Agilent Technologies

Advanced Design System 2011.01

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HSUPA Design Library

Acknowledgments

About the HSUPA Design Library

The HSUPA Design Library is designed for 3GPP FDD enhanced uplink, also known as HSUPA, defined in release 6 of 3GPP specification. This design library focuses on the physical layer aspects of HSUPA 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 release 5 and previous versions of 3GPP specification such as DCH, DPDCH are also supported by HSUPA design library. But they are treated as the accessory channels because HSUPA design library focus on the modeling and test of channels defined in release 6, say HSUPA. The test for the scenario with only 3GPP FDD with/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.x.x), release 4 (Version 4.x.x), release 5 (Version 5.x.x), release 6 (Version 6.x.x) release 7(Version 7.x.x). Basically, the contents defined in lower version specifications duplicate the contents from release '99, release 4 and release 5 that are published simultaneously.

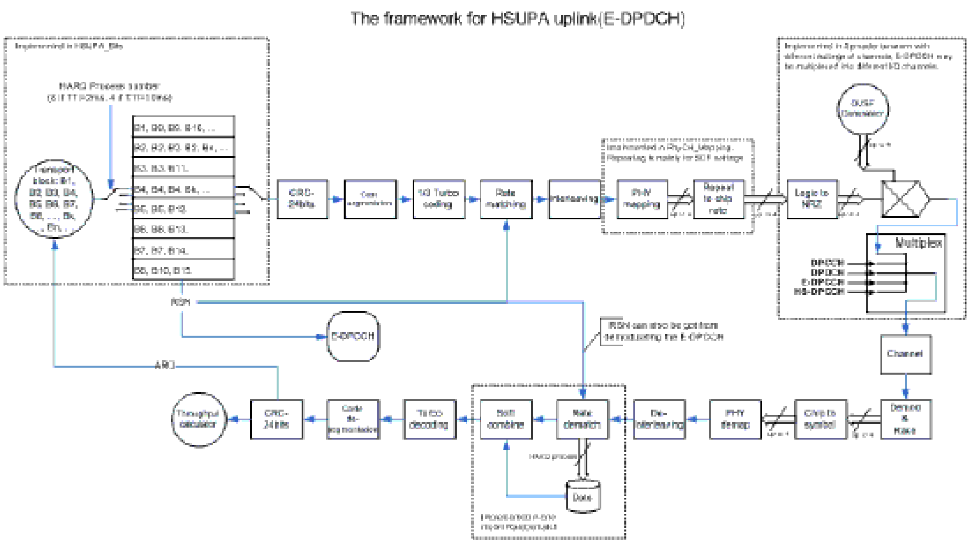
The HSUPA design library is compliant with 3GPP release 6 technical specifications published in 2006-03.

HSUPA 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 and 2003-09 for HSDPA part in release 5. The version may be changed if 3GPP design library is updated.

HSUPA Systems

HSUPA aims at providing significant enhancements in terms of user experience (throughput and delay) and/or capacity. It enables you to achieve significant improvements in overall system performance when operated together with HSDPA. In other words, the aim of HSUPA is to enhance the uplink DCH operation and performance to support services like video-clips, multimedia, e-mail, telematics, gaming, video-streaming, and etc. At the same time, HSUPA is backward-compatible with 3GPP FDD with HSDPA defined in release 5 and previous versions of 3GPP specification.

In the uplink, two new physical channels E-DPDCH and E-DPCCH are defined.
The **HSUPA uplink transmitter and receiver structure** block diagram for E-DPDCH is shown below:



In HSUPA downlink, three new channels E-AGCH, E-HICH and E-RGCH are defined. The HSUPA downlink physical layer structure is almost the same as 3GPP FDD with HSDPA defined in release 5 and previous released versions. All downlink physical channels including three new channels are spread, QPSK-mapped and scrambled separately and then combined as the downlink signal. The structure of downlink transmitter and receiver can be found in 3GPP design library.

Specifications for E-DCH and E-DPDCH

- HSUPA E-DCH physical layer categories are shown in the **FDD E-DCH physical layer categories** table below:

E-DCH category	Maximum number of E-DPDCH transmitted	Minimum spreading factor of E-DPDCH	Support for 10 and 2 ms TTI E-DCH	Maximum number of bits of an E-DCH transport block transmitted within a 10 ms E-DCH TTI	Maximum number of bits of an E-DCH transport block transmitted within a 2 ms E-DCH TTI
Category 1	1	SF4	10 ms TTI only	7110	-
Category 2	2	SF4	10 ms and 2 ms TTI	14484	2798
Category 3	2	SF4	10 ms TTI only	14484	-
Category 4	2	SF2	10 ms and 2 ms TTI	20000	5772
Category 5	2	SF2	10 ms TTI only	20000	-
Category 6	4	SF2	10 ms and 2 ms TTI	20000	11484
Category 7	4	SF2	10 ms and 2 ms TTI	20000	22996
NOTE: When 4 codes are transmitted in parallel, two codes shall be transmitted with SF2 and two with SF4					

- The **physical channel parameters on E-DPDCH for E-DCH test** are shown in the table below:

TTI	Number of processes
2 ms	8
10 ms	4

HSUPA Component Libraries Overview

The HSUPA Library is categorized as below:
Channel Components:

- Multipath fading channel

Channel Coding Components:

- Turbo code as E-DCH forward error control code
- Revised TFCI Reed-Muller (RM) coding as E-DPCCH channel coding and signal quality indicator
- Orthogonal signature sequence as E-HICH/E-RGCH channel coding and signal quality indicator
- Rate match (puncturing and repetition) used to implement channel coding with flexible coding rate for E-DCH and E-AGCH
- Interleaving used to spread burst errors into random errors in order to improve the error correction code performance

Multiplex Components:

- Code segmentation used to adjust code block to suitable size
- Physical channel mapping used to map E-DCH to E-DPDCH
- Uplink spreader used to spread, power-scale and multiplex various uplink channels

Measurement Components :

- Throughput, BER and PER vs. retransmission time measurement
- Output power measurement as well as cubic metric calculator
- EVM and phase discontinuity measurements

Receiver Components:

- Rake receivers for HSUPA uplink and downlink
- Baseband receivers for HSUPA uplink and downlink
- RF receiver for HSUPA uplink and downlink Base Station and User Equipment Components

Signal Source Components:

- E-DCH information bit source which support HARQ process
- Uplink fixed reference channel in baseband and RF
- Uplink general signal source in baseband and RF
- Downlink signal source for E-AGCH and E-HICH/E-RGCH
- Downlink general signal source in baseband and RF

Design Examples

The RF characteristics can be measured using the HSUPA 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 HSUPA_BS_Rx_wrk workspace shows base station receiver performance on E-DCH. Designs for these measurements include:
    - E-DPDCH demodulation performance: BS_Rx_Demodulation
    - E-DPDCH demodulation performance in fading channel: BS_Rx_DemodulationFading
    - E-DPCCH missed detection: BS_Rx_MissedDetection
    - E-DPCCH missed detection in fading channel: BS_Rx_MissedDetectionFading
    - E-DPCCH false alarm: BS_Rx_FalseAlarm
    - E-DPCCH false alarm in fading channel: BS_Rx_FalseAlarmFading

- The HSUPA_UE_Rx_wrk workspace shows HSUPA user equipment receiver performance. Designs for these measurements include:
    - E-AGCH demodulation performance: UE_Rx_EAGCH_Demodulation
    - E-AGCH demodulation performance in fading channel: UE_Rx_EAGCH_DemodulationFading
    - E-HICH detection performance: UE_Rx_EHICH_Detection
    - E-HICH detection performance in fading channel: UE_Rx_EHICH_DetectionFading
    - E-RGCH detection performance: UE_Rx_ERGCH_Detection
    - E-RGCH detection performance in fading channel: UE_Rx_ERGCH_DetectionFading

- The HSUPA_UE_Tx_wrk workspace demonstrates user equipment transmitter measurement characteristics. Designs for these measurements include:
    - Adjacent channel leakage power ratio measurements: UE_Tx_ACLR
    - CCDF and peak-to-mean information measurements: UE_Tx_CCDF
    - Error vector magnitude and phase discontinuity measurements: UE_Tx_EVM
    - Maximum power measurements: UE_Tx_Max_Power
    - Spectrum emission measurements: UE_Tx_SpecEmissions

- The HSUPA_RF_Verification_wrk workspace has only one WTB-like design:
    - HSUPA_UE_TX_test

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
E-AGCH	E-DCH absolute grant channel
E-DCH	enhanced DCH
E-DPCCH	E-DCH HARQ acknowledgement indicator channel
E-DPDCH	E-DCH relative grant channel
E-HICH	E-DCH dedicated physical control channel
E-RGCH	E-DCH dedicated physical data channel
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.

HSUPA Base Station Receiver Design Examples

The HSUPA_BS_Rx_wrk workspace shows base station receiver measurement performances, including E-DPDCH demodulation performance, E-DPCCH signaling false alarm performance, and E-DPCCH signaling missed detection performance.

Designs for these measurements are described in the following sections; they include:

- Demodulation performance:
  - BS_Rx_Demodulation
  - BS_Rx_DemodulationFading
- Signaling detection performance - false alarm:
  - BS_RX_FalseAlarm
  - BS_RX_FalseAlarmFading
- Signaling detection performance - missed detection:
  - BS_RX_MissedDetection
  - BS_RX_MissedDetectionFading

Designs under this workspace consist of:

- Uplink RF band signal source: HSUPA_FRC_RF is used to provide an RF HSUPA uplink 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.
- Base station RF receiver: HSUPA_FRC_ReceiverRF is used to provide a receiver of RF HSUPA uplink signals.

Demodulation Performance Measurements

Design: BS_Rx_DemodulationFading, BS_Rx_Demodulation, BS_RX_Demodulation_FRC8

Features:

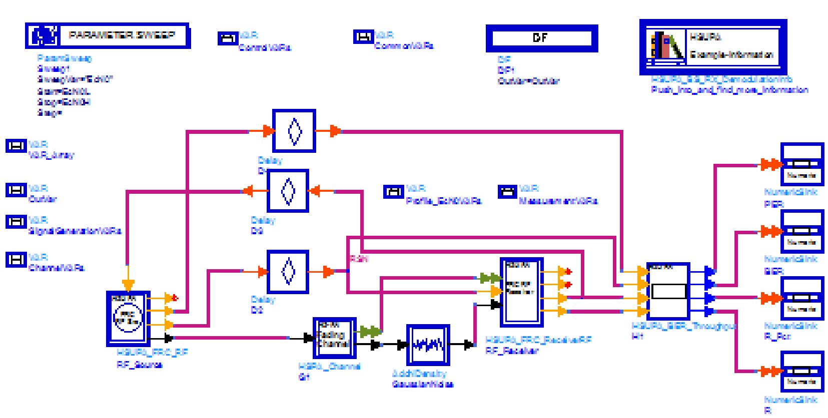
- Base station receiver demodulation performance measurements
- Uplink fixed reference channel (FRC) and receiver
- ARQ (feedback) controlled source
- Integrated RF models
- Throughput (R)
- Multiple E_c/N_0 measurement points
- Multi-path fading propagation conditions

Description:

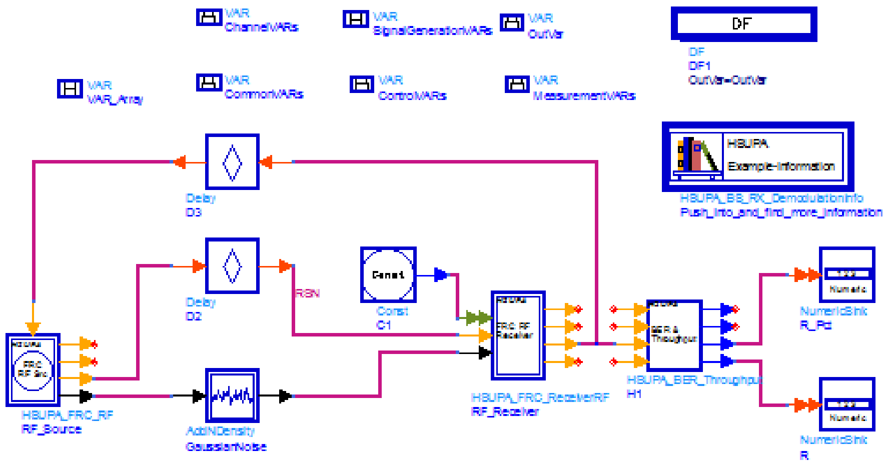
- BS_Rx_DemodulationFading measures base station receiver E-DPDCH demodulation performance according to section 8.11 in TS 25.104.
- BS_Rx_Demodulation measures base station receiver E-DPDCH demodulation performance over AWGN condition to provide the baseline reference.
- BS_Rx_DemodulationFading_FRC8 measures base station receiver E-DPDCH demodulation performance according to section 8.11 in TS 25.104.

The schematics of fading and AWGN conditions are shown in BS_Rx_DemodulationFading Schematic and BS_Rx_Demodulation Schematic respectively.

