 2.7 MHz	-22 dBm	30 kHz †
2.7 ≤ Δf < 3.5 MHz	-22 - 15(Δf - 2.7) dBm	30 kHz †
3.5 ≤ Δf < 7.5 MHz	-21 dBm	1 MHz ††
7.5 ≤ Δf ≤ Δf ~max~ MHz	-25 dBm	1 MHz ††
Base Station Maximum Output Power 31 ≤ P < 39 dBm		
2.5 ≤ Δf < 2.7 MHz	P - 53 dBm	30 kHz †
2.7 ≤ Δf < 3.5 MHz	P - 53 - 15(Δf - 2.7) dBm	30 kHz †
3.5 ≤ Δf < 7.5 MHz	P - 52 dBm	1 MHz ††
7.5 ≤ Δf ≤ Δf ~max~ MHz	P - 56 dBm	1 MHz ††
Base Station Maximum Output Power 39 ≤ P < 43 dBm		
2.5 ≤ Δf < 2.7 MHz	-14 dBm	30 kHz †
2.7 ≤ Δf < 3.5 MHz	-14 - 15(Δf - 2.7) dBm	30 kHz †
3.5 ≤ Δf < 7.5 MHz	-13 dBm	1 MHz ††
7.5 ≤ Df ≤ Dfmax MHz	P - 56 dBm	1 MHz ††
Base Station Maximum Output Power P ≥ 43 dBm		
2.5 ≤ Δf < 2.7 MHz	-14 dBm	30 kHz †
2.7 ≤ Δf < 3.5 MHz	- 14 - 15(Δf - 2.7) dBm	30 kHz †
3.5 ≤ Δf ≤ Δf ~max~ MHz	-13 dBm	1 MHz ††
† The first and last measurement positions with a 30 kHz filter are 2.515 and 3.485 MHz, respectively. †† The first and last measurement positions with a 2 MHz filter are 4 MHz and (Δf_{max} - 500 kHz), respectively.		

- The figure below shows the spectrum emission for the base station output powers listed in the table above:



Benchmark:

- Hardware Platform: Pentium IV 2.2GHz, 1 GB memory
- Software Platform: Windows 2000, ADS 2005A
- Data Points: 1slot sweeping frequency offset from -12.5 MHz to 12.5 MHz
- Simulation Time: approximately 2 hours

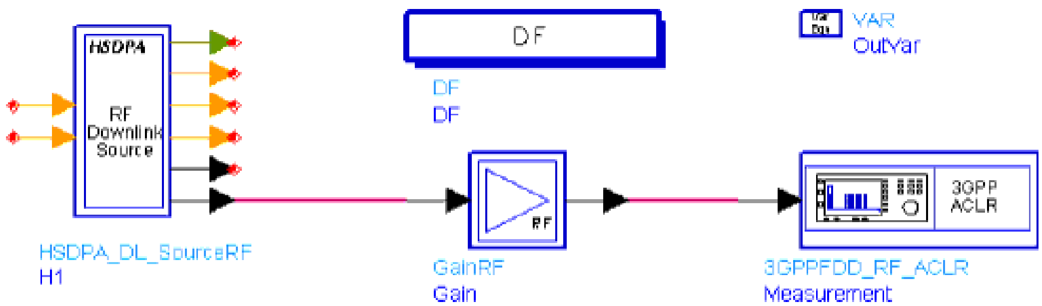
Adjacent Channel Leakage Power Measurements in Frequency Domain

Design: BS_Tx_ACLR Design

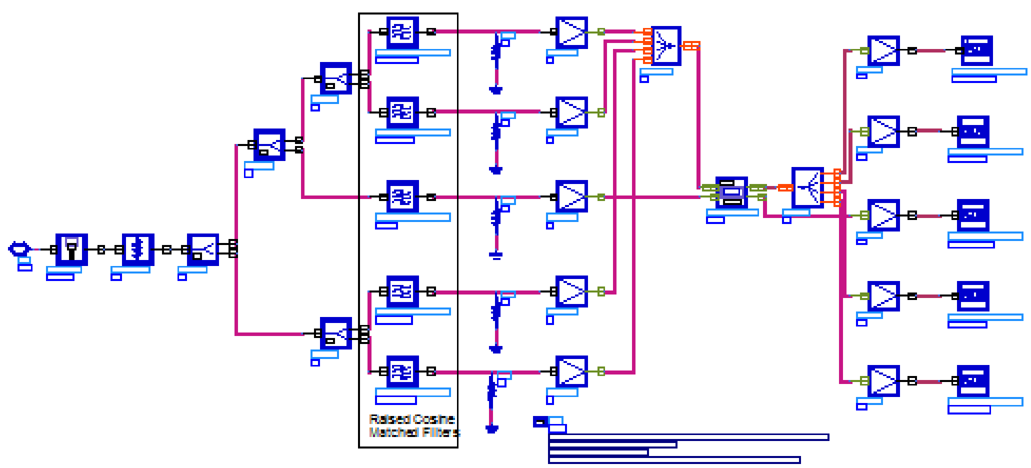
Features:

- adjacent channel leakage power ratio measured in the frequency domain
- HSDPA signal or test model 1 can be used as the signal source
- synchronized slot measurement

Description:
BS_Tx_ACLR measures the base station transmitter adjacent channel leakage power ratio (ACLR) in the frequency domain. ACLR is the ratio of the transmitted power to the power measured after a receiver filter in the adjacent channel. In this design, both the transmitted and received power are measured through a root raised-cosine and roll-off 0.22 matched filter; noise power bandwidth is set to 3.84 MHz. The schematic for this design is shown below:

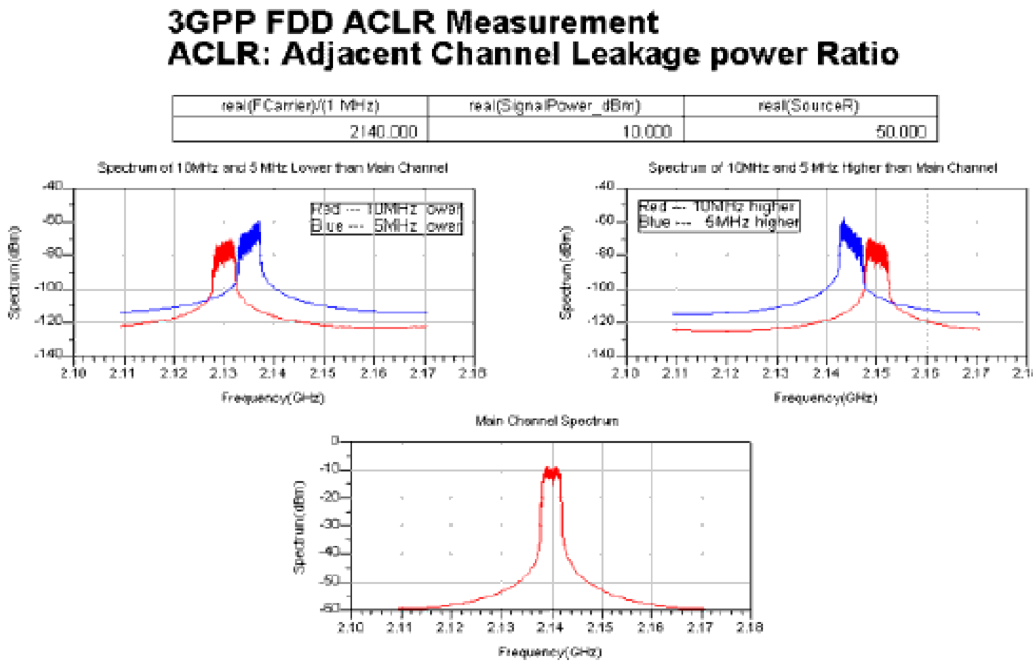


The BS_Tx_ACLR_FilterBank subnetwork used in this workspace is shown below; it consists of 5 root raised-cosine matched filters; the center frequencies of these filters are set to 2140 MHz with offsets of +5, +10, -5, and -10 MHz.



Simulation Results:
The Spectrum analyzer is used to measure the transmitted power and adjacent channel power in the frequency domain. When the base station adjacent channel offset is +5 or -5 MHz, the ACLR limit is 45 dB; when the base station adjacent channel offset is +10 or -10 MHz, the ACLR limit is 50 dB. The measurement is deployed after the first frame (15 slots)

and the signal becomes stable. The figure below shows the ACLR performance of the base station transmitter.



Benchmark:

- Hardware Platform: Pentium IV 2.2GHz, 1 GB memory
- Software Platform: Window 2000, ADS 2005A
- Data Points: 1 slot
- Simulation Time: approximately 26 seconds

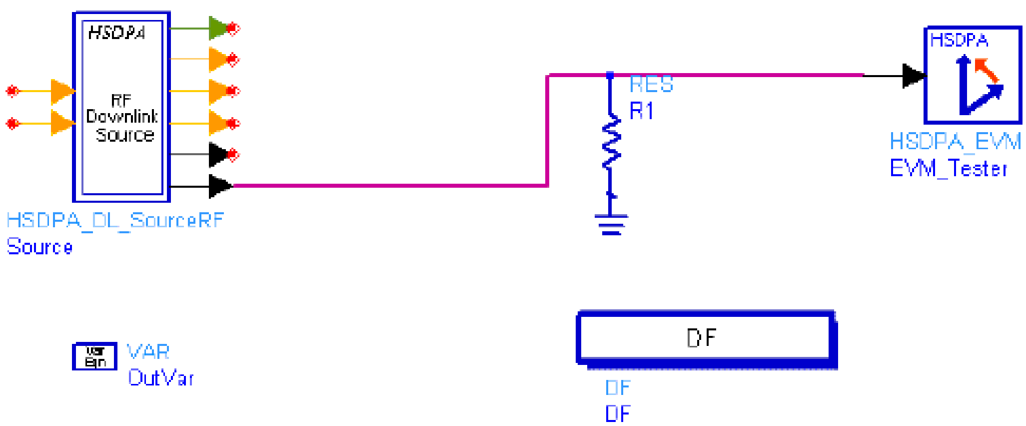
Transmitter EVM Measurements

Design: BS_Tx_EVM Design

Features:

- error vector magnitude measurements
- test model 5 is used as the signal source

Description:
This design measures the error vector magnitude (EVM) of the base station transmitter. EVM is the difference between the measured waveform and the theoretical modulated waveform and shows modulation accuracy. According to the Specification TS 25.104 (2005-12), the Error Vector Magnitude shall not be worse than 17.5% when the base station is transmitting a composite signal using only QPSK modulation. The Error Vector Magnitude shall not be worse than 12.5% when the base station is transmitting a composite signal that includes 16QAM modulation. The schematic for this design is shown below:



Simulation Results:
The EVM result is shown below:

Composite Error Summary

EVM_rms_percent (%)	MagErr_rms_percent (%)	PhaseErr_deg
0.263	0.183	0.286

FreqErr_Hz	IQOffset_dB	Rho
0.222	-88.140	1.000

Channel Error Summary

AnalysisCodeLevel	AnalysisCodeIndex
4	4

Channel_EVM (%)	Channel_MagErr_rms_percent (%)	Channel_PhaseErr_deg
4.215	2.017	2.876

Benchmark:

- Hardware Platform: Pentium IV 2.26 GHz, 1 GB memory
- Software Platform: Windows 2000, ADS 2005A
- Data Points: 1 slot
- Simulation Time: approximately 13 seconds.

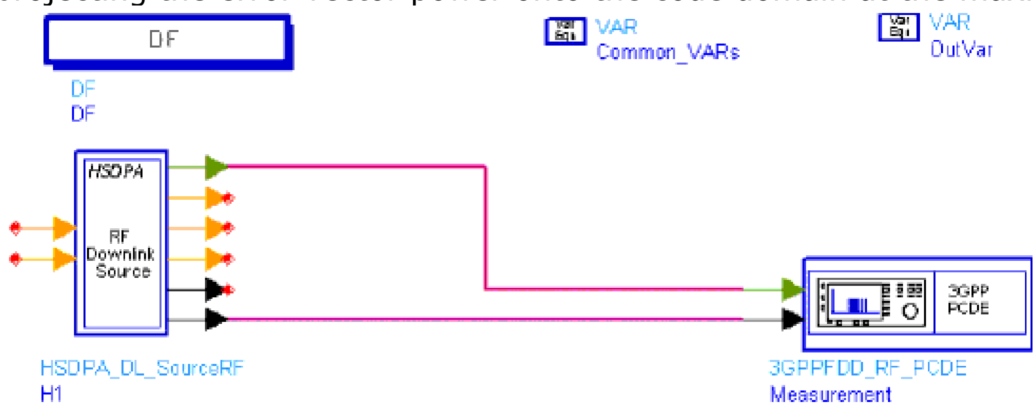
Transmitter Peak Code Domain Error Measurements

Design: BS_Tx_Pk_Code_Error Design

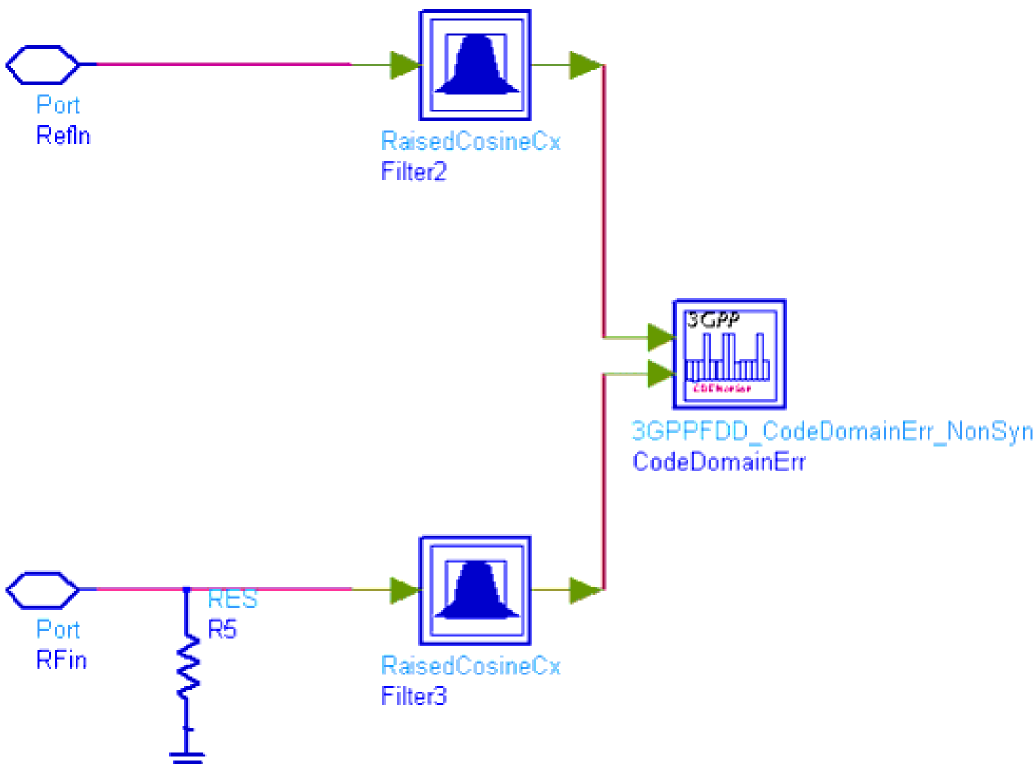
Features:

- peak code domain error calculation
- HSDPA signal or test model 3 can be used as the signal source
- synchronized slot measurement with reference signal

Description:
The schematic for this design is shown below. The code domain error is calculated by projecting the error vector power onto the code domain at the maximum spreading code.

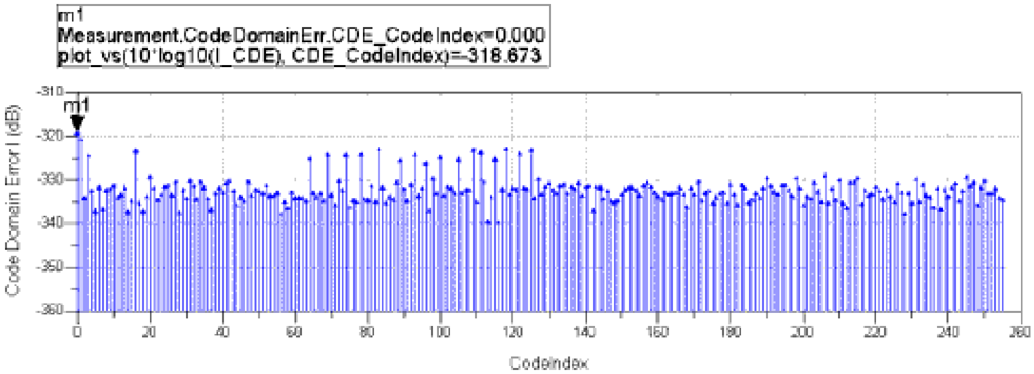


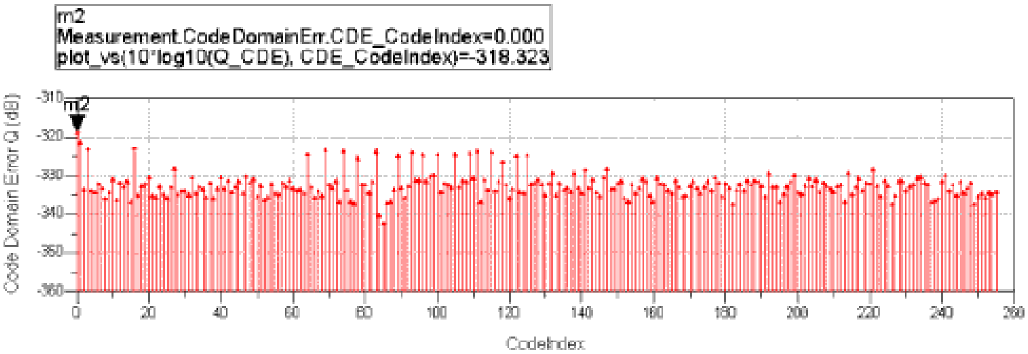
The measurement is implemented by the 3GPPFDD_RF_PCDE subnetwork shown in the *3GPPFDD_RF_PCDE Schematic*. The peak code domain error is defined as the maximum value for the code domain error and cannot exceed −33 dB.



Simulation Results:

The peak code domain error is shown below:





Benchmark:

- Hardware Platform: Pentium IV 2.2GHz, 1 GB memory
- Software Platform: Window 2000, ADS 2005A
- Data Points: 1 slot
- Simulation Time: 34 seconds

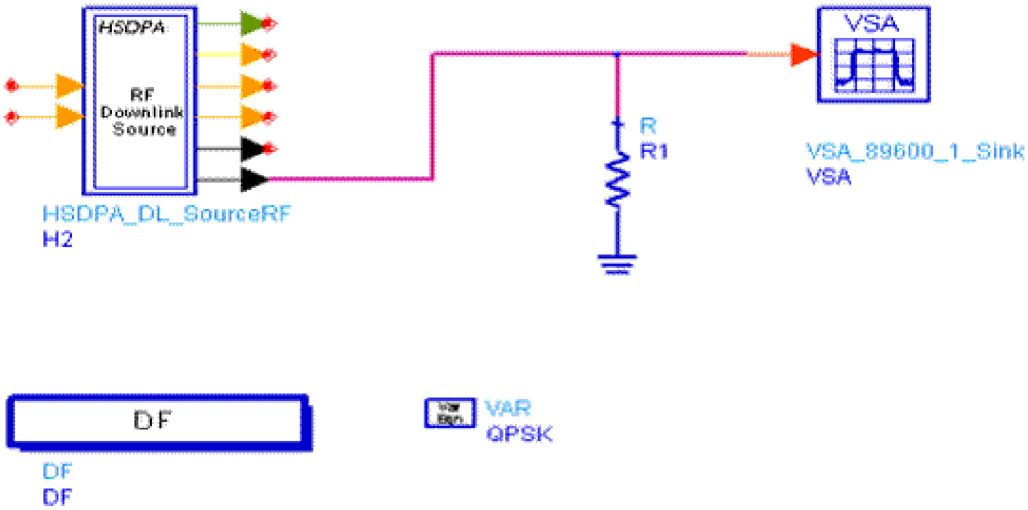
Connection with 89600 VSA Software

Design: BS_Tx_VSA Design

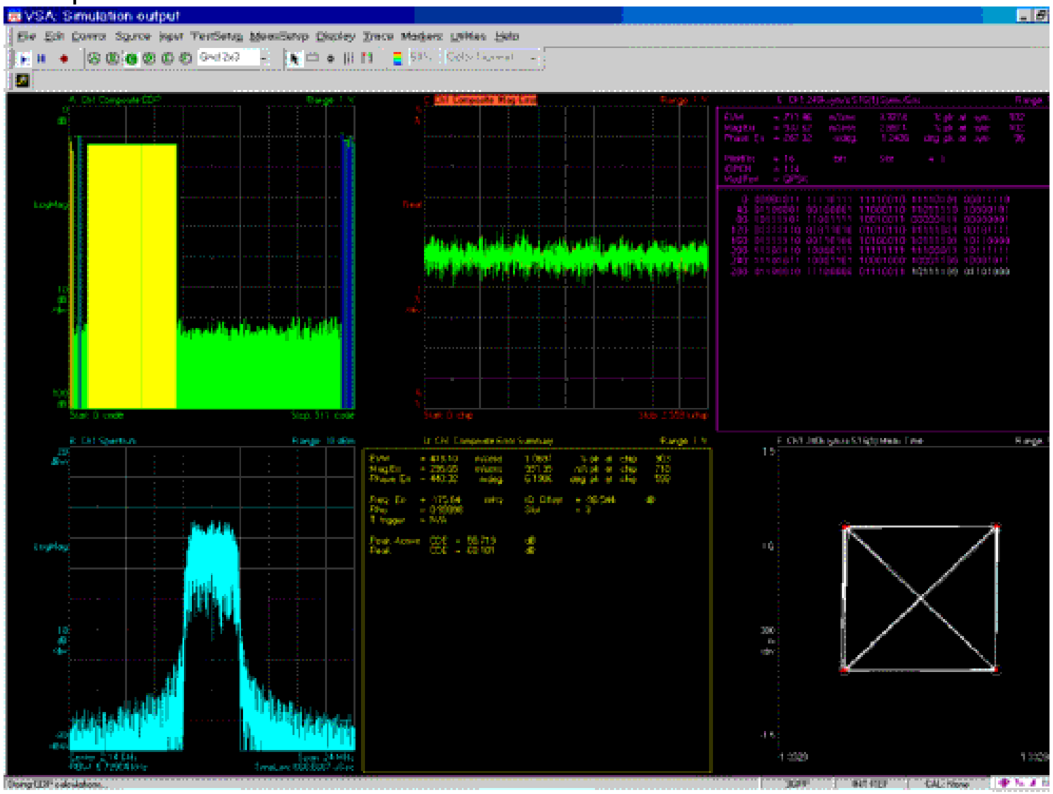
Features:

- Connect with 89600 VSA software and show the results of 89600 VSA software.

Description:
The schematic for this design is shown below:



Simulation Results:
The peak code domain error is shown below:



Benchmark:

- Hardware Platform: Pentium IV 2.26GHz, 1 GB memory
- Software Platform: Window 2000, ADS 2005A, 89600 VSA

References

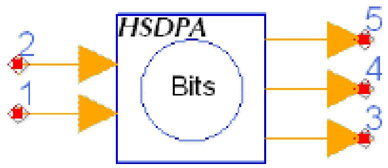
1. 3GPP Technical Specification TS 34.121 V6.3.0 "Terminal conformance Specification: Radio transmission and reception (FDD)," December 2005.
2. 3GPP Technical Specification TS 25.104 V6.11.0, "Base Station (BS) radio transmission and reception (FDD)," December 2005.
3. 3GPP Technical Specification TS 25.141 V6.12.0, "Base station (BS) conformance testing (FDD)," December 2005.

HSDPA Components

Contents

- *HSDPA STTD Encoder* (hsdpa)
- *HSDPA Throughput* (hsdpa)
- *HSPA Channel ITU* (hsdpa)

HSDPA_Bits



Description: HSDPA information bit generator
Library: HSDPA, Signal Sources

Parameters

Name	Description	Default	Type	Range
UE_Category	: Category_1, Category_2, Category_3, Category_4, Category_5, Category_6, Category_7, Category_8, Category_9, Category_10, Category_11, Category_12, Category_13, Category_14, Category_15, Category_16, Category_17, Category_18	Category_1	enum	
TransBlockSize	Transport block size	3202	int	[1,max transport block size]†
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum	
NumHARQ	Number of HARQ processes	1	int	[1,6]
RVSeq	Redundancy and constellation version coding sequence	{0, 2, 5, 6}	int array	[0,7]
DataPattern	Source data pattern: Random, PN9, PN15, Repeat Bits	Random	enum	
RepeatBitValue	Repeating data value	0x0001	int	[0, 65535]
RepeatBitPeriod	Repeating data period	2	int	[1, 16]
TTIPattern	inter-TTI pattern	{1, 1, 1, 1, 1, 1}	int array	[0,1]

Pin Inputs

Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int
2	ARQ	automatic repeat request	int

Pin Outputs

Pin	Name	Description	Signal Type
3	DataOut	data out	int
4	RV	redundancy version	int
5	nd	new data indicatior	int

Notes/Equations

1. This model is used to generate information bits for HS-DSCH block by block, and also supports HARQ and AMC.
2. Each firing, MaxTransBlockSize tokens are generated at pin Output, one token at pin RV and one token at pin nd, while one token is consumed at pin CQI or ARQ if either is connected.
3. If pin CQI is connected, this model is in AMC (Adaptive Modulation and Coding) mode and if pin ARQ is connected, this model is in HARQ (Hybrid ARQ) mode. Note that pin

CQI and ARQ are optional. If they are not connected, no tokens are consumed. But they cannot be connected simultaneously, which means this model does not support HARQ and AMC simultaneously.

4. If pin CQI is not connected, MaxTransBlockSize is equal to TransBlockSize and all the MaxTransBlockSize data bits are for HS-DSCH.
5. If pin CQI is connected, MaxTransBlockSize is equal to the maximum transport block size the UE_Category supports, and the number of data bits for HS-DSCH is determined by the input CQI value according to Table 7 of 6A.2 in Reference [2]. If the number is less than MaxTransBlockSize, 0s are padded.
6. The input value of CQI is in the range of 1 to 30. In AMC mode, there is no re-transmission, RV is always the first element of the RVSeq, and nd is always 1.
7. The input value of ARQ is in the range of 0 to 1. If the input of ARQ is 0, it means NACK and the correspondent packet are not received correctly. Otherwise, it means ACK and the correspondent packet are received correctly.
8. If ACK is received, BS will transmit new packet within current HARQ process. If NACK is received, BS will re-transmit the packet. The maximum re-transmission number is determined by the size of RVSeq. if re-transmission number is larger than the size of RVSeq, then this packet will be discarded and a new packet will be transmitted.
9. The delay for ARQ depends on NumHARQ and TTIPattern. User can set the value of NumHARQ and TTIPattern. For example, if the NumHARQ set to 4 and TTIPattern set to {1,0,0,1,0,0}, UE will get the ARQ signal of the first packet when it send the ninth packet.
10. The output of RV is the redundancy version of current packet. If it is a new packet, RV is the first element of RVSeq; If not, RV can be the second, third,...,last element of RVSeq incrementally.
11. For the **DataPattern** parameter:
    - if Random is selected, random bits are generated.
    - if PN9 is selected, a 511-bit pseudo-random test pattern is generated according to CCITT Recommendation O.153
    - if PN15 is selected, a 32767-bit pseudo-random test pattern is generated according to CCITT Recommendation O.151
    - if Repeat Bits is selected, the data pattern depends on RepeatBitValue and RepeatBitPeriod. The RepeatBitPeriod length of LSB of RepeatBitValue will be repeated and filled in the data packet.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 6.7.0, Dec. 2005.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 6.7.0, Dec. 2005.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 6.4.0, Sept. 2005.
4. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 6.7.1, Dec. 2005.
5. 3GPP Technical Specification TS 25.104, "UTRA (BS) FDD: Radio transmission and Reception," Version 6.11.0, Dec. 2005.
6. 3GPP Technical Specification TS 25.141, "Base station conformance test," Version 6.12.0, Dec. 2005.
7. CCITT, Recommendation O.151(10/92).
8. CCITT, Recommendation O.153(10/92).

HSDPA_BitScrambling

Description: Bit scrambler
Library: HSDPA, Multiplexers & Coders

Parameters

Name	Description	Default	Type	Range
UE_Category	: Category_1, Category_2, Category_3, Category_4, Category_5, Category_6, Category_7, Category_8, Category_9, Category_10, Category_11, Category_12, Category_13, Category_14, Category_15, Category_16, Category_17, Category_18	Category_1	enum	
TransBlockSize	Transport block size	3202	int	[1,max transport block size]†
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum	

Pin Inputs

Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int
2	DataIn	data in	int

Pin Outputs

Pin	Name	Description	Signal Type
3	DataOut	data out	int

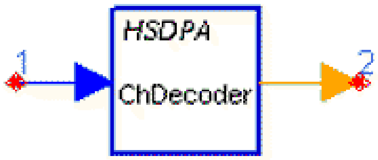
Notes/Equations

1. This model is used to implement bit scrambling on HS-DSCH defined in 4.5.1a in Reference [1].
2. Each firing, Ndata DataOut tokens are generated while Ndata DataIn tokens consumed.
3. If CQI pin is connected and has input tokens, **Ndata = N_TransBlockSize+24** where, N_TransBlockSize is the maximum transport block size, which the UE of specified category can support according to Table 7 of 6A.2 in [2].
4. If the CQI pin is not connected then **Ndata = TransBlockSize+24** where, TransBlockSize is a parameter of this model.
5. The TransBlockSize parameter determines the transport block size of HS-DSCH. The largest transport block size is 27,952 bits, which corresponds to the highest data rate of 13.976 Mb/s (27,952 bits/2 ms = 13.976 Mb/s). This data rate is obtained by using 16 QAM, an effective code rate of 0.9714, and 15 HS-PDSCHs.
6. The input pin CQI is optional. If connected, the input value of CQI should be in the range of 1 to 30.

References

1. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2005.
2. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 7.9.0, May 2008.

HSDPA_ChDecoder



Description: Turbo decoder
Library: HSDPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Type	Range
TransBlockSize	Transport block size	3202	int	[1,max transport block size]†
TC_Iteration	Turbo code decoder iteration number	4	int	[1,10]
TC_Alfa	Alfa of lowpass filter	0.4	real	

Pin Inputs

Pin	Name	Description	Signal Type
1	DataIn	data in	real

Pin Outputs

Pin	Name	Description	Signal Type
2	DataOut	data out	int

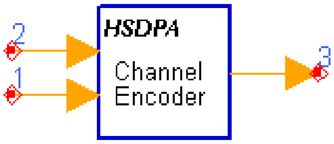
Notes/Equations

1. This model is used to implement channel decoding of one code block for HS-DSCH.
2. Each firing, ($CodeBlockSize$) DataOut tokens are generated while ($3 \times CodeBlockSize + 12$) DataIn tokens consumed.
3. The TransBlockSize parameter determines the transport block size of HS-DSCH. The largest transport block size is 27,952 bits, which corresponds to the highest data rate of 13.976 Mb/s (27,952 bits/2 ms = 13.976 Mb/s).
4. This data rate is obtained by using 16 QAM, an effective code rate of 0.9714, and 15 HS-PDSCHs. The CodeBlockSize is calculated according to section 4.2.2.2 in References [1], with $X_i = TransBlockSize$.
5. The schematic of Turbo coder in 3GPP is a parallel concatenated convolutional code (PCCC). A iterative Turbo decoder using modified BAHL et al. algorithm References [2]&[3] is used in this model. The iterative number can be set from 1 through 10 using parameter setting.

References

1. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2008.
2. L.R. Bahl, J. Cocke, F. Jeinek and J. Raviv. "Optimal decoding of linear codes for minimizing symbol error rate." IEEE Trans. Inform. Theory, vol. IT-20. pp.248-287, March 1974.
3. C. Berrou and A. Glavieus. "Near optimum error correcting coding and decoding: turbo-codes", IEEE Trans. Comm., pp. 1261-1271, Oct. 1996.

HSDPA_ChEncoder



Description: Code block segmentation and turbo encoder
Library: HSDPA, Multiplexers & Coders

Parameters

Name	Description	Default	Type	Range
UE_Category	: Category_1, Category_2, Category_3, Category_4, Category_5, Category_6, Category_7, Category_8, Category_9, Category_10, Category_11, Category_12, Category_13, Category_14, Category_15, Category_16, Category_17, Category_18	Category_1	enum	
TransBlockSize	Transport block size	3202	int	[1,max transport block size]†
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum	

Pin Inputs

Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int
2	DataIn	data in	int

Pin Outputs

Pin	Name	Description	Signal Type
3	DataOut	data out	int

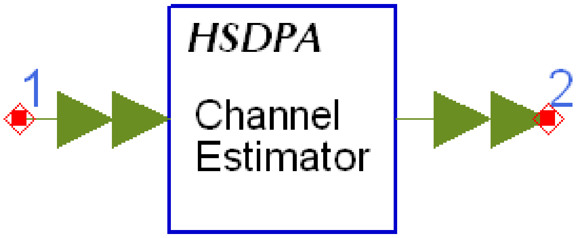
Notes/Equations

1. This model is used to implement code block segmentation and channel coding for HS-DSCH as defined in 4.5.3 in [1].
2. There will be a maximum of one transport block. The rate 1/3 turbo coding shall be used.
3. Each firing, ($BlockNum \times BlockSize$) DataOut tokens are generated while ($N_{data} + 24$) DataIn tokens consumed.
4. If CQI pin is connected and has input tokens, **Ndata = N_TransBlockSize** where, N_TransBlockSize is the maximum transport block size, which the UE of specific category can support according to Table 7 of 6A.2 in [2].
5. If CQI pin is not connected, **Ndata = TransBlockSize** where, TransBlockSize is a parameter of this model. The BlockNum and BlockSize are calculated according to section 4.2.2.2 in [1], with $X_i = N_{data}$.
6. The TransBlockSize parameter determines the transport block size of HS-DSCH. The largest transport block size is 27,952 bits, which corresponds to the highest data rate of 13.976 Mb/s (27,952 bits/2 ms = 13.976 Mb/s). This data rate is obtained by using 16 QAM, an effective code rate of 0.9714, and 15 HS-PDSCHs.
7. The input pin CQI is optional. If connected, the input value of CQI should be in the range of 1 to 30.