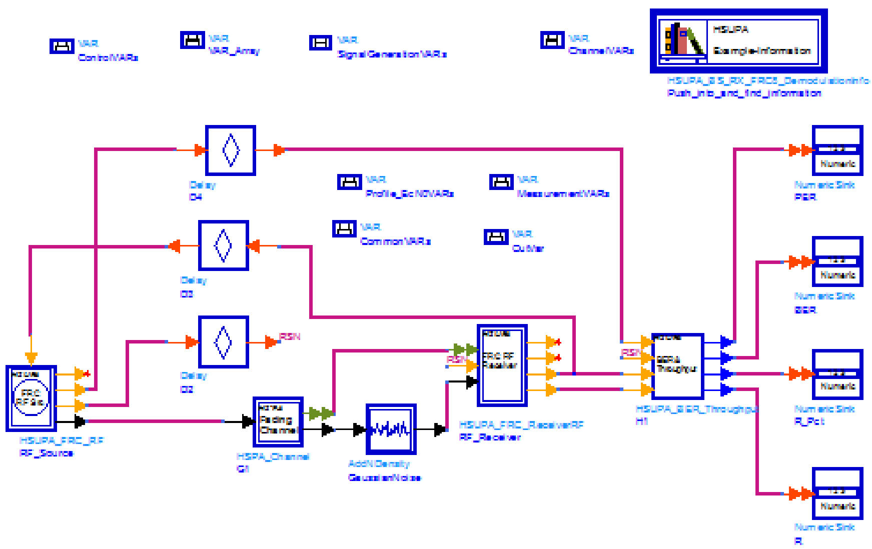
BS_Rx_DemodulationFading Schematic



BS_Rx_Demodulation Schematic



BS_Rx_DemodulationFading_FRC8 Schematic



Simulation Results:

Simulation results are shown in Throughput Results (R) for Base Station Demodulation Performance Measurement (Fading) and Throughput Results (R) for Base Station Demodulation Performance Measurement (AWGN).

Throughput Results (R) for Base Station Demodulation Performance Measurement (Fading)

HSUPA E-DPDCH Demodulation Performance Fading--Tables

RefCH	Profile	...(FCarrier[0,0])/(1 MHz)	...ignalPower_dBm[0,0])
FRC4 FRC4	PA3 PA3	1950.000	24.000

Throughput results

Index	R		R_Pct	
	EcN0=-7.100	EcN0=-0.600	EcN0=-7.100	EcN0=-0.600
500	207.101	399.989	0.408	0.788

3GPP Specification TS 25.104 (2006-3) Section 8.11

Specification requirements	Test results
R >= 30% and R >= 70% of maximum information bit rate at given Ec/N0 For PA3 channel simulation, Ec/N0 are -7.1 and -0.6 dB	Passed

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

Throughput Results (R) for Base Station Demodulation Performance Measurement (AWGN)

HSUPA E-DPDCH Demodulation Performance Tables

real(FCarrier[0,0])/(1 MHz)	...l(SignalPower_dBm[0,0])	real(SourceR[0,0])
1950.000	24.000	50.000

Throughput results

Index	R		R_Pct	
	EcN0=-5.300	EcN0=0.500	EcN0=-5.300	EcN0=0.500
10000	674.200	1276.826	0.498	0.944

3GPP Specification TS 25.104 (2006-3) Section 8.11

Specification requirements	Test results
R >= 30% and R >= 70% of maximum information bit rate at given Ec/N0 For AWGN simulation, Ec/N0 are -5.3 and 0.5 dB.	Passed

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

Throughput Results (R) for Base Station Demodulation Performance Measurement (Fading) for FRC8

HSUPA E-DPDCH Demodulation Performance Fading–Tables

real(FCarrier)/(1 MHz)	real(SignalPower_dBm)	RefCH	Profile
1950.000	24.000	FRC8	PA3

Throughput results

Index	R	R_Pct
501	5806.044	0.716

3GPP Specification TS 25.104 (2006-3) Section 8.11

Specification requirements

R >= 70% of maximum information bit rate at given Ec/N0
For PA3 channel simulation, Ec/N0 are 16.2dB

Test results

Passed

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

Benchmark:
Simulation time is about 8.3 hours for two sweep points of 500 10ms TTI over fading condition and 4 hours for two sweep points of 10000 2ms TTI over AWGN condition, on a P4/2.6GHz 512MB PC running ADS 2005A on Microsoft Windows 2000.

Signaling Detection Performance Measurements - False Alarm

Design: BS_RX_FalseAlarmFading, BS_RX_FalseAlarm

Features:

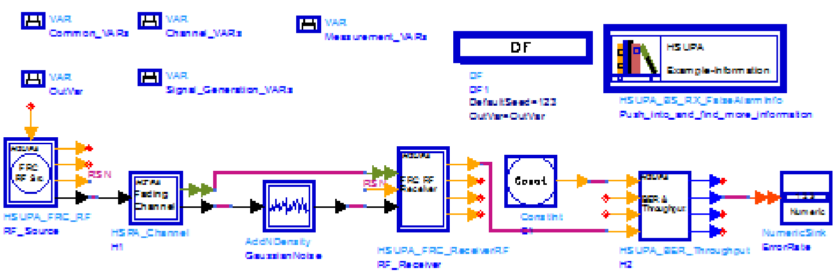
- Base station receiver E-DPCCH signaling detection performance measurements
- Uplink fixed reference channel (FRC) and receiver
- Integrated RF models
- Multi-path fading propagation conditions

Description:

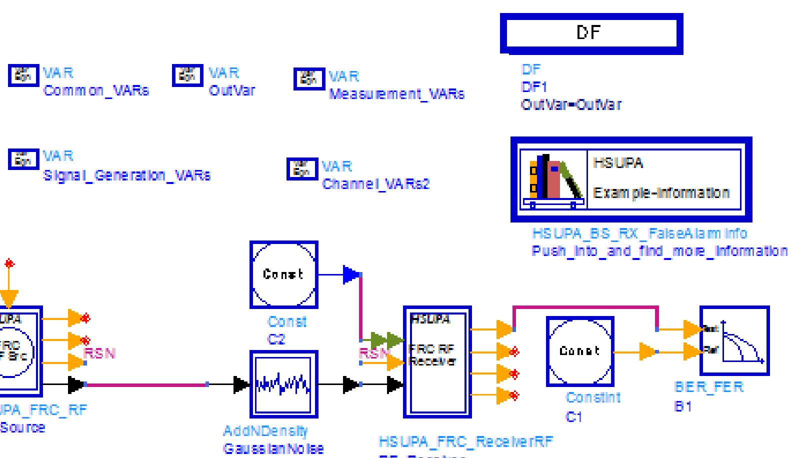
- BS_RX_FalseAlarmFading measures base station receiver E-DPCCH signaling false alarm performance according to section 8.12 in TS 25.104.
- BS_RX_FalseAlarm measures base station receiver E-DPCCH signaling false alarm performance over AWGN condition to provide the baseline reference.

The schematics for BS_RX_FalseAlarmFading and BS_RX_FalseAlarm are shown in BS_RX_FalseAlarmFading Schematic and BS_RX_FalseAlarm Schematic respectively.

BS_RX_FalseAlarmFading Schematic



BS_RX_FalseAlarm Schematic



Simulation Results:

Simulation results are shown in False Alarm Results for Base Station Signaling Detection Performance Measurements (Fading) and False Alarm Results for Base Station Signaling Detection Performance Measurements (AWGN).

False Alarm Results for Base Station Signaling Detection Performance Measurements (Fading)

HSUPA E-DPCCH False Alarm Fading--Tables

...l(FCarrier)/(1 MHz)	...ignalPower_dBm)	Profile	RefCH
1950.000	24.000	PB3	FRC1

False alarm results

real(EcN0)	ErrorRate
-13.800	0.004

3GPP Specification TS 25.104 (2006-3) Section 8.12

Specification requirements

Probability of false alarm < 1e-2 at given Ec/N0
For PB3 channel simulation, Ec/N0 is -13.8 dB.

Test results

Passed

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

False Alarm Results for Base Station Signaling Detection Performance Measurements (AWGN)

HSUPA E-DPCCH False Alarm--Tables

real(FCarrier)/(1 MHz)	...(SignalPower_dBm)	real(SourceR)
1950.000	24.000	50.000

Missed detection results

real(EcN0)	BER
-21.400	0.004

3GPP Specification TS 25.104 (2006-3) Section 8.12

Specification requirements

Probability of false alarm < 1e-2 at given Ec/N0
For AWGN channel, Ec/N0 is -21.4 dB.

Test results

Passed

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

Benchmark:
Simulation time is about 14.7 hours for 5000 2ms TTI over fading (PB3) condition and 1.5 hours for 10000 2ms TTI over AWGN condition, on a P4/2.6GHz 512MB PC running ADS 2005A on Microsoft Windows 2000.

Signaling Detection Performance Measurements - Missed Detection

Design: BS_RX_MissedDetectionFading, BS_RX_MissedDetection

Features:

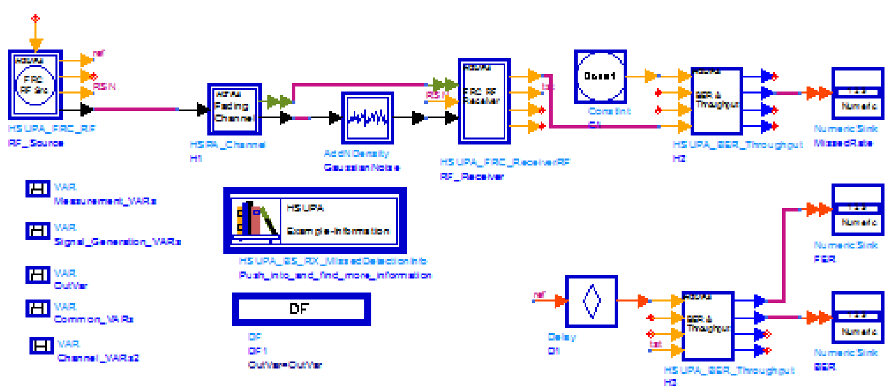
- Base station receiver E-DPCCH signaling detection performance measurements
- Uplink fixed reference channel (FRC) and receiver
- Integrated RF models
- Multi-path fading propagation conditions

Description:

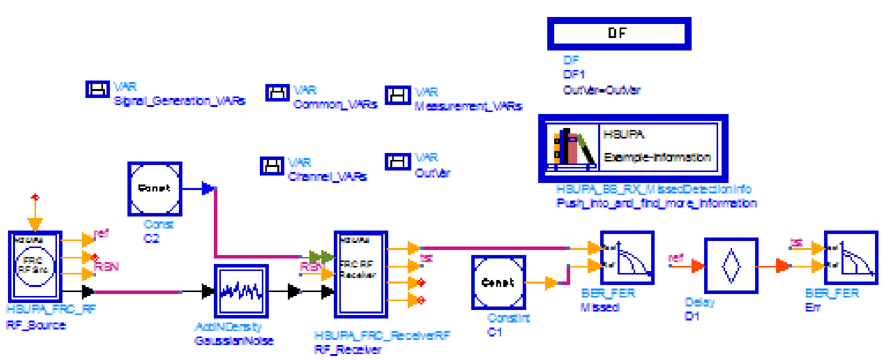
- BS_RX_MissedDetectionFading measures base station receiver E-DPCCH signaling missed detection performance according to section 8.12 in TS 25.104.
- BS_RX_MissedDetection measures base station receiver E-DPCCH signaling missed detection performance over AWGN condition to provide the baseline reference.

The schematics for fading and AWGN conditions are shown in BS_RX_MissedDetectionFading Schematic and BS_RX_MissedDetection Schematic respectively.

BS_RX_MissedDetectionFading Schematic



BS_RX_MissedDetection Schematic



Simulation Results:
Simulation results are shown in Missed Detection Results for Base Station Signaling Detection Performance Measurements (Fading) and Missed Detection Results for Base Station Signaling Detection Performance Measurements (AWGN).

Missed Detection Results for Base Station Signaling Detection Performance Measurements (Fading)

HSUPA E-DPCCH Missed Detection Fading--Tables

real(FCarrier)/(1 MHz)	...SignalPower_dBm)	RefCH	Profile
1950.000	24.000	FRC1	PB3

Missed detection results

real(EcN0)	MissedRate
1.500E0	4.000E-4

Error rate result

FER	BER
0.000	0.000

3GPP Specification TS 25.104 (2006-3) Section 8.12

Specification requirements	Test results
Probability of Missed Detection < 0.2% at given Ec/N0 For PB3 channel simulation, Ec/N0 is 1.5 dB.	Passed

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

Missed Detection Results for Base Station Signaling Detection Performance Measurements (AWGN)

HSUPA E-DPCCH Missed Detection--Tables

real(FCarrier)/(1 MHz)	real(SignalPower_dBm)	real(SourceR)
1950.000	24.000	50.000

Missed detection results

real(EcN0)	Missed.BER
-6.100	0.000

Error rate result

FER	Err.BER
0.000	0.000

3GPP Specification TS 25.104 (2006-3) Section 8.12

Specification requirements	Test results
Probability of Missed Detection < 0.2% at given Ec/N0 For AWGN channel simulation, Ec/N0 is -6.1 dB.	Passed

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

Benchmark:
Simulation time is about 15.5 hours for 5000 2ms TTI over fading (PB3) condition and 1.5 hours for 10000 2ms TTI over AWGN condition, on a P4/2.6GHz 512MB PC running ADS 2005A on Microsoft Windows 2000.

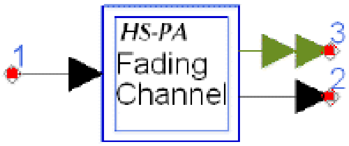
References

1. 3GPP Technical Specification TS 25.104, "UTRA (BS) FDD: Radio transmission and Reception," Version 7.10.0, Mar. 2008.

HSUPA Components

Contents

HSPA_Channel



Description: HSPA fading channel model
Library: HSUPA, Channel

Parameters

Name	Description	Default	Unit	Type	Range
RIn	Input resistance	DefaultRIn	Ohm	real	(0,∞)
ROut	Output resistance	DefaultROut	Ohm	real	(0,∞)
FreqBand	Frequency band: Band I II III IV, Band V VI	Band I II III IV		enum	
ChProfile	Channel profile: PA3, PB3, VA30, VA120, Case 8 for HSDPA CQI Test	VA30		enum	
VelocitySetting	Velocity setting: Follow ChProfile, User defined	Follow ChProfile		enum	
Velocity	Mobile velocity in km/hour	30		real	[1,500]
PathLoss	Option for inclusion of large-scale pathloss: NO, YES	NO		enum	
PropDistance	Propagation distance	2000	m	real	[500,5000]

Pin Inputs

Pin	Name	Description	Signal Type
1	input	channel input signal	timed

Pin Outputs

Pin	Name	Description	Signal Type
2	output	output signal	timed
3	outChM	fading factor	multiple complex

Notes/Equations

1. This subnetwork is the fading channel emulator.
2. Each firing, 1 output token and 1 outChM token are generated when 1 input token is consumed.
3. The input signal is fed into a multipath Rayleigh fading channel based on a tapped-delay line model.
4. The Doppler spectrum is classic. The way to generate the classic Doppler spectrum is to pass AWGN noise through a shaping filter. This filter is identical with the one used in CDMA2K_ClassicSpec which is available in CDMA2K design library.
5. Fading channel profiles defined for HSUPA and HSDPA in [4] and [5] are supported. The mobile speed, relative channel delay spread and average power are given in the tables below:

Propagation Conditions for Multi-Path Fading Environments for HSDPA and HSUPA Performance Requirements (Pedestrian Speed)

ITU Pedestrian A Speed 3 km/h (PA3)		ITU Pedestrian B Speed 3 km/h (PB3)	
Speed for Band I, II, III and IV3 km/h		Speed for Band I, II, III and IV3 km/h	
Speed for Band V, VI7 km/h		Speed for Band V, VI7 km/h	
RelativeDelay[ns]	Relative MeanPower[dB]	RelativeDelay[ns]	Relative MeanPower[dB]
0	0	0	0
110	-9.7	200	-0.9
190	-19.2	800	-4.9
410	-22.8	1200	-8.0
		2300	-7.8
		3700	-23.9

Propagation Conditions for Multi-Path Fading Environments for HSDPA and HSUPA Performance Requirements (Vehicular Speed)

ITU vehicular A Speed 30 km/h (VA30)		ITU vehicular A Speed 120 km/h (VA120)	
Speed for Band I, II, III and IV30 km/h		Speed for Band I, II, III and IV120 km/h	
Speed for Band V, VI71 km/h		Speed for Band V, VI282 km/h†	
RelativeDelay[ns]	Relative MeanPower[dB]	RelativeDelay[ns]	Relative MeanPower[dB]
0	0	0	0
310	-1.0	310	-1.0
710	-9.0	710	-9.0
1090	-10.0	1090	-10.0
1730	-15.0	1730	-15.0
2510	-20.0	2510	-20.0
† Speed above 120 km/h is applicable to demodulation performance requirements only.			

Propagation Conditions for CQI test in multi-path fading

Case 8, speed 30 km/h	
Relative Delay [ns]	Relative mean Power [dB]
0	0
976	-10

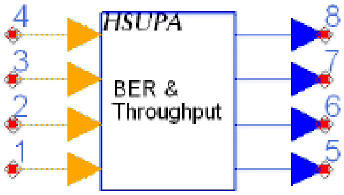
6. Users can also customize the speed of each channel profile as explained below:
   - Set VelocitySetting = User defined.
   - Set Velocity to the target speed.
7. If the input time step is too large, interpolation will be performed to up-sample the signal so that the resulted time step will be less than 1 nsec. Simulation time in the case of a large interpolation rate would increase; in other cases when the delay for a path is larger, the signals to be buffered and interpolated would increase which would lead to increased simulation time.
8. Path loss is calculated according to [3], when PathLoss set to YES.
   - For ITU PA3 and PB3, pass loss is $L=40 \log_{10} R+30 \log_{10} f + 49$;
   - For ITU VA30, VA120, pass loss is $L=40 (1 - 4\times10^{-3} \Delta h_b) \log_{10} R - 18 \log_{10} \Delta hb\ hb+21 \log_{10} f + 80$ dB where:

     R: base station – mobile station separation (km), which can be set using parameter PropDistance
     f: carrier frequency (MHz)
     Δh_b: base station antenna height (m), measured from the average rooftop level. Δh_b is fixed at 15m.

References

1. 3GPP Technical Specification TS 25.104, "UTRA (BS) FDD: Radio transmission and Reception," Version 6.12.0, Mar. 2006.
2. 3GPP Technical Specification TS 25.101, "UE Radio transmission and Reception (FDD)," Version 6.11.0, Mar. 2006.
3. Recommendation ITU-R M.1225, Guidelines for evaluation of radio transmission technologies for IMT-2000, 1997.

HSUPA_BER_Throughput



Description: EDCH BER and throughput calculator
Library: HSUPA, Measurement

Parameters

Name	Description	Default	Symbol	Type	Range
EDCH_Category	FDD E-DCH physical layer categories: Category 1, Category 2, Category 3, Category 4, Category 5, Category 6, Category 7	Category 6		enum	
TransBlockSize	Transport block size	2706	L	int	[1,max transport block size]†
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms		enum	
MaxRSN	Maximum retransmission sequence number	3		int	[0,3]
TransBlockIgnored	Transport block Ignored due to system delay	1		int	[0,5]

† Please refer to table of FDD E-DCH physical layer categories.

Pin Inputs

Pin	Name	Description	Signal Type
1	Rcvd	received bits	int
2	Parity	CRC result of received bits	int
3	RSN	retransmission sequence number	int
4	Ref	reference bits	int

Pin Outputs

Pin	Name	Description	Signal Type
5	R	throughput in kbps	real
6	R_Pct	throughput in percent	real
7	BER	bit error rate	real
8	PER	packet error rate	real

Notes/Equations

1. This model is used to estimate throughput as well as BER/PER vs. retransmission time of HSUPA uplink.
2. Each firing, MaxRSN+1 BER and PER tokens, one R and R_Pct tokens are produced when TransBlockSize Rcvd and Ref tokens, one parity token and one RSN token consumed.
3. All the input pins are optional. But at any time either pin parity or both pin Rcvd and Ref must be connected. If parity is connected, throughput is estimated. If pin Rcvd and Ref are connected, BER/PER is calculated.
4. When BER/PER is calculated, if RSN is connected, BER/PER vs. retransmission is calculated; if RSN is not connected, retransmission is not taken into account. That is,

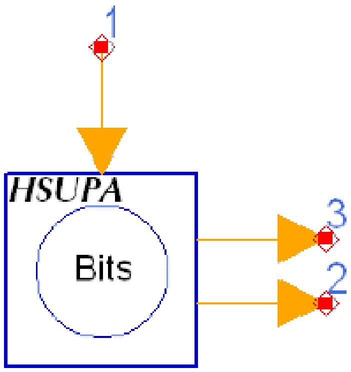
in this way this model can be used as common BER/FER calculator.

5. R_Pct is number of packet with Parity 1 divided by the total number of Parity received. R is R_Pct multiplied by information bit rate.

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 6.5.0, Mar. 2006.
4. 3GPP Technical Specification TS 25.104, "UTRA (BS) FDD: Radio transmission and Reception," Version 6.12.0, Mar. 2006.
5. 3GPP Technical Specification TS 25.141, "Base station conformance test," Version 6.13.0, Mar. 2006.

HSUPA_Bits



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

Parameters

Name	Description	Default	Symbol	Type	Range
EDCH_Category	FDD E-DCH physical layer categories: Category 1, Category 2, Category 3, Category 4, Category 5, Category 6, Category 7	Category 6		enum	
TransBlockSize	Transport block size	2706	L	int	[1,max transport block size]†
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms		enum	
MaxRSN	Maximum retransmission sequence number	3		int	[0,3]
HARQ_PrcssMode	Way to setting number of HARQ: Depending on TTI, User defined	Depending on TTI		enum	
NumHARQ	Number of HARQ processes	4		int	[2,8]
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]

† Please refer to table of FDD E-DCH physical layer categories.

Pin Inputs

Pin	Name	Description	Signal Type
1	ARQ	automatic repeat request	int

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	output	int
3	RSN	retransmission sequence number	int

Notes/Equations

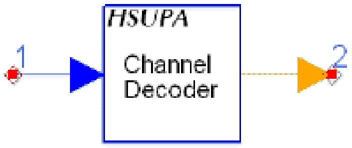
1. This model is used to generate information bits packet by packet for use of HSUPA uplink transport channel. HARQ process is also implemented in this model. Each firing, TransBlockSize Output tokens and one RSN token are generated when one ARQ token consumed. Note that ARQ pin is optional. When no output pin connected to it, no ARQ token is consumed.

2. The input value of ARQ is better to be in the range of but not limited to the set of 0 and 1. If the input of ARQ is 0, it means NACK and the correspondent packet is not received correctly. Otherwise, it means ACK and the correspondent packet is received correctly.
3. If ACK is received, UE will transmit new packet within current HARQ process. If NACK is received, UE will re-transmit the packet. The maximum re-transmission number is determined by parameter MaxRSN. if the re-transmission number is larger than MaxRSN, then this packet will be discarded and a new packet will be transmitted.
4. The delay for ARQ is fixed to NumHARQ * TTI. If HARQ_PrcssMode is set to *Depending on TTI* , NumHARQ is set to 8 for TTI 2ms and 4 for TTI 10 ms. Otherwise, the user can set the value of NumHARQ. For example, if 2ms TTI is used, UE will get the ARQ signal of the first packet when it send the ninth packet.
5. The output of RSN is the retransmission number of current packet. If it is a new packet, RSN is 0; if not, RSN can be 1, 2,..., MaxRSN incrementally.
6. For the DataPattern parameter:
   - If Random is selected, random bits is 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 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.
4. 3GPP Technical Specification TS 25.104, "Base Station (BS) radio transmission and reception (FDD)," Version 7.10.0, Mar. 2008.
5. 3GPP Technical Specification TS 25.141, "Base station (BS) conformance testing (FDD)," V7.11.0, Mar. 2008.
6. 3GPP Technical Specification TS 25.306, "UE Radio Access capabilities," Version 7.8.0, Sep. 2008.
7. CCITT, Recommendation O.151(10/92).
8. CCITT, Recommendation O.153(10/92).

HSUPA_ChDecode



Description: EDCH turbo decoder
Library: HSUPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Symbol	Type	Range
EDCH_Category	FDD E-DCH physical layer categories: Category 1, Category 2, Category 3, Category 4, Category 5, Category 6, Category 7	Category 6		enum	
TransBlockSize	Transport block size	2706	L	int	[1,max transport block size]†
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms		enum	
TC_Iteration	Turbo code decoder iteration number	4		int	[1,10]
TC_Alfa	Alfa of lowpass filter	0.4		real	[0,1.0)

† Please refer to table of FDD E-DCH physical layer categories.

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	input	real

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	output	int

Notes/Equations

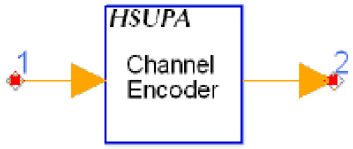
1. This model is used to implement channel decoding in one code block for HSUPA uplink.
2. Each firing, (code block size) Output tokens are generated while (code block size * 3 + 12) Input tokens consumed.
3. A simple way to get the value of code block number, code block size and the number of padding bits and their relationship with the value of TransBlockSize is just to run the model HSUPA_CodeBlkSeg with wanted TransBlockSize in a minimal runnable design. The information will then be displayed in the simulation window.
4. A iterative Turbo MAP decoder using modified BAHL et al. algorithm [4][5] is used in this model. The iterative number can be set from 1 through to 10 through parameter TC_Iteration.
5. Alfa low-pass filter can be used to lower the variance of estimation of noise power, when noise power does not vary significantly block by block.
6. $\mathbf{P}_{\mathbf{noise}} = P_{noise} \times (1-\alpha) + P_{noise\_current\_block} \times \alpha$ Where α can be set by parameter TC_Alfa.

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 6.5.0, Mar. 2006.
4. 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.
5. C. Berrou and A. Glavieus. "Near optimum error correcting coding and decoding: turbo-codes", IEEE Trans. Comm., pp. 1261-1271, Oct. 1996.

HSUPA_ChEncode



Description: EDCH turbo encoder
Library: HSUPA, Multiplexers & Coders

Parameters

Name	Description	Default	Symbol	Type	Range
EDCH_Category	FDD E-DCH physical layer categories: Category 1, Category 2, Category 3, Category 4, Category 5, Category 6, Category 7	Category 6		enum	
TransBlockSize	Transport block size	2706	L	int	[1,max transport block size]†
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms		enum	

† Please refer to table of FDD E-DCH physical layer categories.

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	input	int

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	output	int

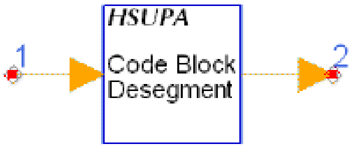
Notes/Equations

1. This model is used to implement turbo code defined in 4.8.3 in [2] for HSUPA uplink.
2. Each firing, (code block size * 3 + 12) Output tokens are generated while (code block size) Input tokens consumed.
3. A simple way to get the value of the code block number, code block size and the number of padding bits and their relationship with the value of TransBlockSize is to run the model HSUPA_CodeBlkSeg with wanted TransBlockSize in a minimal runnable design. The information will then be displayed in the simulation window.

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 6.5.0, Mar. 2006.

HSUPA_CodeBlkDeseg



Description: EDCH code block desegmentation
Library: HSUPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Symbol	Type	Range
EDCH_Category	FDD E-DCH physical layer categories: Category 1, Category 2, Category 3, Category 4, Category 5, Category 6, Category 7	Category 6		enum	
TransBlockSize	Transport block size	2706	L	int	[1,max transport block size]†
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms		enum	

† Please refer to table of FDD E-DCH physical layer categories.

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	input	int

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	output	int

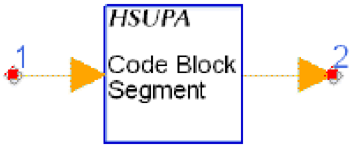
Notes/Equations

1. This model is used to combine the decoded bits of each code block and recover the transport block.
2. This model implements the converse operation of HSUPA_CodeBlkSeg. For more information, see *HSUPA_CodeBlkSeg* (hsupa).