References

1. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2008.
2. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 7.9.0, May 2008.

HSDPA_ChEstimate



Description: Path parameter estimate aided by pilot symbols
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Symbol	Type	Range
TXDiversity	transmit diversity in downlink: No_Diversity, STTD	No_Diversity		enum	
PathNum	number of paths or fingers of Rake	6	L	int	[1,16]

Pin Inputs

Pin	Name	Description	Signal Type
1	SymCH1	despread signals of the first code channel in downlink,\n Common Pilot Channel in downlink or the DPCCH in uplink\n of current slot	multiple complex

Pin Outputs

Pin	Name	Description	Signal Type
2	CHEst	estimation of path parameter of current slot based on \n DPCCH or CPICH	multiple complex

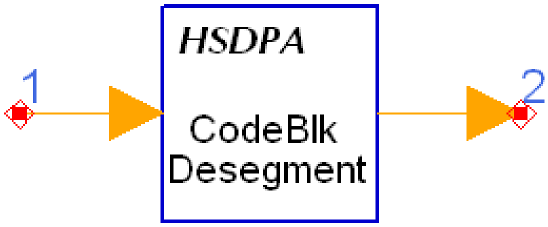
Notes/Equations

1. This model is used to estimate path characteristics aided by pilot symbols of CPICH in downlink.
2. Each firing, N tokens are consumed at SymCH per each port, and N tokens are produced at CHEst per each port, where N is the symbol number CPICH in downlink per TTI, and N is the symbol number of CPICH per TTI. The number of ports for SymCH and CHEst depends on the PathNum.

References

1. 3GPP Technical Specification TS25.211 V7.10.0,"Physical channels and mapping of transport channels onto physical channels (FDD)," Dec. 2008.
2. S.Tanaka, M.Sawahashi, and F.Adachi, "Pilot Symbol-Assisted Decision-Directed Coherent Adaptive Array Diversity for DS-CDMA Mobile Radio Reverse Link," Proc. Wireless'97, Canada, July 1997.
3. Y.Honda, K.Jamal, "Channel Estimation based on Time-Multiplexed Pilot Symbols," IEICE Technical Report RCS96-70, August 1996.

HSDPA_CodeBlkDeseg



Description: Code block desegmentation
Library: HSDPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Type	Range
TransBlockSize	Transport block size	3202	int	[1,max transport block size]†

Pin Inputs

Pin	Name	Description	Signal Type
1	DataIn	data in	int

Pin Outputs

Pin	Name	Description	Signal Type
2	DataOut	data out	int

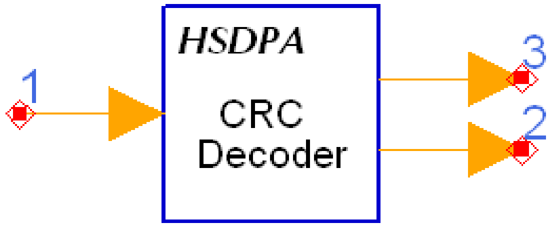
Notes/Equations

1. This model is used to implement code block desegmentation.
2. Each firing, the tokens of all code blocks within one TTI are consumed at pin DataIn, while TransBlockSize + 24 tokens are generated at pin DataOut.
3. This model performs the inverse operation of code block segmentation to combine all transport blocks within one TTI.

References

1. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Dec. 2005.

HSDPA_CRCDecoder



Description: CRC decoder
Library: HSDPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Type	Range
TransBlockSize	Transport block size	3202	int	[1,max transport block size]†
Polynomial	generator polynomial	0x1800063	int	[3, ∞)

Pin Inputs

Pin	Name	Description	Signal Type
1	DataIn	data in	int

Pin Outputs

Pin	Name	Description	Signal Type
2	CRCOut	data out	int
3	DataOut	data out	int

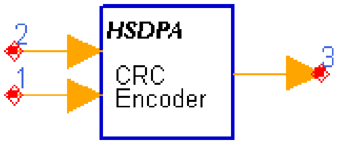
Notes/Equations

1. This model is used to implement CRC check for each transport block in HS-DSCH. The calculation of the CRC parity bits is referenced in Reference[1].
2. Each firing, TransBlockSize DataOut tokens are generated while (TransBlockSize+24) DataIn tokens and 1 CRCOut token consumed.
3. The TransBlockSize parameter determines the transport block size of HS-DSCH. The largest transport block size is 27,952 bits, which corresponds to the highest data rate of 13.976 Mb/s (27,952 bits/2 ms = 13.976 Mb/s). This data rate is obtained by using 16 QAM, an effective code rate of 0.9714, and 15 HS-PDSCHs.
4. The cyclic generator polynomial for HS-DSCH is: $g_{CRC24}(D) = D^{24} + D^{23} + D^{6} + D^{5} + D + 1$, and the hex representation of polynomial is 0x1800063.

References

1. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2008.

HSDPA_CRCEncoder



Description: Add CRC to each Transport Block
Library: HSDPA, Multiplexers & Coders

Parameters

Name	Description	Default	Type	Range
UE_Category	: Category_1, Category_2, Category_3, Category_4, Category_5, Category_6, Category_7, Category_8, Category_9, Category_10, Category_11, Category_12, Category_13, Category_14, Category_15, Category_16, Category_17, Category_18	Category_1	enum	
TransBlockSize	Transport block size	3202	int	[1,max transport block size]†
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum	
Polynomial	generator polynomial	0x1800063	int	[3, ∞)

Pin Inputs

Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int
2	DataIn	data in	int

Pin Outputs

Pin	Name	Description	Signal Type
3	DataOut	data out	int

Notes/Equations

1. This model is used to implement CRC attachment on HS-DSCH as defined in 4.5.1 in [1].
2. Each firing, (Ndata+24) DataOut tokens are generated while Ndata DataIn tokens consumed.
3. If CQI pin is connected and has input tokens, **Ndata = N_TransBlockSize** where, N_TransBlockSize is the maximum transport block size, which the UE of specific category can support according to Table 7 of 6A.2 in [2].
4. If CQI pin is not connected, **Ndata = TransBlockSize** where, TransBlockSize is a parameter of this model.
5. The input pin CQI is optional. If connected, the input value of CQI should be in the range of 1 to 30.
6. The TransBlockSize parameter determines the transport block size of HS-DSCH. The largest transport block size is 27,952 bits, which corresponds to the highest data rate of 13.976 Mb/s (27,952 bits/2 ms = 13.976 Mb/s). This data rate is obtained by using 16 QAM, an effective code rate of 0.9714, and 15 HS-PDSCHs.
7. The cyclic generator polynomial for HS-DSCH is: $g_{CRC24}(D) = D^{24} + D^{23} + D^{6} + D^{5} + D + 1$, and the hex representation of polynomial is 0x1800063.

References

1. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2008.
2. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 7.9.0, May 2008.

HSDPA_Deinterleaver

Description: Deinterleaver
Library: HSDPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Type
MS	Modulation scheme: _QPSK, _16QAM	_QPSK	enum
NumHSPDSCH	Number of HS_PDSCH	5	int

Pin Inputs

Pin	Name	Description	Signal Type
1	DataInM	data in	multiple real

Pin Outputs

Pin	Name	Description	Signal Type
2	DataOutM	data out	multiple real

Notes/Equations

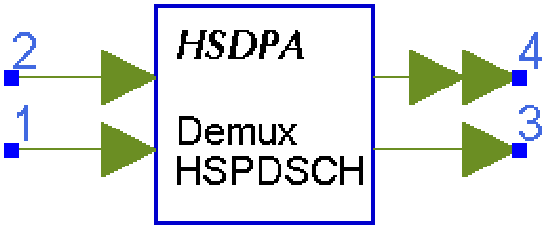
1. This model is used to implement deinterleaving on HS-DSCH.
2. Each firing, 1920 tokens are consumed at each sub-port of pin DataInM, while 1920 tokens are generated at each sub-port of pin DataOutM.
3. NumHSPDSCH specifies the number of HS-PDSCHs to be processed and each HS-PDSCH occupies one sub-port of pin DataInM and one sub-port of pin DataOutM. MS specifies the modulation scheme of each HS-PDSCH.
4. Deinterleaving is the inverse operation of interleaving defined in 4.5.6 of Reference [1].
5. The bits of each HS-PDSCH input to the deinterleaver at each firing are denoted by $u_{p,1}, u_{p,2}, u_{p,3}, \ldots, u_{p,1920}$, wherein p is the index of HS-PDSCHs.
6. The basic deinterleaver is a block deinterleaver of fixed size 960, which performs the inverse operation of basic interleaver described in 4.2.11 of Reference [1].
7. For QPSK, the first 960 bits $u_{p,1}, u_{p,2}, u_{p,3}, \ldots, u_{p,960}$ are processed by the basic deinterleaver, and the deinterleaved 960 bits are padded 960 0s as the output of corresponding sub-port of pin DataOutM at each firing.
8. For 16QAM, two identical basic deinterleavers are used. $u_{p,1}, u_{p,2}, u_{p,3}, \ldots, u_{p,1920}$ are divided two by two between the deinterleavers: bits $u_{p,k}, u_{p,k+1}$ go to the first basic deinterleaver and $u_{p,k+2}, u_{p,k+3}$ go to the second basic deinterleaver. Bits are collected two by two from the deinterleavers: $v_{p,k}, v_{p,k+1}$ are obtained from the first basic deinterleaver and $v_{p,k+2}, v_{p,k+3}$ are obtained from the second basic

deinterleaver.

References

1. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2008.

HSDPA_DemuxHSPDSCH



Description: demux HSPDSCH code channels and power normalization
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Symbol	Type	Range
NumHSPDSCH	number of NumHSPDSCH	5	M	int	[1,15]

Pin Inputs

Pin	Name	Description	Signal Type
1	HSPDSCHSym	de-spread signals for all code channels	complex
2	HSSCHSyml	de-spread signals for all code channels	complex

Pin Outputs

Pin	Name	Description	Signal Type
3	HSSCCH	combined signals of all code channels	complex
4	HSPDSCH	combined signals of all code channels	multiple complex

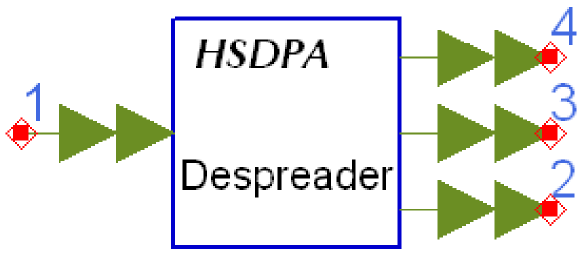
Notes/Equations

1. This model is used to seperate the HS-PDSCH code channels.
2. Each firing, M tokens are consumed at HSPDSCHSym port and P tokens are consumed at HSSCCHSym, where M is the number of symbols per TTI in all HS-PDSCHs, P is the number of symbols per TTI in HS-SCCH. Q tokens are produced at HSPDSCH per each port, where Q is the number of symbols per TTI in one HS-PDSCH. P tokens are produced at HSSCCH, where P is the number of symbols per TTI in HS-SCCH. The number of ports at HSPDSCH depends on the NumHSPDSCH.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.6.0, May 2008.

HSDPA_Despread



Description: De-spread chip sequence of code channels
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Symbol	Type	Range
PathNum	number of paths or fingers of Rake	6	L	int	[1,16]
ScrambleCode	Index of scramble code	0		int	
NumHSPDSCH	number of HS-PDSCHs	5	M	int	[1,16]
HS_PDSCH_CodeOffset	Spread code offset	1		int	

Pin Inputs

Pin	Name	Description	Signal Type
1	ChpSeq	chip sequences of optimum multi-path	multiple complex

Pin Outputs

Pin	Name	Description	Signal Type
2	HSPDSCHSym	de-spread signals of all code channels of current slot	multiple complex
3	HSSCCHSym	de-spread signals HSSCCH Channel in downlink	multiple complex
4	PilotSym	de-spread signals of Common in downlink	multiple complex

Notes/Equations

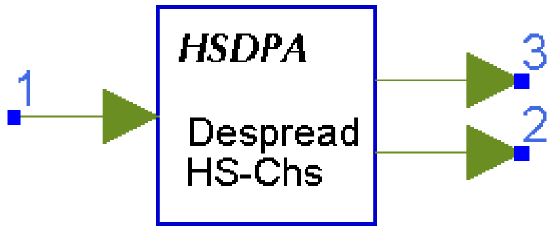
1. This model is used to despread the resolved multiple path signals from HSDPA_DownSample.
2. Each firing, N tokens are consumed at ChipSeq per each port, where N is the number of chips per TTI. The port number of ChipSeq depends on PathNum. M tokens are produced at HSPDSCHSym per each port, where M is the number of symbols per TTI in all HS-PDSCHs. P tokens are produced at HSSCCHSym per each port, where P is the number of symbols per TTI in HS-SCCH. Q tokens are produced at PilotSym per each port, where Q is the number of symbols per TTI in CPICH. The port number of HSPDSCHSym, HSSCCHSym and PilotSym all depends on PathNum.
3. One TTI delay is inserted to spread code to keep the synchronization with ChipSeq.

References

1. 3GPP Technical Specification TS25.211 V7.10.0, "Physical channels and mapping of transport channels onto physical channels (FDD)," Dec. 2008.
2. 3GPP Technical Specification TS25.213 V7.6.0, "Spreading and modulation (FDD)," Sept. 2008.

3. A. J. Viterbi, "CDMA: Principles of Spread Spectrum Communication," Wesley Publishing Company, 1995.

HSDPA_DespreadHSCh



Description: De-spread chip sequence of code channels
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Symbol	Type	Range
ScrambleCode	Index of scramble code	0		int	
NumHSPDSCH	number of HS-PDSCHs	5	M	int	[1,16]
HS_PDSCH_CodeOffset	Spread code offset	1		int	
Suppress_SCH	select whether to suppress SCHs: NO, YES	YES		enum	
PSCH_OutputSTTD	: NO, YES	YES		enum	
SSCH_OutputSTTD	: NO, YES	YES		enum	
SSCH_ScrambleCode	index of scramble code for SSCH	0		int	[0,511]
PSCH_Gain	the PSCH gain	0		real	[0, +∞)
SSCH_Gain	the SSCH gain	0		real	[0, +∞)

Pin Inputs

Pin	Name	Description	Signal Type
1	ChpSeq	chip sequences of optimum multi-path	complex

Pin Outputs

Pin	Name	Description	Signal Type
2	HSPDSCHSym	de-spread signals of all code channels of current slot	complex
3	HSSCCHSym	de-spread signals HSSCCH Channel in downlink	complex

Notes/Equations

1. This model is used to despread the resolved multiple path signals from HSDPA_Equalizer and depress the interference from the PSCH and SSCH.
2. In this model, the PSCH and SSCH are regenerated and deleted from the equalized signal.
3. Each firing, N tokens are consumed at ChipSeq per each port, where N is the number of chips per TTI. The port number of ChipSeq depends on PathNum. M tokens are produced at HSPDSCHSym per each port, where M is the number of symbols per TTI in all HS-PDSCHs. P tokens are produced at HSSCCHSym per each port, where P is the number of symbols per TTI in HS-SCCH. The port number of HSPDSCHSym and HSSCCHSym depends on PathNum.
4. One TTI delay is inserted to spread code to keep the synchronization with ChipSeq.

References

1. 3GPP Technical Specification TS25.211 V7.10.0, "Physical channels and mapping of transport channels onto physical channels (FDD)," Dec. 2008.

HSDPA_DespreadPilot

Description: De-spread chip sequence of code channels
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Symbol	Type	Range
PathNum	number of paths or fingers of Rake	6	L	int	[1,16]
ScrambleCode	Index of scramble code	0		int	

Pin Inputs

Pin	Name	Description	Signal Type
1	ChpSeq	chip sequences of optimum multi-path	multiple complex

Pin Outputs

Pin	Name	Description	Signal Type
2	PilotSym	de-spread signals of Common in downlink	multiple complex

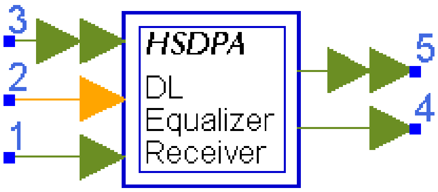
Notes/Equations

1. This model is used to despread the CPICH to get the pilot symbols for channel estimation.
2. Each firing, N tokens are consumed at ChipSeq per each port, where N is the number of chips per TTI. The port number of ChipSeq depends on PathNum. Q tokens are produced at PilotSym per each port, where Q is the number of symbols per TTI in CPICH. The port number of PilotSym depends on PathNum.
3. One TTI delay is inserted to spread code to keep the synchronization with ChipSeq.

References

1. 3GPP Technical Specification TS25.211 V7.10.0, "Physical channels and mapping of transport channels onto physical channels (FDD)," Dec. 2008.
2. 3GPP Technical Specification TS25.213 V7.6.0, "Spreading and modulation (FDD)," Sept. 2008.
3. A. J. Viterbi, "CDMA: Principles of Spread Spectrum Communication," Wesley Publishing Company, 1995.

HSDPA_DL_Equalizer



Description: HSDPA receiver type 2
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Unit	Type	Range
Power	RF output power	0.01	W	real	[0,∞)
TXDiversity	transmit diversity in downlink: No_Diversity, DL_STTD	No_Diversity		enum	
SamplesPerChip	number of samples per chip	4		int	[1,32]
PathNum	number of paths or fingers of Rake	6		int	[1,16]
MaxDelaySample	maximum path delay in terms of samples	40		int	[PathNum,number of half chips of one slot]
MaxDelaySpread	the maximal multi-paths delay spread, to decide the length of channal implus response	80		int	(PathSpread , +∞)
ScrambleCode	Index of scramble code	0		int	
NumHSPDSCH	number of DPCHs	5		int	[1,15]
HS_PDSCH_CodeOffset	Spread code offset	1		int	
EqualizerLength	the coefficients length of the equalizer	64		int	(MaxDelayChip , +∞)
sigma2	the variance of the AWGN noise	0.0001		real	[0 , +∞)
FilterLength	RRC filter length (chips)	16		int	[2,128]
ExcessBW	Excess bandwidth of raised cosine filters	0.22		real	(0.0,1.0)
OutputSTTD	Whether or not export STTD: NO, YES	NO		enum	
SCH_EcToIor	SCH power gain in dB	-15	dB	real	(-∞,∞)

Pin Inputs

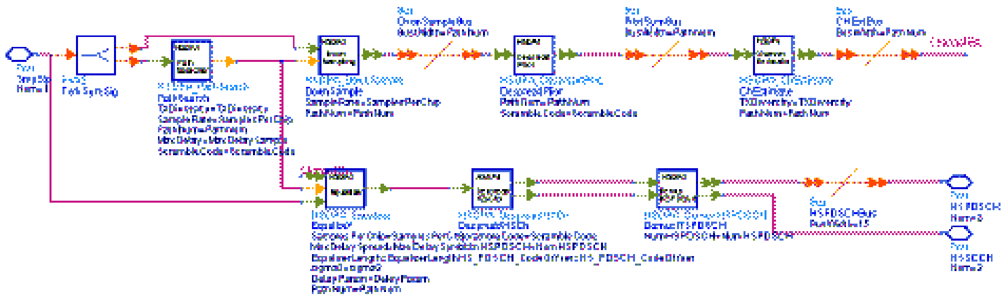
Pin	Name	Description	Signal Type
1	SmpSig	received baseband complex envelope signal samples	complex
2	PathDelay	intput the pathes delay	int
3	ChEst	estimation of path parameter	multiple complex

Pin Outputs

Pin	Name	Description	Signal Type
4	HS_SCCH	combined signals of the HS_SCCH	complex
5	HS_PDSCH	combined signals of the HS_PDSCH	multiple complex

Notes/Equations

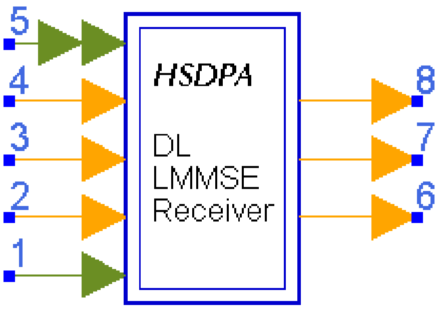
1. This subnetwork is used to implement LMMSE equalizer on multiple code channels.
2. Each firing, S × T tokens are consumed at SmpSig, where T is the number of chips per TTI, S is the number of SamplesPerChip. N1 tokens are produced at HS-PDSCH, where N1 is the number of HS-PDSCH symbols per TTI. N2 tokens are produced at HS-SCCH, where N2 is the number of HS-SCCH symbols per TTI. The outputs at HS-PDSCH and HS-SCCH are delayed by one TTI because of equalizer signal processing.
3. The schematic for this (**HSDPA_DL_Equalizer**) subnetwork is shown below:



References

1. 3GPP Technical Specification TS25.211 V7.10.0,"Physical channels and mapping of transport channels onto physical channels (FDD)," Dec. 2008.
2. 3GPP Technical Specification TS25.213 V7.6.0,"Spreading and modulation (FDD)," Sept. 2008.
3. A. J. Viterbi, "CDMA: Principles of Spread Spectrum Communication," Wesley Publishing Company, 1995.

HSDPA_DL_LMMSE_Receiver



Description: HSDPA receiver
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Unit	Type	Range
Power	RF output power	0.01	W	real	[0,∞)
SamplesPerChip	number of samples per chip	4		int	[1,32]
PathNum	number of paths or fingers of Rake	6		int	[1,16]
MaxDelaySample	maximum path delay in terms of samples	40		int	[PathNum,number of half chips of one slot]
MaxDelaySpread	the maximal multi-paths delay spread, to decide the length of channal implus response	80		int	(PathSpread , +∞)
HS_PDSCH_FRC	Fixed reference channel: H-Set_1, H-Set_2, H-Set_3, H-Set_4, H-Set_5, H-Set_6, H-Set_7, H-Set_8	H-Set_1		enum	
UEIdentity	UE identity (16 bits)	0xAAAA		int	[0,66535]
SignalingSource	: SCCH, External	External		enum	
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK		enum	
HS_PDSCH_CodeOffset	Spread code offset	1		int	
EqualizerLength	the coefficients length of the equalizer	64		int	(MaxDelayChip , +∞)
sigma2	the variance of the AWGN noise	0.0001		real	[0 , +∞)
FilterLength	RRC filter length (chips)	16		int	[2,128]
ExcessBW	Excess bandwidth of raised cosine filters	0.22		real	(0.0,1.0)
TC_Iteration	Turbo code decoder iteration number	4		int	[1,10]
TTIPattern	inter-TTI pattern	{1, 0, 0, 1, 0, 0}		int array	[0,1]
OutputSTTD	Whether or not export STTD: NO, YES	NO		enum	
SCH_EcToIor	SCH power gain in dB	-15	dB	real	(-∞,∞)

Pin Inputs

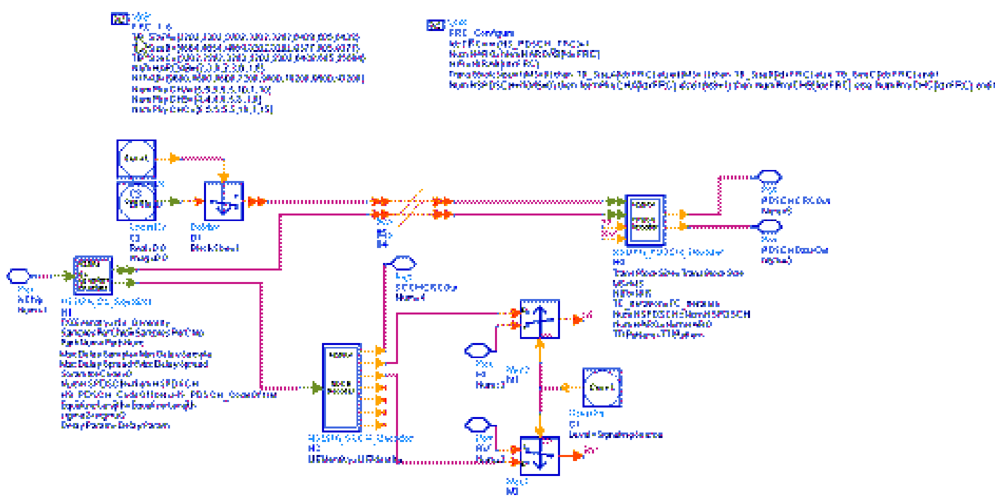
Pin	Name	Description	Signal Type
1	inCHip	received baseband complex envelope signal samples	complex
2	RV	redundancy version	int
3	nd	new data indicator	int
4	PathDelay	intput the pathes delay	int
5	ChEst	estimation of path parameter	multiple complex

Pin Outputs

Pin	Name	Description	Signal Type
6	SCCHCRC	SCCH CRC result	int
7	PDSCH	PDSCH dtat	int
8	PDSCHCRC	PDSCH CRC result	int

Notes/Equations

1. This subnetwork model is used to demodulate and decode HSDPA related downlink signals, i.e., HS-DSCH and HS-SCCH.
2. The schematic for this (**HSDPA_DL_LMMSE_Receiver**) subnetwork is shown below.



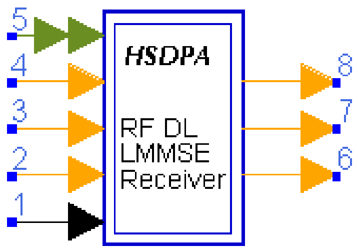
3. To despread and demodulate a CDMA signal, the channel information and path delay information must be determined. Errors in channel estimation and path search deteriorate the receiver performance.
4. The path searching is performed by correlating the received signals with the spreading code specified in a window whose size is set by MaxDelaySample. The correlations at different offsets are ranked; the top ones are assumed to be the offsets where the paths could occur.
5. After channel estimation, the received signal are equalized using LMMSE algorithm.
6. There is one slot delay associated with the decoded information.
7. For more information regarding the LMMSE receiver and different channel decoders, see *HSDPA_DL_Equalizer* (hsdpa), *HSDPA_PDSCH_Decoder* (hsdpa), and *HSDPA_SCCH_Decoder* (hsdpa) respectively.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.10.0, Dec. 2008.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD),"

Version 7.9.0, Sept. 2008.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 7.6.0, Sept. 2008.

HSDPA_DL_LMMSE_ReceiverRF



Description: HSDPA receiver
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Unit	Type	Range
FCarrier	Carrier frequency	2140 MHz	Hz	real	(0,∞)
Power	RF output power	0.01	W	real	[0,∞)
RIn	Input resistance	50	Ohm	real	(0,∞)
Phase	Reference phase in degrees	0.0	deg	real	(-∞,∞)
RRC_FilterLength	RRC filter length (chips)	16		int	[2,128]
ExcessBW	Excess bandwidth of raised cosine filters	0.22		real	(0.0,1.0)
SamplesPerChip	number of samples per chip	4		int	[1,32]
PathNum	number of paths or fingers of Rake	6		int	[1,16]
MaxDelaySample	maximum path delay in terms of samples	40		int	[PathNum,number of half chips of one slot]
MaxDelaySpread	the maximal multi-paths delay spread, to decide the length of channal implus response	80		int	(PathSpread , +∞)
HS_PDSCH_FRC	Fixed reference channel: H-Set_1, H-Set_2, H-Set_3, H-Set_4, H-Set_5, H-Set_6, H-Set_7, H-Set_8	H-Set_1		enum	
UEIdentity	UE identity (16 bits)	0xAAAA		int	[0,66535]
SignalingSource	: SCCH, External	External		enum	
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK		enum	
HS_PDSCH_CodeOffset	Spread code offset	1		int	
EqualizerLength	the coefficients length of the equalizer	64		int	(MaxDelayChip , +∞)
sigma2	the variance of the AWGN noise	0.0001		real	[0 , +∞)
TC_Iteration	Turbo code decoder iteration number	4		int	[1,10]
TTIPattern	inter-TTI pattern	{1, 0, 0, 1, 0, 0}		int array	[0,1]
OutputSTTD	Whether or not export STTD: NO, YES	NO		enum	
SCH_EcToIor	SCH power gain in dB	-15	dB	real	(-∞,∞)

Pin Inputs

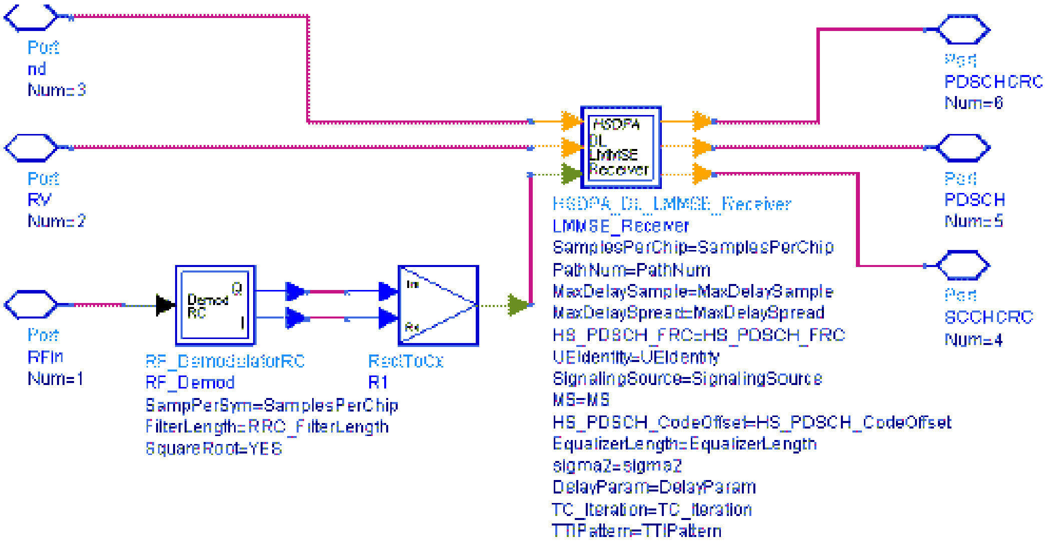
Pin	Name	Description	Signal Type
1	RFin	input RF signal	timed
2	RV	redundancy version	int
3	nd	new data indicator	int
4	PathDelay	intput the pathes delay	int
5	ChEst	estimation of path parameter	multiple complex

Pin Outputs

Pin	Name	Description	Signal Type
6	SCCHCRC	SCCH CRC result	int
7	PDSCH	PDSCH dtat	int
8	PDSCHCRC	PDSCH CRC result	int

Notes/Equations

1. This subnetwork model is used to demodulate and decode HSDPA related downlink RF signals, i.e., HS-DSCH and HS-SCCH.
2. The schematic for this subnetwork is shown below:



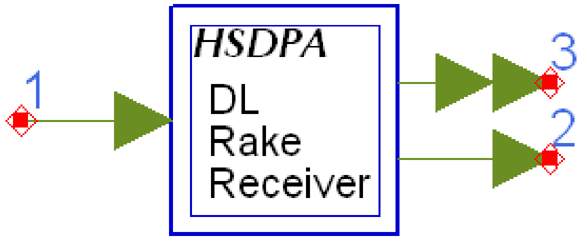
3. To despread and demodulate a CDMA signal, the channel information and path delay information must be determined. Errors in channel estimation and path search deteriorate the receiver performance.
4. The path searching is performed by correlating the received signals with the spreading code specified in a window whose size is set by MaxDelaySample. The correlations at different offsets are ranked; the top ones are assumed to be the offsets where the paths could occur.
5. After channel estimation, the received signal are equalized using LMMSE algorithm.
6. There is one slot delay associated with the decoded information.
7. For more information regarding the Rake receiver and different channel decoders, see *HSDPA_DL_Equalizer* (hsdpa), *HSDPA_PDSCH_Decoder* (hsdpa), and *HSDPA_SCCH_Decoder* (hsdpa) respectively.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport

channels onto physical channels (FDD)," Version 7.6.0, May 2008.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sep. 2008.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 7.6.0, Sep. 2008.

HSDPA_DL_Rake



Description: Rake receiver
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Symbol	Type	Range
TXDiversity	transmit diversity in downlink: No_Diversity, DL_STTD	No_Diversity		enum	
SampleRate	number of samples per chip	4	S	int	[1,32]
PathNum	number of paths or fingers of Rake	6	L	int	[1,16]
MaxDelay	maximum path delay in terms of samples	40	D	int	[PathNum,number of half chips of one slot]
ScrambleCode	Index of scramble code	0		int	
NumHSPDSCH	number of DPCHs	5	M	int	[1,15]
HS_PDSCH_CodeOffset	Spread code offset	1		int	

Pin Inputs

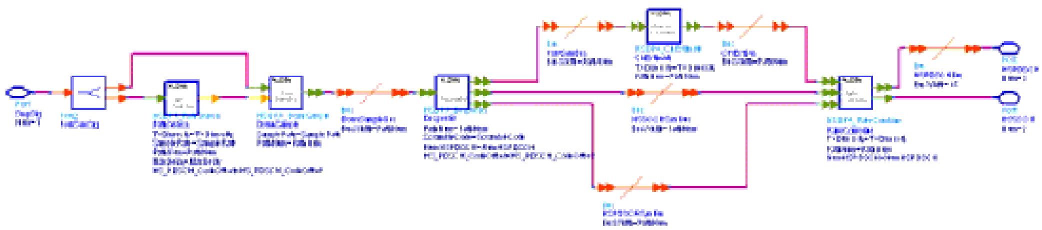
Pin	Name	Description	Signal Type
1	SmpSig	received baseband complex envelope signal samples	complex

Pin Outputs

Pin	Name	Description	Signal Type
2	HS_SCCH	combined signals of the HS_SCCH	complex
3	HS_PDSCH	combined signals of the HS_PDSCH	multiple complex

Notes/Equations

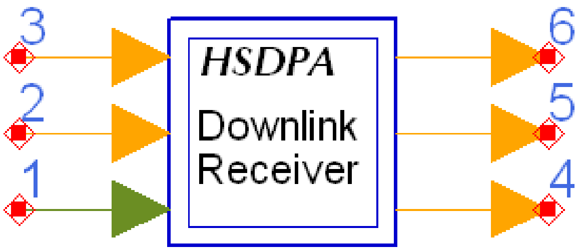
1. This subnetwork is used to implement coherent Rake receiver with maximal ratio combining (MRC) on multiple code channels.
2. Each firing, S × T tokens are consumed at SmpSig, where T is the number of chips per TTI, S is the number of SamplesPerChip. N1 tokens are produced at HS-PDSCH, where N1 is the number of HS-PDSCH symbols per TTI. N2 tokens are produced at HS-SCCH, where N2 is the number of HS-SCCH symbols per TTI. The outputs at HS-PDSCH and HS-SCCH are delayed by one TTI because of Rake receiver signal processing.
3. The schematic for this subnetwork is shown below:



References

1. 3GPP Technical Specification TS25.211 V6.7.0,"Physical channels and mapping of transport channels onto physical channels (FDD)," Dec. 1999.
2. 3GPP Technical Specification TS25.213 V6.4.0,"Spreading and modulation (FDD)," Sept. 2005.
3. A. J. Viterbi, "CDMA: Principles of Spread Spectrum Communication," Wesley Publishing Company, 1995.