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 6.5.0, Mar. 2006.

HSUPA_CodeBlkSeg



Description: EDCH code block segmentation
Library: HSUPA, Multiplexers & Coders

Parameters

Name	Description	Default	Symbol	Type	Range
EDCH_Category	FDD E-DCH physical layer categories: Category 1, Category 2, Category 3, Category 4, Category 5, Category 6, Category 7	Category 6		enum	
TransBlockSize	Transport block size	2706	L	int	[1,max transport block size]†
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms		enum	

† Please refer to table of FDD E-DCH physical layer categories.

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	input	int

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	output	int

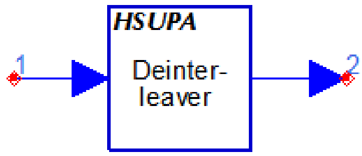
Notes/Equations

1. This model is used to segment uplink transport block into suitable size to fit the encoder.
2. Each firing, TransBlockSize+24 Input tokens are consumed. The Output tokens generated are generally the same as the Input tokens consumed. But padding bits may be appended depending on the algorithm described in 4.8.2 in [2].
3. If no padding bits are appended, the input and output of this model are the same.
4. A simple way to get the value of code block number, code block size and the number of padding bits and their relationship with the value of TransBlockSize is to run this model in a minimal runnable design. The information will then be displayed in the simulation window.

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 6.5.0, Mar. 2006.

HSUPA_Deinterleaver



Description: EDCH deinterleaver
Library: HSUPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Symbol	Type	Range
EDCH_Category	FDD E-DCH physical layer categories: Category 1, Category 2, Category 3, Category 4, Category 5, Category 6, Category 7	Category 6		enum	
TransBlockSize	Transport block size	2706	L	int	[1,max transport block size]†
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms		enum	
PuncLimit	Puncturing limit for uplink	0.468		real	[PLmax , 1]‡
maxNumElement_Set0	maximum number of element in Set0	11		int	[1,11]

†Please refer to table of FDD E-DCH physical layer categories.
‡PLmax is 0.33 for Category 6 and is 0.44 for all other categories.

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	input	real

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	output	real

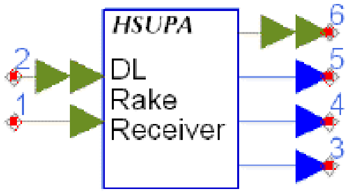
Notes/Equations

1. This model is used to implement channel de-interleaving for HSUPA uplink. Function of this model is exactly converse of that of HSUPA_Interleaver.
2. For more information, see *HSUPA_Interleaver* (hsupa).

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 6.5.0, Mar. 2006.

HSUPA_DL_Rake



Description: HSUPA downlink Rake receiver
Library: HSUPA, Receivers

Parameters

Name	Description	Default	Type	Range
ScrambleCode	index of scramble code	0	int	[0,512] for downlink; [0, 16777215] for uplink
ScrambleOffset	scramble code offset	0	int	[0,15]
ScrambleType	scramble code type: normal, right, left	normal	enum	
SampleRate	sample rate	8	int	[1,256]
MaxDelaySample	maximum delay boundary, in terms of samples	0	int	[0,2559] for RAKE receiver; [0,102400] in other models
ChannelType	select the channel type to be processed: CH_GAUSSIAN, CH_FADING	CH_GAUSSIAN	enum	
ChannelInfo	fading channel information source: Known, Estimated	Known	enum	
ChannelInfoOffset	offset between spread code and channel information in terms of sample	0	int	[0,MaxDelaySample]
PathSearch	path search frequency: EverySlot, Once	Once	enum	
SearchMethod	path search method: Coherent, NonCoherent, Combined	Coherent	enum	
SearchSlotsNum	number of slots for path search	1	int	[1,12]
PathNum	number of Rake fingers	1	int	[1,6]
PathDelaySample	delay for each finger, in terms of samples	0	int array	[0,MaxDelaySample]; array size shall be equal to PathNum
EstSlotsNum	Number of slots for channel estimation	1	int	[1,3]
EHI_ERG_SpreadCode	Spreading code for E-HICH and E-RGCH	19	int	[0,127]
EAGCH_SpreadCode	Spreading code for E-AGCH	100	int	[0,255]
RxEHICH_ERGCH	Switch of EHICH and/or ERGCH demodulation: OFF, ON	ON	enum	
RxEAGCH	Switch of EAGCH demodulation: OFF, ON	ON	enum	

† [0:5] for uplink DPCCH;
[0:16] for downlink DPCH;
[0:17] for downlink SCCPCH;
[0:5] for uplink PCPCH (Ver 03_00);
[0:2] for uplink PCPCH (Ver 12_00);
[0:1] for uplink PCPCH (Ver 03_02).

Pin Inputs

Pin	Name	Description	Signal Type
1	inChip	input data stream	complex
2	inChM	input known channel information	multiple complex

Pin Outputs

Pin	Name	Description	Signal Type
3	HI_RG	E-HICH or E-RGCH	real
4	EAGCH_Sym	absolute grant value index of E-AGCH	real
5	symCPI	symbols of CPICH	real
6	outChM	estimated channel information	multiple complex

Notes/Equations

1. This model is used to demodulate and despread 3GPP/HSUPA downlink signals (E-HICH, E-RGCH, and E-AGCH) with chip rate at 3.84 MHz. These signals may have multipath fading channel and additive Gaussian noise corruption.
2. 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.
3. The signal processing flow inside the model is:
   - Input data until slots specified by SearchSlotsNum are received
   - Slot index identification
   - SCH code index identification
   - IQ offset correction, to eliminate any DC component
   - Multipath search
   - Channel estimate for each path
   - Decoding and despreading of individual path
   - Multipath combining
   - Output decoded data to align at the slot boundary
   - Output channel information (slots delayed are specified by SearchSlotsNum).
4. This model can be configured to work under ideal conditions; in other words, the real time channel information can be input from the input pin and the path delay information can be set by PathDelaySample. ChannelInfo determines if channel information is pin input or estimated inside the model. The delay for each path is expressed in terms of samples as individual elements in the array.
   If path delay is known from the parameter, it is recommended to set the parameter SearchSlotsNum to 1, in order to save the simulation time.
5. If the first element in PathDelaySample is zero, the path searching is performed inside the receiver model. Otherwise, the numbers specified by PathDelaySample are taken as the delays for each path.
6. 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.
7. If SearchMethod = Coherent, correlation will be performed at the pilot bits only. If the SearchMethod = NonCoherent, correlation will be performed on the data field. Note that the coherent correlation obtained over pilot bits is unbiased, while the non-coherent correlation is biased. If SearchMethod = Combined, the coherent and non-coherent correlations are summed as the matrix for path resolution.
8. Another factor that impacts the correlation is the SearchSlotsNum parameter. This parameter sets the number of slots over which the correlation is accumulated. More

slots are necessary for a reliable path resolution for signals with noise contamination. Usually, six slots are required if Eb/N0 is 2 dB. The user must determine the appropriate slot number and search method for the best trade-off between accuracy and speed.

9. If the path delay is fixed, the path search is necessary only at the start of simulation. In this case, set PathSearch=Once to save simulation time. Otherwise, the path search will be performed for each slot received to update the dynamic path delay information.
10. Channel estimation varies according to channel type.
    - If ChannelType = CH_GAUSSIAN, the channel is assumed to be time-invariant and the IQ phase shift is estimated using the pilot field of the signals received so far.
    - If ChannelType = CH_FADING, channel characteristics are assumed to be time-variant and more complicated channel estimation must be used. A simple channel estimation is used that takes the fading characteristic averaged over the pilot field of the current slot as the channel information for the entire slot.
11. Generally the pilot in current slots is enough for channel estimation. But if Eb/N0 is very low, while channel status varies relatively slowly, more slots are necessary for a reliable channel estimation. EstSlotsNum can be used to set number of slots used for channel estimation.
12. Channel information that is estimated on CPICH or known from input pins is output from pin outChM for reference. Each firing, 2560 tokens are produced as the channel information for the chips of the current demodulation slot.

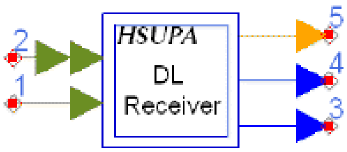
    > **Note**
    > If ChannelInfo = Estimated, CPICH must be included in the received signal for the Rake receiver to make the inside channel estimation.

13. 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.
14. This model can be used to decode E-AGCH and E-HICH / E-RGCH. These channels are assumed to be time-aligned. If decoding of a specific channel is not necessary, it can be disabled by relative parameters to reduce simulation time.
15. Each firing, the number of input tokens is 2560 × SampleRate. There is a delay in terms of slots associated with the decoded information. The results are output after the number of firings equals SearchSlotsNum.
16. If the 3GPP/HSUPA signal is S(t), this signal may be delayed t1 by some filters (such as the Tx RC filters). So, the delayed signal is S(t-t1) and the signal from 0 to t1 is zero and the real 3GPP signal transmission starts from t1. When the delayed signals pass through a fading channel, the fading factor is applied to the overall signals starting from time 0. The offset t1 must be known if the receiver of the channel information is input from outside; this offset is expressed in terms of samples.

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.

HSUPA_DL_Receiver



Description: HSUPA downlink receiver
Library: HSUPA, Receivers

Parameters

Name	Description	Default	Symbol	Type	Range
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms		enum	
EHICH_SqnIdx	Signature sequence index of EHICH	0		int	[0,39]
ERGCH_SqnIdx	Signature sequence index of ERGCH	1		int	[0,39]
EHI_ERG_SpreadCode	Spreading code for E-HICH and E-RGCH	19		int	[0,127]
EAGCH_SpreadCode	Spreading code for E-AGCH	100		int	[0,255]
ERNTI	E-DCH radio network temporary identifier	19		int	[0,65535]
ScrambleOffset	Scramble code offset	0		int	[0,15]
ScrambleType	Scramble code type: normal, right, left	normal		enum	
ScrambleCode	Index of scramble code	0		int	[0,512] for downlink; [0, 16777215] for uplink
SamplesPerChip	Samples per chip	8	S	int	[2,32]
MaxDelaySample	Maximum delay boundary, in terms of samples	0		int	[0,2559] for RAKE receiver; [0,102400] in other models
ChannelType	Select the channel type to be processed: CH_GAUSSIAN, CH_FADING	CH_GAUSSIAN		enum	
ChannelInfo	Fading channel information source: Known, Estimated	Known		enum	
ChannelInfoOffset	Offset between spread code and channel information in terms of sample	0		int	[0,MaxDelaySample]
PathSearch	Path search frequency: EverySlot, Once	Once		enum	
SearchMethod	Path search method: Coherent, NonCoherent,	Coherent		enum	

	Combined				
SearchSlotsNum	Number of slots for path search	1		int	[1,12]
PathNum	Number of Rake fingers	1		int	[1,6]
PathDelaySample	Delay for each finger, in terms of samples	0		int array	[0,MaxDelaySample]; array size shall be equal to PathNum
RxEHICH_ERGCH	Switch of EHICH and/or ERGCH demodulation: OFF, ON	ON		enum	
RxEAGCH	Switch of EAGCH demodulation: OFF, ON	ON		enum	
Threshold_EHICH	Threshold for decoding E-HICH	-32		real	(-∞,∞)
Threshold_ERGCH	Threshold for decoding E-RGCH	-20		real	(-∞,∞)

Pin Inputs

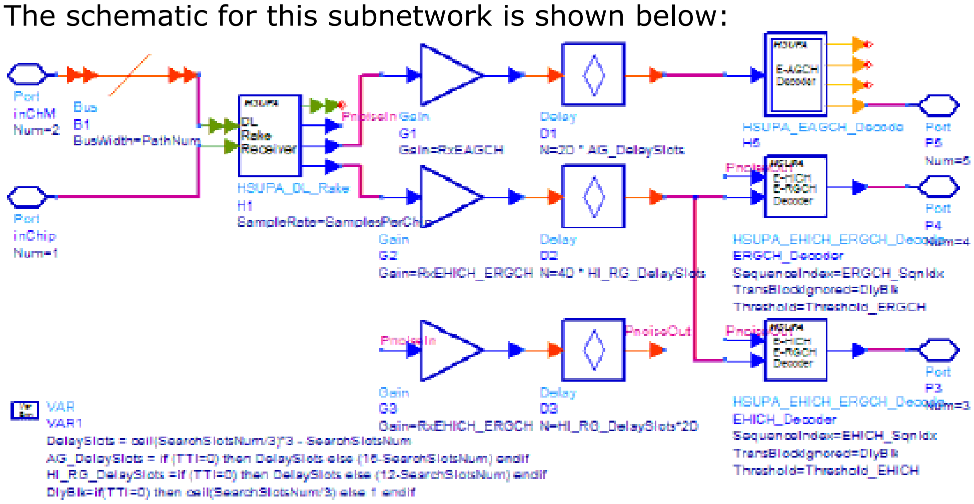
Pin	Name	Description	Signal Type
1	Input	input	complex
2	CH_M	channel information	multiple complex

Pin Outputs

Pin	Name	Description	Signal Type
3	EHICH	E-HICH	real
4	ERGCH	E-RGCH	real
5	EAGCH	E-AGCH	int

Notes/Equations

1. This subnetwork model is used to demodulate and decode HSUPA related downlink signals, i.e., E-DCH Absolute Grant Channel (E-AGCH), E-DCH Hybrid ARQ Indicator Channel (E-HICH), and E-DCH Relative Grant Channel (E-RGCH).
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. This model can be configured to work under ideal conditions; in other words, the real time channel information can be input from input pin and the path delay information can be set by PathDelaySample. ChannelInfo determines if channel information is pin

input or estimated inside the model. The delay for each path is expressed in terms of samples as individual elements in the array.
If path delay is known from the parameter, it is recommended to set the parameter SearchSlotsNum to 1, in order to save the simulation time.

5. If the first element in PathDelaySample is zero, the path searching is performed inside the receiver model. Otherwise, the numbers specified by PathDelaySample are taken as the delays for each path.
6. 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.
7. If SearchMethod = Coherent, correlation will be performed at the pilot bits only. If the SearchMethod = NonCoherent, correlation will be performed on the data field. Note that the coherent correlation obtained over pilot bits is unbiased, while the non-coherent correlation is biased. If SearchMethod = Combined, the coherent and non-coherent correlations are summed as the matrix for path resolution.
8. Another factor that impacts the correlation is the SearchSlotsNum parameter. This parameter sets the number of slots over which the correlation is accumulated. More slots are necessary for a reliable path resolution for signals with noise contamination. Usually, 6 slots are required if Eb/No is 2 dB. The user must determine the appropriate slot number and search method for the best trade-off between accuracy and speed.
9. If the path delay is fixed, the path search is necessary only at the start of simulation. In this case, set PathSearch=Once to save simulation time. Otherwise, the path search will be performed for each slot received to update the dynamic path delay information.
10. Channel estimation varies according to channel type.
    - If ChannelType = CH_GAUSSIAN, the channel is assumed to be time-invariant and the IQ phase shift is estimated using the pilot field of the signals received so far.
    - If ChannelType = CH_FADING, channel characteristics are assumed to be time-variant and more complicated channel estimation must be used. A simple channel estimation is used that takes the fading characteristic averaged over the pilot field of the current slot as the channel information for the entire slot.
11. Channel information that is estimated on CPICH or known from input pins.

    Note
    If ChannelInfo = Estimated, CPICH must be included in the received signal for the Rake receiver to make the inside channel estimation.

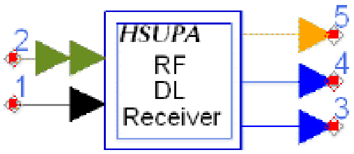
12. All paths are combined assuming that all paths are useful for improving the decoding reliability. In some cases, paths with low SNR are actually harmful to the final SNR improvement. The user must set PathNum for better decoding performance in multipath conditions.
13. This model can be used to decode E-AGCH and E-HICH / E-RGCH. These channels are assumed to be time-aligned. If decoding of a specific channel is not necessary, it can be disabled by relative parameters to reduce simulation time.
14. There is a delay in terms of slots associated with the decoded information, and it varies for different SearchSlotsNum and TTI combinations.
15. For more information regarding the Rake receiver and different channel decoders, please refer to the documents of HSUPA_DL_Rake, HSUPA_EAGCH_Decode, and HSUPA_EHICH_ERGCH_Decode 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. 2005.
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.

HSUPA_DL_ReceiverRF



Description: HSUPA downlink receiver
Library: HSUPA, Receivers

Parameters

Name	Description	Default	Symbol	Unit	Type	Range
RLoad	Input resistance	DefaultRLoad		Ohm	real	(0,∞)
FCarrier	Carrier frequency	1950MHz		Hz	real	(0,∞)
Phase	Reference phase in degrees	0.0		deg	real	(-∞,∞)
SamplesPerChip	Samples per chip	8	S		int	[2,32]
RRC_FilterLength	RRC filter length (chips)	16			int	[2,128]
ExcessBW	Excess bandwidth of raised cosine filters	0.22			real	(0.0,1.0)
ScrambleCode	Index of scramble code	0			int	[0,512] for downlink; [0, 16777215] for uplink
ScrambleOffset	Scramble code offset	0			int	[0,15]
ScrambleType	Scramble code type: normal, right, left	normal			enum	
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms			enum	
EHICH_SqnIdx	Signature sequence index of EHICH	0			int	[0,39]
ERGCH_SqnIdx	Signature sequence index of ERGCH	1			int	[0,39]
EHI_ERG_SpreadCode	Spreading code for E-HICH and E-RGCH	19			int	[0,127]
EAGCH_SpreadCode	Spreading code for E-AGCH	100			int	[0,255]
ERNTI	E-DCH radio network temporary identifier	19			int	[0,65535]
MaxDelaySample	Maximum delay boundary, in terms of samples	0			int	[0,2559] for RAKE receiver; [0,102400] in other models

ChannelType	Select the channel type to be processed: CH_GAUSSIAN, CH_FADING	CH_GAUSSIAN			enum	
ChannelInfo	Fading channel information source: Known, Estimated	Known			enum	
ChannelInfoOffset	Offset between spread code and channel information in terms of sample	0			int	[0,MaxDelaySample]
PathSearch	Path search frequency: EverySlot, Once	Once			enum	
SearchMethod	Path search method: Coherent, NonCoherent, Combined	Coherent			enum	
SearchSlotsNum	Number of slots for path search	1			int	[1,12]
PathNum	Number of Rake fingers	1			int	[1,6]
PathDelaySample	Delay for each finger, in terms of samples	0			int array	[0,MaxDelaySample]; array size shall be equal to PathNum
RxEHICH_ERGCH	Switch of EHICH and/or ERGCH demodulation: OFF, ON	ON			enum	
RxEAGCH	Switch of EAGCH demodulation: OFF, ON	ON			enum	
Threshold_EHICH	Threshold for decoding E-HICH	-32			real	(-∞,∞)
Threshold_ERGCH	Threshold for decoding E-RGCH	-20			real	(-∞,∞)

Pin Inputs

Pin	Name	Description	Signal Type
1	RF	input	timed
2	CH_M	channel information	multiple complex

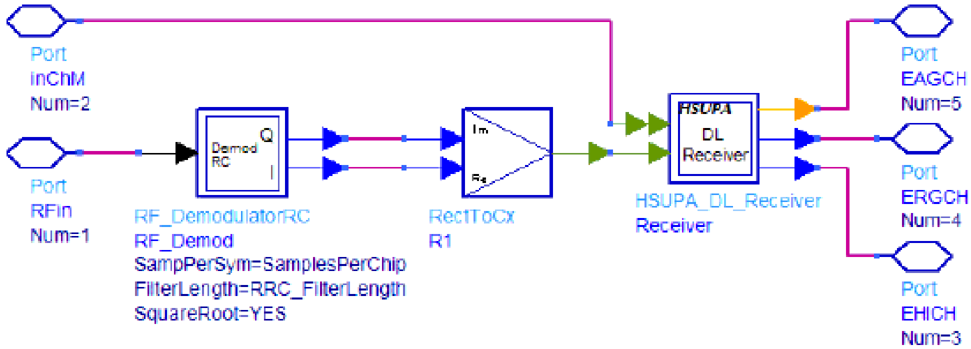
Pin Outputs

Pin	Name	Description	Signal Type
3	EHICH	E-HICH	real
4	ERGCH	E-RGCH	real
5	EAGCH	E-AGCH	int

Notes/Equations

1. This subnetwork model is used to demodulate and decode HSUPA related downlink RF signals, i.e., E-DCH Absolute Grant Channel (E-AGCH), E-DCH Hybrid ARQ Indicator Channel (E-HICH), and E-DCH Relative Grant Channel (E-RGCH).

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. This model can be configured to work under ideal conditions; in other words, the real time channel information can be input from input pin and the path delay information can be set by PathDelaySample. ChannelInfo determines if channel information is pin input or estimated inside the model. The delay for each path is expressed in terms of samples as individual elements in the array.
   If path delay is known from the parameter, it is recommended to set the parameter SearchSlotsNum to 1, in order to save the simulation time.
5. If the first element in PathDelaySample is zero, the path searching is performed inside the receiver model. Otherwise, the numbers specified by PathDelaySample are taken as the delays for each path.
6. 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.
7. If SearchMethod = Coherent, correlation will be performed at the pilot bits only. If the SearchMethod = NonCoherent, correlation will be performed on the data field. Note that the coherent correlation obtained over pilot bits is unbiased, while the non-coherent correlation is biased. If SearchMethod = Combined, the coherent and non-coherent correlations are summed as the matrix for path resolution.
8. Another factor that impacts the correlation is the SearchSlotsNum parameter. This parameter sets the number of slots over which the correlation is accumulated. More slots are necessary for a reliable path resolution for signals with noise contamination. Usually, six slots are required if Eb/N0 is 2 dB. The user must determine the appropriate slot number and search method for the best trade-off between accuracy and speed.
9. If the path delay is fixed, the path search is necessary only at the start of simulation. In this case, set PathSearch=Once to save simulation time. Otherwise, the path search will be performed for each slot received to update the dynamic path delay information.
10. Channel estimation varies according to channel type.
    - If ChannelType = CH_GAUSSIAN, the channel is assumed to be time-invariant and the IQ phase shift is estimated using the pilot field of the signals received so far.
    - If ChannelType = CH_FADING, channel characteristics are assumed to be time-variant and more complicated channel estimation must be used. A simple channel estimation is used that takes the fading characteristic averaged over the pilot field of the current slot as the channel information for the entire slot.
11. Channel information that is estimated on CPICH or known from input pins.

    > **Note**
    > If ChannelInfo = Estimated, CPICH must be included in the received signal for the Rake receiver to make the inside channel estimation.

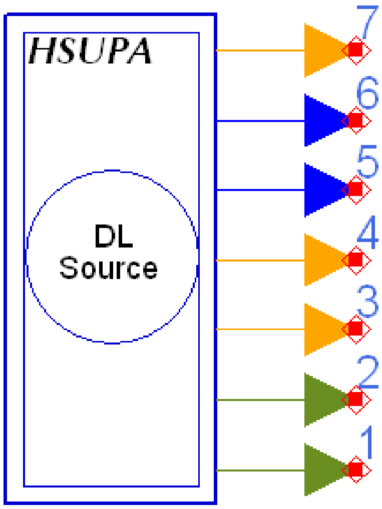
12. All paths are combined assuming that all paths are useful for improving the decoding

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.
13. This model can be used to decode E-AGCH and E-HICH / E-RGCH. These channels are assumed to be time-aligned. If decoding of a specific channel is not necessary, it can be disabled by relative parameters to reduce simulation time.
14. There is a delay in terms of slots associated with the decoded information, and it varies for different SearchSlotsNum and TTI combinations.
15. For more information regarding the Rake receiver and different channel decoders, please see *HSUPA_DL_Rake* (hsupa), *HSUPA_EAGCH_Decode* (hsupa), and *HSUPA_EHICH_ERGCH_Decode* (hsupa).

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 6.5.0, Mar. 2006.
4. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 6.8.0, Mar. 2006.
5. 3GPP Technical Specification TS 25.101, "UE Radio transmission and Reception (FDD)," Version 6.11.0, Mar. 2006.

HSUPA_DL_Source



Description: HSUPA downlink source
Library: HSUPA, Signal Sources

Parameters

Name	Description	Default	Type	Range
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms	enum	
EHICH_SgnlPttrn	E-HICH signal pattern	1.0	int array	[-1, +1]
ERGCH_SgnlPttrn	E-RGCH signal pattern	1.0	int array	[-1, +1]
EHICH_SqnIdx	Signature sequence index of EHICH	0	int	[0,39]
ERGCH_SqnIdx	Signature sequence index of ERGCH	1	int	[0,39]
EHI_ERG_SpreadCode	Spreading code for E-HICH and E-RGCH	19	int	[0,127]
EAGCH_SpreadCode	Spreading code for E-AGCH	100	int	[0,255]
ERNTI	E-DCH radio network temporary identifier	19	int	[0,65535]
EHICH_GainFactor	EHICH power gain in dB	1.0	real	(-∞,∞)
ERGCH_GainFactor	ERGCH power gain in dB	1.0	real	(-∞,∞)
EAGCH_GainFactor	EAGCH power gain in dB	1.0	real	(-∞,∞)
ScrambleOffset	Scramble code offset	0	int	[0,15]
ScrambleType	Scramble code type: normal, right, left	normal	enum	
ScrambleCode	Index of scramble code	0	int	[0,512] for downlink; [0, 16777215] for uplink
RefCh	Reference measurement channel:	DL_REF_12_2	enum	

	DL_REF_12_2, DL_REF_64, DL_REF_144, DL_REF_384			
DPCH_SpreadCode	Spread code index of DPCH	127	int	[0,127] for 12.2kbps; [0,31] for 64kbps; [0,15] for 144kbps; [0,7] for 384kbps
CPICH_SpreadCode	Spread code index of CPICH	2	int	[0,255]
PICH_SpreadCode	Spread code index of PICH	16	int	[0,255]
SCCPCH_SlotFormat	SCCPCH slot format	0	int	[0,17]
SCCPCH_SpreadCode	Spread code index of SCCPCH	3	int	[0,SpreadFactor-1]; SpreadFactor is set by SCCPCH_SlotFormat
DPCH_GainFactor	DPCH Ec over Ior in dB, valid only if PowerReference is Ior	1.0	real	(-∞,∞)
P_CPICH_GainFactor	Primary CPICH power gain in dB	1.0	real	(-∞,∞)
S_CPICH_GainFactor	Secondary CPICH power gain in dB	1.0	real	(-∞,∞)
PCCPCH_GainFactor	PCCPCH power gain in dB	1.0	real	(-∞,∞)
SCCPCH_GainFactor	SCCPCH power gain in dB	1.0	real	(-∞,∞)
P_SCH_GainFactor	Primary SCH power gain in dB	1.0	real	(-∞,∞)
S_SCH_GainFactor	Secondary SCH power gain in dB	1.0	real	(-∞,∞)
PICH_GainFactor	PICH power gain in dB	1.0	real	(-∞,∞)
OCNS_GainFactor	OCNS gain in dB, valid only if PowerReference is DPCH_Ec	1.0	real	(-∞,∞)
OCNS_ChannelNum	OCNS channel number	16	int	[1,512]
OCNS_PowerArray	OCNS channel power array in dB	-1 -3 -3 -5 -2 -4 -8 -7 -4 -6 -5 -9 -10 -8 -6 0	real array	(-∞,∞); the array size shall be equal to OCNS_ChannelNum
OCNS_SpreadFactorArray	OCNS 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 OCNS_ChannelNum
OCNS_SpreadCodeArray	OCNS spread code array	2 11 17 23 31 38 47 55 62 69 78 85 94 125 113 119	int array	[0,OCNS_SpreadFactorArray-1]; array size shall be equal to OCNS_ChannelNum; code conflict is checked
OCNS_DataPatternArray	OCNS data pattern array: 0-random, 1-PN9, 2-PN15, 3-Repeat Bits	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	int array	[0,1,2,3]; array size shall be equal to OCNS_ChannelNum
OCNS_RepBitValueArray	OCNS repeat bit value array	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	int array	[0,255]; array size shall be equal to OCNS_ChannelNum
OCNS_tOffsetArray	OCNS time offset in terms of 256 chips	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	int array	[0,149]; array size shall be equal to OCNS_ChannelNum