HSDPA_DL_Receiver



Description: HSDPA receiver
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Type	Range
SamplesPerChip	number of samples per chip	4	int	[1,32]
PathNum	number of paths or fingers of Rake	6	int	[1,16]
MaxDelaySample	maximum path delay in terms of samples	40	int	[PathNum,number of half chips of one slot]
HS_PDSCH_FRC	Fixed reference channel: H-Set_1, H-Set_2, H-Set_3, H-Set_4, H-Set_5, H-Set_6, H-Set_7, H-Set_8	H-Set_1	enum	
UEIdentity	UE identity (16 bits)	0xAAAA	int	[0,66535]
SignalingSource	: SCCH, External	External	enum	
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum	
HS_PDSCH_CodeOffset	Spread code offset	1	int	
TC_Iteration	Turbo code decoder iteration number	4	int	[1,10]
TTIPattern	inter-TTI pattern	{1, 0, 0, 1, 0, 0}	int array	[0,1]

Pin Inputs

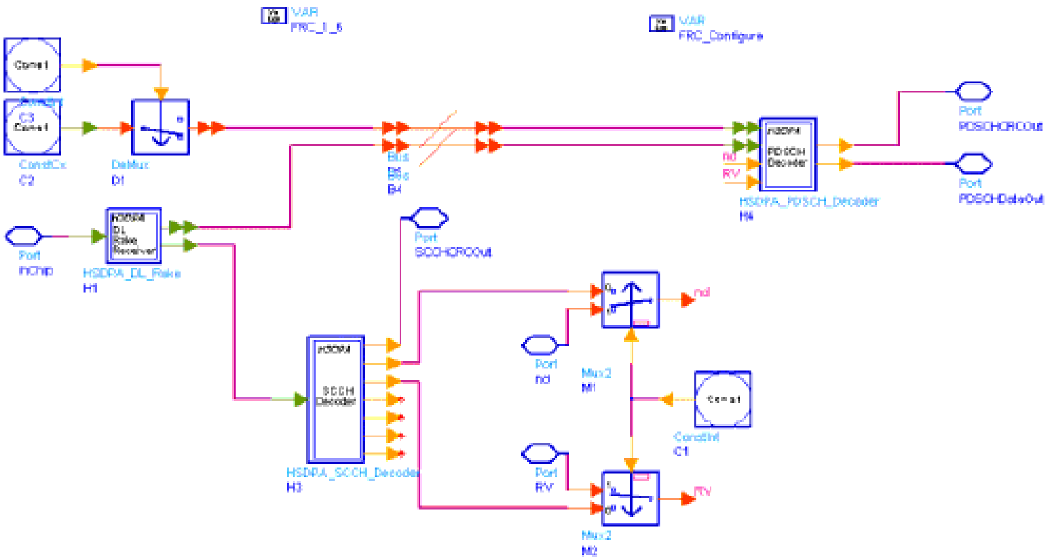
Pin	Name	Description	Signal Type
1	inCHip	received baseband complex envelope signal samples	complex
2	RV	redundancy version	int
3	nd	new data indicator	int

Pin Outputs

Pin	Name	Description	Signal Type
4	SCCHCRC	SCCH CRC result	int
5	PDSCH	PDSCH dtat	int
6	PDSCHCRC	PDSCH CRC result	int

Notes/Equations

1. This subnetwork model is used to demodulate and decode HSDPA related downlink signals, i.e., HS-DSCH and HS-SCCH.
2. The schematic for this subnetwork is shown below:



3. To despread and demodulate a CDMA signal, the channel information and path delay information must be determined. Errors in channel estimation and path search deteriorate the receiver performance.
4. The path searching is performed by correlating the received signals with the spreading code specified in a window whose size is set by MaxDelaySample. The correlations at different offsets are ranked; the top ones are assumed to be the offsets where the paths could occur.
5. All paths are combined assuming that all paths are useful for improving the decoding reliability. In some cases, paths with low SNR are actually harmful to the final SNR improvement. The user must set PathNum for better decoding performance in multipath conditions.
6. There is one slot delay associated with the decoded information.
7. For more information regarding the Rake receiver and different channel decoders, see *HSDPA_DL_Rake* (hsdpa), *HSDPA_PDSCH_Decoder* (hsdpa), and *HSDPA_SCCH_Decoder* (hsdpa) respectively.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 6.7.0, Dec. 2005.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 6.7.0, Dec. 2005.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 6.4.0, Sept. 2005.

HSDPA_DL_Receiver_CQI (HSDPA downlink receiver)

Description: HSDPA receiver
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Type	Range
CQI	value of CQI	1	int	[1,30]
SamplesPerChip	number of samples per chip	4	int	[1,32]
PathNum	number of paths or fingers of Rake	6	int	[1,16]
MaxDelaySample	maximum path delay in terms of chips	40	int	[PathNum,number of half chips of one slot]
HS_PDSCH_CodeOffset	Spread code offset of HS_PDSCH	1	int	[1,15]
TC_Iteration	Turbo code decoder iteration number	4	int	[1,10]

Pin Inputs

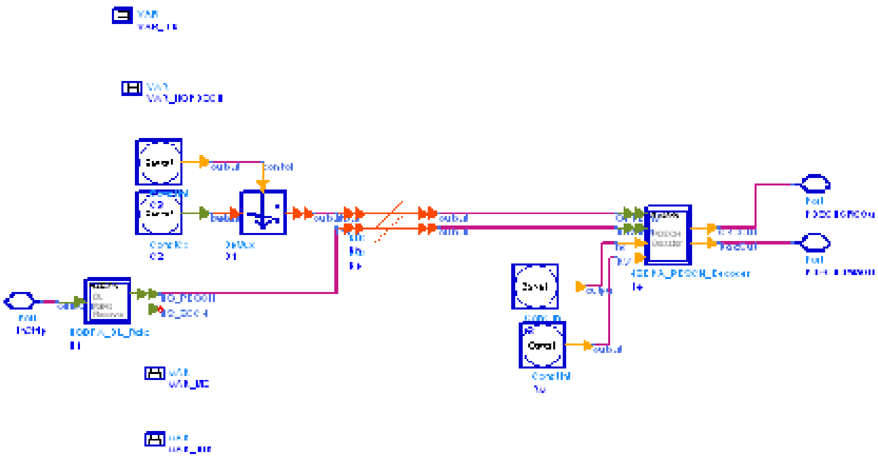
Pin	Name	Description	Signal Type
1	inCHip	received baseband complex envelope signal samples	complex

Pin Outputs

Pin	Name	Description	Signal Type
2	PDSCHDataOut	PDSCH data	int
3	PDSCHCRC	PDSCH CRC result	int

Notes/Equations

1. This subnetwork model is used to demodulate and decode HS-DSCH channel, the format of HS-DSCH is specified by the value of parameter CQI.
2. The schematic for this subnetwork is shown below:

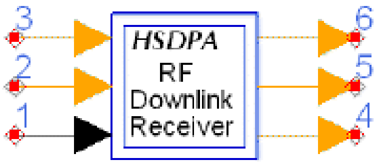


3. To despread and demodulate a CDMA signal, the channel information and path delay information must be determined. Errors in channel estimation and path search deteriorate the receiver performance.
4. The path searching is performed by correlating the received signals with the spreading code specified in a window whose size is set by MaxDelaySample. The timing of multiple paths are determined by the largest correlations and the path number of specified by parameter PathNum.
5. All paths are combined assuming that all paths are useful for improving the decoding reliability. In some cases, paths with low SNR are actually harmful to the final SNR improvement. The user must set PathNum for better decoding performance in multipath conditions.
6. There is one slot delay associated with the decoded information.
7. For more information regarding the Rake receiver and different channel decoders, please refer to the documents of HSDPA_DL_Rake, HSDPA_PDSCH_Decoder and HSDPA_SCCH_Decoder respectively.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.6.0, May 2008.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sep. 2008.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 7.6.0, Sep. 2008.

HSDPA_DL_ReceiverRF



Description: HSDPA receiver
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Unit	Type	Range
FCarrier	Carrier frequency	2140 MHz	Hz	real	(0,∞)
RIn	Input resistance	50	Ohm	real	(0,∞)
Phase	Reference phase in degrees	0.0	deg	real	(-∞,∞)
RRC_FilterLength	RRC filter length (chips)	16		int	[2,128]
ExcessBW	Excess bandwidth of raised cosine filters	0.22		real	(0.0,1.0)
SamplesPerChip	number of samples per chip	4		int	[1,32]
PathNum	number of paths or fingers of Rake	6		int	[1,16]
MaxDelaySample	maximum path delay in terms of samples	40		int	[PathNum,number of half chips of one slot]
HS_PDSCH_FRC	Fixed reference channel: H-Set_1, H-Set_2, H-Set_3, H-Set_4, H-Set_5, H-Set_6, H-Set_7, H-Set_8	H-Set_1		enum	
UEIdentity	UE identity (16 bits)	0xAAAA		int	[0,66535]
SignalingSource	: SCCH, External	External		enum	
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK		enum	
HS_PDSCH_CodeOffset	Spread code offset	1		int	
TC_Iteration	Turbo code decoder iteration number	4		int	[1,10]
TTIPattern	inter-TTI pattern	{1, 0, 0, 1, 0, 0}		int array	[0,1]

Pin Inputs

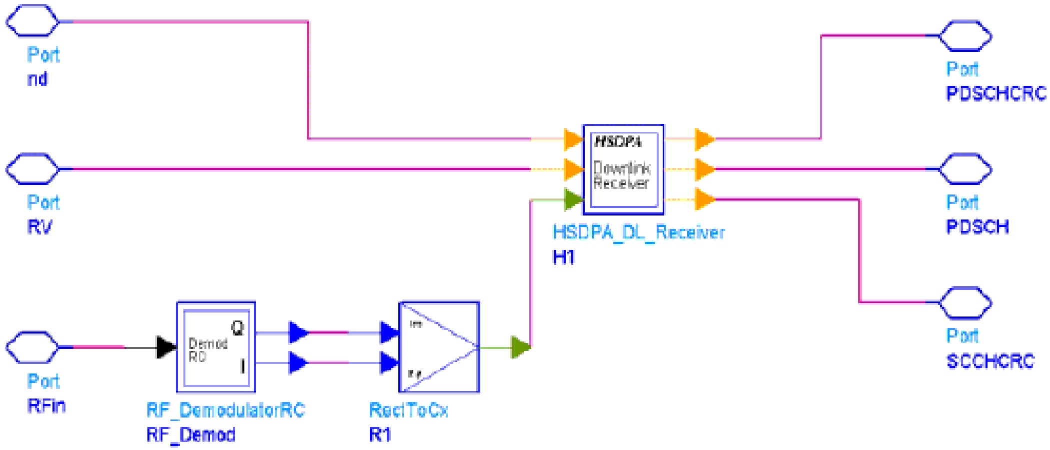
Pin	Name	Description	Signal Type
1	RFin	input RF signal	timed
2	RV	redundancy version	int
3	nd	new data indicator	int

Pin Outputs

Pin	Name	Description	Signal Type
4	SCCHCRC	SCCH CRC result	int
5	PDSCH	PDSCH dtat	int
6	PDSCHCRC	PDSCH CRC result	int

Notes/Equations

1. This subnetwork model is used to demodulate and decode HSDPA related downlink RF signals, i.e., HS-DSCH and HS-SCCH.
2. The schematic for this subnetwork is shown below:

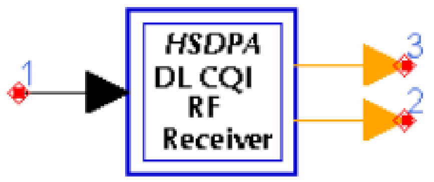


3. To despread and demodulate a CDMA signal, the channel information and path delay information must be determined. Errors in channel estimation and path search deteriorate the receiver performance.
4. The path searching is performed by correlating the received signals with the spreading code specified in a window whose size is set by MaxDelaySample. The correlations at different offsets are ranked; the top ones are assumed to be the offsets where the paths could occur.
5. All paths are combined assuming that all paths are useful for improving the decoding reliability. In some cases, paths with low SNR are actually harmful to the final SNR improvement. The user must set PathNum for better decoding performance in multipath conditions.
6. There is one slot delay associated with the decoded information.
7. For more information regarding the Rake receiver and different channel decoders, see *HSDPA_DL_Rake* (hsdpa), *HSDPA_PDSCH_Decoder* (hsdpa), and *HSDPA_SCCH_Decoder* (hsdpa) respectively.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.6.0, May 2008.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sep. 2008.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 7.6.0, Sep. 2008.

HSDPA_DL_ReceiverRF_CQI (HSDPA downlink RF receiver)



Description: HSDPA downlink RF receiver
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Unit	Type	Range
FCarrier	Carrier frequency	2140 MHz	Hz	real	(0,∞)
RIn	Input resistance	50	Ohm	real	(0,∞)
Phase	Reference phase in degrees	0.0	deg	real	(-∞,∞)
RRC_FilterLength	RRC filter length (chips)	16		int	[2,128]
ExcessBW	Excess bandwidth of raised cosine filters	0.22		real	(0.0,1.0)
UE_Category	: Category_1, Category_2, Category_3, Category_4, Category_5, Category_6, Category_7, Category_8, Category_9, Category_10, Category_11, Category_12	Category_1		enum	
CQI	value of CQI	1		int	[1,30]
HS_PDSCH_CodeOffset	Spread code offset	1		int	
SamplesPerChip	number of samples per chip	4		int	[1,32]
PathNum	number of paths or fingers of Rake	6		int	[1,16]
MaxDelaySample	maximum path delay in terms of chips	40		int	[PathNum,number of half chips of one slot]
TC_Iteration	Turbo code decoder iteration number	4		int	[1,10]

Pin Inputs

Pin	Name	Description	Signal Type
1	RFin	input RF signal	timed

Pin Outputs

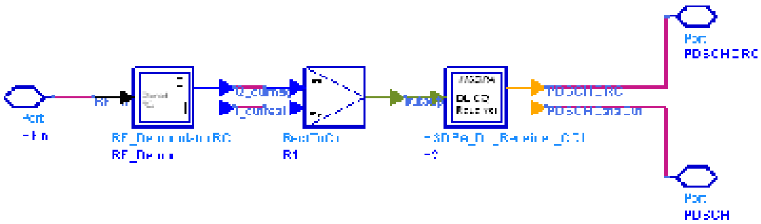
Pin	Name	Description	Signal Type
2	PDSCH	PDSCH data	int
3	PDSCHCRC	PDSCH CRC result	int

Notes/Equations

1. This subnetwork model is used to perform downlink RF receiver for HSDPA supporting CQI functionality. The subnetwork includes HSDPA_DL_ReceiverRF_CQI, which is the baseband HSDPA downlink receiver supporting CQI functionality, and the QAM

Demodulation.

2. The schematic for this subnetwork is shown below:

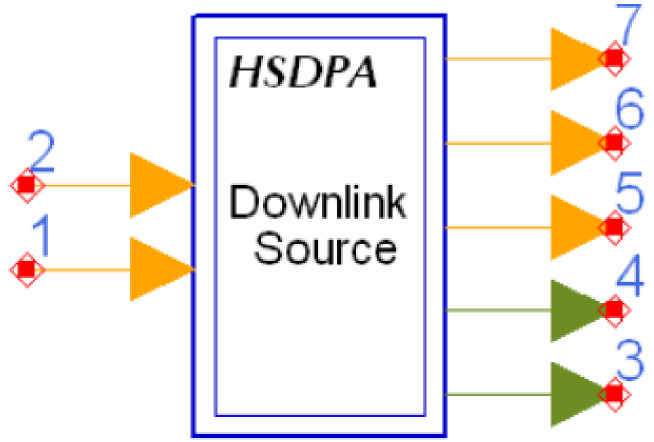


3. To despread and demodulate a CDMA signal, the channel information and path delay information must be determined. Errors in channel estimation and path search deteriorate the receiver performance.
4. The path searching is performed by correlating the received signals with the spreading code specified in a window whose size is set by MaxDelaySample. The timing of multiple paths are determined by the largest correlations and the path number of specified by parameter PathNum.
5. All paths are combined assuming that all paths are useful for improving the decoding reliability. In some cases, paths with low SNR are actually harmful to the final SNR improvement. The user must set PathNum for better decoding performance in multipath conditions.
6. There is one slot delay associated with the decoded information.
7. For more information regarding the Rake receiver and different channel decoders, please refer to the documents of HSDPA_DL_Rake, HSDPA_PDSCH_Decoder and HSDPA_SCCH_Decoder respectively.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 6.7.0, Dec. 2005.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 6.7.0, Dec. 2005.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 6.4.0, Sep. 2005.

HSDPA_DL_Source



Description: HSDPA downlink source
Library: HSDPA, Signal Sources

Parameters

Name	Description	Default	Unit	Type	Range
OutputSTTD	Whether or not export STTD: NO, YES	NO		enum	
DPCH_Configured	Setting to YES if DPCH is configured, otherwise NO: NO, YES	NO		enum	
DPCH_EcToIor	DPCH power gain factor	-15	dB	real	(-∞,∞)
PCPICH_EcToIor	Primary CPICH power gain in dB	-10.0	dB	real	(-∞,∞)
PCCPCH_EcToIor	PCCPCH power gain in dB	-12	dB	real	(-∞,∞)
SCH_EcToIor	SCH power gain in dB	-15	dB	real	(-∞,∞)
PICH_EcToIor	PICH power gain in dB	-15	dB	real	(-∞,∞)
HS_SCCH_Configured	Whether or not SCCH 1 to 4 configured	{1, 0, 0, 0}		int array	
HS_SCCH_EcToIor	Power gain factor of HS-SCCH 1 to 4 in dB	{-10, -10, -10, -10}	dB	real array	
HS_PDSCH_Configured	Whether or not HS-PDSCH 1 to 4 configured	{1, 0, 0, 0}		int array	
HS_PDSCH_EcToIor	Power gain factor of of HS-PDSCH 1 to 4 in dB	{-6, -6, -6, -6}	dB	real array	
HS_PDSCH_UE_Category	UE category of of HS-PDSCH 1 to 4	{0, 0, 0, 0}		int array	

HS_PDSCH_UEIdentity	UE identity of of HS-PDSCH 1 to 4	{0xAAAA, 0x12AA, 0x1AAA, 0x1FAA}		int array	[0,66535]
HS_PDSCH_MS	Modulation scheme of HS-PDSCH 1 to 4	{0, 0, 0, 0}		int array	
HS_PDSCH_CodeOffset	Spread code offset of HS-PDSCH 1 to 4	{1, 13, 14, 15}		int array	
HS_PDSCH_1_FRC	Fixed reference channel of HS-PDSCH 1: H-Set_1, H-Set_2, H-Set_3, H-Set_4, H-Set_5, H-Set_6, H-Set_7, H-Set_8	H-Set_1		enum	
HS_PDSCH_1_RVSeq	RV coding sequence of of HS-PDSCH 1	{0, 2, 5, 6}		int array	
HS_PDSCH_1_DataPattern	Data pattern of HS-PDSCH 1: Random, PN9, PN15, Repeat Bits	Random		enum	
HS_PDSCH_1_RepeatBitValue	Repeating data value of HS-PDSCH 1	0x0001		int	[0, 65535]
HS_PDSCH_1_RepeatBitPeriod	Repeating data period of HS-PDSCH 1	2		int	[1, 16]
HS_PDSCH_1_TTIPattern	Inter-TTI pattern of HS-PDSCH 1	{1, 0, 0, 1, 0, 0}		int array	[0,1]
HS_PDSCH_2_TTIPattern	Inter-TTI pattern of HS-PDSCH 2	{1, 0, 0, 1, 0, 0}		int array	[0,1]
HS_PDSCH_3_TTIPattern	Inter-TTI pattern of HS-PDSCH 3	{1, 0, 0, 1, 0, 0}		int array	[0,1]
HS_PDSCH_4_TTIPattern	Inter-TTI pattern of HS-PDSCH 4	{1, 0, 0, 1, 0, 0}		int array	[0,1]
HS_PDSCH_2_NumPhyCH	Number of physical channels of HS-PDSCH 2	1		int	
HS_PDSCH_3_NumPhyCH	Number of physical channels of HS-PDSCH 3	1		int	
HS_PDSCH_4_NumPhyCH	Number of physical channels of HS-PDSCH 4	1		int	
OCNS_DPCHNum	downlink DPCH number	1		int	[1,8] for other models; [1,512] for 3GPPHSUPA_OCNS and 3GPPHSUPA_DPCHs
OCNS_ScrambleCode	index of scramble code	0		int	[0,512] for downlink; [0, 16777215] for uplink
OCNS_ScrambleOffset	scramble code offset	0		int	[0,15]
OCNS_ScrambleType	scramble code type: normal, right, left	normal		enum	
OCNS_SpreadCodeArray	index array of	0		int	the i_{th} element shall be in

	spread codes			array	[0,SpreadFactor[i]-1]; array size shall be equal to code channel number; codes shall be in different OVSF code branch
OCNS_DataPatternArray	data pattern array: 0-random, 1-PN9, 2-PN15, 3-Repeat Bits	0		int array	[0,1,2,3]; array size shall be equal to code channel number
OCNS_RepBitValueArray	bits value array to be filled in data sequence	0x55		int array	[0,255]; array size shall be equal to code channel number
OCNS_PowerArray	channel power array in decibels	0.0		real array	(-∞,∞); array size shall be equal to code channel number
OCNS_tDPCHOffsetArray	DPCH channel offset array	0		int array	[0,149]; array size shall be equal to DPCH channel number
OCNS_SpreadFactorArray	orthogonal channel spread factor array	128 128 128 128 128 128 128 128 128 128 128 128 128 128 128 128		int array	2^n, n=1,...,9; array size shall be equal to DPCHNum

Pin Inputs

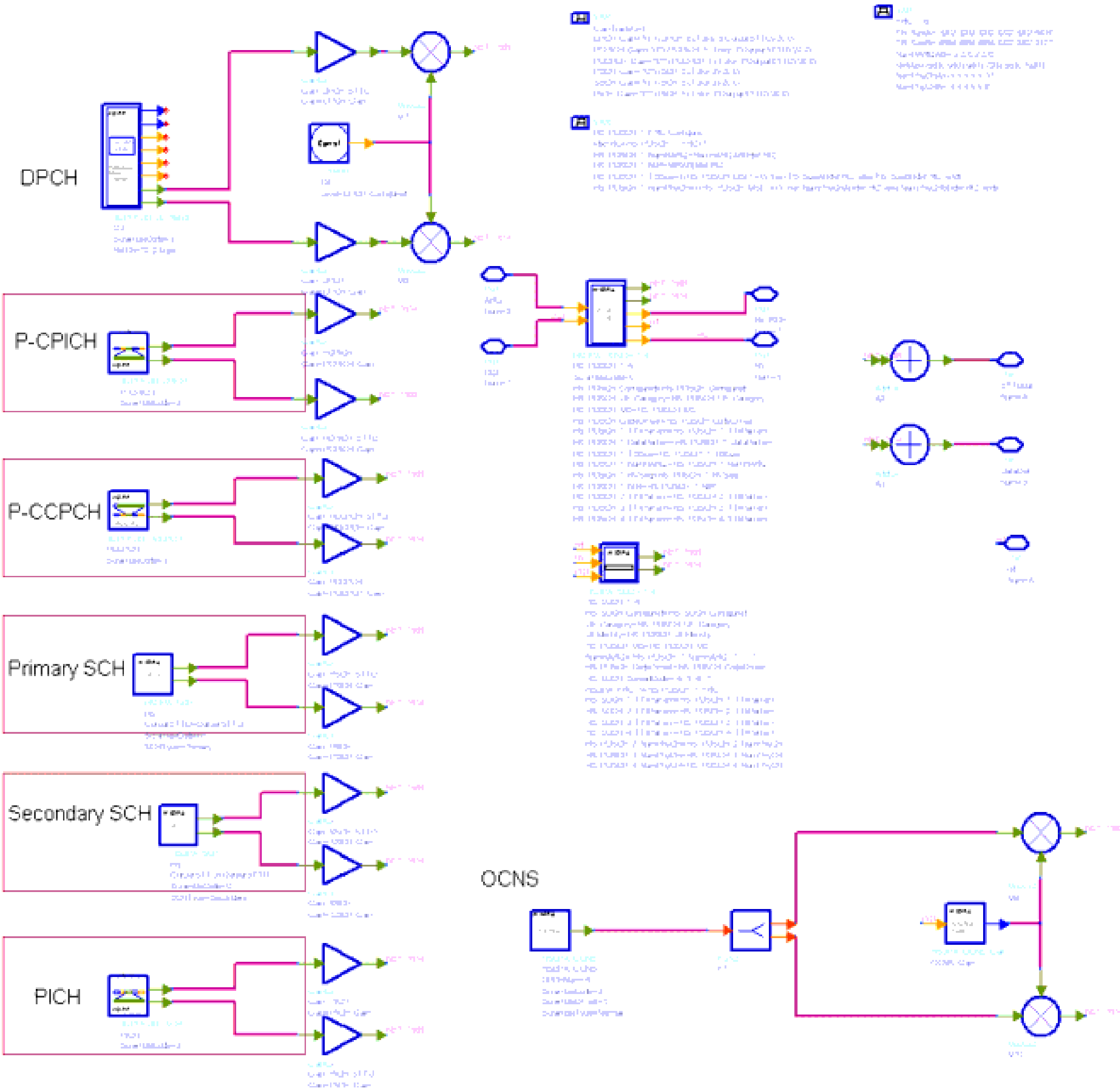
Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int
2	ARQ	automatic repeat request	int

Pin Outputs

Pin	Name	Description	Signal Type
3	DataOut	data out	complex
4	STTDOut	data out	complex
5	RV	redundancy version	int
6	nd	new data indicator	int
7	BitDSCH	DSCH bit	int

Notes/Equations

1. This subnetwork model is used to simulate integrated HSDPA base station signal source.
2. The schematic for this subnetwork is shown below:



3. The physical channels integrated in this subnetwork model are listed in the table below:

Physical Channel
P_CPICH
S_CPICH
PCCPCH
P_SCH
S_SCH
SCCPCH
PICH
DPCH
HS-PDSCH
HS-SCCH
OCNS

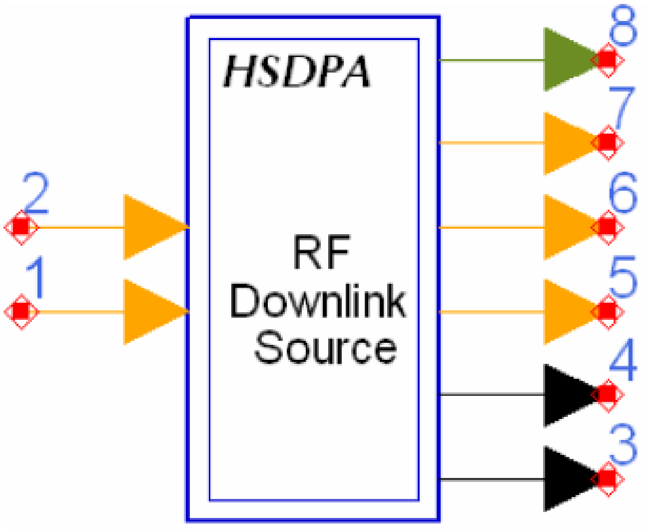
4. The HS-PDSCH is generated by the composite HSDPA_PDSCH_1_4 which can support

one full coded and three uncoded HS-PDSCH sources.
5. The HS-SCCH is generated by the full coded HSDPA_SCCH_1_4 which can support four full coded HS-SCCH sources.
6. The DPCH is generated by the fully-coded 3GPPFDD_DL_RefCh signal source.
7. Four data patterns are supported: random, PN9, PN15, and repeated.
8. If data is from a user-defined file, the file name is defined by the respective UserFileName. The user can edit the file with any text editor. The separator between bits can be a space, comma, or any other separator. If the bit sequence is shorter than the output length, data will be output repeatedly.
9. The DPCH data rate can be set through RefCh. DPCH channelization code is set through DPCH_SpreadCode.
10. CPICH includes primary and secondary CPICH. Primary CPICH channelization code is fixed at C256,0. CPICH_SpreadCode is set on secondary CPICH, with a spread factor of 256.
11. The PICH spread factor is 256. PICH channelization code is set through PICH_SpreadCode.
12. The PCCPCH channelization code is fixed at C256,1. The SCCPCH spread factor and spread channelization code are set through SCCPCH_SpreadFactor and SCCPCH_SpreadCode.
13. Relative gain factor of each channel can be set through the respective GainFactor parameters. They are multiplied to the output of each channel model. A channel can be disabled by setting its gain factor to 0.
14. It is suggested that the square of all the GainFactors add up to 1 to make sure the RMS value of output downlink signal is 1. However, it isn't so important for baseband signal. A normalized downlink source can be implemented by HSDPA_DL_SourceRF.
15. OCNS can be set through the OCNS_ChannelNum and six OCNS array parameters. The default OCNS channel is 16 and corresponding array parameters are 16 elements long. To change the OCNS channel number, the corresponding array parameters must be changed. For details regarding OCNS settings, refer to *HSDPA_OCNS_Gain* (hsdpa).

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 6.7.0, Dec. 2005.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 6.7.0, Dec. 2005.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 6.4.0, Sept. 2005.
4. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 6.7.1, Dec. 2005.

HSDPA_DL_SourceRF



Description: HSDPA downlink RF signal source
Library: HSDPA, Signal Sources

Parameters

Name	Description	Default	Unit	Type	Range
ROut	Output resistance	DefaultROut	Ohm	real	(0,∞)
FCarrier	Carrier frequency	2140 MHz	Hz	real	(0,∞)
Power	RF output power	0.01	W	real	[0,∞)
PhasePolarity	If set to Invert, Q channel signal is inverted: DL_Normal, DL_Invert	DL_Normal		enum	
GainImbalance	Gain imbalance, I to Q channel, in dB	0.0		real	(-∞,∞)
PhaseImbalance	Phase imbalance, I to Q channel, in degrees	0.0		real	(-∞,∞)
I_OriginOffset	I origin offset in percent with respect to output rms voltage	0.0		real	(-∞,∞)
Q_OriginOffset	Q origin offset in percent with respect to output rms voltage	0.0		real	(-∞,∞)
IQ_Rotation	IQ rotation in degress	0.0		real	(-∞,∞)
NDensity	Additive noise density in dBm per Hz	-10000		real	(-∞,∞)
SamplesPerChip	Samples per chip	4		int	[2,32]
ExcessBW	Excess bandwidth of raised cosine filters	0.22		real	(0.0,1.0)
RRC_FilterLength	Length of raised cosine filters in number of symbols	16		int	[2,128]
SourceType	Signal source type: HSDPA, TestModel1_16DPCHs,	HSDPA		enum	

	TestModel1_32DPCHs, TestModel1_64DPCHs, TestModel2, TestModel3_16DPCHs, TestModel3_32DPCHs, TestModel4, TestModel5_6DPCHs, TestModel5_14DPCHs, TestModel5_30DPCHs, TestModel6				
OutputSTTD	Whether or not export STTD: NO, YES	NO		enum	
DPCH_Configured	Setting to YES if DPCH is configured, otherwise NO: NO, YES	NO		enum	
DPCH_EcToIor	DPCH power gain factor	-15	dB	real	(-∞,∞)
PCPICH_EcToIor	Primary CPICH power gain in dB	-10.0	dB	real	(-∞,∞)
PCCPCH_EcToIor	PCCPCH power gain in dB	-12	dB	real	(-∞,∞)
SCH_EcToIor	SCH power gain in dB	-15	dB	real	(-∞,∞)
PICH_EcToIor	PICH power gain in dB	-15	dB	real	(-∞,∞)
HS_SCCH_Configured	Whether or not SCCH 1 to 4 configured	{1, 0, 0, 0}		int array	
HS_SCCH_EcToIor	Power gain factor of HS-SCCH 1 to 4 in dB	{-10, -10, -10, -10}	dB	real array	
HS_PDSCH_Configured	Whether or not HS-PDSCH 1 to 4 configured	{1, 0, 0, 0}		int array	
HS_PDSCH_EcToIor	Power gain factor of of HS-PDSCH 1 to 4 in dB	{-6, -6, -6, -6}	dB	real array	
HS_PDSCH_UE_Category	UE category of of HS-PDSCH 1 to 4	{1, 1, 1, 1}		int array	
HS_PDSCH_UEIdentity	UE identity of of HS-PDSCH 1 to 4	{0xAAAA, 0x12AA, 0x1AAA, 0x1FAA}		int array	[0,66535]
HS_PDSCH_MS	Modulation scheme of HS-PDSCH 1 to 4	{0, 0, 0, 0}		int array	
HS_PDSCH_CodeOffset	Spread code offset of HS-PDSCH 1 to 4	{1, 13, 14, 15}		int array	
HS_PDSCH_1_FRC	Fixed reference channel of HS-PDSCH 1: H-Set_1, H-Set_2, H-Set_3, H-Set_4, H-Set_5, H-Set_6, H-Set_7, H-Set_8	H-Set_1		enum	
HS_PDSCH_1_RVSeq	RV coding sequence of of HS-PDSCH 1	{0, 2, 5, 6}		int array	
HS_PDSCH_1_DataPattern	Data pattern of HS-PDSCH 1: Random, PN9, PN15, Repeat Bits	Random		enum	
HS_PDSCH_1_RepeatBitValue	Repeating data value of HS-PDSCH 1	0x0001		int	[0, 65535]
HS_PDSCH_1_RepeatBitPeriod	Repeating data period of HS-PDSCH 1	2		int	[1, 16]
HS_PDSCH_1_TTIPattern	Inter-TTI pattern of HS-	{1, 0, 0, 1,		int	[0,1]

	PDSCH 1	0, 0}		array	
HS_PDSCH_2_TTIPattern	Inter-TTI pattern of HS-PDSCH 2	{1, 0, 0, 1, 0, 0}		int array	[0,1]
HS_PDSCH_3_TTIPattern	Inter-TTI pattern of HS-PDSCH 3	{1, 0, 0, 1, 0, 0}		int array	[0,1]
HS_PDSCH_4_TTIPattern	Inter-TTI pattern of HS-PDSCH 4	{1, 0, 0, 1, 0, 0}		int array	[0,1]
HS_PDSCH_2_NumPhyCH	Number of physical channels of HS-PDSCH 2	1		int	
HS_PDSCH_3_NumPhyCH	Number of physical channels of HS-PDSCH 3	1		int	
HS_PDSCH_4_NumPhyCH	Number of physical channels of HS-PDSCH 4	1		int	
TM_OutputMode	output mode of test model: Ramp, Stable	Ramp		enum	
TM4_EnableP_CPICH	Test Model 4 enable primary CPICH?: NO, YES	YES		enum	
TM4_PCCPCH_SCH_Gain	Test Model 4 PCCPCH_SCH level setting	-6	dB	real	(-∞,∞)
TM4_P_CPICH_Gain	Test Model 4 P_CPICH level setting	-6	dB	real	(-∞,∞)
OCNS_DPCHNum	downlink DPCH number	1		int	[1,8] for other models; [1,512] for 3GPPHSUPA_OCNS and 3GPPHSUPA_DPCHs
OCNS_ScrambleCode	index of scramble code	0		int	[0,512] for downlink; [0, 16777215] for uplink
OCNS_ScrambleOffset	scramble code offset	0		int	[0,15]
OCNS_ScrambleType	scramble code type: normal, right, left	normal		enum	
OCNS_SpreadCodeArray	index array of spread codes	0		int array	the i_{th} element shall be in [0,SpreadFactor[i]-1]; array size shall be equal to code channel number; codes shall be in different OVSF code branch
OCNS_DataPatternArray	data pattern array: 0-random, 1-PN9, 2-PN15, 3-Repeat Bits	0		int array	[0,1,2,3]; array size shall be equal to code channel number
OCNS_RepBitValueArray	bits value array to be filled in data sequence	0x55		int array	[0,255]; array size shall be equal to code channel number
OCNS_PowerArray	channel power array in decibels	0.0		real array	(-∞,∞); array size shall be equal to code channel number
OCNS_tDPCHOffsetArray	DPCH channel offset array	0		int array	[0,149]; array size shall be equal to DPCH channel number
OCNS_SpreadFactorArray	orthogonal channel spread factor array	128 128 128 128 128 128		int array	2^n, n=1,...,9; array

		128 128 128 128 128 128 128 128 128 128			size shall be equal to DPCHNum

Pin Inputs

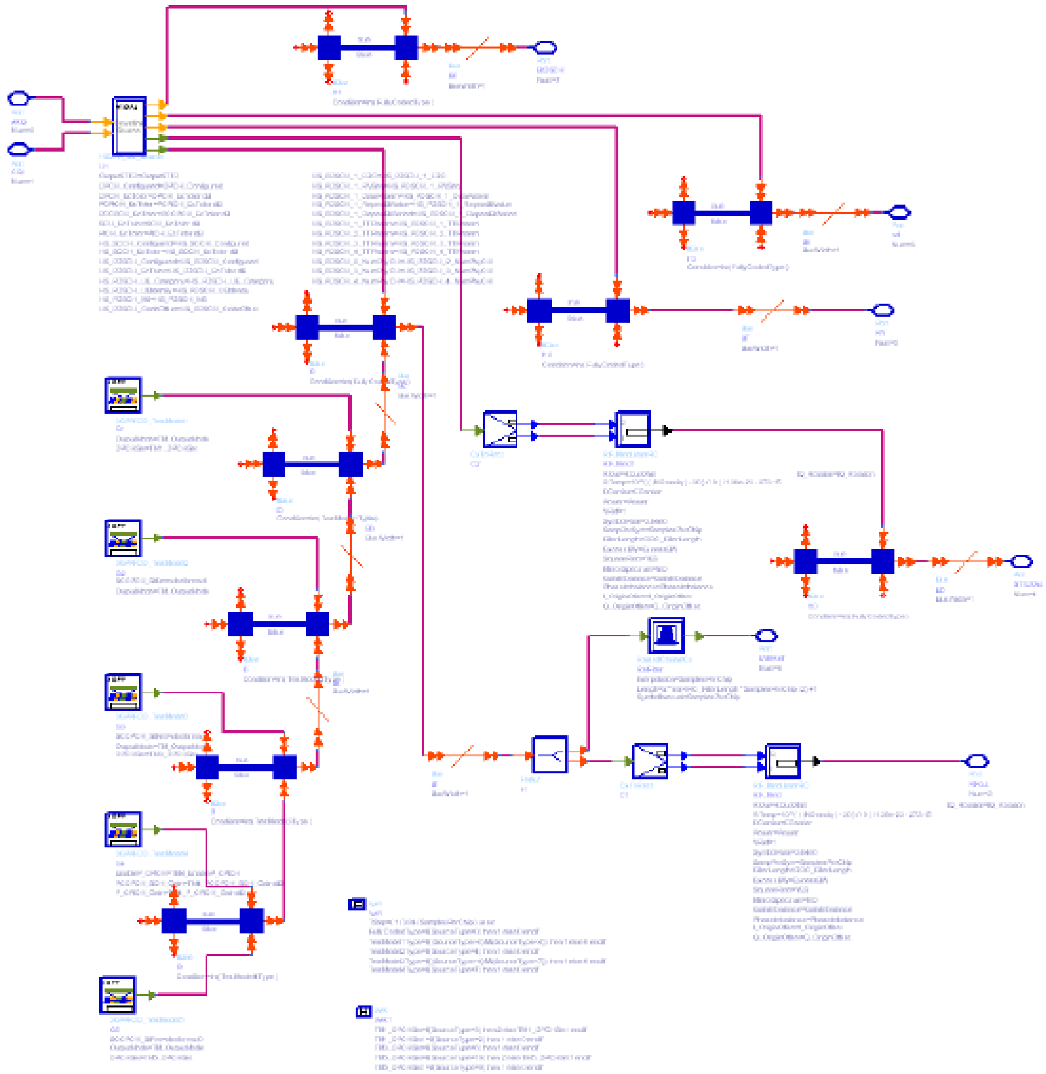
Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int
2	ARQ	automatic repeat request	int

Pin Outputs

Pin	Name	Description	Signal Type
3	RFout	output RF signal	timed
4	STTDOut	data out	timed
5	RV	redundancy version	int
6	nd	new data indicator	int
7	BitDSCH	DSCH bit	int
8	EVMRef	reference signal for EVM	complex

Notes/Equations

1. This subnetwork model is used to simulate integrated HSDPA base station RF signal source.
2. The schematic for this subnetwork is shown below:



3. The physical channels integrated in this subnetwork model are listed in the table below:

Physical Channel
P_CPICH
S_CPICH
PCCPCH
P_SCH
S_SCH
SCCPCH
PICH
DPCH
HS-PDSCH
HS-SCCH
OCNS

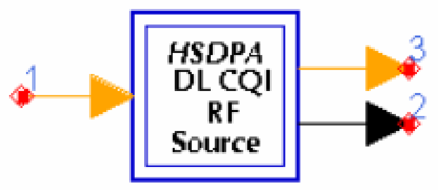
4. The HS-PDSCH is generated by the composite HSDPA_PDSCH_1_4 which can support one full coded and three uncoded HS-PDSCH source.
5. The HS-SCCH is generated by the full coded HSDPA_SCCH_1_4 which can support four full coded HS-SCCH source.
6. The DPCH is generated by the fully-coded 3GPPFDD_DL_RefCh signal source.
7. Four data patterns are supported: random, PN9, PN15, and repeated.

8. If data is from a user-defined file, the file name is defined by the respective UserFileName. The user can edit the file with any text editor. The separator between bits can be a space, comma, or any other separator. If the bit sequence is shorter than the output length, data will be output repeatedly.
9. The DPCH data rate can be set through RefCh. DPCH channelization code is set through DPCH_SpreadCode.
10. CPICH includes primary and secondary CPICH. Primary CPICH channelization code is fixed at C256,0. CPICH_SpreadCode is set on secondary CPICH, with a spread factor of 256.
11. The PICH spread factor is 256. PICH channelization code is set through PICH_SpreadCode.
12. The PCCPCH channelization code is fixed at C256,1. The SCCPCH spread factor and spread channelization code are set through SCCPCH_SpreadFactor and SCCPCH_SpreadCode.
13. The transmitter power is set by the parameter Power.
    Relative power levels of each channel can then be set through the respective GainFactor parameters, in dB units. OCNS_GainFactor is calculated from other GainFactors. (Refer to Table C.6 in Reference [5].
    The GainFactors are converted into voltage values and multiplied to the output of each channel model. A channel can be disabled by setting its gain factor to a large minus value such as -300 dB.
14. OCNS can be set through the OCNS_ChannelNum and six OCNS array parameters. The default OCNS channel is 16 and corresponding array parameters are 16 elements long. To change the OCNS channel number, the corresponding array parameters must be changed. The output of OCNS must be normalized. For details regarding OCNS settings, see *HSDPA_OCNS_Gain* (hsdpa).

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 6.7.0, Dec. 2005.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 6.7.0, Dec. 2005.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 6.4.0, Sept. 2005.
4. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 6.7.1, Dec. 2005.
5. 3GPP Technical Specification TS 25.101, "UE Radio transmission and Reception (FDD)," Version 6.10.0, Dec. 2005.

HSDPA_DL_SourceRF_CQI (HSDPA downlink RF signal source)



Description: HSDPA downlink RF signal source
Library: HSDPA, Signal Sources

Parameters

Name	Description	Default	Unit	Type	Range
ROut	Output resistance	DefaultROut	Ohm	real	(0,∞)
FCarrier	Carrier frequency	2140 MHz	Hz	real	(0,∞)
PhasePolarity	If set to Invert, Q channel signal is inverted: DL_Normal, DL_Invert	DL_Normal		enum	
GainImbalance	Gain imbalance, I to Q channel, in dB	0.0		real	(-∞,∞)
PhaseImbalance	Phase imbalance, I to Q channel, in degrees	0.0		real	(-∞,∞)
I_OriginOffset	I origin offset in percent with respect to output rms voltage	0.0		real	(-∞,∞)
Q_OriginOffset	Q origin offset in percent with respect to output rms voltage	0.0		real	(-∞,∞)
IQ_Rotation	IQ rotation in degress	0.0		real	(-∞,∞)
NDensity	Additive noise density in dBm per Hz	-10000		real	(-∞,∞)
Power_PCPICH	RF output power of PCPICH	0.01	W	real	[0,∞)
Power_PCCPCH	RF output power of PCCPCH	0.01	W	real	[0,∞)
Power_PSCH	RF output power of PSCH	0.01	W	real	[0,∞)
Power_SSCH	RF output power of SSCH	0.01	W	real	[0,∞)
Power_PICH	RF output power of PICH	0.01	W	real	[0,∞)
Power_PDSCH	RF output power of PDSCH	0.01	W	real	[0,∞)
Power_SCCH	RF output power of SCCH	0.01	W	real	[0,∞)
SamplesPerChip	Samples per chip	4		int	[2,32]
ExcessBW	Excess bandwidth of raised cosine filters	0.22		real	(0.0,1.0)
RRC_FilterLength	Length of raised cosine filters in number of symbols	16		int	[2,128]
UE_Category	UE category of HS-PDSCH	1		int	[0,11]
UEIdentity	UE identity	0xAAAA		int	[0,65535]
HS_PDSCH_CodeOffset	Spread code offset of HS-PDSCH	1		int	[1,15]
HS_SCCH_SpreadCode	Spread code of HS-SCCH	1		int	

Pin Inputs

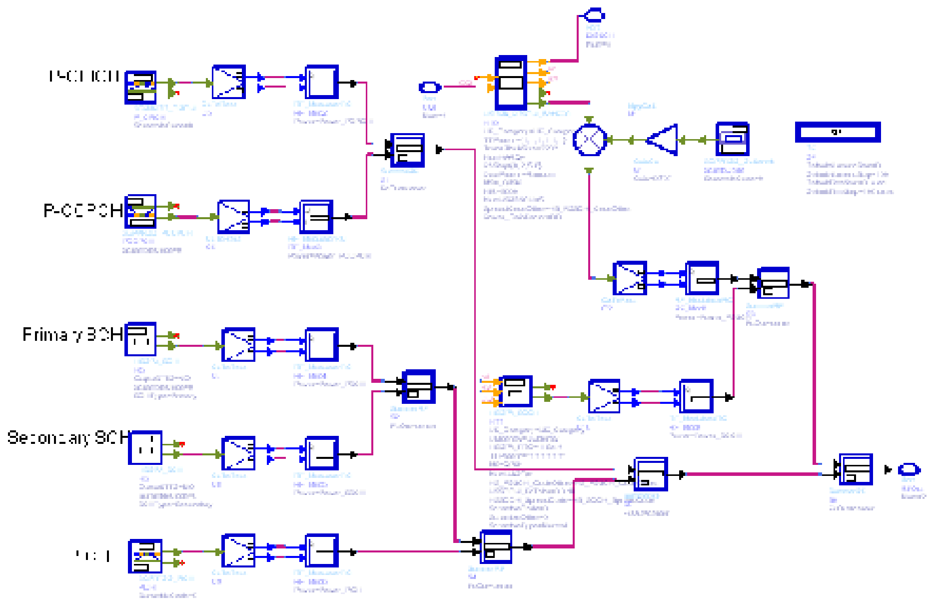
Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int

Pin Outputs

Pin	Name	Description	Signal Type
2	RFout	output RF signal	timed
3	BitDSCH	output DSCH	int

Notes/Equations

1. This subnetwork model is used to generate integrated HSDPA base station RF signal, with input CQI controlling the format of HS-DSCH.
2. The schematic for this subnetwork is shown in below:



3. The physical channels integrated in this subnetwork model are listed in the table below:

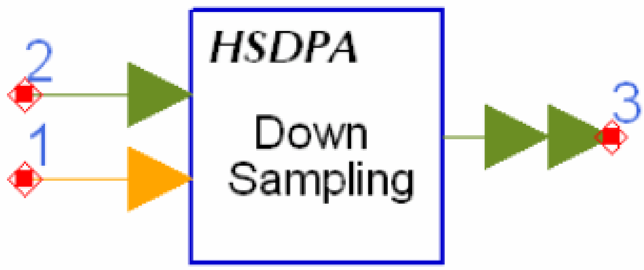
Physical Channel
P_CPICH
PCCPCH
P_SCH
S_SCH
PICH
HS-PDSCH
HS-SCCH

4. The HSDPA_PDSCH_WithFEC can support one full coded HS-DSCH channel. The input CQI value is used to control the fromat of HS-DSCH.
5. The HS-SCCH can support one full coded HS-SCCH channel.
6. Primary CPICH channelization code is fixed at C256,0.
7. The PICH spread factor is 256. PICH channelization code is set through PICH_SpreadCode.
8. The PCCPCH channelization code is fixed at C256,1. The SCCPCH spread factor and spread channelization code are set through SCCPCH_SpreadFactor and SCCPCH_SpreadCode.
9. The parameters Power_PCPICH, Power_PCCPCH, Power_PSCH, Power_SSCH, Power_PICH, Power_PDSCH and Power_SCCH are used to specify the transmit powers of PCPICH, PCCPCH, PSCH, SSCH, PICH, PDSCH and SCCH respectively.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 6.7.0, Dec. 2005.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 6.7.0, Dec. 2005.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 6.4.0, Sept. 2005.
4. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 6.7.1, Dec. 2005.
5. 3GPP Technical Specification TS 25.101, "UE Radio transmission and Reception (FDD)," Version 6.10.0, Dec. 2005.

HSDPA_DownSample



Description: Extract optimum samples according to path delay timing
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Symbol	Type	Range
SampleRate	number of samples per chip	4	S	int	[1,32]
PathNum	number of paths or fingers of Rake	6	L	int	[1,16]

Pin Inputs

Pin	Name	Description	Signal Type
1	Delays	path delays in terms of samples	int
2	SmpSig	received baseband complex envelope signal samples	complex

Pin Outputs

Pin	Name	Description	Signal Type
3	ChpSeq	extracted optimum chip sequence	multiple complex

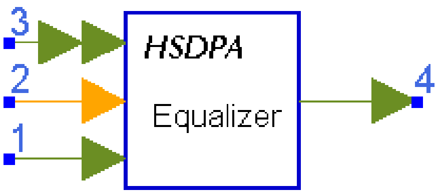
Notes/Equations

1. This model is used to extract optimum samples using the path delay timing given by HSDPA_PathSearch.
2. Each firing, S × N tokens are consumed at SmpSig, L tokens are consumed at Delays, N tokens are produced at ChipSeq per each port, where N is the number of chips per TTI, S is the SampleRate, and L is the number of path. The port number of ChipSeq depends on PathNum.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.6.0, May 2008.
2. A. J. Viterbi, "CDMA: Principles of Spread Spectrum Communication," Wesley Publishing Company, 1995.

HSDPA_Equalizer



Description: MMSE equalizer for HSDPA
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Symbol	Type	Range
IdealChannelEst	using ideal channel estimation or not: NO, YES	YES		enum	
SamplesPerChip	number of samples per chip	4		int	[1 , 32]
MaxDelaySpread	the maximal multi-paths delay spread in the unit of sample, to decide the length of channal implus response	80		int	(PathSpread , +∞)
EqualizerLength	the coefficients length of the equalizer in the unit of chip	64		int	(MaxDelayChip , +∞)
sigma2	the variance of the AWGN noise	0.0001		real	[0 , +∞)
PathNum	number of paths	6		int	[1,6]
UpdatePeriod	the period to update the channel information in the unit of chip	32		int	[1 , 256]
RC_Length	number of RC filter taps	64	L	int	[1,∞)
RC_SymbolInterval	distance of RC filter from center to first zero crossing	16	T	int	[1,∞)
RC_ExcessBW	RC filter excess bandwidth	1.0	α	real	[0,1]
RC_SquareRoot	square root raised-cosine pulse of RC filter: NO, YES	YES		enum	

Pin Inputs

Pin	Name	Description	Signal Type
1	SmpSig	received baseband complex envelope signal samples	complex
2	PathDelay	multi-pathes delay in sample	int
3	ChEst	estimation of path parameter	multiple complex

Pin Outputs

Pin	Name	Description	Signal Type
4	ChipOut	equalized chip output	complex

Notes/Equations

1. This model is used to do the LMMSE equalizer. Each firing, S × T tokens are consumed at SmpSig, where T is the number of chips per TTI and S is the number of SamplesPerChip. 30 channel estimation valus are consumed for each path. The output at Delays is delayed by one TTI because signals of multiple path may be overlapped on adjacent slots.

2. The chip level LMMSE equalizer algorithm is demonstrated below:
As a general concept, the equalizer consists of a FIR filters w of length FxNs: **w**= [w(0).... w(FNs-2)... w(FNs-1)*]^T, where, the **Ns** is the number of samples per chip and F is the length of the equalizer in units of chips. The sampled received vectors at two;antennas are denoted by: **r**(m) = [r((m+D+1)Ns-1)...r(mNs) r((m+D-F+1)Ns)*]^T, where, **D** is a delay parameter (0 ≤ D ≤ F+L')
3. The equalization operation amounts to obtaining the filtered signal: y(m) = **w**^{T}- r*(m)
4. The received signal r(m) can be expressed as: **r**(m) = **H**^{T}- **d**(m)+**n**$_i$(m), where,

$$\mathbf{H} = \begin{bmatrix} \mathbf{h}_{N_s\times(L'+1)} & \mathbf{0}_{N_s\times 1} & \mathbf{0}_{N_s\times 1} & \cdots & \mathbf{0}_{N_s\times 1} \\ \mathbf{0}_{N_s\times 1} & \mathbf{h}_{N_s\times(L'+1)} & \mathbf{0}_{N_s\times 1} & \cdots & \mathbf{0}_{N_s\times 1} \\ \mathbf{0}_{N_s\times 1} & \mathbf{0}_{N_s\times 1} & \mathbf{h}_{N_s\times(L'+1)} & \ddots & \vdots \\ \mathbf{0}_{N_s\times 1} & \mathbf{0}_{N_s\times 1} & \mathbf{0}_{N_s\times 1} & \ddots & \mathbf{0}_{N_s\times 1} \\ \mathbf{0}_{N_s\times 1} & \mathbf{0}_{N_s\times 1} & \cdots & \mathbf{0}_{N_s\times 1} & \mathbf{h}_{N_s\times(L'+1)} \end{bmatrix}^T$$

is the (F_L') x FNs channel-matrix for the i-th antenna with

$$\mathbf{h}_{N_s\times(L'+1)} = \begin{bmatrix} h(N_s-1) & h(2N_s-1) & \cdots & h((L'+1)N_s-1) \\ h(N_s-2) & h(2N_s-2) & \cdots & h((L'+1)N_s-2) \\ \vdots & \vdots & \ddots & \vdots \\ h(0) & h(N_s) & \cdots & h(L'N_s) \end{bmatrix}$$

where $L' = \lfloor L/N_s \rfloor$ is the delay spread normalized by the chip interval.
5. **d(m)** = [d(m+D) ...d(m)... d(m+D-F-L'+1)]^T is the m-th subsequence of the transmitted chip-rate sequence, and n(m) is the corresponding noise vector.
6. Using the same assumptions, the LMMSE equalizer taps can be calculated as follows

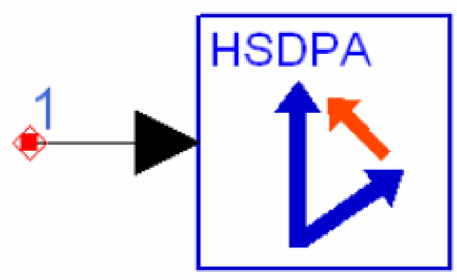
$$\mathbf{w} = \underbrace{\mathbf{C}_{rr}^{-1}}_{received\ sig\ cov\ matrix} \cdot (\mathbf{H}\ )^H \delta_D$$

, where the notation means the D-th column of the matrix X.
7. The C*rr is based on the known propagation channels only. Thus, the C*rr matrix is constructed as: $\mathbf{C}_{rr} = \left(\mathbf{H}^H\mathbf{H} + \sigma_n^2 I\right)$, σ is the variance of the noise vector n(m).

References

1. 3GPP TS25.963 V7.0.0,"Feasibility study on interference cancellation for UTRA FDD User Equipment (UE)" Apr. 2007.
2. R4-060514, "Reference structure for interference mitigation simulations with HSDPA and receiver diversity", Nokia, RAN4 #39.

HSDPA_EVM



Description: HSDPA EVM measurement
Library: HSDPA, Measurement

Parameters

Name	Description	Default	Unit	Type	Range
RLoad	load resistance. DefaultRLoad will inherit from the DF controller.	DefaultRLoad	Ohm	real	(0,∞)
RTemp	physical temperature, in degrees C, of load resistance. DefaultRTemp will inherit from the DF controller.	DefaultRTemp	Celsius	real	[-273.15,∞)
FCarrier	carrier frequency	1.9 GHz	Hz	real	(0,∞)
ChipRate	symbol rate	3840000	Hz	real	
AnalysisCodeLevel	specifies the channel level that Channel EVM with be calculated for	2		int	[2,9]
AnalysisCodeIndex	specifies the channel index that Channel EVM with be calculated for	0		int	[0,2^AnalysisCodeLevel-1]
ModScheme	modulation scheme for selected AnalysisCodeLevel and AnalysisCodeIndex: AutoDetect, QPSK, QAM16, QAM64	AutoDetect		enum	
ScrambleCode	index of scramble code	0		int	[0,511]
ScrambleOffset	scramble code offset	0		int	[0,15]
ScrambleType	scramble code type: normal, right, left	normal		enum	
syncModeSelection	Sync mode selection: CPICH, SCH, CPICH2	SCH		enum	
TestModel	test model selection: NONE, MODEL_1_DPCH_16, MODEL_1_DPCH_32, MODEL_1_DPCH_64, MODEL_2, MODEL_3_DPCH_16, MODEL_3_DPCH_32, MODEL_4, MODEL_1_DPCH_16_SCCPCH, MODEL_1_DPCH_32_SCCPCH, MODEL_1_DPCH_64_SCCPCH, MODEL_2_SCCPCH, MODEL_3_DPCH_16_SCCPCH, MODEL_3_DPCH_32_SCCPCH,	NONE		enum	

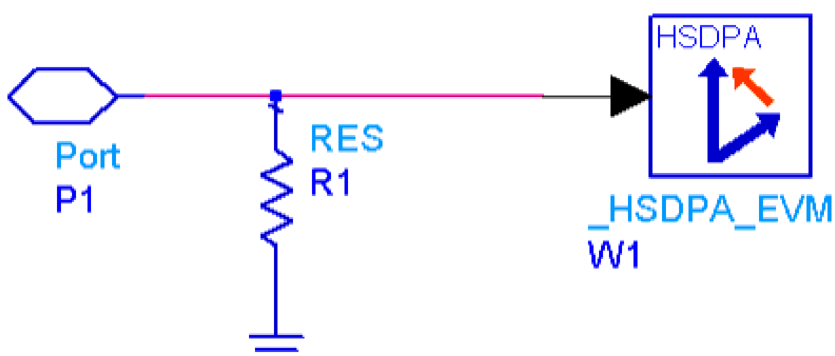
	MODEL_4_PCPICH, MODEL_5_HSPDSCH_2_DPCH_6, MODEL_5_HSPDSCH_4_DPCH_14, MODEL_5_HSPDSCH_8_DPCH_30, MODEL_6				
MirrorSpectrum	Mirror spectrum about carrier?: NO, YES	NO		enum	
EVMIncludeIQOffset	selection of calculating EVM pre-compensating for IQ origin offset: NO, YES	NO		enum	
SuppressSCH	suppress SCH for channel measurements: NO, YES	NO		enum	
Start	start time for data recording. DefaultTimeStart will inherit from the DF Controller.	DefaultTimeStart	sec	real	[0,∞)
AverageType	average type: OFF, RMS (Video)	OFF		enum	
SlotsToAverage	number of slots that will be averaged if AverageType is RMS (Video)	15		int	[1,∞)
alpha	specify the alpha for 3GPP root raised cosine filtering.	0.22		real	[0,1]
DTXDetection	Discontinuous Transmission channels detection: NO, YES	NO		enum	
MultiChannelEstimator	When set to TRUE, channel-by-channel timing estimation and compensation: NO, YES	NO		enum	

Pin Inputs

Pin	Name	Description	Signal Type
1	input	input signal	timed

Notes/Equations

1. This subnetwork model is used to measure EVM for 3GPP HSDPA transmitter as defined in Reference [1]. Additionally, it can be used to measure EVM of a specific channel. The input signal must be a timed RF (complex envelope) signal.
2. The schematic for this subnetwork is shown below:



3. The Error Vector Magnitude is a measure of the difference between the reference waveform and the measured waveform. This difference is called the error vector. Both waveforms pass through a matched Root Raised Cosine filter with bandwidth 3.84 MHz and roll-off = 0.22. Both waveforms are then further modified by selecting the frequency, absolute phase, absolute amplitude and chip clock timing so as to minimize the error vector. The EVM result is defined as the square root of the ratio of the mean error vector power to the mean reference power expressed as a %. The

measurement interval for the composite EVM and channel EVM are both one timeslot. The available results from this measurement are:

- Avg_Channel_EVM: average channel EVM rms in %
- Avg_Channel_MagErr_rms_percent: average channel magnitude error rms in %
- Avg_Channel_PhaseErr_deg: average channel phase error in degrees
- Avg_EVM_dB: average composite EVM rms in dB
- Avg_EVM_rms_percent: average composite EVM rms in %
- Avg_FreqErr_Hz: average frequency error in Hz
- Avg_IQOffset_dB: average IQ offset in dB
- Avg_MagErr_rms_percent: average composite magnitude error rms in %
- Avg_PhaseErr_deg: average composite phase error in degree
- Avg_Rho: average Rho
- Channel_EVM: channel EVM rms in % versus slot
- Channel_MagErr_rms_percent: channel magnitude error rms in % versus slot
- Channel_PhaseErr_deg: channel phase error in degree versus slot
- EVM_dB: composite EVM in dB versus slot
- EVM_rms_percent: composite EVM rms in % versus slot
- FreqErr_Hz: frequency error in Hz versus slot
- IQOffset_dB: IQ offset in dB versus slot
- MagErr_rms_percent: magnitude error rms in % versus slot
- PhaseErr_deg: phase error in degree versus slot
- Rho: rho versus slot

4. The Error Vector Magnitude shall not be worse than 17.5% when the base station is transmitting a composite signal using only QPSK modulation. The Error Vector Magnitude shall not be worse than 12.5% when the base station is transmitting a composite signal that includes 16QAM modulation.
5. The AnalysisCodeLevel parameter specifies the channel level that Channel EVM with be calculated for. The AnalysisCodeIndex parameter specifies the channel index that Channel EVM with be calculated for.
6. If ScrambleType is normal, the scramble code index is equal to *ScrambleCode × 16 + ScrambleOffset*. If ScrambleType is right, the index is *ScrambleCode × 16 + ScrambleOffset + 16384*. If ScrambleType is left, the index is *ScrambleCode × 16 + ScrambleOffset + 8192*.
7. The syncModeSelection parameter specifies synchronization mode: CPICH, SCH or CPICH2.
8. The MirrorSpectrum parameter can be used to mirror the spectrum (invert the Q envelope) at the output of the modulator. Depending on the configuration of the mixers in the upconverter, which typically follows a modulator, the signal at the upconverter's input may need to be mirrored. If such a configuration is used, then this parameter should be set to YES.
9. The EVMIncludeIQOffset parameter specifies whether to pre-compensate for IQ origin offset or not when calculating EVM.
10. The SuppressSCH parameter specifies whether to suppress SCH for channel EVM measurements or not.The SCH Synchronization Channel may cause significant increase in symbol EVM. SCH is non-orthogonal to other Code Channels, this can raise the code domain noise floor and degrade EVM. To correct this, the P-SCH and S-SCH are demodulated first. Then their combined signal is subtracted from the incoming signal before any other channels are demodulated. The effect of SCH suppression will result in less noise in the improved EVM.
11. The Start parameter specifies the start time for data recording.
12. If AverageType is set to OFF, only one slot (the first slot in the first frame) is detected, demodulated, and analyzed.

If AverageType is set to RMS (Video), SlotsToAverage slots are processed.

13. The SlotsToAverage parameter specifies the number of slots that will be averaged if AverageType is RMS Video.
    If, for any reason, a slot is mis-detected, the results from its analysis are discarded. The EVM results obtained from all the successfully slots, demodulated, and analyzed slots are averaged to give the final averaged results. The EVM results from each successfully analyzed slots are also recorded (in the variables without the Avg_ prefix in their name).
    This signal segment is searched in order for a complete frame including 15 slots to be detected. If there is an unknown idle part at the begin of the burst, then a TimedSink component can be used to plot the signal in the data display. By observing the magnitude of the signal's envelope versus time one can determine the duration of the burst and the idle interval. Making the Start parameter equals to the idle interval will facilitate the testing.
    If the acquired signal segment does not contain 15 slots, the algorithm may fail to detect any frame and the analysis that follows will most likely produce incorrect results. Therefore, ResultLength must be longer than 15.
14. The alpha parameter specifies the alpha for 3GPP root raised cosine filtering and should be 0.22 in this testing.
15. The DTXDetection parameter specifies whether to detect and perform correct measurement analysis on DTX "Discontinuous Transmission" channels. DTX measurement analysis mode does not affect the EVM result unless the measurement data includes a partially transmitted frame in a channel. It is recommended that you select YES to measure DTX signals and select NO to measure non-DTX signals.
16. The MultiChannelEstimator parameter specifies the operation mode of the parameter estimator used to perform best fitting for EVM. If the MultiChannelEstimator is set to YES, channel by channel timing estimation and compensation will be performed.

References

1. 3GPP Technical Specification TS 25.104, "Base Station (BS) radio transmission and reception (FDD)," Version 6.11.0, Dec. 2005.
2. 3GPP Technical Specification TS 25.141, "Base station (BS) conformance testing (FDD)," V6.12.0, Dec. 2005.

HSDPA_Interleaver

Description: Interleaver
Library: HSDPA, Multiplexers & Coders

Parameters

Name	Description	Default	Type
UE_Category	: Category_1, Category_2, Category_3, Category_4, Category_5, Category_6, Category_7, Category_8, Category_9, Category_10, Category_11, Category_12, Category_13, Category_14, Category_15, Category_16, Category_17, Category_18	Category_1	enum
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum
NumHSPDSCH	Number of HS_PDSCH	5	int

Pin Inputs

Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int
2	DataIn	data in	int

Pin Outputs

Pin	Name	Description	Signal Type
3	DataOut	data out	int

Notes/Equations

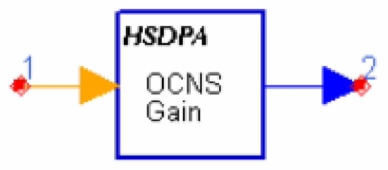
1. This model is used to implement interleaving on HS-DSCH defined in 4.5.6 of Reference [1].
   Each firing, $1920 \times MaxNumHSPDSCH$ tokens are consumed at pin DataIn, and 1 token is consumed at pin CQI if it is connected, while $1920 \times MaxNumHSPDSCH$ tokens are generated at pin DataOut.
   $1920 \times MaxNumHSPDSCH$ is the possible maximum data bits and MaxNumHSPDSCH is the possible maximum HS-PDSCHs within one TTI. If pin CQI is connected, MaxNumHSPDSCH equals to maximum HS-PDSCHs *UE_Category* supports. Otherwise, MaxNumHSPDSCH equals to *NumHSPDSCH*.
2. If pin CQI is connected, modulation scheme and number of HS-PDSCHs practically used (EffectiveNumHSPDSCH) are determined by input CQI value and UE_Category according to Table 7 of 6A.2 in Reference [2]. Otherwise, modulation schemes are determined by MS, and EffectiveNumHSPDSCH is equal to NumHSPDSCH.
3. Although $1920 \times MaxNumHSPDSCH$ tokens are consumed at each firing, only the first EffectiveNumHSPDSCH HS-PDSCHs are occupied and 0s are padded for the other HS-PDSCHs. Each HS-PDSCH contains 1920 bits. If the modulation scheme is QPSK, only the first 960 bits are useful data bits, and the other 960 bits are 0s. If the modulation scheme is 16QAM, all 1920 bits are useful data bits.
4. The bits input to the interleaver are denoted by $u_{p,1}, u_{p,2}, u_{p,3}, \ldots, u_{p,1920},$

wherein *p* is the index of HS-PDSCHs. The basic interleaver is a block interleaver of fixed size 960, which is described in 4.2.11 of Reference [1]. For QPSK, the useful data bits $u_{p,1}$, $u_{p,2}$, $u_{p,3}$, ..., $u_{p,960}$ are interleaved by the basic interleaver, and the interleaved 960 bits are padded 960 0s as the output. For 16QAM, two identical basic interleavers are used. $u_{p,1}$, $u_{p,2}$, $u_{p,3}$, ..., $u_{p,1920}$ are divided two by two between the interleavers: bits $u_{p,k}$, $u_{p,k+1}$ go to the first basic interleaver and $u_{p,k+2}$, $u_{p,k+3}$ go to the second basic interleaver. Bits are collected two by two from the interleavers: $v_{p,k}$, $v_{p,k+1}$ are obtained from the first basic interleaver and $v_{p,k+2}$, $v_{p,k+3}$ are obtained from the second basic interleaver.