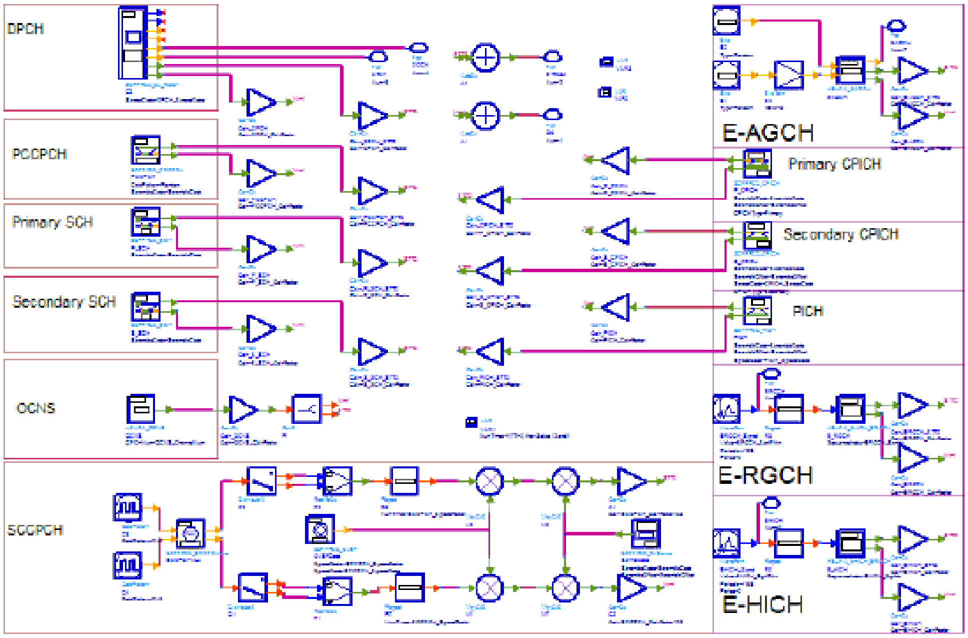
DTCHDataPattern	DTCH source data pattern: DTCH_random, DTCH_PN9, DTCH_PN15, DTCH_bits_repeat, DTCH_user_file	DTCH_random	enum	
DTCHRepBitValue	DTCH repeating data value	0xff	int	[0,255]
DTCHUserFileName	DTCH user-defined data file name	datafile.txt	filename	
DCCHDataPattern	DCCH source data pattern: DCCH_random, DCCH_PN9, DCCH_PN15, DCCH_bits_repeat, DCCH_user_file	DCCH_random	enum	
DCCHRepBitValue	DCCH repeating data value	0xff	int	[0,255]
DCCHUserFileName	DCCH user-defined data file name	datafile.txt	filename	
TPCDataPattern	Source data pattern: TPC_random, TPC_PN9, TPC_PN15, TPC_bits_repeat, TPC_user_file	TPC_random	enum	
TPCRepBitValue	TPC repeating data value	0xff	int	[0,255]
TPCUserFileName	TPC user-defined data file name	datafile.txt	filename	

Pin Outputs

Pin	Name	Description	Signal Type
1	Output	output	complex
2	STTD	space time transmit diversity output	complex
3	DTCH	DTCH data	int
4	DCCH	DCCH data	int
5	EHICH	E-HICH data	real
6	ERGCH	E-RGCH data	real
7	EAGCH	E-AGCH	int

Notes/Equations

1. This subnetwork model is used to simulate integrated 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 following table:

Physical Channel
P_CPICH
S_CPICH
PCCPCH
P_SCH
S_SCH
SCCPCH
PICH
DPCH
E-AGCH
E-HICH
E-RGCH
OCNS

4. The DPCH is generated by the fully-coded 3GPPFDD_DL_RefCh signal source.
5. DTCH, DCCH, and TPC patterns can be set through the DTCHDataPattern, DCCHDataPattern, and TPCDataPattern parameters; Five data patterns are supported: random, PN9, PN15, fixed repeated 8-bits, and user-defined file.
6. If the data pattern is 8-bits repeating, the bits to be repeated are set by the respective RepBitValue. For example if RepBitValue is set as 0x7a, bit sequence 0,1,1,1,1,0,1,0 will be output repeatedly.
7. 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.
8. The DPCH data rate can be set through RefCh. DPCH channelization code is set through DPCH_SpreadCode.
9. 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.
10. The PICH spread factor is 256. PICH channelization code is set through PICH_SpreadCode.
11. The PCCPCH channelization code is fixed at C256,1. The SCCPCH spread factor and spread channelization code are set through SCCPCH_SpreadFactor and

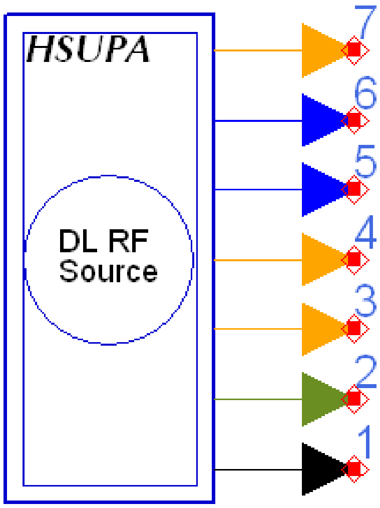
SCCPCH_SpreadCode.

12. The E-HICH can be set by EHICH_SgnlPttrn (Signal Pattern), EHICH_SqnIdx (Signature Sequence Index), and EHI_ERG_SpreadCode.
13. The E-RGCH can be set by ERGCH_SgnlPttrn (Signal Pattern), ERGCH_SqnIdx (Signature Sequence Index), and EHI_ERG_SpreadCode.
14. The E-AGCH can be set by EAGCH_SpreadCode and ERNTI.
15. 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.
16. 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 the baseband signal. A normalized downlink source can be implemented by HSUPA_DL_SourceRF.
17. 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, see *HSUPA_OCNS* (hsupa).

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 6.5.0, Mar. 2006.

HSUPA_DL_SourceRF



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

Parameters

Name	Description	Default	Symbol	Unit	Type	Range
ROut	Source resistance	DefaultROut		Ohm	real	(0,∞)
RTemp	Temperature	DefaultRTemp		Celsius	real	[-273.15,∞)
TStep	Expression showing how TStep is related to the other source parameters	1/3.84 MHz/SamplesPerChip			string	
FCarrier	Carrier frequency	1950MHz		Hz	real	(0,∞)
Power	Power, valid only if PowerReference setting is Ior	dbmtow(43.0)		W	real	[0,∞)
PowerReference	Reference for all channels with relative power level: Ior, DPCH__Ec	Ior			enum	
DPCH_Ec	Ec of DPCH in dBm/3.84 MHz	-100		dB	real	(-∞,∞)
MirrorSpectrum	Mirror spectrum about carrier?: NO, YES	NO			enum	
GainImbalance	Gain imbalance, Q vs I	0.0		dB	real	(-∞,∞)
PhaseImbalance	Phase imbalance, Q vs I	0.0		deg	real	(-∞,∞)
I_OriginOffset	I origin offset (percent)	0.0			real	(-∞,∞)
Q_OriginOffset	Q origin offset (percent)	0.0			real	(-∞,∞)
IQ_Rotation	IQ rotation	0.0		deg	real	(-∞,∞)
SamplesPerChip	Samples per chip	8	S		int	[2,32]

RRC_FilterLength	RRC filter length (chips)	16			int	[2,128]
ExcessBW	Excess bandwidth of raised cosine filters	0.22			real	(0.0,1.0)
ScrambleCode	Index of scramble code	0			int	[0,512] for downlink; [0, 16777215] for uplink
ScrambleOffset	Scramble code offset	0			int	[0,15]
ScrambleType	Scramble code type: normal, right, left	normal			enum	
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms			enum	
EHICH_SgnlPttrn	E-HICH signal pattern	1.0			int array	[-1, +1]
ERGCH_SgnlPttrn	E-RGCH signal pattern	1.0			int array	[-1, +1]
EHICH_SqnIdx	Signature sequence index of EHICH	0			int	[0,39]
ERGCH_SqnIdx	Signature sequence index of ERGCH	1			int	[0,39]
EHI_ERG_SpreadCode	Spreading code for E-HICH and E-RGCH	19			int	[0,127]
EAGCH_SpreadCode	Spreading code for E-AGCH	100			int	[0,255]
ERNTI	E-DCH radio network temporary identifier	19			int	[0,65535]
EHICH_GainFactor	EHICH power gain in dB	-28.3		dB	real	(-∞,∞)
ERGCH_GainFactor	ERGCH power gain in dB	-24.4		dB	real	(-∞,∞)
EAGCH_GainFactor	EAGCH power gain in dB	-23.2		dB	real	(-∞,∞)
RefCh	Reference measurement channel: DL_REF_12_2, DL_REF_64, DL_REF_144, DL_REF_384	DL_REF_12_2			enum	
DPCH_SpreadCode	Spread code index of DPCH	127			int	[0,127] for 12.2kbps; [0,31] for 64kbps; [0,15] for 144kbps; [0,7] for 384kbps
CPICH_SpreadCode	Spread code index of CPICH	2			int	[0,255]
PICH_SpreadCode	Spread code index of PICH	16			int	[0,255]
SCCPCH_SlotFormat	SCCPCH slot format	0			int	[0,17]
SCCPCH_SpreadCode	Spread code index of SCCPCH	3			int	[0,SpreadFactor-1]; SpreadFactor is set by

						SCCPCH_SlotFormat
DPCH_GainFactor	DPCH Ec over Ior in dB, valid only if PowerReference is Ior	-15		dB	real	(-∞,∞)
P_CPICH_GainFactor	Primary CPICH power gain in dB	-10.0		dB	real	(-∞,∞)
S_CPICH_GainFactor	Secondary CPICH power gain in dB	-300.0		dB	real	(-∞,∞)
PCCPCH_GainFactor	PCCPCH power gain in dB	-12		dB	real	(-∞,∞)
SCCPCH_GainFactor	SCCPCH power gain in dB	-300		dB	real	(-∞,∞)
P_SCH_GainFactor	Primary SCH power gain in dB	-15		dB	real	(-∞,∞)
S_SCH_GainFactor	Secondary SCH power gain in dB	-15		dB	real	(-∞,∞)
PICH_GainFactor	PICH power gain in dB	-15		dB	real	(-∞,∞)
OCNS_GainFactor	OCNS gain in dB, valid only if PowerReference is DPCH_Ec	-300		dB	real	(-∞,∞)
OCNS_ChannelNum	OCNS channel number	16			int	[1,512]
OCNS_PowerArray	OCNS channel power array in dB	-1 -3 -3 -5 -2 -4 -8 -7 -4 -6 -5 -9 -10 -8 -6 0			real array	(-∞,∞); the array size shall be equal to OCNS_ChannelNum
OCNS_SpreadFactorArray	OCNS 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 OCNS_ChannelNum
OCNS_SpreadCodeArray	OCNS spread code array	2 11 17 23 31 38 47 55 62 69 78 85 94 125 113 119			int array	[0,OCNS_SpreadFactorArray-1]; array size shall be equal to OCNS_ChannelNum; code conflict is checked
OCNS_DataPatternArray	OCNS data pattern array: 0-random, 1-PN9, 2-PN15, 3-Repeat Bits	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0			int array	[0,1,2,3]; array size shall be equal to OCNS_ChannelNum
OCNS_RepBitValueArray	OCNS repeat bit value array	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0			int array	[0,255]; array size shall be equal to OCNS_ChannelNum
OCNS_tOffsetArray	OCNS time offset in terms of 256 chips	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0			int array	[0,149]; array size shall be equal to OCNS_ChannelNum
DTCHDataPattern	DTCH source data pattern: DTCH_random, DTCH_PN9, DTCH_PN15, DTCH_bits_repeat, DTCH_user_file	DTCH_random			enum	
DTCHRepBitValue	DTCH repeating data value	0xff			int	[0,255]
DTCHUserFileName	DTCH user-defined data file name	datafile.txt			filename	
DCCHDataPattern	DCCH source data pattern:	DCCH_random			enum	