References

1. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 6.7.0, Dec. 2005.
2. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 6.7.1, Dec. 2005.

HSDPA_OCNS_Gain



Description: HSDPA OCNS gain calculator
Library: HSDPA, Multiplexers & Coders

Parameters

Name	Description	Default	Unit	Type	Range
OutputSTTD	Output STTD mode option: NO, YES	NO		enum	
HS_PDSCH_UE_Category	UE category	1 1 1 1		int array	
PCPICH_Power_EcToIor	Primary CPICH power gain in dB	-10.0	dB	real	(-∞,∞)
PCCPCH_Power_EcToIor	PCCPCH power gain in dB	-12.0	dB	real	(-∞,∞)
SCH_Power_EcToIor	SCH power gain in dB	-15.0	dB	real	(-∞,∞)
PICH_Power_EcToIor	PICH power gain in dB	-15.0	dB	real	(-∞,∞)
DPCH_Configured	Setting to YES if DPCH is configured, otherwise NO: NO, YES	NO		enum	
DPCH_Power_EcToIor	DPCH power gain in dB	-15.0	dB	real	(-∞,∞)
HS_SCCH_Configured	HS-SCCH configured flags	1 0 0 0		int array	
HS_SCCH_EcToIor	HS-SCCH power gain in dB	-9 -9 -9 -9	dB	real array	
HS_PDSCH_Configured	HS-PDSCH configured flags	1 0 0 0		int array	
HS_PDSCH_EcToIor	HS-PDSCH power gain in dB	-10 -10 -10 -10	dB	real array	
HS_PDSCH_1_TTIPattern	inter-TTI pattern	1 1 1 1 1 1		int array	[0,1]
HS_PDSCH_2_TTIPattern	inter-TTI pattern	1 1 1 1 1 1		int array	[0,1]
HS_PDSCH_3_TTIPattern	inter-TTI pattern	1 1 1 1 1 1		int array	[0,1]
HS_PDSCH_4_TTIPattern	inter-TTI pattern	1 1 1 1 1 1		int array	[0,1]
HS_PDSCH_MS	Modulation scheme of HS-PDSCH 1 to 4	{0, 0, 0, 0}		int array	

Pin Inputs

Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int

Pin Outputs

Pin	Name	Description	Signal Type
2	GainOut	Gain for OCNS group	real

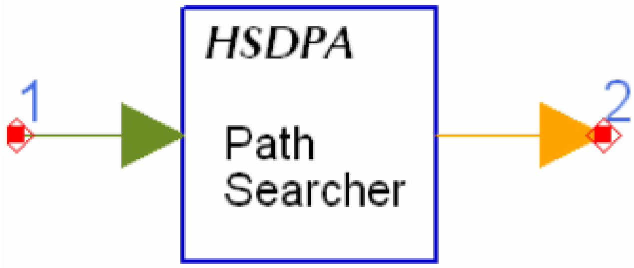
Notes/Equations

1. This model is used to calculate OCNS gain so that total transmit power spectral density of Node B(Ior) adds to one. OCNS interference consists of six dedicated data channels as specified in table C.13 of Reference [3].
   Each firing, 7680 GainOut tokens are generated for one TTI.
2. The input pin CQI is optional. If connected, the input value of CQI should be in the range of 1 to 30. The CQI value is used to determined the reference power adjustment according to section 6A.2 of Reference [2]

References

1. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 6.7.0, Dec. 2005.
2. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 6.7.1, Dec. 2005.
3. 3GPP Technical Specification TS 25.101, "User Equipment (UE) radio transmission and reception (FDD)," Version 6.10.0, Dec. 2005.

HSDPA_PathSearch



Description: Multiple path maximum power timing search
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Symbol	Type	Range
TXDiversity	transmit diversity in downlink: No_Diversity, STTD	No_Diversity		enum	
SampleRate	number of samples per chip	4	S	int	[1,32]
PathNum	number of paths or fingers of Rake	6	L	int	[1,16]
MaxDelay	maximum path delay in terms of samples	40	D	int	[PathNum,number of half chips of one slot]
ScrambleCode	Index of scramble code	0		int	

Pin Inputs

Pin	Name	Description	Signal Type
1	SmpSig	received baseband complex envelope signal samples	complex

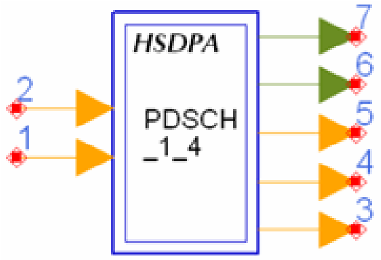
Pin Outputs

Pin	Name	Description	Signal Type
2	Delays	searched timing of path delay in terms of samples	int

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.6.0, May 2008.
2. A. J. Viterbi, "CDMA: Principles of Spread Spectrum Communication," Wesley Publishing Company, 1995.
3. S.Fukumoto, M.Sawahashi, F.Adachi, "Matched Filter-Based RAKE Combiner for Wideband DS-CDMA Mobile Radio," IEICE Trans. Commun., Vol., E81-B, No.7, July 1998.

HSDPA_PDSCH_1_4



Description: HSDPA HS-PDSCH Source
Library: HSDPA, Signal Sources

Parameters

Name	Description	Default	Unit	Type	Range
ScrambleCode	Index of scramble code	0		int	
HS_PDSCH_Configured	Whether or not HS-PDSCH 1 to 4 configured	{1, 1, 1, 1}		int array	
HS_PDSCH_EcToIor	Power gain factor of of HS-PDSCH 1 to 4 in dB	{-10, -10, -10, -10}	dB	real array	
HS_PDSCH_UE_Category	UE category of of HS-PDSCH 1 to 4	{1, 1, 1, 1}		int array	
HS_PDSCH_MS	Modulation scheme of HS-PDSCH 1 to 4	{0, 0, 0, 0}		int array	
HS_PDSCH_NumPhyCH	Number of physical channels HS PDSCH 1 to 4	{5, 1, 1, 1}		int array	
HS_PDSCH_CodeOffset	HS-PDSCH spread code offset	{1, 13, 14, 15}		int array	
HS_PDSCH_1_TTIPattern	Inter-TTI pattern of HS-PDSCH 1	{1, 0, 0, 1, 0, 0}		int array	[0,1]
HS_PDSCH_1_DataPattern	HS-PDSCH1 data pattern: Random_1, PN9_1, PN15_1, Repeat Bits_1	Random_1		enum	
HS_PDSCH_1_RepeatBitValue	HS-PDSCH1 repeating bit value	0x0001		int	[0, 65535]
HS_PDSCH_1_RepeatBitPeriod	HS-PDSCH1 repeating bit period	2		int	[1, 16]
HS_PDSCH_1_TBSize	HS-PDSCH1 transport block size	3202		int	[1,max transport block size]†
HS_PDSCH_1_NumHARQ	Number of HARQ processes of HS-PDSCH1	1		int	[1,6]
HS_PDSCH_1_RVSeq	HS-PDSCH1 redundancy version coding sequence	{0, 2, 5, 6}		int array	[0,7]
HS_PDSCH_1_NIR	HS-PDSCH1 Inremental Redundancy Register Buffer Size	9600		int	
HS_PDSCH_2_TTIPattern	Inter-TTI pattern of HS-PDSCH 2	{1, 0, 0, 1, 0, 0}		int array	[0,1]
HS_PDSCH_2_DataPattern	HS-PDSCH2 data pattern: PN9_2, PN15_2, FIX4_2, _4_1_4_0_2, _8_1_8_0_2, _16_1_16_0_2, _32_1_32_0_2, _64_1_64_0_2	PN9_2		enum	
HS_PDSCH_3_TTIPattern	Inter-TTI pattern of HS-PDSCH 3	{1, 0, 0, 1, 0, 0}		int array	[0,1]
HS_PDSCH_3_DataPattern	HS-PDSCH3 data pattern: PN9_3, PN15_3, FIX4_3, _4_1_4_0_3, _8_1_8_0_3, _16_1_16_0_3, _32_1_32_0_3, _64_1_64_0_3	PN9_3		enum	
HS_PDSCH_4_TTIPattern	Inter-TTI pattern of HS-PDSCH 4	{1, 0, 0, 1, 0, 0}		int array	[0,1]
HS_PDSCH_4_DataPattern	HS-PDSCH4 data pattern: PN9_4, PN15_4, FIX4_4, _4_1_4_0_4, _8_1_8_0_4, _16_1_16_0_4, _32_1_32_0_4, _64_1_64_0_4	PN9_4		enum	

Pin Inputs

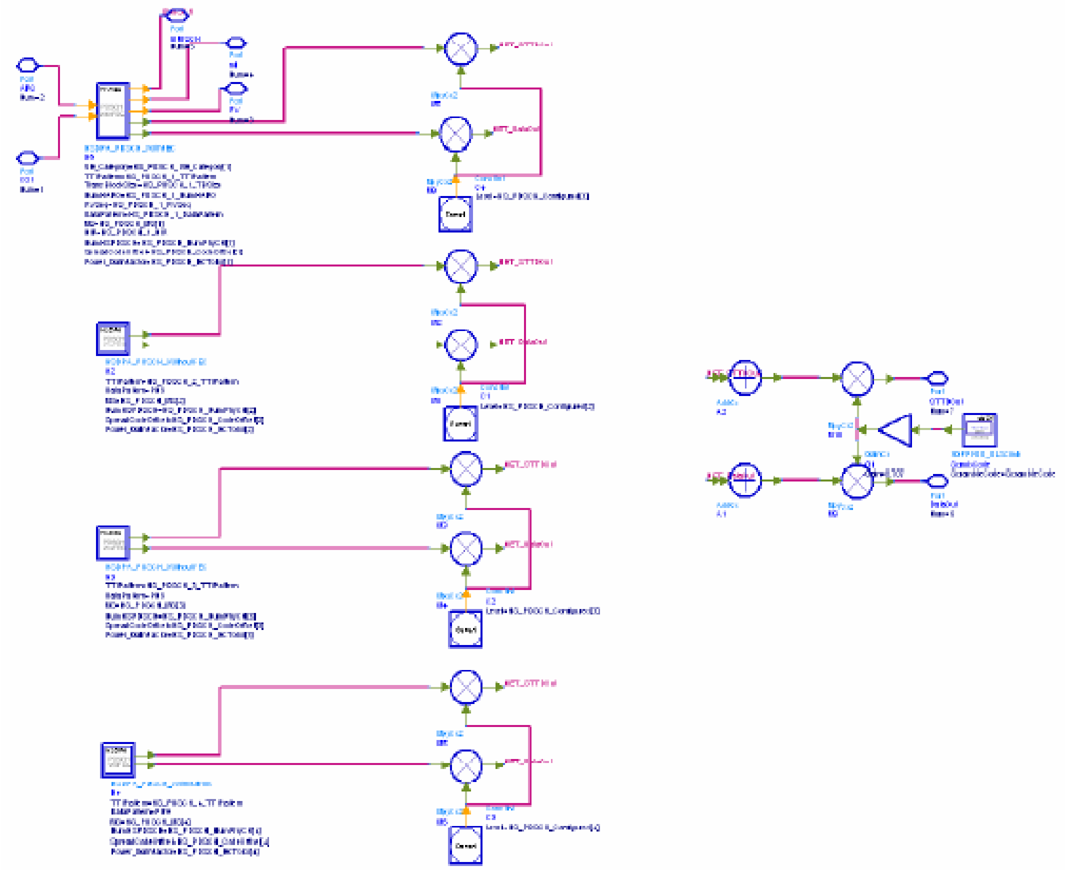
Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int
2	ARQ	automatic repeat request	int

Pin Outputs

Pin	Name	Description	Signal Type
3	RV	redundancy version	int
4	nd	new data indicator	int
5	BitDSCH	DSCH bit	int
6	DataOut	data out	complex
7	STTDOut	data out	complex

Notes/Equations

1. This subnetwork model is used to simulate the integrated base station signal source.
2. The schematic for this subnetwork is shown below:

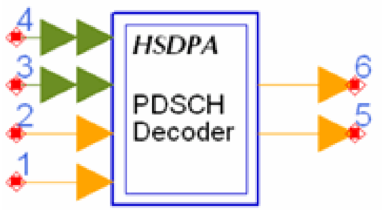


3. The HSDPA_PDSCH_1_4 is generated by one fully-coded *HSDPA_PDSCH_WithFEC* (hsdpa) signal source and three *HSDPA_PDSCH_WithoutFEC* (hsdpa) signal sources.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.10.0, May. 2008.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2008.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 7.6.0, Sept. 2008.
4. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 7.9.0, May. 2008.

HSDPA_PDSCH_Decoder



Description:
Library: HSDPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Type	Range
TransBlockSize	Transport block size	3202	int	[1,max transport block size]†
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum	
NIR		9600	int	
TC_Iteration	Turbo code decoder iteration number	4	int	[1,10]
NumHSPDSCH	Number of HS_PDSCH	5	int	
NumHARQ	Number of HARQ processes	1	int	[1,6]
TTIPattern	inter-TTI pattern	{1, 1, 1, 1, 1, 1}	int array	[0,1]

Pin Inputs

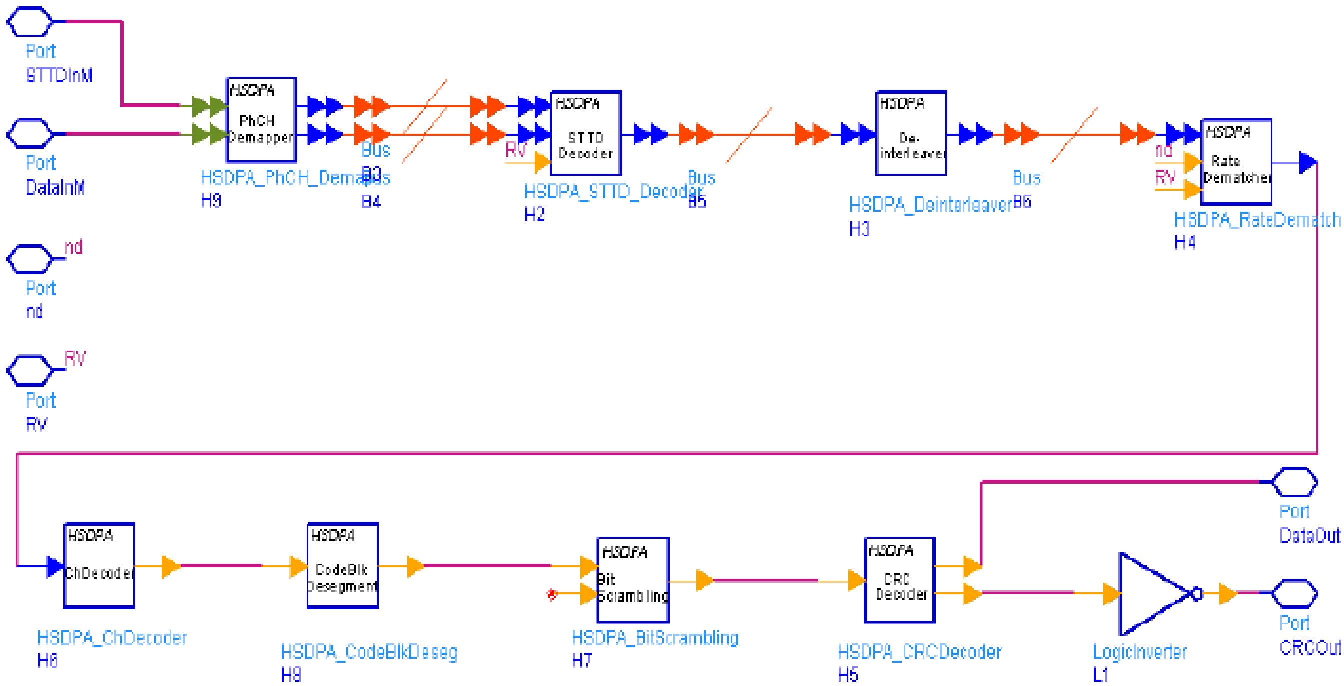
Pin	Name	Description	Signal Type
1	RV	redundancy version	int
2	nd	new data indicator	int
3	DataInM	data for physical channel(s)	multiple complex
4	STTDInM	data for physical channel(s)	multiple complex

Pin Outputs

Pin	Name	Description	Signal Type
5	DataOut	data out	int
6	CRCOut	CRC out	int

Notes/Equations

1. This subnetwork model is used to fulfill the inverse process of "Coding for HS-DSCH", which is defined in Reference [2].
2. The schematic for this subnetwork is shown below:

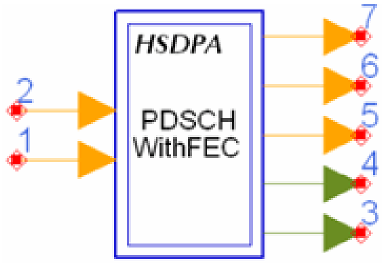


3. This subnetwork model completes the following operations:
    - Physical channel demapping
    - STTD decoding
    - De-Interleaving
    - Rate de-matching
    - Channel decoding
    - Code block desegmentation
    - Bit de-scrambling
    - CRC de-attachment
4. For each received HS-DSCH transport block, error-detection is performed by checking the CRC. If there is no error, the pin CRCOut outputs 1 (otherwise outputs 0).

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.6.0, May 2008.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sep. 2008.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 7.6.0, Sep. 2008.

HSDPA_PDSCH_WithFEC



Description: HSDPA PDSCH with coding
Library: HSDPA, Signal Sources

Parameters

Name	Description	Default	Type	Range
UE_Category	: Category_1, Category_2, Category_3, Category_4, Category_5, Category_6, Category_7, Category_8, Category_9, Category_10, Category_11, Category_12, Category_13, Category_14, Category_15, Category_16, Category_17, Category_18	Category_1	enum	
TTIPattern	inter-TTI pattern	{1, 0, 1, 0, 1, 0}	int array	[0,1]
TransBlockSize	Transport block size	3202	int	[1,max transport block size]†
NumHARQ	Number of HARQ processes	1	int	[1,6]
RVSeq	Redundancy and constellation version coding sequence	{0, 2, 5, 6}	int array	[0,7]
DataPattern	Source data pattern: Random, PN9, PN15, Repeat Bits	Random	enum	
RepeatBitValue	Repeating data value	0x0001	int	[0, 65535]
RepeatBitPeriod	Repeating data period	2	int	[1, 16]
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum	
NIR		9600	int	
NumHSPDSCH	number of physical channels	5	int	
SpreadCodeOffset	Spread code offset	1	int	
Power_GainFactor	Power gain factor	-10.0	real	

Pin Inputs

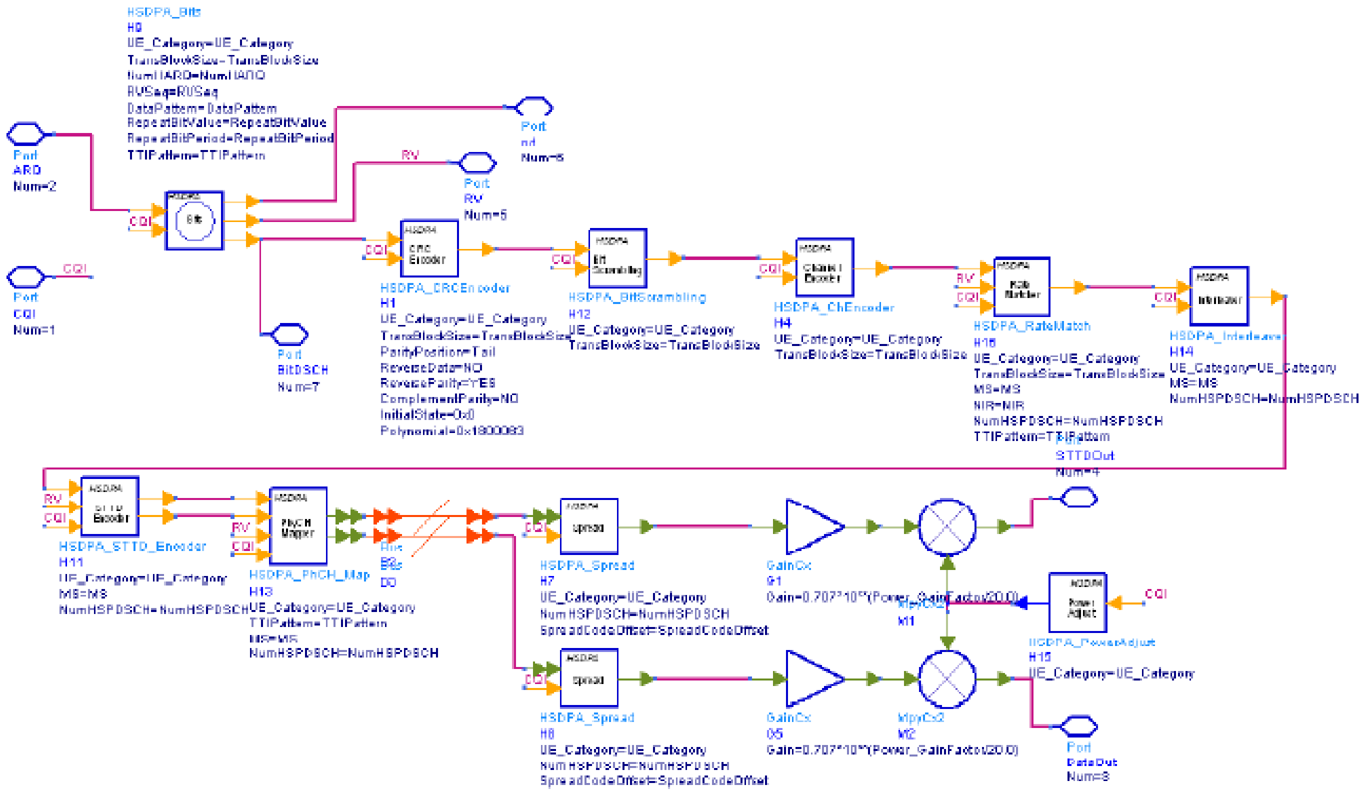
Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int
2	ARQ	automatic repeat request	int

Pin Outputs

Pin	Name	Description	Signal Type
3	DataOut	data out	complex
4	STTDOut	data out	complex
5	RV	redundancy version	int
6	nd	new data indicator	int
7	BitDSCH	DSCH bit	int

Notes/Equations

1. This subnetwork model is used to simulate a full coded HS-PDSCH signal source.
2. The schematic for this subnetwork is shown below:

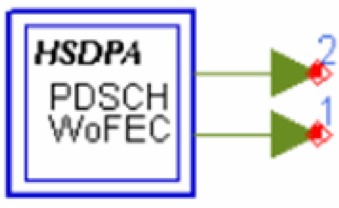


3. The HS_PDSCH_WithFEC generates one full coded HS-PDSCH signal source.
4. For more information about HS-PDSCH parameters, see *HSDPA_RateMatch* (hsdpa).
5. For more information about HARQ function, see *HSDPA_Bits* (hsdpa) and *HSDPA_RateMatch* (hsdpa).
6. For more information about the models used in this subnetwork, see their respective documentation.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.10.0, May. 2008.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2008.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 7.6.0, Sept. 2008.
4. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 7.9.0, May. 2008.

HSDPA_PDSCH_WithoutFEC



Description: HSDPA PDSCH without coding
Library: HSDPA, Signal Sources

Parameters

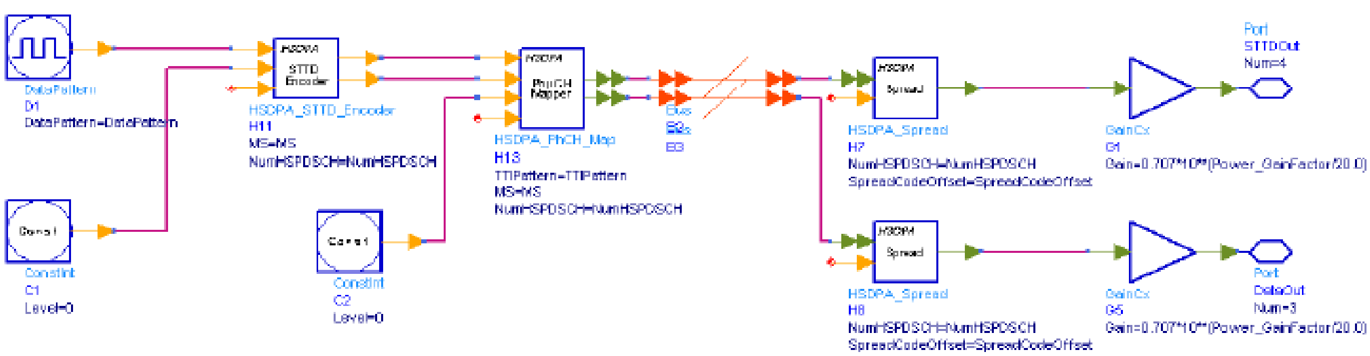
Name	Description	Default	Type	Range
TTIPattern	inter-TTI pattern	{1, 0, 1, 0, 1, 0}	int array	[0,1]
DataPattern	: PN9, PN15, FIX4, _4_1_4_0, _8_1_8_0, _16_1_16_0, _32_1_32_0, _64_1_64_0	PN9	enum	
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum	
NumHSPDSCH	number of physical channels	1	int	
SpreadCodeOffset		13	int	
Power_GainFactor	Power gain factor	-10.0	real	

Pin Outputs

Pin	Name	Description	Signal Type
1	DataOut	data out	complex
2	STTDOut	data out	complex

Notes/Equations

1. This subnetwork model is used to simulate an uncoded HS-PDSCH signal source.
2. The schematic for this subnetwork is shown below:



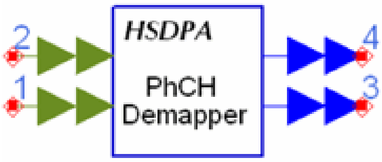
3. The HS_PDSCH_WithoutFEC generates an uncoded HS-PDSCH signal source.
4. For more information about the models used in this subnetwork, see their respective documentation.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.10.0, May. 2008.
2. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version

7.6.0, Sept. 2008.
3. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 7.9.0, May. 2008.

HSDPA_PhCH_Demap



Description: Soft demapper
Library: HSDPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Type
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum
NumHSPDSCH	Number of HS_PDSCH	5	int

Pin Inputs

Pin	Name	Description	Signal Type
1	DataInM	data for physical channel(s)	multiple complex
2	STTDInM	data for physical channel(s)	multiple complex

Pin Outputs

Pin	Name	Description	Signal Type
3	DataOutM	soft-decision data for physical channel(s)	multiple real
4	STTDOutM	soft-decision STTD data for physical channel(s)	multiple real

Notes/Equations

1. This model is used to implement soft-decision modulation demapping of HS-PDSCH. Each firing, 480 tokens are consumed at pin DataInM, and 480 tokens are consumed at pin STTDInM, while 1920 tokens are generated at pin DataOutM, and 1920 tokens are generated at pin STTDOutM for each HS-PDSCH.
2. The *NumHSPDSCH* parameter determines the number of HS-PDSCHs. Each HS-PDSCH contains 1920 bits. If the modulation scheme is QPSK, only the first 960 bits are useful data bits, and the other 960 bits are 0s. If the modulation scheme is 16QAM, all 1920 bits are useful data bits.
3. Assuming the received symbols have been normalized to the standard constellation as QPSK modulation mapping or 16QAM modulation mapping, the soft modulation demapping bits can be determined by the decision equations as follows, where I is the real part of product and Q is the imaginary part.
   - **16QAM decision equations are:**

     b0 = $I \times \sqrt{5}$

     b1 = $Q \times \sqrt{5}$

     b2 = 2 - |b0|

     b3 = 2 - |b1|

input bit sequence	I branch	Q branch
0000	0.4472	0.4472
0001	0.4472	1.3416
0010	1.3416	0.4472
0011	1.3416	1.3416
0100	0.4472	-0.4472
0101	0.4472	-1.3416
0110	1.3416	-0.4472
0111	1.3416	-1.3416
1000	-0.4472	0.4472
1001	-0.4472	1.3416
1010	-1.3416	0.4472
1011	-1.3416	1.3416
1100	-0.4472	-0.4472
1101	-0.4472	-1.3416
1110	-1.3416	-0.4472
1111	-1.3416	-1.3416

- **QPSK decision equations are:**

  b0 = I

  b1 = Q

input bit sequence	I branch	Q branch
00	1	1
01	1	-1
10	-1	1
11	-1	-1

4. The final soft bit informations b are output at pin DataOutM. The final STTD soft bit informations b are output at pin STTDOutM.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.6.0, May 2008.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sep. 2008.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 7.6.0, Sep. 2008.

HSDPA_PhCH_Map

Description: Physical channel mapper
Library: HSDPA, Multiplexers & Coders

Parameters

Name	Description	Default	Type	Range
UE_Category	: Category_1, Category_2, Category_3, Category_4, Category_5, Category_6, Category_7, Category_8, Category_9, Category_10, Category_11, Category_12, Category_13, Category_14, Category_15, Category_16, Category_17, Category_18	Category_1	enum	
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum	
TTIPattern	inter-TTI pattern	{1, 1, 1, 1, 1, 1}	int array	[0,1]
NumHSPDSCH	Number of HS_PDSCH	5	int	

Pin Inputs

Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int
2	DataIn	data in	int
3	STTDIn	sttd in	int

Pin Outputs

Pin	Name	Description	Signal Type
4	DataOutM	data out	multiple complex
5	STTDOutM	sttd out	multiple complex

Notes/Equations

1. This model is used to implement physical channel mapping and modulation mapping. Each firing, *2880* × *MaxNumHSPDSCH* tokens are consumed at pin DataIn, *2880* × *MaxNumHSPDSCH* tokens are consumed at pin STTDIn, and 1 token is consumed at pin CQI if it is connected, while 480 tokens are generated at pin DataOutM, and 480 tokens are generated at pin STTDOutM.
   MaxNumHSPDSCH is the possible maximum HS-PDSCHs within one TTI and 2880 is the possible maximum data bits within one HS-PDSCH. If pin CQI is connected, MaxNumHSPDSCH equals to the maximum HS-PDSCHs the UE_Category supports. Otherwise, MaxNumHSPDSCH equals to NumHSPDSCH.
2. If pin CQI is connected, modulation scheme and number of HS-PDSCHs practically used (EffectiveNumHSPDSCH) are determined by input CQI value and UE_Category according to Table 7 of 6A.2 in Reference [3]. Otherwise, modulation schemes are determined by MS, and EffectiveNumHSPDSCH equals to NumHSPDSCH.
3. Although *2880* × *MaxNumHSPDSCH* tokens are consumed at each firing, only the first EffectiveNumHSPDSCH HS-PDSCHs are occupied and 0s are padded for the other HS-PDSCHs. Each HS-PDSCHs contains 2880 bits. If modulation scheme is QPSK,

only the first 960 bits are useful data bits, and the other 1920 bits are 0s. If modulation scheme is 16QAM, the first 1920 bits are useful data bits and the remained 960 bits are 0s. If modulation scheme is 64QAM, all the 2880 bits are useful data bits.

4. If TTIPattern of current TTI is set to 1:
   - For QPSK, the first 960 bits of each HS-PDSCH from DataIn are grouped two by two and each two-bit group are converted to a complex according to **QPSK modulation mapping** shown below:

input bit sequence	I branch	Q branch
00	1	1
01	1	-1
10	-1	1
11	-1	-1

   - For 16QAM, the 1920 bits of each HS-PDSCH are grouped four by four and each four-bit group are converted to a complex according to **16QAM modulation mapping** shown below:

input bit sequence	I branch	Q branch
0000	0.4472	0.4472
0001	0.4472	1.3416
0010	1.3416	0.4472
0011	1.3416	1.3416
0100	0.4472	-0.4472
0101	0.4472	-1.3416
0110	1.3416	-0.4472
0111	1.3416	-1.3416
1000	-0.4472	0.4472
1001	-0.4472	1.3416
1010	-1.3416	0.4472
1011	-1.3416	1.3416
1100	-0.4472	-0.4472
1101	-0.4472	-1.3416
1110	-1.3416	-0.4472
1111	-1.3416	-1.3416

   - For 64QAM, the 2880 bits of each HS-PDSCH are grouped six by six and each six-bit group are converted to a complex according to **64QAM modulation mapping** shown below:

input bit sequence	I branch	Q branch
000000	0.6547	0.6547
000001	0.6547	0.2182
000010	0.2182	0.6547
000011	0.2182	0.2182
000100	0.6547	1.0911
000101	0.6547	1.5275
000110	0.2182	1.0911
000111	0.2182	1.5275
001000	1.0911	0.6547
001001	1.0911	0.2182

001010	1.5275	0.6547
001011	1.5275	0.2182
001100	1.0911	1.0911
001101	1.0911	1.5275
001110	1.5275	1.0911
001111	1.5275	1.5275
010000	0.6547	-0.6547
010001	0.6547	-0.2182
010010	0.2182	-0.6547
010011	0.2182	-0.2182
010100	0.6547	-1.0911
010101	0.6547	-1.5275
010110	0.2182	-1.0911
010111	0.2182	-1.5275
011000	1.0911	-0.6547
011001	1.0911	-0.2182
011010	1.5275	-0.6547
011011	1.5275	-0.2182
011100	1.0911	-1.0911
011101	1.0911	-1.5275
011110	1.5275	-1.0911
011111	1.5275	-1.5275
100000	-0.6547	0.6547
100001	-0.6547	0.2182
100010	-0.2182	0.6547
100011	-0.2182	0.2182
100100	-0.6547	1.0911
100101	-0.6547	1.5275
100110	-0.2182	1.0911
100111	-0.2182	1.5275
101000	-1.0911	0.6547
101001	-1.0911	0.2182
101010	-1.5275	0.6547
101011	-1.5275	0.2182
101100	-1.0911	1.0911
101101	-1.0911	1.5275
101110	-1.5275	1.0911
101111	-1.5275	1.5275
110000	-0.6547	-0.6547
110001	-0.6547	-0.2182
110010	-0.2182	-0.6547
110011	-0.2182	-0.2182
110100	-0.6547	-1.0911
110101	-0.6547	-1.5275
110110	-0.2182	-1.0911

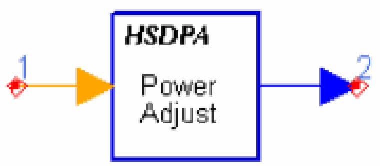
110111	-0.2182	-1.5275
111000	-1.0911	-0.6547
111001	-1.0911	-0.2182
111010	-1.5275	-0.6547
111011	-1.5275	-0.2182
111100	-1.0911	-1.0911
111101	-1.0911	-1.5275
111110	-1.5275	-1.0911
111111	-1.5275	-1.5275

5. If TTIPattern of current TTI is set to 1, 480 0s are output at each port of the pin DataOutM.
6. The same operation is performed on the data bits from STTDIn and output at pin STTDOutM.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.10.0, May. 2008.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2008.
3. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 7.9.0, May. 2008.