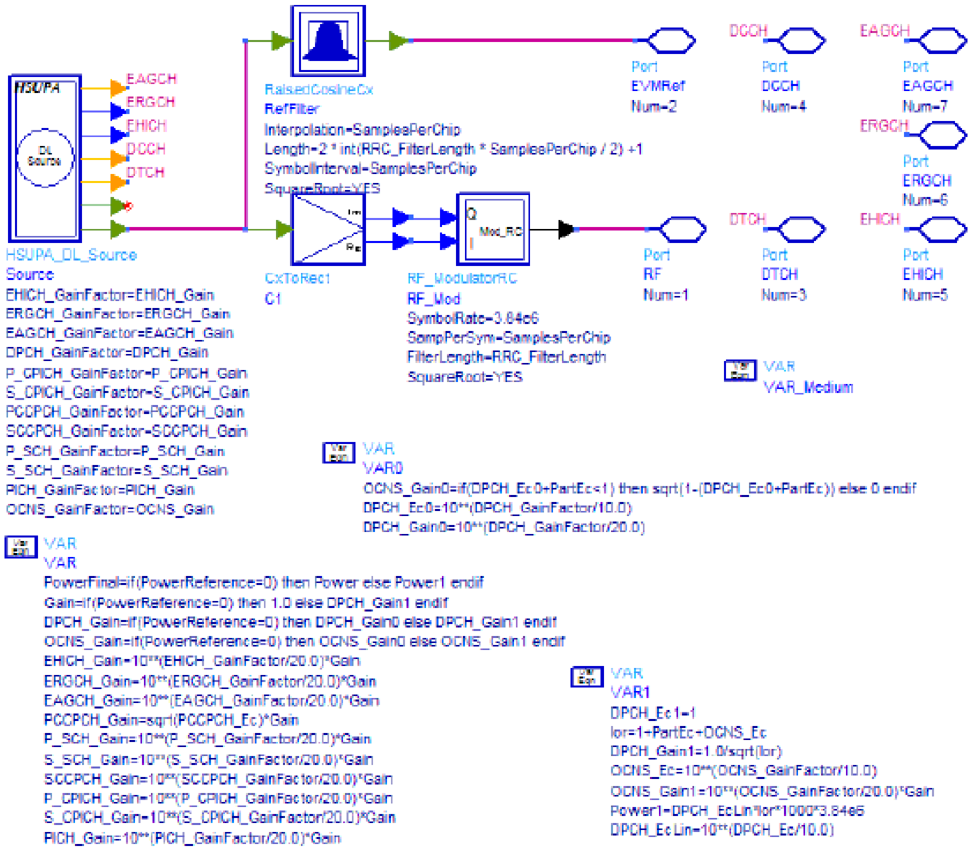
	DCCH_random, DCCH_PN9, DCCH_PN15, DCCH_bits_repeat, DCCH_user_file					
DCCHRepBitValue	DCCH repeating data value	0xff			int	[0,255]
DCCHUserFileName	DCCH user-defined data file name	datafile.txt			filename	
TPCDataPattern	Source data pattern: TPC_random, TPC_PN9, TPC_PN15, TPC_bits_repeat, TPC_user_file	TPC_random			enum	
TPCRepBitValue	TPC repeating data value	0xff			int	[0,255]
TPCUserFileName	TPC user-defined data file name	datafile.txt			filename	

Pin Outputs

Pin	Name	Description	Signal Type
1	RF	RF output	timed
2	EVM_Ref	reference signal for EVM	complex
3	DTCH	DTCH data	int
4	DCCH	DCCH data	int
5	EHICH	E-HICH data	real
6	ERGCH	E-RGCH data	real
7	EAGCH	E-AGCH	int

Notes/Equations

1. This subnetwork model is used to simulate integrated 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 below:

Physical Channel
P_CPICH
S_CPICH
PCCPCH
P_SCH
S_SCH
SCCPCH
PICH
DPCH
E-AGCH
E-HICH
E-RGCH
OCNS

4. The DPCH is generated by the fully-coded 3GPPFDD_DL_RefCh signal source.
5. DTCH, DCCH, and TPC patterns can be set through the DTCHDataPattern, DCCHDataPattern, and TPCDataPattern parameters; five data patterns are supported: random, PN9, PN15, fixed repeated 8-bits, and user-defined file.
6. If the data pattern is 8-bits repeating, the bits to be repeated are set by the respective RepBitValue. For example if RepBitValue is set as 0x7a, bit sequence 0,1,1,1,1,0,1,0 will be output repeatedly.
7. 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.
8. The DPCH data rate can be set through RefCh. DPCH channelization code is set through DPCH_SpreadCode.
9. 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

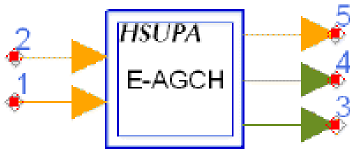
of 256.

10. The PICH spread factor is 256. PICH channelization code is set through PICH_SpreadCode.
11. 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.
12. The E-HICH can be set by EHICH_SgnlPttrn (Signal Pattern), EHICH_SqnIdx (Signature Sequence Index), and EHI_ERG_SpreadCode.
13. The E-RGCH can be set by ERGCH_SgnlPttrn (Signal Pattern), ERGCH_SqnIdx (Signature Sequence Index), and EHI_ERG_SpreadCode.
14. The E-AGCH can be set by EAGCH_SpreadCode and ERNTI.
15. There are two ways to set the power ratio defined in Table C.2 and Table C.3 in [5]. Although each of these two ways can be converted to the other by calculation, the parameter PowerReference is provided for the user to set the power easily.
16. If PowerReference is Ior, the power of transmitter is set by parameter Power; if it is DPCH_Ec, the power of transmitter depends on the value of parameter DPCH_Ec and is calculated in the equations of the subnetwork.
17. Relative power levels of each channel can then be set through the respective GainFactor parameters, in dB units.
    - If PowerReference is Ior, OCNS_GainFactor is calculated from other GainFactors. (Refer to Table C.6 in [5]);
    - If PowerReference is DPCH_Ec, the relative Ior is calculated. DPCH_GainFactor is equal to the inverse of Ior.
    - All "GainFactors" are changed to power ratio over Ior by multiplying DPCH_GainFactor.
    - 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.
18. 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 *HSUPA_OCNS* (hsupa).

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 6.5.0, Mar. 2006.
4. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 6.8.0, Mar. 2006.
5. 3GPP Technical Specification TS 25.101, "UE Radio transmission and Reception (FDD)," Version 6.11.0, Mar. 2006.

HSUPA_EAGCH



Description: E-DCH absolute grant channel
Library: HSUPA, Signal Sources

Parameters

Name	Description	Default	Type	Range
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms	enum	
EAGCH_SpreadCode	Spreading code for E-AGCH	100	int	[0,255]
ERNTI	E-DCH radio network temporary identifier	19	int	[0,65535]
ScrambleOffset	Scramble code offset	0	int	[0,15]
ScrambleType	Scramble code type: normal, right, left	normal	enum	
ScrambleCode	Index of scramble code	0	int	[0,512] for downlink; [0, 16777215] for uplink

Pin Inputs

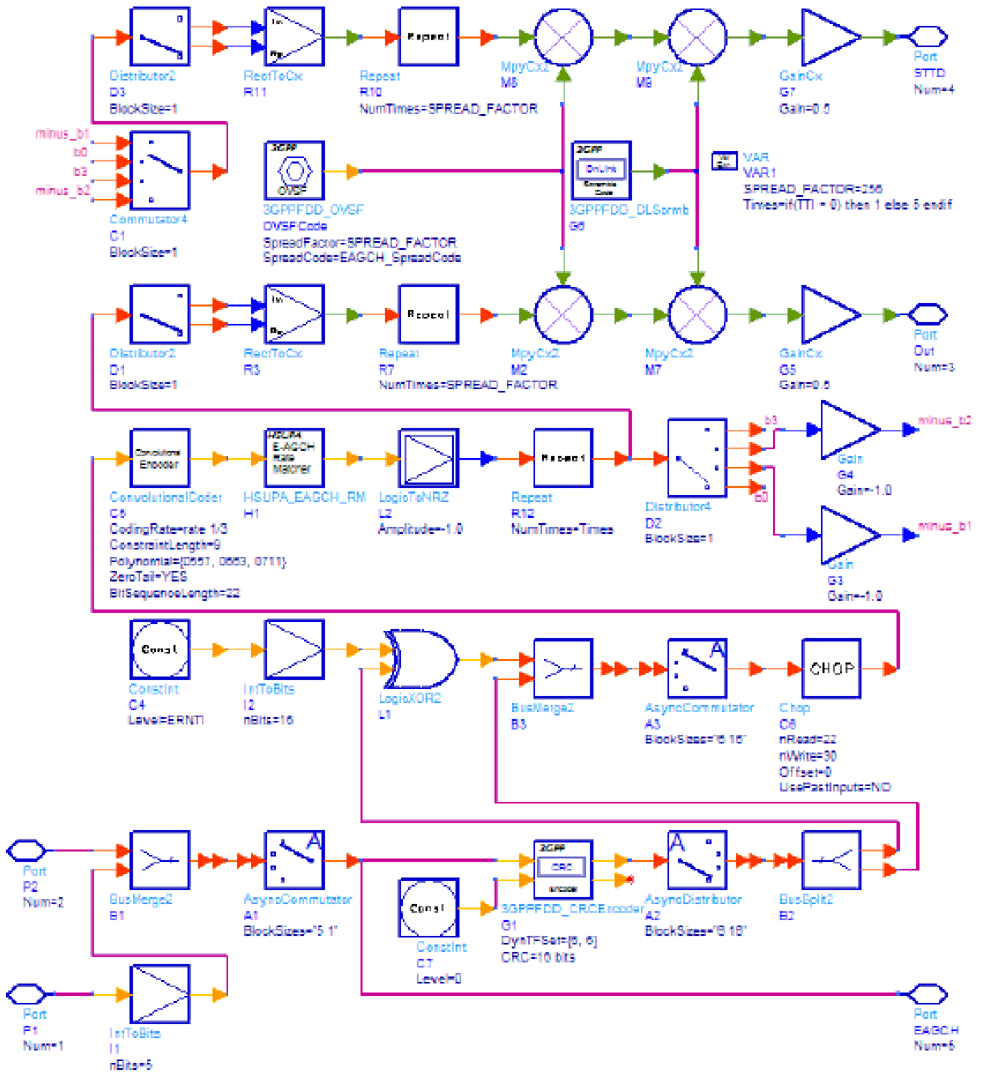
Pin	Name	Description	Signal Type
1	ValueIdx	absolute grant value index	int
2	Scope	absolute grant scope	int

Pin Outputs

Pin	Name	Description	Signal Type
3	Output	output	complex
4	STTD	space time transmit diversity output	complex
5	EAGCH	E-AGCH	int

Notes/Equations

1. This subnetwork model is used to generate the 3GPP/HSUPA absolute grant channel (E-AGCH) as defined in [2], Figure 24: "Coding for E-AGCH".
2. The schematic for this subnetwork is shown below:

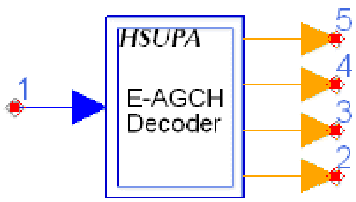


3. This subnetwork model completes the following operations:
   - Multiplexing of E-AGCH information: Absolute Grant Value and Absolute Grant Scope
   - CRC attachment for E-AGCH (including E-RNTI mask)
   - Channel coding for E-AGCH
   - Rate matching for E-AGCH
   - Physical channel mapping for E-AGCH.

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 6.5.0, Mar. 2006.

HSUPA_EAGCH_Decode



Description: Channel decoder of E-DCH absolute grant channel
Library: HSUPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Type	Range
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms	enum	
ERNTI	E-DCH radio network temporary identifier	19	int	[0,65535]

Pin Inputs

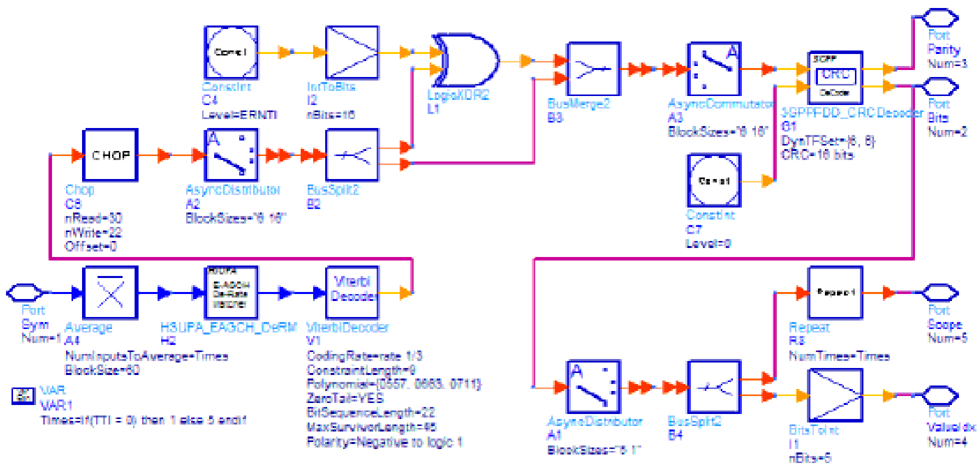
Pin	Name	Description	Signal Type
1	AG_Sym	input symbols	real

Pin Outputs

Pin	Name	Description	Signal Type
2	EAGCH	Information bits for H-AGCH	int
3	Parity	The result of CRC	int
4	ValueIdx	absolute grant value index	int
5	Scope	absolute grant scope	int

Notes/Equations

1. This subnetwork model completes the inverse process of "Coding for E-AGCH", which is defined in [2], Figure 24.
2. The schematic for this subnetwork is shown below:

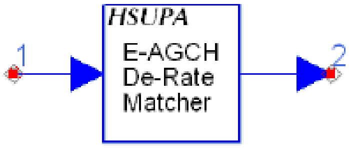


3. This subnetwork model completes the following operations:
    - Rate de-matching for E-AGCH
    - Viterbi decoding for E-AGCH
    - CRC checking for E-AGCH
    - De-multiplexing of E-AGCH information: Absolute Grant Value and Absolute Grant Scope

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. 2005.
3. 3GPP Technical Specification TS 25.213, "Spreading and modulation (FDD)," Version 7.6.0, Sept. 2006.