HSDPA_PowerAdjust



Description: Power adjust
Library: HSDPA, Multiplexers & Coders

Parameters

Name	Description	Default	Type
UE_Category	: Category_1, Category_2, Category_3, Category_4, Category_5, Category_6, Category_7, Category_8, Category_9, Category_10, Category_11, Category_12, Category_13, Category_14, Category_15, Category_16, Category_17, Category_18	Category_1	enum
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum

Pin Inputs

Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int

Pin Outputs

Pin	Name	Description	Signal Type
2	DataOut	data out	real

Notes/Equations

1. This model is used to implement power adjustment.
2. Each firing, 1 token is consumed at pin CQI if it is connected, while 7680 tokens are generated at pin DataOut.
3. If pin CQI is connected, power gain is determined by input CQI value and UE_Category according to Table 7 of 6A.2 in Reference [1]. Otherwise, 1.0 is output.

References

1. 3GPP Technical Specification TS 25.214, "Physical layer procedure (FDD)" Version 6.7.1, Dec. 2005.

HSDPA_RakeCombine

Description: Combine signals of optimum paths according to path estimation
Library: HSDPA, Receiver

Parameters

Name	Description	Default	Symbol	Type	Range
TXDiversity	transmit diversity in downlink: No_Diversity, STTD	No_Diversity		enum	
PathNum	number of paths or fingers of Rake	6	L	int	[1,16]
NumHSPDSCH	number of NumHSPDSCH	5	M	int	[1,15]

Pin Inputs

Pin	Name	Description	Signal Type
1	HSPDSCHSym	de-spread signals of each path for all code channels	multiple complex
2	HSSCHSyml	de-spread signals of each path for all code channels	multiple complex
3	CHEst	path estimation of one slot based on DPCH or CPICH	multiple complex

Pin Outputs

Pin	Name	Description	Signal Type
4	HSSCCH	combined signals of all code channels	complex
5	HSPDSCH	combined signals of all code channels	multiple complex

Notes/Equations

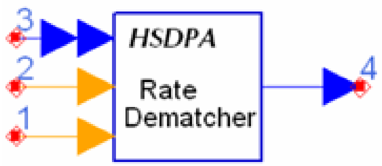
1. This model is used to fulfill maximal ratio combining.
2. Each firing, N tokens are consumed at CHEst per each port, M tokens are consumed at HSPDSCHSym per each port and P tokens are consumed at HSSCCHSym, where N is the number of symbols per TTI in downlink CPICH, M is the number of symbols per TTI in all HS-PDSCHs, P is the number of symbols per TTI in HS-SCCH.
3. Q tokens are produced at HSPDSCH per each port, where Q is the number of symbols per TTI in one HS-PDSCH. P tokens are produced at HSSCCH, where P is the number of symbols per TTI in HS-SCCH. The number of ports at ChEst, HSPDSCHSym and HSSCCHSym depend on PathNum. The number of ports at HSPDSCH depends on the NumHSPDSCH.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.6.0, May 2008.
2. S.Tanaka, M.Sawahashi, and F.Adachi, "Pilot Symbol-Assisted Decision-Directed Coherent Adaptive Array Diversity for DS-CDMA Mobile Radio Reverse Link," Proc. Wireless'97, Canada, July 1997.
3. A. J. Viterbi, "CDMA: Principles of Spread Spectrum Communication," Wesley

Publishing Company, 1995.

HSDPA_RateDematch



Description: HS_DSCH Rate matching
Library: HSDPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Type	Range
TransBlockSize	Transport block size	3202	int	[1,max transport block size]†
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum	
NIR		9600	int	
NumHSPDSCH	Number of HS_PDSCH	5	int	
NumHARQ	Number of HARQ processes	1	int	[1,6]
TTIPattern	inter-TTI pattern	{1, 1, 1, 1, 1, 1}	int array	[0,1]

Pin Inputs

Pin	Name	Description	Signal Type
1	RV	redundancy version	int
2	nd	new data indicator	int
3	DataIn	data in	multiple real

Pin Outputs

Pin	Name	Description	Signal Type
4	DataOut	data in	real

Notes/Equations

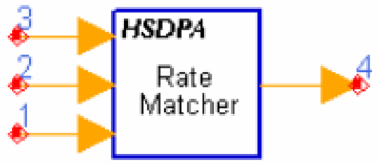
1. This model is used to implement rate dematch for HSDPA downlink. Each firing, ((TransBlockSize + number of padding bits) * 3 + code block number * 12) Output tokens are generated while Ndata Input tokens are consumed. Determination of Ndata is described in 4.8.4.1 in Reference [2].
2. This model implementation is the inverse operation of HSDPA_RateMatch. For more information, refer to *HSDPA_RateMatch* (hsdpa).
3. The received signal for each HARQ process are buffered in this model. If the input nd is 1 and TTIPattern is 1, current input data will be stored into the buffer of current HARQ process directly. If the input of nd is 0 and TTIPattern is 1, it means the received signal is a redundancy version and there is a previous version stored in the buffer of current HARQ process. Versions of received signal are combined and then stored into buffer of current HARQ process. The data in the buffer for current HARQ process are then fed into channel decoder(s).
4. Since the soft combination described above depends on HARQ process and rate dematch is implemented TTI by TTI, the beginning of the first HARQ process must be

known to the model. Generally, receiver may introduce some delays into data stream.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.6.0, May 2008.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sep. 2008.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 7.6.0, Sep. 2008.

HSDPA_RateMatch



Description: HS_DSCH Rate matching
Library: HSDPA, Multiplexers & Coders

Parameters

Name	Description	Default	Type	Range
UE_Category	: Category_1, Category_2, Category_3, Category_4, Category_5, Category_6, Category_7, Category_8, Category_9, Category_10, Category_11, Category_12, Category_13, Category_14, Category_15, Category_16, Category_17, Category_18	Category_1	enum	
TransBlockSize	Transport block size	3202	int	[1,max transport block size]†
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum	
NIR		9600	int	
NumHSPDSCH	Number of HS_PDSCH	5	int	
TTIPattern	inter-TTI pattern	{1, 1, 1, 1, 1, 1}	int array	[0,1]

Pin Inputs

Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int
2	RV	redundancy version	int
3	DataIn	data in	int

Pin Outputs

Pin	Name	Description	Signal Type
4	DataOut	data out	int

Notes/Equations

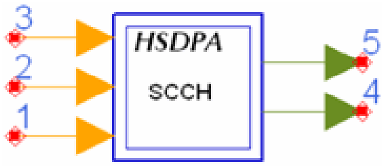
1. This model is used to implement rate match defined in 4.5.4 in Reference [2] for HSDPA downlink.
2. Each firing, Ndata Output tokens are generated while ((TransBlockSize + number of padding bits) * 3 + code block number * 12) Input tokens consumed.
3. Determination of Ndata and number of HS-PDSCH is described in 4.5.4.1 in Reference [2].
4. The process of bit separation, rate match with specific RV value and bit collection can be found in 4.5.4 in Reference [2].

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.10.0, May. 2008.

2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2008.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 7.6.0, Sept. 2008.
4. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 7.9.0, May. 2008.

HSDPA_SCCH



Description: HS-SCCH
Library: HSDPA, Signal Sources

Parameters

Name	Description	Default	Unit	Type	Range
UE_Category	UE category	1		int	
UEIdentity	UE identity (16 bits)	0B1010101010101010		int	[0,66535]
HSDPA_FRC	Fixed reference channel: H-Set 1, H-Set 2, H-Set 3, H-Set 4, H-Set 5, H-Set 6, UserDefined	H-Set 1		enum	
TTIPattern	inter-TTI pattern	1 0 0 1 0 0		int array	[0,1]
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK		enum	
NumHARQ	Number of HARQ processes	1		int	[1,6]
HS_PDSCH_CodeOffset	Spread code offset	1		int	
HSSCCH_EcToIor	HS-SCCH power gain in dB	-10.0	dB	real	(-∞,∞)
HSSCCH_SpreadCode	spread code for HS-SCCH	4		int	[0,127]
ScrambleCode	index of scramble code	0		int	[0,511]
ScrambleOffset	scramble code offset	0		int	[0,15]
ScrambleType	scramble code type: normal, right, left	normal		enum	
HS_PDSCH_NumCh	number of HS-PDSCH channels, valid when HSDPA_FRC = UserDefined	1		int	

Pin Inputs

Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int
2	Xrv	redundancy and constellation version (3 bits)	int
3	Xnd	new data indicator (1 bit)	int

Pin Outputs

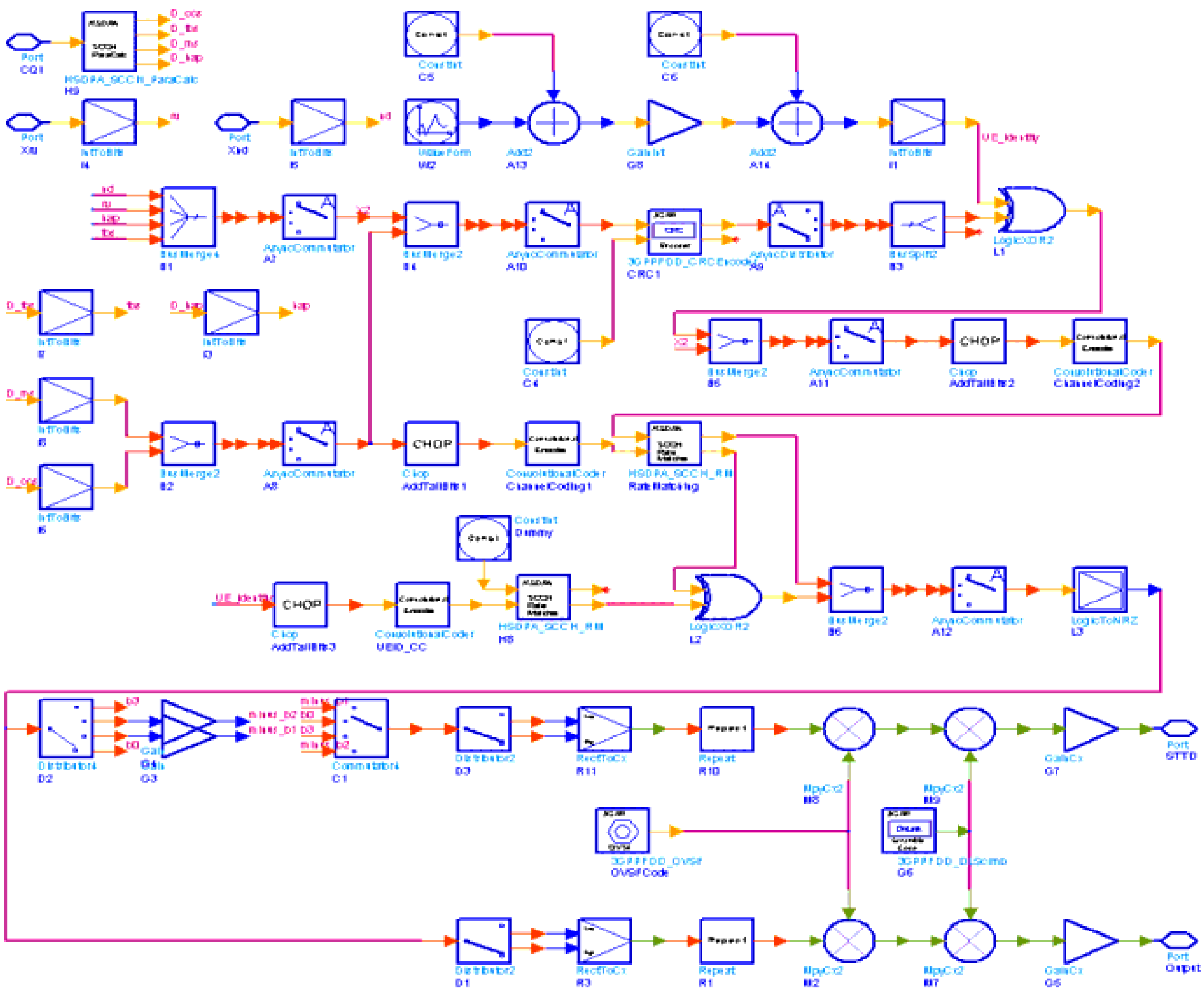
Pin	Name	Description	Signal Type
4	Output	output	complex
5	STTD	space time transmit diversity output	complex

Notes/Equations

1. This subnetwork model is used to generate the baseband signal of HS-SCCH as defined in Reference [1].
2. The HS-SCCH carries signaling information related to the HS-DSCH transport channel transmission. The HS-SCCH bit rate is fixed at 60 Kb/s, but its code number can be

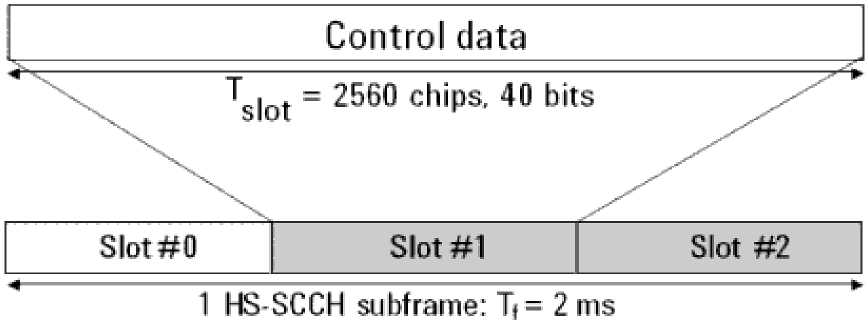
configured.

3. The schematic for this subnetwork is shown below:



4. The input pin CQI is optional. If connected, the input value of CQI should be in the range of 1 to 30. The pin Xrv inputs redundancy and constellation version indicator. The pin Xnd inputs new data indicator.
5. The parameter HSDPA_FRC determines the fixed reference channel set for HSDPA tests. The fixed reference channel is defined in section A.7 Reference [2].
6. The parameter HS_PDSCH_NumCh is used to generate the HS-DSCH channel coding information in HS-SCCH. It is valid only when the corresponding HSDPA_FRC = UserDefined.
7. The physical channel structure of the HS-SCCH is illustrated below. The first slot carries critical information for HS-PDSCH reception, such as the channelization code set (7 bits) and the modulation scheme (1 bit). The second and third slots carry the HS-DSCH channel coding information, such as the transport block size (6 bits), HARQ information (3 bits), the redundancy and constellation version (3 bits), and the new data indicator (1 bit).

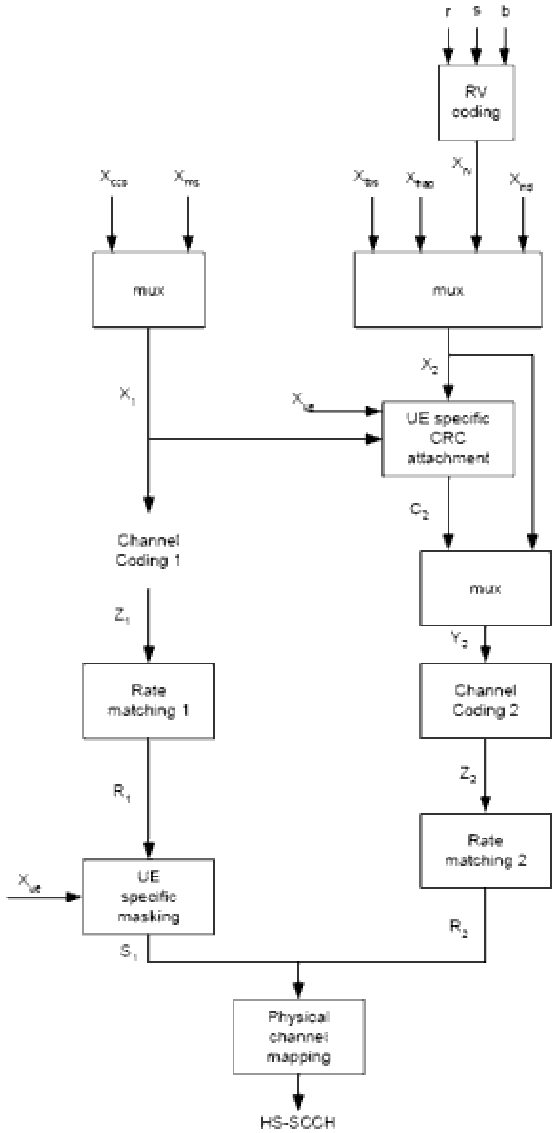
Structure of the HS-SCCH (Ref: 3GPP TS 25.211 5.3.3.12)



Modulation	Channel bit rate (kb/s)	Channel symbol rate (ks/s)	SF	Bits/ slot
QPSK	60	30	128	40

8. The overall coding chain for HS-SCCH is illustrated below. If the pin CQI is connected, then Xccs, Xtbs and Xms are calculated according to Table 7 of 6A.2 in Reference [2]. If the pin CQI is unconnected, then Xccs, Xtbs and Xms are calculated according to the section A.7 of Reference [2]. At the end of coding chain, the signal of each slot is spreaded and scrambled as defined in Reference [2], then output at pin output (non STTD). Pin STTD outputs the signal with STTD encoding.

Coding chain for HS-SCCH

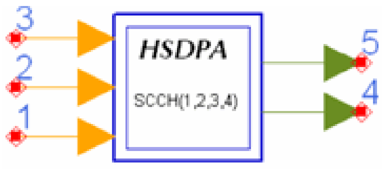


9. If ScrambleType is normal, the scramble code index for HS-SCCH is equal to *ScrambleCode* × *16* + *ScrambleOffset*. If ScrambleType is right, the index is *ScrambleCode* × *16* + *ScrambleOffset* + *16384*. If ScrambleType is left, the index is *ScrambleCode* × *16* + *ScrambleOffset* + *8192*.

References

1. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2008.
2. 3GPP Technical Specification TS 25.101, "User Equipment (UE) radio transmission and reception (FDD)," Version 7.13.0, Sept. 2008.

HSDPA_SCCH_1_4



Description: HS-SCCH
Library: HSDPA, Signal Sources

Parameters

Name	Description	Default	Unit	Type	Range
HS_SCCH_Configured		{1, 0, 0, 0}		int array	
UE_Category	UE category	{1, 1, 1, 1}		int array	
UEIdentity	UE identity (16 bits)	{0xAAAA, 0x12AA, 0x1AAA, 0x1FAA}		int array	[0,66535]
HS_PDSCH_MS	Modulation scheme	{0, 0, 0, 0}		int array	
NumHARQ	Number of HARQ processes	{1, 1, 1, 1}		int array	[1,6]
HS_PDSCH_CodeOffset	Spread code offset	{1, 13, 14, 15}		int array	
HS_SCCH_EcToIor	Power gain factor	{-9, -9, -9, -9}	dB	real array	
HS_SCCH_SpreadCode	spread code for HS-SCCH	{4, 5, 6, 7}		int array	[0,127]
HS_SCCH_ScrambleCode	index of scramble code	{0, 0, 0, 0}		int array	[0,511]
HS_SCCH_ScrambleOffset	scramble code offset	{0, 0, 0, 0}		int array	[0,15]
HSDPA_FRC_1	Fixed reference channel: H-Set 1_1, H-Set 2_1, H-Set 3_1, H-Set 4_1, H-Set 5_1, H-Set 6_1, UserDefined_1	H-Set 1_1		enum	
HS_SCCH_1_TTIPattern	inter-TTI pattern	{1, 0, 0, 1, 0, 0}		int array	[0,1]
HS_SCCH_1_ScrambleType	scramble code type: normal_1, right_1, left_1	normal_1		enum	
HSDPA_FRC_2	Fixed reference channel: H-Set 1_2, H-Set 2_2, H-Set 3_2, H-Set 4_2, H-Set 5_2, H-Set 6_2, UserDefined_2	H-Set 1_2		enum	
HS_SCCH_2_TTIPattern	inter-TTI pattern	{1, 0, 0, 1, 0, 0}		int array	[0,1]
HS_SCCH_2_ScrambleType	scramble code type: normal_2, right_2, left_2	normal_2		enum	
HSDPA_FRC_3	Fixed reference channel: H-Set 1_3, H-Set 2_3, H-Set 3_3, H-Set 4_3, H-Set	H-Set 1_3		enum	

	5_3, H-Set 6_3, UserDefined_3				
HS_SCCH_3_TTIPattern	inter-TTI pattern	{1, 0, 0, 1, 0, 0}		int array	[0,1]
HS_SCCH_3_ScrambleType	scramble code type: normal_3, right_3, left_3	normal_3		enum	
HSDPA_FRC_4	Fixed reference channel: H-Set 1_4, H-Set 2_4, H-Set 3_4, H-Set 4_4, H-Set 5_4, H-Set 6_4, UserDefined_4	H-Set 1_4		enum	
HS_SCCH_4_TTIPattern	inter-TTI pattern	{1, 0, 0, 1, 0, 0}		int array	[0,1]
HS_SCCH_4_ScrambleType	scramble code type: normal_4, right_4, left_4	normal_4		enum	
HS_PDSCH_NumCh	number of physical channels for HS-DSCHs, valid when the corresponding HSDPA_FRC = UserDefined	{1, 1, 1, 1}		int array	

Pin Inputs

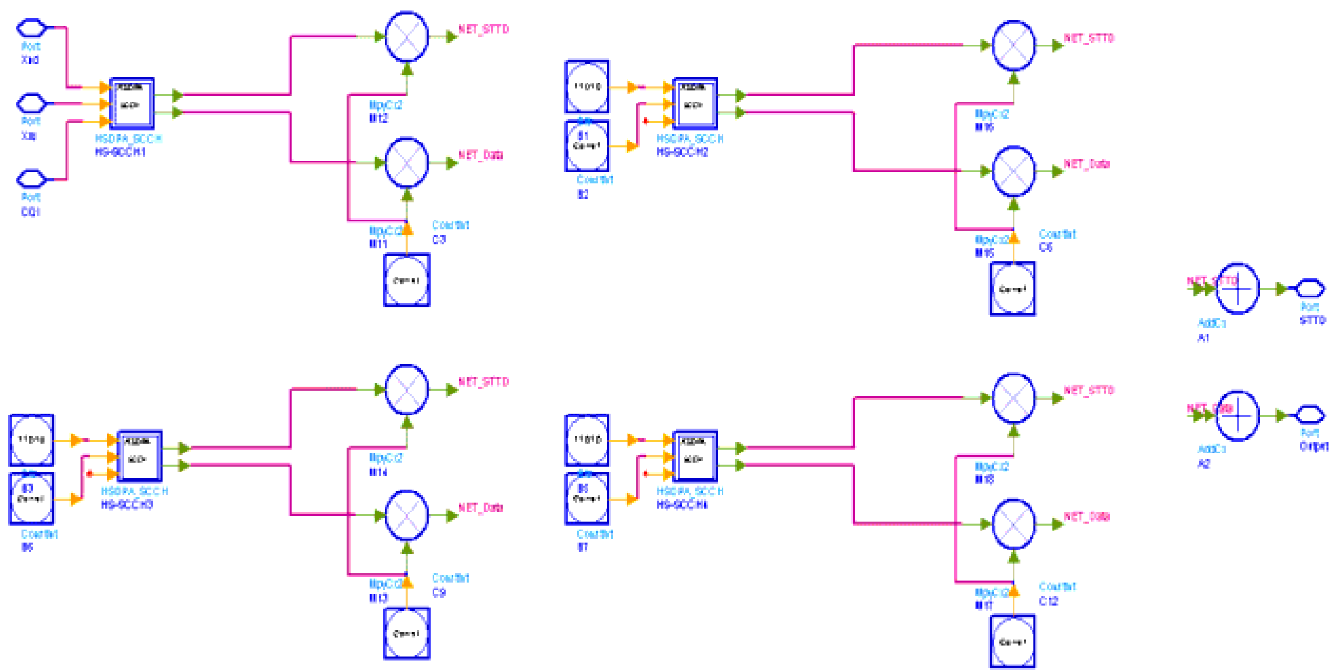
Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int
2	Xrv	redundancy and constellation version (3 bits)	int
3	Xnd	new data indicator (1 bit)	int

Pin Outputs

Pin	Name	Description	Signal Type
4	Output	output	complex
5	STTD	space time transmit diversity output	complex

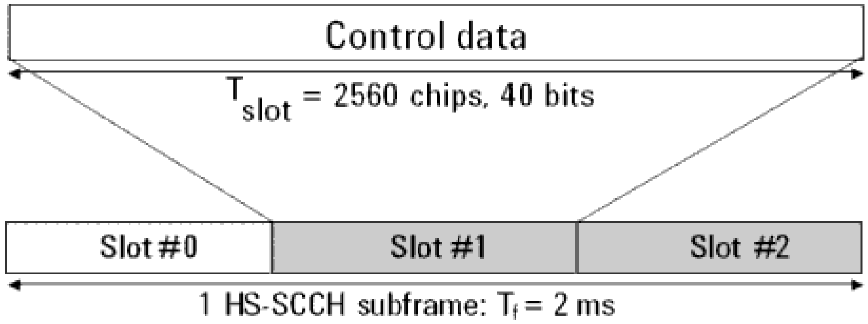
Notes/Equations

1. This subnetwork model is used to generate the baseband signal of up to four HS-SCCHs. The HS-SCCH carries signaling information related to the HS-DSCH transport channel transmission. The HS-SCCH bit rate is fixed at 60 Kb/s, but its code number can be configured. Each UE monitors up to four of these channels (known as the HS-SCCH set) simultaneously.
2. The schematic for this subnetwork is shown below:



3. The input pin CQI is optional. If connected, the input value of CQI should be in the range of 1 to 30. The pin Xrv inputs redundancy and constellation version indicator. The pin Xnd inputs new data indicator.
4. The parameter HSDPA_FRC determines the fixed reference channel set for HSDPA tests. The fixed reference channel is defined in section A.7 Reference [3].
5. This subnetwork model can output up to 4 HS-SCCHs. The parameter HS_SCCH_Configured determines the number of HS-SCCH channels. It is an int array type parameter. If HS_SCCH_Configured[i]=1, then the number i HS-SCCH channel is active, otherwise inactive (i is a integer number, can be 1, 2, 3 or 4).
6. The parameter HS_PDSCH_NumCh is used to generate the HS-DSCH channel coding information in HS-SCCH. It is an int array type parameter. Its element is valid only when the corresponding HSDPA_FRC = UserDefined.
7. The physical channel structure of the HS-SCCH is illustrated below. The first slot carries critical information for HS-PDSCH reception, such as the channelization code set (7 bits) and the modulation scheme (1 bit). The second and third slots carry the HS-DSCH channel coding information, such as the transport block size (6 bits), HARQ information (3 bits), the redundancy and constellation version (3 bits), and the new data indicator (1 bit).

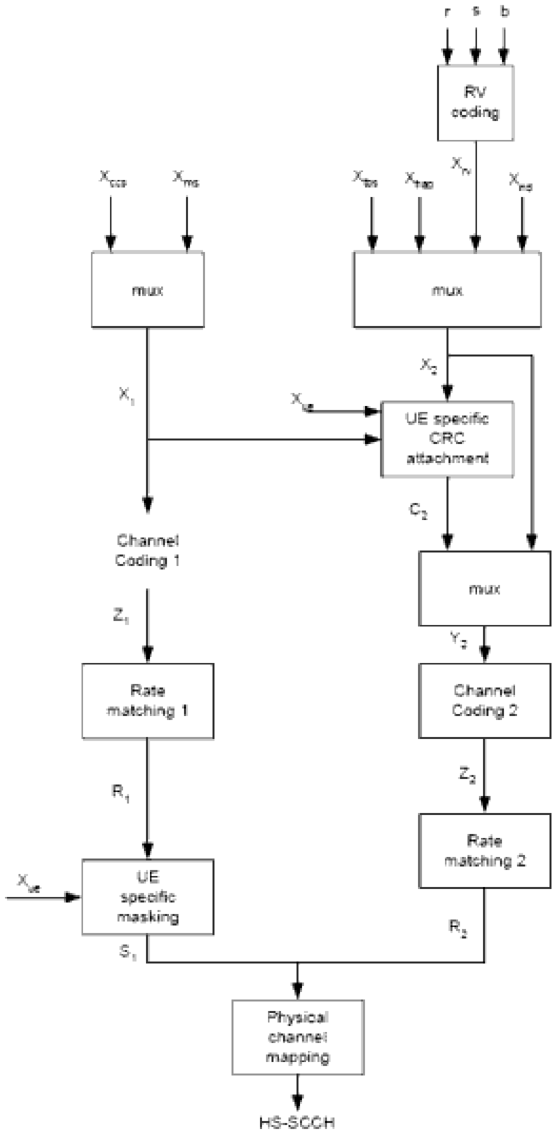
Structure of the HS-SCCH (Ref: 3GPP TS 25.211 5.3.3.12)



Modulation	Channel bit rate (kb/s)	Channel symbol rate (ks/s)	SF	Bits/ slot
QPSK	60	30	128	40

8. The HS-SCCH baseband signal is generated by subnetwork HSDPA_SCCH. The overall coding chain for HS-SCCH is illustrated below. If the pin CQI is connected, then Xccs, Xtbs and Xms are calculated according to Table 7 of 6A.2 in Reference [2]. If the pin CQI is unconnected, then Xccs, Xtbs and Xms are calculated according to the section A.7 of Reference [3]. At the end of coding chain, the signal of each slot is spreaded and scrambled as defined in Reference [2], then output at pin output (non STTD). Pin STTD outputs the signal with STTD encoding.

Coding chain for HS-SCCH

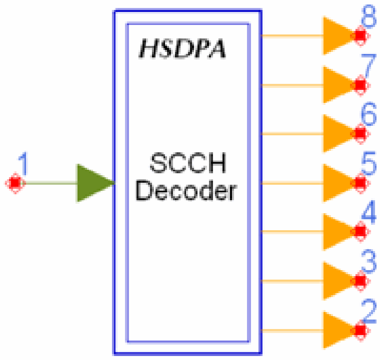


9. If ScrambleType is normal, the scramble code index for the corresponding HS-SCCH is equal to *ScrambleCode* × *16* + *ScrambleOffset*. If ScrambleType is right, the index is *ScrambleCode* × *16* + *ScrambleOffset* + *16384*. If ScrambleType is left, the index is *ScrambleCode* × *16* + *ScrambleOffset* + *8192*.

References

1. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2008.
2. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 7.9.0, May. 2008.
3. 3GPP Technical Specification TS 25.101, "User Equipment (UE) radio transmission and reception (FDD)," Version 7.13.0, Sept. 2008.

HSDPA_SCCH_Decoder



Description: HS-SCCH decoder
Library: HSDPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Type	Range
UEIdentity	UE identity (16 bits)	0xAAAA	int	[0,66535]

Pin Inputs

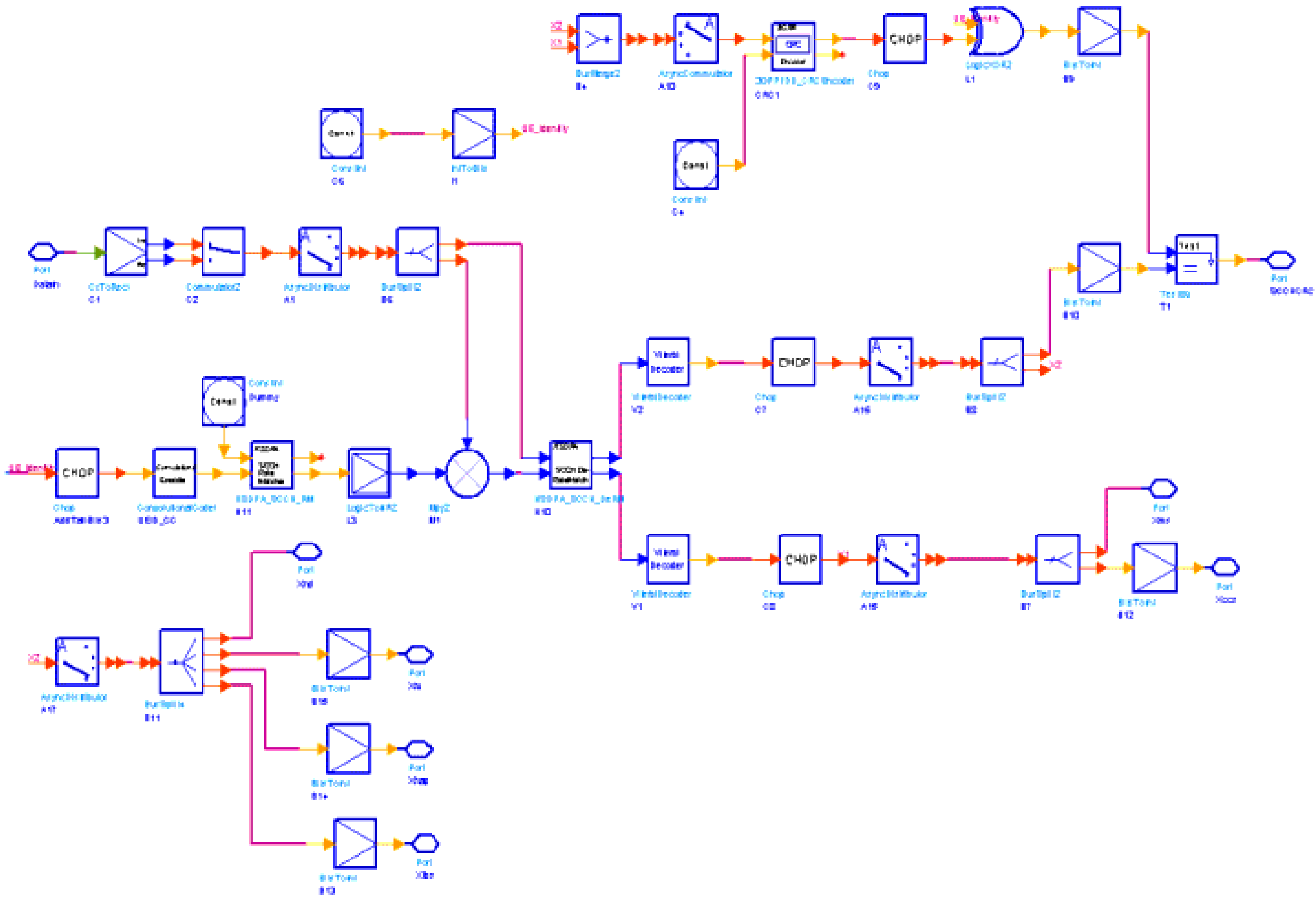
Pin	Name	Description	Signal Type
1	DataIn	SCCH input	complex

Pin Outputs

Pin	Name	Description	Signal Type
2	Xccs	channelization code set	int
3	Xms	modulation scheme	int
4	Xtbs	transport-block size information	int
5	Xhap	HARQ process information (3 bits)	int
6	Xrv	redundancy and constellation version (3 bits)	int
7	Xnd	new data indicator (1 bit)	int
8	SCCHCRC	SCCH CRC result	int

Notes/Equations

1. This subnetwork model is used to decode the baseband signal of HS-SCCH as defined in Reference [1].
2. The schematic for this subnetwork is shown below:

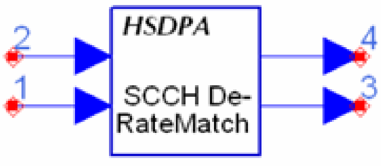


3. For each received HS-SCCH sub-frame, error-detection is performed by checking the CRC. If there is no error, the pin SCCHCRC outputs 1 (otherwise outputs 0).

References

1. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 6.7.0, Dec. 2005.

HSDPA_SCCH_DeRM



Description: HS-SCCH de-rateMatching
Library: HSDPA, Demultiplexers & Decoders

Pin Inputs

Pin	Name	Description	Signal Type
1	R1	input data 1	real
2	R2	input data 2	real

Pin Outputs

Pin	Name	Description	Signal Type
3	Z1	output data 1	real
4	Z2	output data 2	real

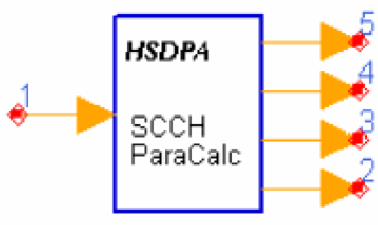
Notes/Equations

1. This model is used to implement rate dematching for HS-SCCH as defined in 4.6.6 in Reference [1].
2. Each firing, 48 Z1 tokens and 111 Z2 are generated, while 40 R1 tokens, 80 R2 tokens tokens are consumed.

References

1. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sep. 2008.

HSDPA_SCCH_ParaCalc



Description: HS-SCCH CQI Mapping
Library: HSDPA, Multiplexers & Coders

Parameters

Name	Description	Default	Type	Range
HSDPA_FRC	Fixed reference channel: H-Set 1, H-Set 2, H-Set 3, H-Set 4, H-Set 5, H-Set 6, H-Set 7, H-Set 8, UserDefined	H-Set 1	enum	
MS	Modulation scheme: QPSK, _16QAM, _64QAM	QPSK	enum	
NumHARQ	Number of HARQ processes, only valid when port CQI is connected	1	int	[1,6]
HS_PDSCH_CodeOffset	Spread code offset	1	int	[1,15]
HS_PDSCH_NumCh	Number of HS-PDSCH channels, valid when HSDPA_FRC = UserDefined	1	int	[1,15]

Pin Inputs

Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int

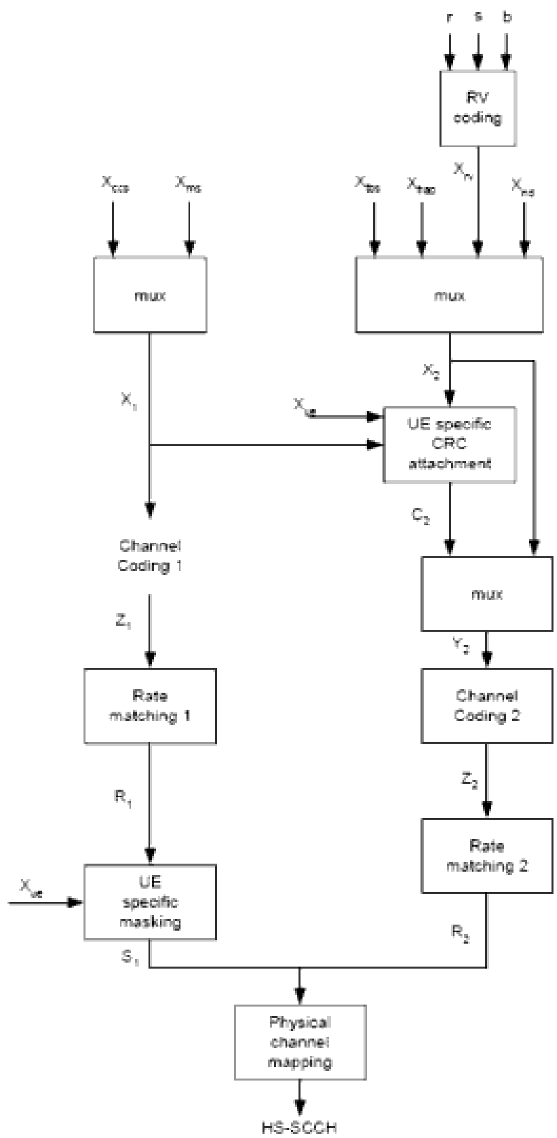
Pin Outputs

Pin	Name	Description	Signal Type
2	Xhap	HARQ process information (3 bits)	int
3	Xms	Modulation scheme information (1 bit)	int
4	Xtbs	transport-block size information (6 bits)	int
5	Xccs	channelization-code-set information (7 bits)	int

Notes/Equations

1. This model is used to calculate the Xccs, Xtbs, Xms and Xhap parameters of HS-SCCH as defined in Reference [1].
2. The input pin CQI is optional. If connected, the input value of CQI should be in the range of 1 to 30.
3. Xccs, Xtbs, Xms and Xhap are used to generate HS-SCCH message. The overall coding chain for HS-SCCH is illustrated below. If the pin CQI is connected, then Xccs, Xtbs and Xms are calculated according to Table 7 of 6A.2 in Reference [2], and Xhap is determined by the parameter NumHARQ. If the pin CQI is unconnected, then Xccs, Xtbs and Xhap are calculated according to the section A.7 of Reference [3], and Xms is determined by the parameter MS.

Coding chain for HS-SCCH

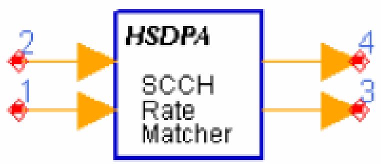


4. Xccs is a channelization-code-set information (7 bits). It is coded according to section 4.6.2.3 Reference [1].
5. Xtbs is a transport-block size information (6 bits). It is coded according to section 4.6.2.6 Reference [1].
6. Xms is a modulation scheme information (1 bit). If modulation scheme is QPSK, then Xms=0; and if modulation scheme is 16QAM, then Xms=1.
7. Xhap is a hybrid-ARQ process information (3 bits). It is coded according to section 4.6.2.5 Reference [1].

References

1. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2008.
2. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 7.9.0, May. 2008.
3. 3GPP Technical Specification TS 25.101, "User Equipment (UE) radio transmission and reception (FDD)," Version 7.13.0, Sept. 2008.

HSDPA_SCCH_RM



Description: HS-SCCH Rate Matching
Library: HSDPA, Multiplexers & Coders

Pin Inputs

Pin	Name	Description	Signal Type
1	Z1	input data 1	int
2	Z2	input data 2	int

Pin Outputs

Pin	Name	Description	Signal Type
3	R1	output data 1	int
4	R2	output data 2	int

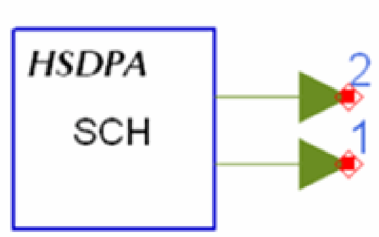
Notes/Equations

1. This model is used to implement rate matching for HS-SCCH as defined in 4.6.6 in Reference [1].
2. Each firing, 40 R1 tokens, 80 R2 tokens are generated, while 48 Z1 tokens and 111 Z2 tokens are consumed.

References

1. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2008.

HSDPA_SCH



Description: Synchronization Channel
Library: HSDPA, Signal Sources

Parameters

Name	Description	Default	Type	Range
OutputSTTD	: NO, YES	YES	enum	
ScrambleCode	index of scramble code	0	int	[0,511]
SCHType	SCH type: Primary, Secondary	Primary	enum	

Pin Outputs

Pin	Name	Description	Signal Type
1	Output	SCH output on antenna 1	complex
2	TSTD	SCH transmitter by TSTD on antenna 2	complex

Notes/Equations

1. This model can be used to generate P-SCH or S-SCH.
2. **SCHType = Secondary** specifies the cell's downlink scrambling code group.
3. **SCHType = Primary** specifies ScrambleCode is not used.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.6.0, May 2008.
2. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 7.6.0, Sep. 2008.

HSDPA_Spread

Description: Physical channnel spreader
Library: HSDPA, Multiplexers & Coders

Parameters

Name	Description	Default	Type
UE_Category	: Category_1, Category_2, Category_3, Category_4, Category_5, Category_6, Category_7, Category_8, Category_9, Category_10, Category_11, Category_12, Category_13, Category_14, Category_15, Category_16, Category_17, Category_18	Category_1	enum
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum
NumHSPDSCH	Number of HS PDSCH	5	int
SpreadCodeOffset	Spread code offset	1	int

Pin Inputs

Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int
2	DataInM	data in	multiple complex

Pin Outputs

Pin	Name	Description	Signal Type
3	DataOut	data for physical channel(s)	complex

Notes/Equations

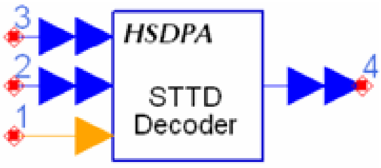
1. This model is used to implement spreading on HS-PDSCH.
2. Each firing, 480 tokens are consumed for each HS-PDSCH, which corresponds to one sub-port of pin DataInM, and 1 token is consumed at pin CQI if it is connected, while 480 × 16 tokens are generated at pin DataOut.
3. If pin CQI is connected, number of HS-PDSCHs occupied (EffectiveNumHSPDSCH) is determined by input CQI value and UE_Category according to Table 7 of 6A.2 in Reference [4]. Otherwise, EffectiveNumHSPDSCH equals to *NumHSPDSCH*.
4. OVSF codes with length 16 and index from SpreadCodeOffset to SpreadCodeOffset+EffectiveNumHSPDSCH-1 are assigned to the EffectiveNumHSPDSCH HS-PDSCHs respectively. Spreading is performed on each token within one HS-PDSCH with the OVSF code assigned to the HS-PDSCH. So 480 × 16 tokens are generated for each HS-PDSCH.
5. The spread tokens for each HS-PDSCH are summed together and output at pin DataOut.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.10.0, May. 2008.

2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2008.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 7.6.0, Sept. 2008.
4. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 7.9.0, May. 2008.

HSDPA_STTD_Decoder



Description: STTD decoder
Library: HSDPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Type
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum
NumHSPDSCH	Number of HS_PDSCH	5	int

Pin Inputs

Pin	Name	Description	Signal Type
1	RV	redundancy version	int
2	DataInM	data in	multiple real
3	STTDInM	sttd in	multiple real

Pin Outputs

Pin	Name	Description	Signal Type
4	DataOutM	data out	multiple real

Notes/Equations

1. This model is used to perform the inverse operation of constellation re-arrangement for 16QAM and will be updated to perform STTD decoding in the future.
   Each firing, 1920 tokens are consumed at each sub-port of pin DataInM, 1920 tokens at each sub-port of pin STTDInM, and 1 token is consumed at pin RV, while 1920 tokens are generated at each sub-port of pin DataOutM.
2. NumHSPDSCH specifies the number of HS-PDSCHs to be processed and each HS-PDSCH occupies one sub-port of pin DataInM and one sub-port of pin DataOutM. MS specifies the modulation scheme of each HS-PDSCH.
3. For QPSK, the 1920 bits consumed at each sub-port of DataInM will pass through this model transparently and output at each sub-port of DataOutM. For 16QAM, the 1920 bits are grouped four by four. The operation which is inverse to that shown in **Constellation re-arrangement for 16QAM** table below:

constellation version parameter b	Output bit sequence	Operation
0	$v_{p,k}, v_{p,k+1}, v_{p,k+2}, v_{p,k+3}$	None
1	$v_{p,k+2}, v_{p,k+3}, v_{p,k}, v_{p,k+1}$	Swapping MSBs with LSBs
2	$v_{p,k}, v_{p,k+1}, \overline{v_{p,k+2}}, \overline{v_{p,k+3}}$	Inversion of the logical values of LSBs
3	$v_{p,k+2}, v_{p,k+3}, \overline{v_{p,k}}, \overline{v_{p,k+1}}$	Swapping MSBs with LSBs and inversion of the logical values of LSBs

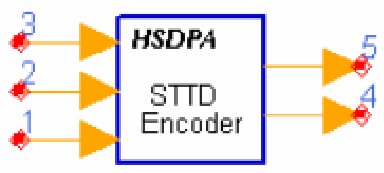
4. The tokens consumed at pin STTDIn are not processed inside the model now. In the

future, STTD decoding and combining with the tokens from DataInM will be performed.

References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.6.0, May 2008.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sep. 2008.

HSDPA_STTD_Encoder



Description: STTD encoder
Library: HSDPA, Multiplexers & Coders

Parameters

Name	Description	Default	Type
UE_Category	: Category_1, Category_2, Category_3, Category_4, Category_5, Category_6, Category_7, Category_8, Category_9, Category_10, Category_11, Category_12, Category_13, Category_14, Category_15, Category_16, Category_17, Category_18	Category_1	enum
MS	Modulation scheme: _QPSK, _16QAM, _64QAM	_QPSK	enum
NumHSPDSCH	Number of HS_PDSCH	5	int

Pin Inputs

Pin	Name	Description	Signal Type
1	CQI	channel quality indicator	int
2	RV	redundancy version	int
3	DataIn	data in	int

Pin Outputs

Pin	Name	Description	Signal Type
4	DataOut	data out	int
5	STTDOut	sttd out	int

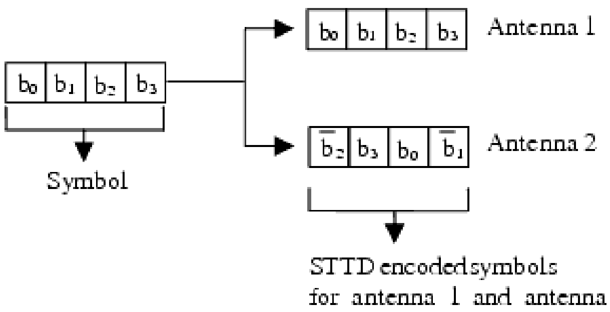
Notes/Equations

1. This model is used to implement constellation re-arrangement for 16QAM, 64QAM and STTD encoding.
   Each firing, *2880 × MaxNumHSPDSCH* tokens are consumed at pin DataIn, 1 token is consumed at pin CQI if it is connected, and 1 token is consumed at pin RV, while *2880 × MaxNumHSPDSCH* tokens are generated at pin DataOut, and *2880 × MaxNumHSPDSCH* tokens are generated at pin STTDOut.
   2880 × MaxNumHSPDSCH is the possible maximum data bits and MaxNumHSPDSCH is the possible maximum HS-PDSCHs within one TTI. If pin CQI is connected, MaxNumHSPDSCH equals to maximum HS-PDSCHs UE_Category supports. Otherwise, MaxNumHSPDSCH equals to *NumHSPDSCH*.
2. If pin CQI is connected, modulation scheme and number of HS-PDSCHs practically used (EffectiveNumHSPDSCH) are determined by input CQI value and UE_Category according to Table 7 of 6A.2 in Reference [3]. Otherwise, modulation scheme are determined by MS, and EffectiveNumHSPDSCH equals to NumHSPDSCH.
3. Although *2880 × MaxNumHSPDSCH* tokens are consumed at each firing, only the first EffectiveNumHSPDSCH HS-PDSCHs are occupied and 0s are padded for the other HS-PDSCHs. Each HS-PDSCHs contains 2880 bits. If modulation scheme is QPSK,

only the first 960 bits are useful data bits, and the other 1920 bits are 0s. If modulation scheme is 16QAM, first 1920 bits are useful data bits, and the remained 960 bits are 0s. If modulation scheme is 64QAM, all 2880 bits are useful data bits.

4. For QPSK, only STTD encoding is performed on the data bits from pin DataIn as shown below:

Generic block diagram of STTD encoder for QPSK

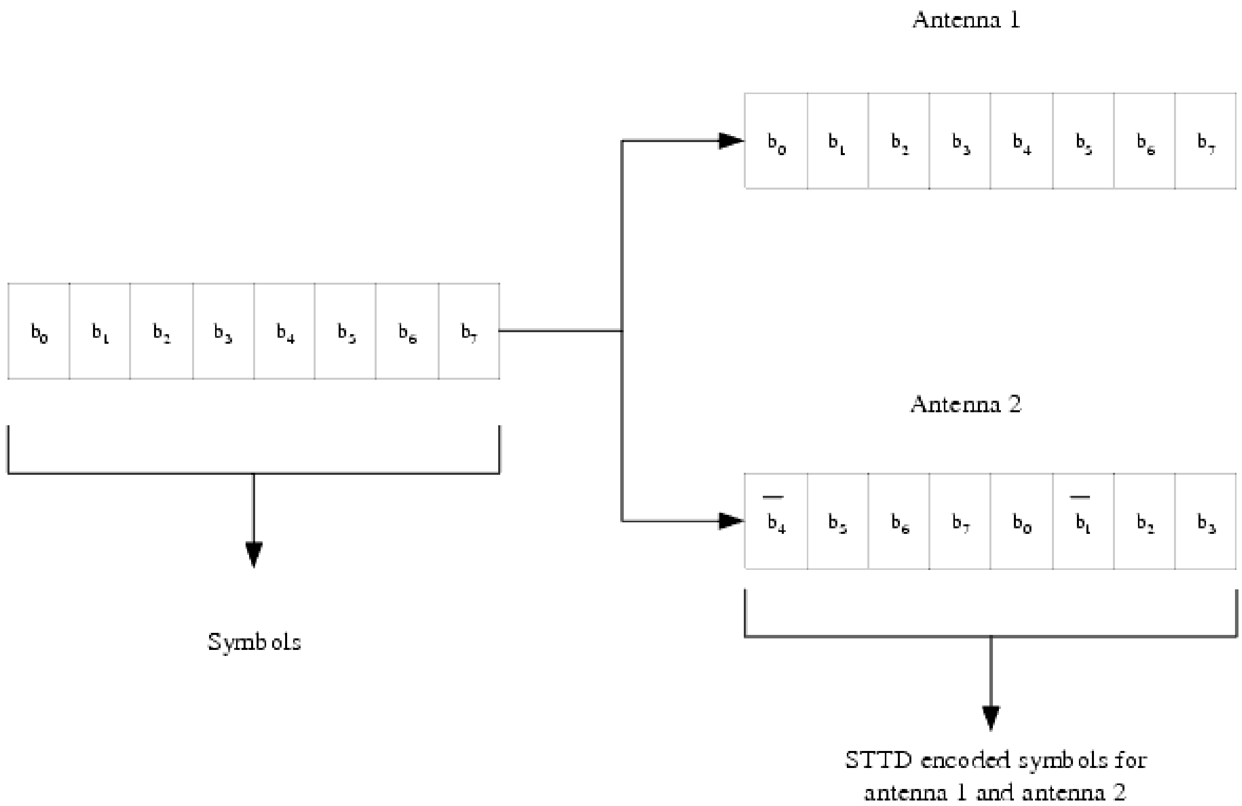


5. For 16QAM, constellation re-arrangement is first performed on the data bits from pin DataIn according to the table below. Then, STTD encoding is performed on the constellation re-arranged bits as shown below:

Constellation re-arrangement for 16QAM

constellation version parameter b	Output bit sequence	Operation
0	$v_{p,k}, v_{p,k+1}, v_{p,k+2}, v_{p,k+3}$	None
1	$v_{p,k+2}, v_{p,k+3}, v_{p,k}, v_{p,k+1}$	Swapping MSBs with LSBs
2	$v_{p,k}, v_{p,k+1}, \overline{v_{p,k+2}}, \overline{v_{p,k+3}}$	Inversion of the logical values of LSBs
3	$v_{p,k+2}, v_{p,k+3}, \overline{v_{p,k}}, \overline{v_{p,k+1}}$	Swapping MSBs with LSBs and inversion of the logical values of LSBs

Generic block diagram of STTD encoder for 16QAM



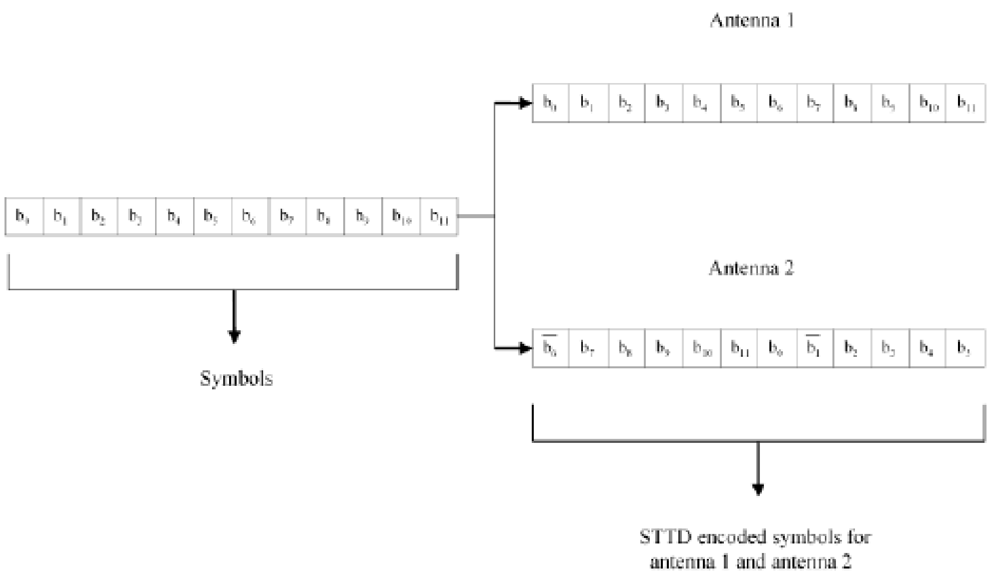
6. For 64QAM, constellation re-arrangement is first perforemd on the data bits from pin DataIn according to the table below:

Constellation re-arrangement for 64QAM

constellation version parameter b	Output bit sequence	Operation
0	$v_{p,k} v_{p,k+1} v_{p,k+2} v_{p,k+3} v_{p,k+4} v_{p,k+5}$	None
1	$v_{p,k+4} v_{p,k+5} \overline{v_{p,k+2}}\, \overline{v_{p,k+3}} v_{p,k} v_{p,k+1}$	Swapping MSBs and LSBs. Inversion of Middle SBs
2	$v_{p,k+2} v_{p,k+3} \overline{v_{p,k+4}}\, \overline{v_{p,k+5}} v_{p,k} v_{p,k+1}$	Left circular shift of pair of SBs. Inversion of Middle SBs
3	$v_{p,k} v_{p,k+1} \overline{v_{p,k+2}}\, \overline{v_{p,k+3}} v_{p,k+4} v_{p,k+5}$	Inversion of Middle SBs

7. Then, STTD encoding is performed on the constellation re-arranged bits as shown below:

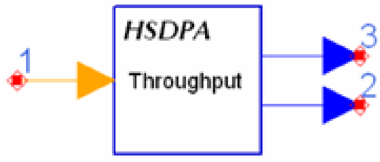
Generic block diagram of STTD encoder for 64QAM



References

1. 3GPP Technical Specification TS 25.211, "Physical channels and mapping of transport channels onto physical channels (FDD)," Version 7.10.0, May. 2008.
2. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 7.9.0, Sept. 2008.
3. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 7.9.0, May. 2008.

HSDPA_Throughput



Description: HSDPA throughput calculator
Library: HSDPA, Measurement

Parameters

Name	Description	Default	Type	Range
TTIPattern	inter-TTI pattern	{1, 1, 1, 1, 1, 1}	int array	[0,1]
TransBlockSize	Transport block size	3202	int	[1,27952]
TransBlockIgnored	Transport block Ignored due to system delay	1	int	[0,5]

Pin Inputs

Pin	Name	Description	Signal Type
1	Parity	CRC result of received bits	int

Pin Outputs

Pin	Name	Description	Signal Type
2	R	throughput in kbps	real
3	R_Pct	throughput in percent	real

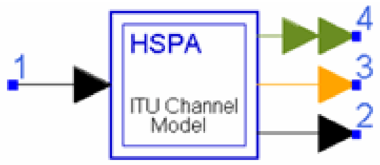
Notes/Equations

1. This model is used to estimate throughput of HSDPA downlink.
2. The TransBlockSize parameter determines the transport block size of HS-DSCH. The largest transport block size is 27,952 bits, which corresponds to the highest data rate of 13.976 Mb/s (27,952 bits/2 ms = 13.976 Mb/s). This data rate is obtained by using 16 QAM, an effective code rate of 0.9714, and 15 HS-PDSCHs.
3. R_Pct is the number of valid TTIs with Parity=1 divided by the total number of Parity in valid TTIs. R is the throughput in kbps: R=R_Pct*TransBlockSize/2.

References

1. 3GPP Technical Specification TS 25.212, "Multiplexing and channel coding (FDD)," Version 6.7.0, Dec. 2005.

HSPA_Channel_ITU (ITU Downlink EVM Channel Model)



Description: ITU channel model
Library: HSDPA, Channel

Parameters

Name	Description	Default	Unit	Type	Range
RIn	Input resistance	50 Ohm	Ohm	int	(0,∞)
ROut	Output resistance	50 Ohm	Ohm	int	(0,∞)
ModelType	the ITU-R M.1225 Channel number or User defined Channel: Pedestrian_A, Pedestrian_B, Vehicular_A, Vehicular_B, UserDefined	Vehicular_A		enum	
Delay	the delay of each tap in usec, effective only when ModelType is set as UserDefined	{0.0 , 0.31 , 0.71 , 1.09 , 1.73 , 2.51 }	sec	real array	[0,1000.0]
Power	the power in each tap in dB, effective only when ModelType is set as UserDefined	{0.0 dB, -1.0 dB, -9.0 dB, -10.0 dB, -15.0 dB, -20.0 dB}		real array	(-∞,0]
Ricean_factor	the Ricean K-factor in linear scale of each tap, effective only when ModelType is set as UserDefined	{0.0, 0.0, 0.0, 0.0, 0.0, 0.0}		real array	[0.0,1000.0]
Velocity	the velocity of mobile station	120		real	[0.001,200]
PathLoss	option for inclusion of large-scale pathloss: NO, YES	NO		enum	
PropDistance	the distance of BS and UE in meter, effective only when PassLoss is set as YES	1000	m	real	[200,5000]
PwrNormal	option for normalization of the output power: NO, YES	NO		enum	
PwrMeasPeriod	The period of power measurement in order to normalize the output power	1 msec	sec	real	(0,∞)

Pin Inputs

Pin	Name	Description	Signal Type
1	input	channel input signal	timed

Pin Outputs

Pin	Name	Description	Signal Type
2	output	channel output signal	timed
3	PathDelay	output the pathes delay	int
4	tap	fading channel coefficients of each tap	multiple complex

Notes/Equations

1. This model is used to generate channel models for mobile wireless applications.
2. This model is implemented following Rec.ITU-R M.1225.
   A set of 4 modified International Telecommunication Union (ITU) channel models are constructed to simulate the multipath fading of the channel. The multipath fading is modeled as a tapped-delay line with 6 taps with non-uniform delays. The gain associated with each tap is characterized by a distribution (Ricean with a K-factor>0, or Rayleigh with K-factor=0) and the maximum Doppler frequency. For each tap, the method of filtered noise is used to generate channel coefficients with the specified distribution and spectral power density.
   The definition of the 4 specific ITU channels is shown in the following tables:

Outdoor to Indoor and Pedestrian Test Environment Tapped-Delay-Line Parameters

Tap	Channel A		Channel B		Doppler Spectrum
	Relative Delay (ns)	Average Power (dB)	Relative Delay (ns)	Average Power (dB)	
1	0	0	0	0	Classic
2	110	-9.7	200	-0.9	Classic
3	190	-19.2	800	-4.9	Classic
4	410	-22.8	1200	-8.0	Classic
5	n/a	n/a	2300	-7.8	Classic
6	n/a	n/a	3700	-23.9	Classic

Vehicular Test Environment Tapped-Delay-Line Parameters

Tap	Channel A		Channel B		Doppler Spectrum
	Relative Delay (ns)	Average Power (dB)	Relative Delay (ns)	Average Power (dB)	
1	0	0.0	0	-2.5	Classic
2	310	-1.0	300	0	Classic
3	710	-9.0	8900	-12.8	Classic
4	1090	-10.0	12900	-10.0	Classic
5	1730	-15.0	17100	-25.2	Classic
6	2510	-20.0	20000	-16.0	Classic

The total channel gain is normalized by adding the specified Normalization Factor to each tap.
The specified Doppler is the maximum Doppler frequency parameter (fm) of the rounded spectrum which has the power spectral density (PSD) function as follows:

$$S(f) = \begin{cases} \dfrac{1}{\pi\sqrt{1-f_0^2}} & |f_0| \le 1 \\ 0 & |f_0| > 1 \end{cases}$$

where $f_0 = \dfrac{f}{f_m}$ and $f_m = \dfrac{v}{c}f$, *v* is the mobile's velocity relative to base station.
The set of ITU channel models specify statistical parameters of microscopic effects. To simulate the real channel, these statistics have to be combined with macroscopic

channel effects, i.e. the path loss (including shadowing) which will be introduced in the later section.
The COST 207 model with a correction term is used to simulate the path loss for both pedestrian and vehicular environments if the PathLoss is ON and other parameters are set according to the specific environment.

3. Parameter Details
   - *ModelType* specifies the type of ITU channel.
     The relationship of the channel type and the terrain type is shown in the following.
     ModelType A and *B* are outdoor to indoor and pedestrian environment, while Type *C* and *D* are vehicular environment. Type *User-Defined* is used to construct user defined channel model.
   - *Velocity* specifies the mobile's velocity relative to base station.
   - *PropDistance* specifies the distance between base station and mobile station.
   - *PathLoss* identifies whether the large-scale pathloss is included.
     If *PathLoss = NO*, then the path loss is not included in this model and the parameters describing the environment are unused.
     If *PathLoss = YES*, then the path loss for both urban and suburban environments is modeled by the COST 207 model with a correction term. There are three terms which make up the model:
     The Path Loss model for outdoor to indoor and pedestrian test environment is,
     $L = 40\log R + 30\log f + 49$
     where R is the propagation distance and f is the frequency.
     The Path Loss model for vehicular test environment is,
     $L = [40(1 - 4 \times 10^{-3}\Delta h_b)]\log R - 18\log\Delta h_b + 21\log f + 80$
     where R is the propagation distance and f is the frequency, Δh_b is the height between base station antenna and mobile.
   - Delay, Power and Ricean_factor specify the delay, power and ricean factor for each path when ModelType selected as *UserDefined*.
4. Output delay
   A delay of 64 tokens is introduced in this model.

References

1. Rec.ITU-R M.1225, *Guidelines For Evaluation Of Radio Transmission Technologies For IMT-2000, 1997* .

HSDPA User Equipment Receiver Design Examples

The HSDPA_UE_Rx_wrk workspace shows user equipment receiver measurement performances, including HS-DSCH demodulation performance, HS-SCCH signaling detection performance.

Designs for these measurements are described in the following sections, including:

- Demodulation performance:
  - UE_Rx_Demodulation_Hset1_PA3_QPSK
  - UE_Rx_Demodulation_Hset2_PB3_16QAM
  - UE_Rx_Demodulation_Hset3_VA30_16QAM
  - UE_Rx_Demodulation_Hset4_PB3_QPSK
  - UE_Rx_Demodulation_Hset5_VA120_QPSK
  - UE_Rx_Demodulation_Hset6_PA3_16QAM
  - UE_Rx_Demodulation_Hset6_PA3_16QAM_LMMSE
  - UE_Rx_Demodulation_Hset6_VA30_16QAM_LMMSE
  - UE_Rx_Demodulation_Hset8_PA3_64QAM_LMMSE
  - UE_Rx_Demodulation_BER_CQI
  - UE_Rx_Demodulation_Throughput_CQI
- Signaling detection performance - false alarm:
  - UE_Rx_HSSCCH_Detection_TS1_PA3.

- Designs under this workspace consist of:
  - Downlink RF band signal source: HSDPA_DL_SourceRF is used to provide an RF HSDPA downlink signal source.
  - Fading channel: HSPA_Channel is used to provide various multi-path fading propagation conditions.
  - AWGN noise: AddNDensity is used to provide AWGN in order to calibrate the system E_c/N_0 at certain levels, which are required by various performance measurements.
  - User Equipment RF receiver: HSDPA_DL_ReceiverRF is used to provide a receiver of RF HSDPA downlink signals.

HS-DSCH Demodulation Performance Measurement

Design:

- UE_Rx_Demodulation_Hset1_PA3_QPSK
- UE_Rx_Demodulation_Hset2_PB3_16QAM
- UE_Rx_Demodulation_Hset3_VA30_16QAM
- UE_Rx_Demodulation_Hset4_PB3_QPSK
- UE_Rx_Demodulation_Hset5_VA120_QPSK
- UE_Rx_Demodulation_Hset6_PA3_16QAM
- UE_Rx_Demodulation_Hset6_PA3_16QAM_LMMSE
- UE_Rx_Demodulation_Hset6_VA30_16QAM_LMMSE
- UE_Rx_Demodulation_Hset8_PA3_64QAM_LMMSE
- UE_Rx_Demodulation_BER_CQI
- UE_Rx_Demodulation_Throughput_CQI

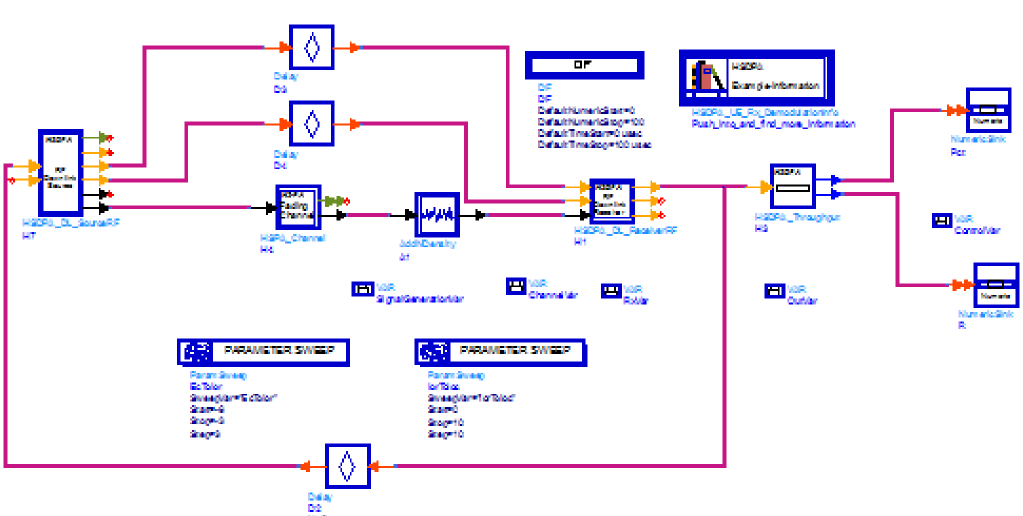
Features:

- Base station receiver demodulation performance measurements
- ARQ (feedback) controlled source
- Integrated RF models
- Throughput (R)
- Multiple E_c/N_0 measurement points
- Multi-path fading propagation conditions

Description:

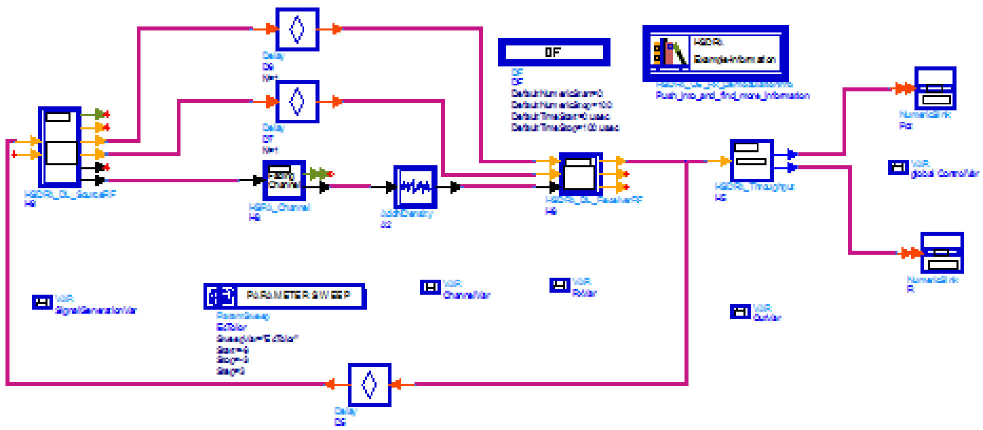
- UE_Rx_Demodulation_Hset1_PA3_QPSK measures user equipment receiver HS-DSCH demodulation performance under H-Set1 FRC (Fixed Reference Channel) and PA3 channel with QPSK modulation.

UE_Rx_Demodulation_Hset1_PA3_QPSK Schematic



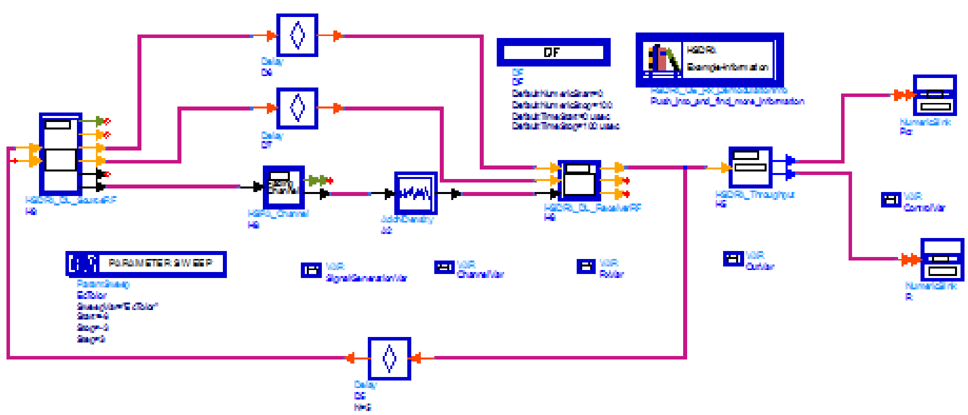
- UE_Rx_Demodulation_Hset2_PB3_16QAM measures user equipment receiver HS-DSCH demodulation performance under H-Set2 FRC and PB3 channel with 16QAM modulation.

UE_Rx_Demodulation_Hset2_PB3_16QAM Schematic



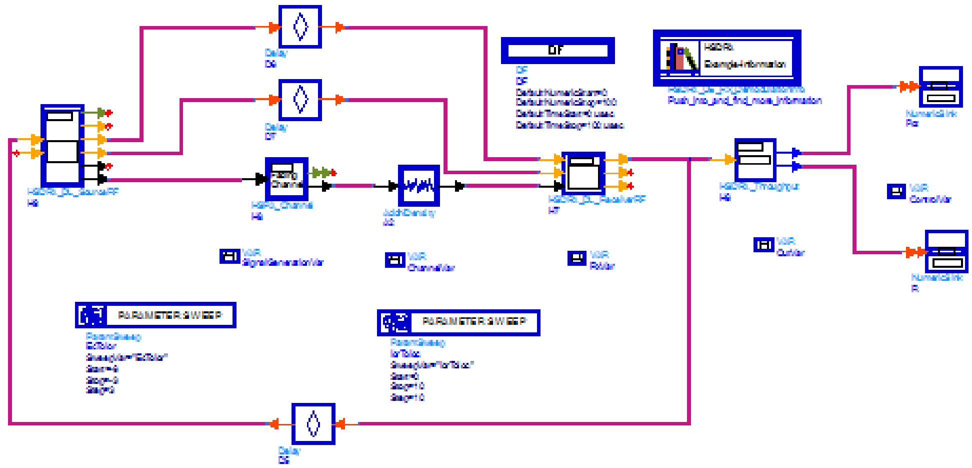
- UE_Rx_Demodulation_Hset3_VA30_16QAM measures user equipment receiver HS-DSCH demodulation performance under H-Set3 FRC and VA30 channel with 16QAM modulation.

UE_Rx_Demodulation_Hset3_VA30_16QAM Schematic



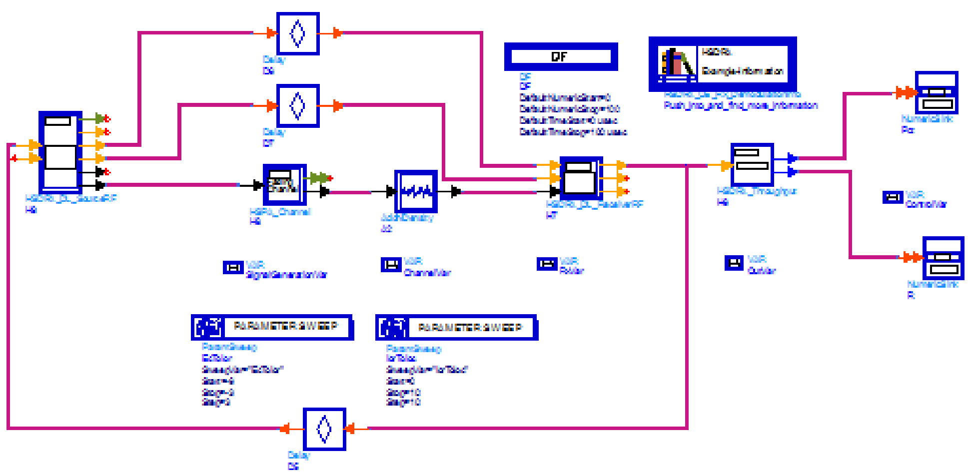
- UE_Rx_Demodulation_Hset4_PB3_QPSK measures user equipment receiver HS-DSCH demodulation performance under H-Set4 FRC and VA30 channel with QPSK modulation.

UE_Rx_Demodulation_Hset4_PB3_QPSK Schematic



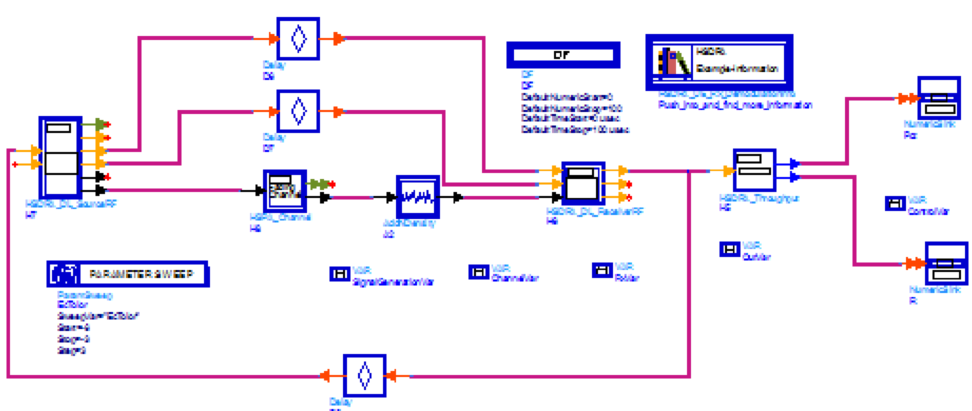
- UE_Rx_Demodulation_Hset5_VA120_QPSK measures user equipment receiver HS-DSCH demodulation performance under H-Set5 FRC and VA120 channel with 16QAM modulation.

UE_Rx_Demodulation_Hset5_VA120_QPSK Schematic



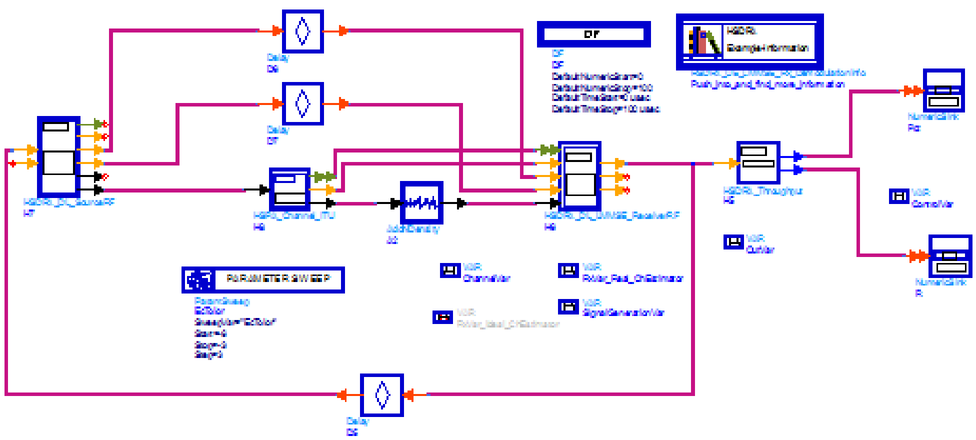
- UE_Rx_Demodulation_Hset6_PA3_16QAM measures user equipment receiver HS-DSCH demodulation performance under H-Set6 FRC and PA3 channel with 16QAM modulation.

UE_Rx_Demodulation_Hset6_PA3_16QAM Schematic



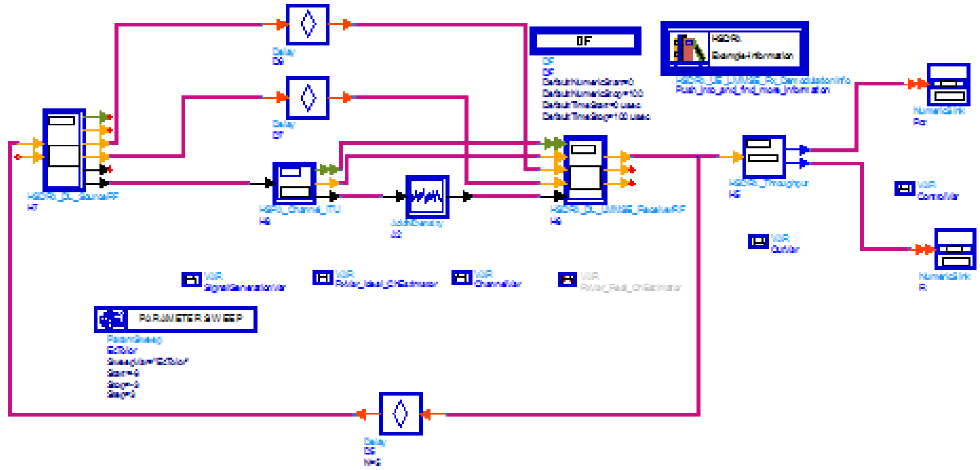
- UE_Rx_Demodulation_Hset6_PA3_16QAM_LMMSE measures user enhanced type2 receiver(LMMSE equalizer) HS-DSCH demodulation performance under H-Set6 FRC and PA3 channel with 16QAM modulation.

UE_Rx_Demodulation_Hset6_PA3_16QAM_LMMSE Schematic



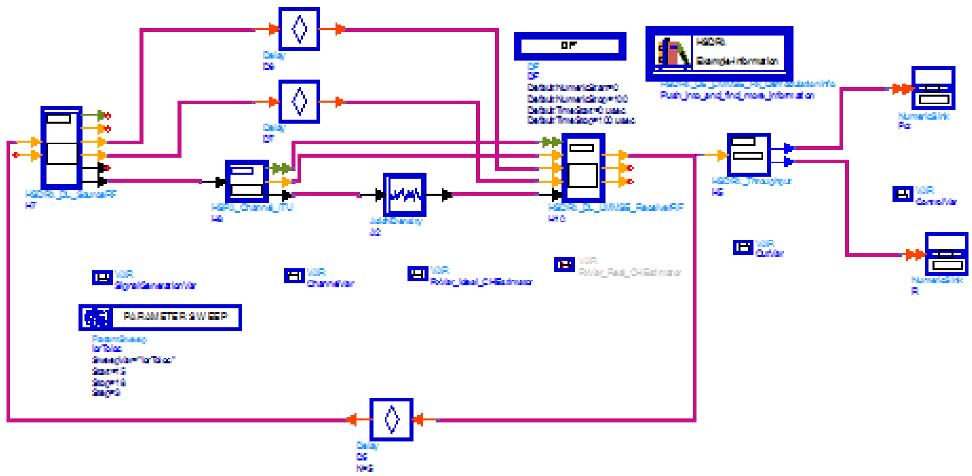
- UE_Rx_Demodulation_Hset6_VA30_16QAM_LMMSE measures user enhanced type2 receiver(LMMSE equalizer) HS-DSCH demodulation performance under H-Set6 FRC and VA30 channel with 16QAM modulation.

UE_Rx_Demodulation_Hset6_VA30_16QAM_LMMSE Schematic



- UE_Rx_Demodulation_Hset8_PA3_64QAM_LMMSE measures user enhanced type2 receiver(LMMSE equalizer) HS-DSCH demodulation performance under H-Set8 FRC and PA3 channel with 64QAM modulation.

UE_Rx_Demodulation_Hset8_PA3_64QAM_LMMSE Schematic



They are all according to section 9.2 in TS 25.101.

- UE_Rx_Demodulation_BER_CQI measures user equipment receiver HS-DSCH demodulation performance, BER for various format specified by CQI value.
- UE_Rx_Demodulation_BER_CQI measures user equipment receiver HS-DSCH demodulation performance, Throughput for various format specified by CQI value.

Simulation Results:
Simulation results are shown in the following diagrams detailed below:

- Throughput Results (R) for User Equipment Demodulation Performance Measurement (Fading) Hset1 under PA3 channel with QPSK modulation

HSDPA HS-DSCH Demodulation Performance--Tables

Throughput results

Index	R	Pct
EcTolor=-6.000, IorToloc=0.000 600	101.397	0.190
EcTolor=-6.000, IorToloc=10.000 600	384.240	0.720
EcTolor=-3.000, IorToloc=0.000 600	157.432	0.295
EcTolor=-3.000, IorToloc=10.000 600	461.622	0.865

3GPP Specification TS 25.101, V6.10.0 Section 9.2.1

Specification requirements

IorToloc=0dB EcTolor=-6dB R=65kbps
IorToloc=0dB EcTolor=-3dB R=N/A
IorToloc=10dB EcTolor=-6dB R=309kbps
IorToloc=10dB EcTolor=-3dB R=423kbps

Test results

Passed

Notes: Please go to page titled Equations to see variable definitions.

- Throughput Results (R) for User Equipment Demodulation Performance Measurement (Fading) Hset2 under PB3 channel with 16QAM modulation

HSDPA HS-DSCH Demodulation Performance--Tables

Throughput results

Index	R		Pct	
	EcTolor=-6.000	EcTolor=-3.000	EcTolor=-6.000	EcTolor=-3.000
600	268.180	443.080	0.230	0.380

3GPP Specification TS 25.101, V6.10.0 Section 9.2.1

Specification requirements

IorToloc=10dB EcTolor=-6dB R=51kbps
IorToloc=10dB EcTolor=-3dB R=329kbps

Test results

Passed

Notes: Please go to page titled Equations to see variable definitions.

- Throughput Results (R) for User Equipment Demodulation Performance Measurement (Fading) Hset3 under VA30 channel with 16QAM modulation

HSDPA HS-DSCH Demodulation Performance--Tables

Throughput results

Index	R		Pct	
	EcTolor=-6.000	EcTolor=-3.000	EcTolor=-6.000	EcTolor=-3.000
600	563.567	932.800	0.242	0.400

3GPP Specification TS 25.101, V6.10.0 Section 9.2.1

Specification requirements

IorToloc=10dB EcTolor=-6dB R=141kbps
IorToloc=10dB EcTolor=-3dB R=642kbps

Test results

Passed

Notes: Please go to page titled Equations to see variable definitions.

- Throughput Results (R) for User Equipment Demodulation Performance Measurement (Fading) Hset4 under PB3 channel with QPSK modulation

HSDPA HS-DSCH Demodulation Performance--Tables

Throughput results

Index	R	Pct
EcTolor=-6.000, IorToIoc=0.000 1200	84.052	0.157
EcTolor=-6.000, IorToIoc=10.000 1200	190.786	0.358
EcTolor=-3.000, IorToIoc=0.000 1200	158.766	0.297
EcTolor=-3.000, IorToIoc=10.000 1200	306.858	0.575

3GPP Specification TS 25.101, V6.10.0 Section 9.2.1

Specification requirements

IorToIoc=0dB EcTolor=-6dB R=24kbps
IorToIoc=0dB EcTolor=-3dB R=142kbps
IorToIoc=10dB EcTolor=-6dB R=186kbps
IorToIoc=10dB EcTolor=-3dB R=299kbps

Test results

Passed

Notes: Please go to page titled Equations to see variable definitions.

- Throughput Results (R) for User Equipment Demodulation Performance Measurement (Fading) Hset5 under VA120 channel with QPSK modulation

HSDPA HS-DSCH Demodulation Performance--Tables

Throughput results

Index	R	Pct
EcTolor=-6.000, IorToIoc=0.000 600	136.085	0.170
EcTolor=-6.000, IorToIoc=10.000 600	304.190	0.380
EcTolor=-3.000, IorToIoc=0.000 600	248.155	0.310
EcTolor=-3.000, IorToIoc=10.000 600	418.928	0.523

3GPP Specification TS 25.101, V6.10.0 Section 9.2.1

Specification requirements

IorToIoc=0dB EcTolor=-6dB R=20kbps
IorToIoc=0dB EcTolor=-3dB R=210kbps
IorToIoc=10dB EcTolor=-6dB R=272kbps
IorToIoc=10dB EcTolor=-3dB R=413kbps

Test results

Passed

Notes: Please go to page titled Equations to see variable definitions.

- Throughput Results (R) for User Equipment Demodulation Performance Measurement (Fading) Hset6 under PA3 channel with 16QAM modulation

HSDPA HS-DSCH Demodulation Performance--Tables

Throughput results

Index	R		Pct	
	EcTIor=-6.000	EcTIor=-3.000	EcTIor=-6.000	EcTIor=-3.000
600	1515.948	2492.719	0.323	0.532

3GPP Specification TS 25.101, V6.10.0 Section 9.2.1

Specification requirements

IorToIoc=10dB EcTIor=-6dB R=887kbps
IorToIoc=10dB EcTIor=-3dB R=1664kbps

Test results

Passed

Notes: Please go to page titled Equations to see variable definitions.

- Throughput Results (R) for User Equipment Demodulation Performance Measurement (Fading) Hset6 under PA3 channel with 16QAM modulation

HSDPA HS-DSCH Demodulation Performance--Tables Real Channel Estimation

Throughput results

Index	R		Pct	
	EcTIor=-6.000	EcTIor=-3.000	EcTIor=-6.000	EcTIor=-3.000
600	1828.515	2719.330	0.390	0.580

3GPP Specification TS 25.101, V7.13.0 Section 9.2.1

Specification requirements

IorToIoc=10dB EcTIor=-6dB R=991kbps
IorToIoc=10dB EcTIor=-3dB R=1808kbps

Test results

Passed

Notes: Please go to page titled Equations to see variable definitions.

- Throughput Results (R) for User Equipment Demodulation Performance Measurement (Fading) Hset6 under VA30 channel with 16QAM modulation

HSDPA HS-DSCH Demodulation Performance--Tables Ideal Channel Estimation

Throughput results

Index	R		Pct	
	EcTolor=-6.000	EcTolor=-3.000	EcTolor=-6.000	EcTolor=-3.000
600	1273.709	1961.356	0.272	0.418

3GPP Specification TS 25.101, V7.13.0 Section 9.2.1

Specification requirements

IorToloc=10dB EcTolor=-6dB R=587kbps
IorToloc=10dB EcTolor=-3dB R=1488kbps

Test results

Passed

Notes : Please go to page titled Equations to see variable definitions.

- Throughput Results (R) for User Equipment Demodulation Performance Measurement (Fading) Hset8 under PA3 channel with 64QAM modulation

HSDPA HS-DSCH Demodulation Performance--Tables Ideal Channel Estimation

Throughput results

Index	R		Pct	
	IorToloc=15.000	IorToloc=18.000	IorToloc=15.000	IorToloc=18.000
600	5786.707	7686.160	0.437	0.580

3GPP Specification TS 25.101, V7.13.0 Section 9.2.1

Specification requirements

IorToloc=15dB EcTolor=-2dB R=4507kbps
IorToloc=18dB EcTolor=-2dB R=5736kbps

Test results

Passed

Notes: Please go to page titled Equations to see variable definitions.

Benchmark:
Simulation time is about 4 hours for 2 sweep points of 600 2ms TTI over fading condition, on a P4/2.2GHz with 1G memory PC running ADS 2005A on Microsoft Windows 2000.

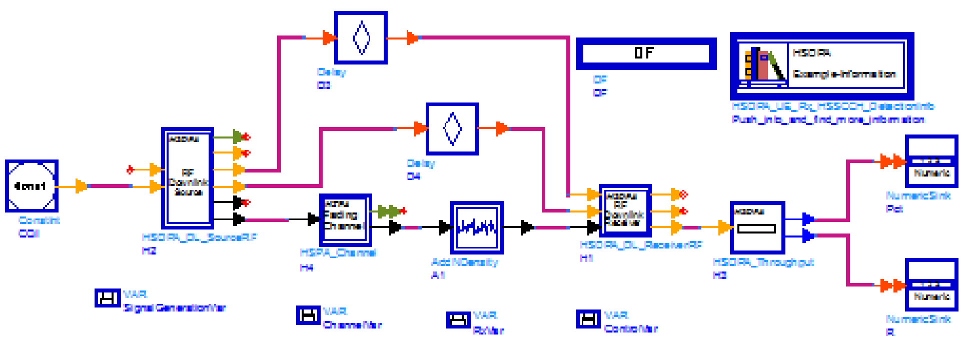
HS-SCCH Detection Performance Measurements

Design: UE_Rx_HSSCCH_Detection_TS1_PA3

Features:

- User equipment receiver HS-SCCH signaling detection performance measurements
- Integrated RF models
- Multi-path fading propagation conditions

Description:
These designs measure user equipment receiver HS-SCCH signaling detection performance according to section 9.4 in TS 34.121. The **UE_Rx_HSSCCH_Detection_TS1_PA3** schematic is shown below:



Simulation Results:
Simulation results are shown below:

- HSDPA HS-SCCH Detection Single Link Performance Measurements

HSDPA HS-SCCH Detection Single Link Performance -- Tables

real(FCarrier)/(1 MHz)	real(SignalPower_dBm)
2140.000	-59.400

Testing results

Index	Measured_P_Em
1200	0.007

3GPP Specification TS 34.121 (2005-12) Section 9.4

Specification requirements	Test results
In the Specification TS 34.121, the measured P(Em) shall be less than or equal to the corresponding specified value of P(Em). For the TestNumber = 1, P(Em) = 0.05; TestNumber = 2 or 3, P(Em) = 0.01.	Passed

Notes: Please go to page titled Equations to see variable definitions.

Benchmark:
Simulation time is about 6.6 hours, on a P4/2.26GHz, 1GB memory, PC running ADS 2005A on Microsoft Windows 2000.

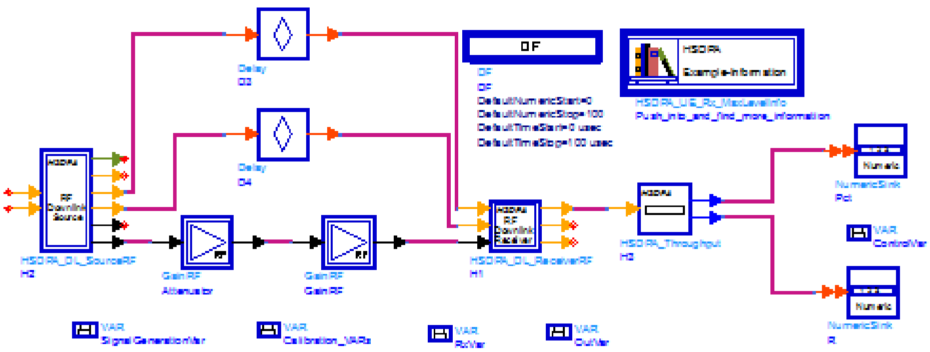
Maximum Input Level Throughput Measurements

Design: UE_Rx_MaxLevel Design

Features:

- measurement for user equipment receiver maximum input level
- downlink reference measurement channels including 1HS-PDSCH, 1HS-SCCH, 1PCCPCH, 1PSCH, 1SSCH, 1CPICH, 1 PICH and 16 OCNS interferers
- existing RF channel loss
- Throughput of HS-DSCH

Description:
This design measures user equipment receiver maximum input level per section 7.4 in TS25.101. The **UE_Rx_MaxLevel** schematic is shown below:

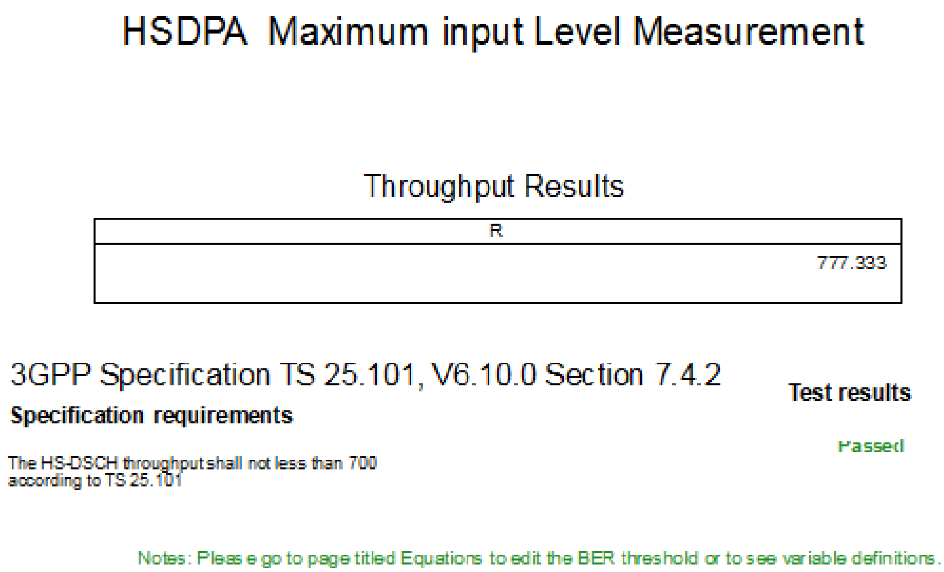


Gain factors of RF models in this design are set to satisfy a condition specified in TS 25.101:

- $\hat{I}_{or} = -25$ dBm/3.84 MHz
- HS-PDSCH_Ec/Ior = -10 dBm
- Throughput performance of HS-DSCH must be no less than 700kbps.

Simulation Results:
Simulation results displayed in UE_Rx_Results.dds includes the Throughput of HS-DSCH is shown below:

HSDPA Maximum Input Level Measurement Result



Benchmark:

- Hardware Platform: Pentium IV 2.26 GHz, 1024 MB memory
- Software Platform: Windows 2000, ADS 2005
- Data Points: 60 TTI
- Simulation Time: approximately 3 minutes.

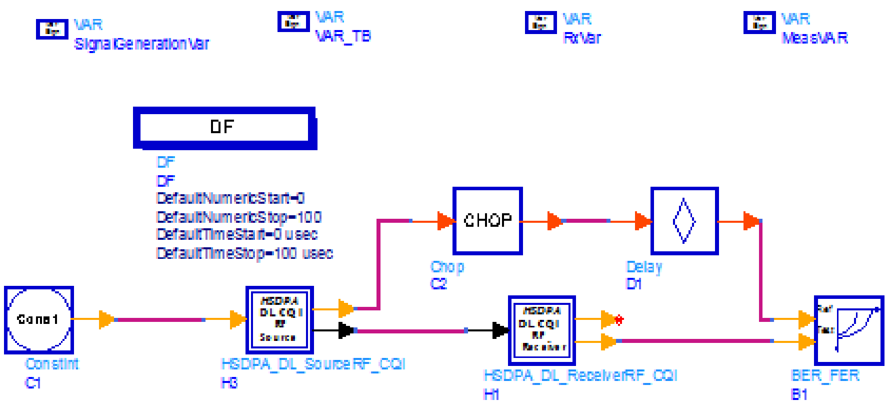
BER Measurement under CQI mode

Design UE_Rx_Demodulatrion_BER_CQI

Features:

- BER measurement of HS_DSCH
- format of HS_DSCH specified by CQI value
- existing RF channel loss

Description:
The **UE_Rx_Demodualtion_BER_CQI** schematic is shown below:



Simulation Results:
Simulation results displayed in UE_Rx_Demodulation_BER_CQI.dds includes the BER measurement result of HS-DSCH is shown below:

HSDPA BER Measurement Result under CQI Mode

Index	BER	FER
0	0.000	0.000

Benchmark:

- Hardware Platform: Pentium IV 2.26 GHz, 1024 MB memory
- Software Platform: Windows 2000, ADS 2006 UR3
- Data Points: 10TTI
- Simulation Time: approximately 25 seconds.

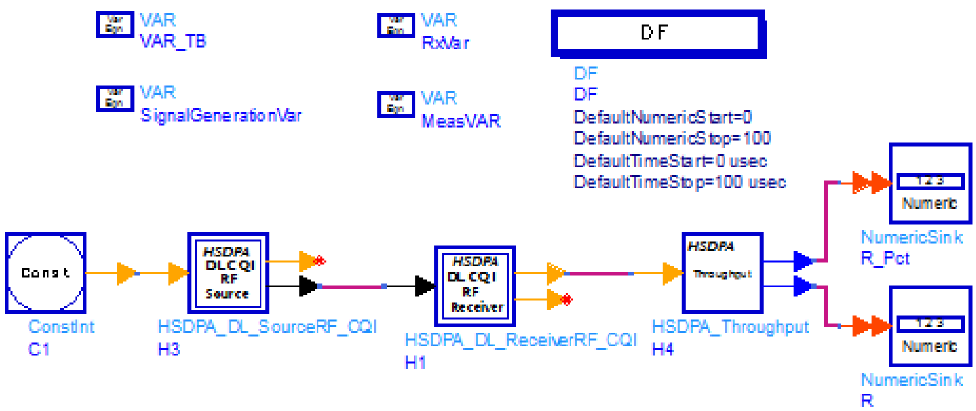
Throughput Measurement under CQI mode

UE_Rx_Demodulatrion_Throughput_CQI Design

Features:

- Throughput measurement of HS_DSCH
- format of HS_DSCH specified by CQI value
- existing RF channel loss

Description:
The **UE_Rx_Demodualtion_Through_CQI** schematic is shown below:



Simulation Results:
Simulation results displayed in UE_Rx_Demodulation_Throughput_CQI.dds includes the throughput measurement result of HS-DSCH is shown below:

HSDPA Throughput Measurement Result under CQI Mode

Index	R	R_Pct
1	12779.000	1.000
2	12779.000	1.000
3	12779.000	1.000
4	12779.000	1.000
5	12779.000	1.000
6	12779.000	1.000
7	12779.000	1.000
8	12779.000	1.000
9	12779.000	1.000
10	12779.000	1.000

Benchmark:

- Hardware Platform: Pentium IV 2.26 GHz, 1024 MB memory
- Software Platform: Windows 2000, ADS 2006 UR3
- Data Points: 10TTI
- Simulation Time: approximately 23 seconds.

References

1. 3GPP Technical Specification TS 25.101, "UE Radio transmission and Reception (FDD)," Version 7.13.0, Sep. 2008.