HSUPA_EAGCH_DeRM



Description: HSUPA E-AGCH rate dematcher
Library: HSUPA, Demultiplexers & Decoders

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	input	real

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	output	real

Notes/Equations

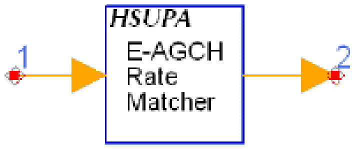
1. This model completes the inverse process of "Rate matching for E-AGCH", which is defined in [2].
2. Each firing, 60 tokens are consumed; 90 tokens are output. The output tokens are obtained by inserting 30 zeros "$z_1, z_2, z_5, z_6, z_7, z_{11}, z_{12}, z_{14}, z_{15}, z_{17}, z_{23}, z_{24}, z_{31}, z_{37}, z_{44}, z_{47}, z_{61}, z_{63}, z_{64}, z_{71}, z_{72}, z_{75}, z_{77}, z_{80}, z_{83}, z_{84}, z_{85}, z_{87}, z_{88}, z_{90}$" to the input tokens.

> **Note**
> The position numbers (1, 2, 5, ..., 87, 88, 90) above are positions relative to the output tokens.

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 6.5.0, Mar. 2006.

HSUPA_EAGCH_RM



Description: HSUPA E-AGCH rate matcher
Library: HSUPA, Multiplexers & Coders

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	input	int

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	output	int

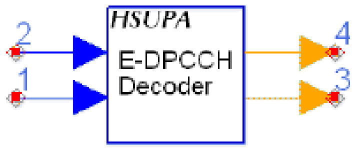
Notes/Equations

1. This model completes the "Rate matching for E-AGCH" process as defined in [2].
2. Each firing, 90 tokens are consumed; 60 tokens are output. The output tokens are obtained by puncturing "z_1, z_2, z_5, z_6, z_7, z_{11}, z_{12}, z_{14}, z_{15}, z_{17}, z_{23}, z_{24}, z_{31}, z_{37}, z_{44}, z_{47}, z_{61}, z_{63}, z_{64}, z_{71}, z_{72}, z_{75}, z_{77}, z_{80}, z_{83}, z_{84}, z_{85}, z_{87}, z_{88}, z_{90}" from input tokens "z_1, z_2, ..., z_{90}".

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 6.5.0, Mar. 2006.

HSUPA_EDPCCH_ChDecode



Description: HSUPA E-DPCCH channel decoder
Library: HSUPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Type	Range
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms	enum	
Threshold	Threshold	-23.6	real	(-∞,∞)

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	input	real
2	PwrN	power of noise estimated from DPCCH	real

Pin Outputs

Pin	Name	Description	Signal Type
3	Output	output	int
4	ActiveE	E-DPCCH flag, 1 for good frames, 0 for bad frames	int

Notes/Equations

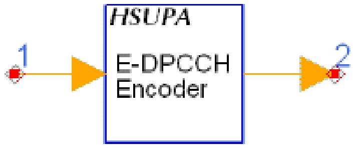
1. This model is used to implement channel decoding for HSUPA uplink E-DPCCH.
2. Each firing, 10 Output token and one ActiveE token are produced when 30 Input and DPCCH tokens consumed
3. Power of input E-DPCCH signal is estimated. SNR over noise power estimated from DPCCH is calculated and compared with a threshold. If SNR is less than the threshold, no enhanced uplink channel is detected and the output of ActiveE is 0, otherwise it is detected and the output of ActiveE is 1.
4. In any case, the input signal will be decoded and output in the pin Output as if enhanced uplink channel did send in the transmit end.
5. The performance of E-DPCCH false alarm test and missed detection test is strongly correlated to each other, and is determined by the threshold of power detection. This threshold is very sensitive to the change of power of configuration of uplink channels. The E-DPCCH performance test follows this order:
    - Sweeping Threshold to get target "false alarm"(1% in [4]).
    - Set the Threshold and run simulation of missed detection.
    - Compare the result of simulation with target "missed detction"(0.2% in [4]).

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.
4. 3GPP Technical Specification TS 25.104, "UTRA (BS) FDD: Radio transmission and Reception," Version 7.10.0, Mar. 2008.

5. 3GPP Technical Specification TS 25.141, "Base station conformance test," Version 6.11.0, Mar. 2008.

HSUPA_EDPCCH_ChEncode



Description: HSUPA E-DPCCH channel encoder
Library: HSUPA, Multiplexers & Coders

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	input	int

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	output	int

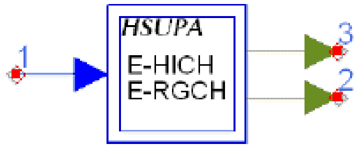
Notes/Equations

1. This model is used to implement channel coding for HSUPA uplink E-DPCCH according to 4.9.4 in [2].
2. For each firing, 30 Output tokens are produced when 10 Input tokens are consumed.

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.

HSUPA_EHICH_ERGCH



Description: E-DCH HARQ ACK indicator channel or E-DCH relative grant channel
Library: HSUPA, Signal Sources

Parameters

Name	Description	Default	Symbol	Type	Range
SequenceIndex	Signature sequence index	0	l	int	[0,39]
EHI_ERG_SpreadCode	Spreading code for E-HICH and E-RGCH	19		int	[0,127]
ScrambleOffset	Scramble code offset	0		int	[0,15]
ScrambleType	Scramble code type: normal, right, left	normal		enum	
ScrambleCode	Index of scramble code	0		int	[0,512] for downlink; [0, 16777215] for uplink

Pin Inputs

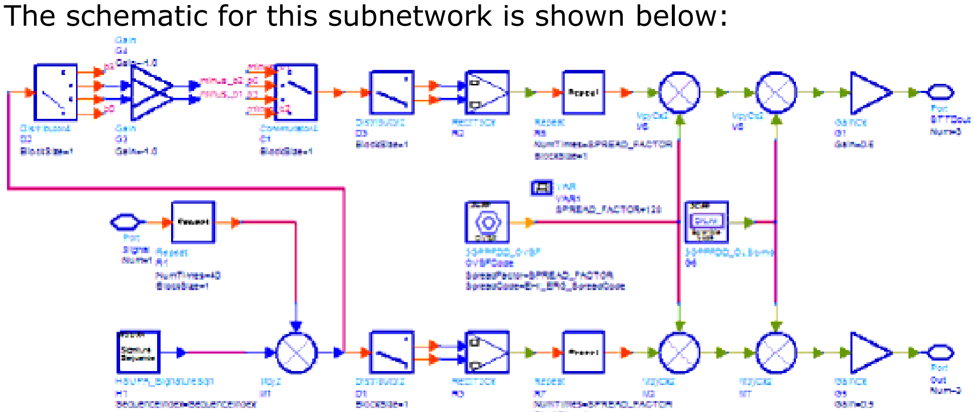
Pin	Name	Description	Signal Type
1	Signal	signal	real

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	output	complex
3	STTD	space time transmit diversity output	complex

Notes/Equations

1. This subnetwork model is used to generate E-DCH Relative Grant Channel (E-RGCH) or E-DCH Hybrid ARQ Indicator Channel (E-HICH) as defined in [1].
2. The schematic for this subnetwork is shown below:

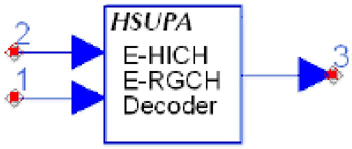


3. E-RGCH and E-HICH are fixed rate (SF=128) dedicated downlink physical channels. The spreading code index is specified by EHI_ERG_SpreadCode.
4. SequenceIndex specifies the sequence index defined in [1], Table 16B: "E-HICH and E-RGCH signature hopping pattern".
5. The STTD-based open loop transmit diversity is implemented.
6. There are no implementation differences between E-RGCH and E-HICH within the scope of this subnetwork model.

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 6.5.0, Mar. 2006.

HSUPA_EHICH_ERGCH_Decode



Description: Decoder of HSUPA EHICH or ERGCH
Library: HSUPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Symbol	Type	Range
SequenceIndex	Signature sequence index	0	l	int	[0,39]
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms		enum	
TransBlockIgnored	Transport block Ignored due to system delay	1		int	[0,5]
Threshold	Threshold	-32		real	

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	input	real
2	CPICH	symbols of CPICH	real

Pin Outputs

Pin	Name	Description	Signal Type
3	Output	output	real

Notes/Equations

1. This model decodes the E-DCH Relative Grant Channel (E-RGCH) or E-DCH Hybrid ARQ Indicator Channel (E-HICH) according to the value for SequenceIndex.
2. The Input of this model is de-spread 60ksps E-RGCH or E-HICH symbols, which may carry signatured E-DCH Relative Grant or Hybrid ARQ Indicator. The CPICH is de-spread 30ksps CPICH symbols, which is used to estimate CPICH signal power as a reference for EDCH channel detection.
3. Each firing, 1 token is produced while 120 Input tokens and 60 CPICH tokens (TTI 2ms) or 480 Input tokens and 240 CPICH tokens (TTI 10ms) are consumed.
4. When TTI is set to 2ms, this model will detect the signal using 3 consecutive slots; when TTI is set to 10ms, 12 consecutive slots will be used to detect the signal.
5. The first "TransBlockIgnored" fires will be ignored (do nothing and output all zeros) to save the simulation time.
6. Threshold sets the threshold for ternary detection. The algorithm for ternary detection is as follows:
   - The Input EDCH signal is decoded as if the signal "+1/-1" was transmitted in the transmit end.
   - Power of E-DCH channel and power of CPICH are estimated. The ratio of these two values will be compared to Threshold.
   - If the ratio (dB) is higher than Threshold, the decoded symbol of step 1 is used as the Output; otherwise the Output is set to "0".
7. The performance of the E-HICH or E-RGCH test is strongly correlated to the threshold described in item 6. Furthermore, this threshold is very sensitive to the change of power of configuration of downlink channels.
8. The performance test follows this order:
   - Sweeping Threshold to get target "false detection"(50% in [4]).
   - Set the Threshold and run simulation of missed detection.

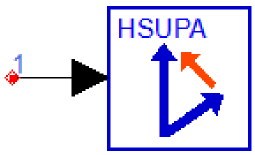
- Compare the result of simulation with target "missed detection" (1% in [4]).

9. There are no implementation differences between E-RGCH and E-HICH within the scope of this model.

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 6.5.0, Mar. 2006.
4. 3GPP Technical Specification TS 25.101, "UE Radio transmission and Reception (FDD)," Version 6.11.0, Mar. 2006.

HSUPA_EVM



Description: HSUPA EVM measurement
Library: HSUPA, 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	
alpha	specify the alpha for 3GPP root raised cosine filtering.	0.22		real	[0,1]
LongScrambleCodeNum	index of Long Scramble Code	0		int	[0,16777215]
syncModeSelection	Sync mode selection: DPCCH, PRACH_MESSAGE	DPCCH		enum	
DPCCHSlotFormat	the slot format for DPCCH, used for synchronization	0		int	[0,5]
AnalysisCodeLevel	specifies the channel level that Channel EVM with be calculated for	1		int	[1,8]
AnalysisCodeIndex	specifies the channel index that Channel EVM with be calculated for	0		int	[0,2^AnalysisCodeLevel-1]
AnalysisIQPart	For symbol EVM, choose IQ part for which you would like calculate EVM for: I, Q, IQ	I		enum	
ModScheme	modulation scheme for selected AnalysisCodeLevel and AnalysisCodeIndex: AutoDetect, BPSK, PAM4	AutoDetect		enum	
EVMLengthInSlot	This variable sets chip interval of the EVM window in a slot, this feature was added to implement half slot EVM: FullSlot, FirstHalfSlot, SecondHalfSlot	FullSlot		enum	
ExcludeTransient	EVM metrics will exclude first/last 96 chips from the calculation length (normally 1 slot): NO, YES	NO		enum	

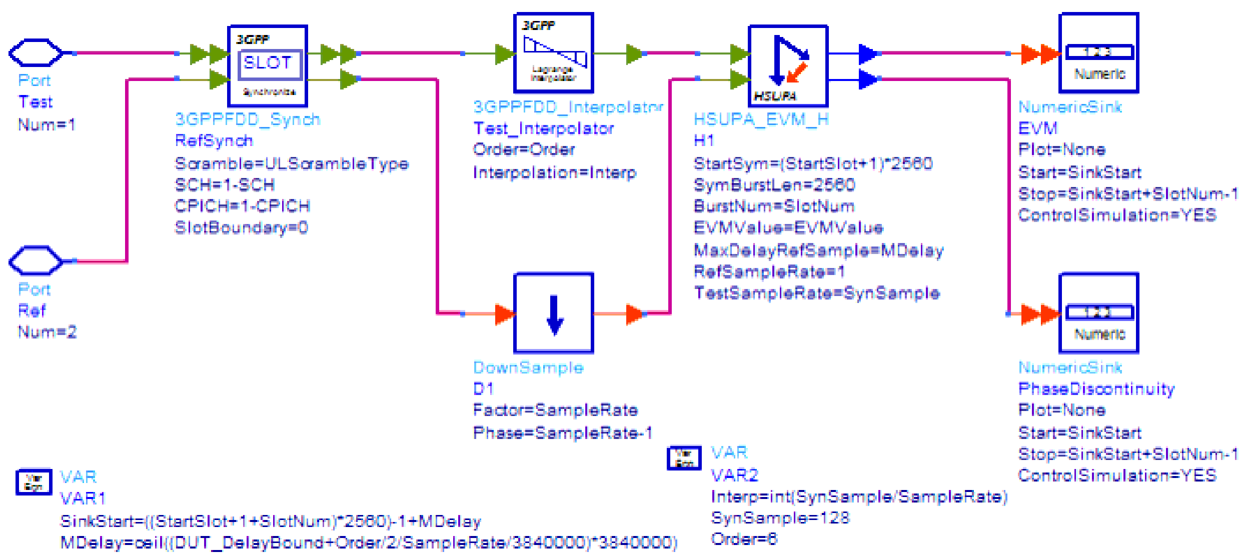
MirrorSpectrum	Mirror spectrum about carrier?: NO, YES	NO		enum	
EVMIncludeIQOffset	selection of calculating EVM pre-compensating for IQ origin offset: NO, YES	NO		enum	
DTXDetection	Discontinuous Transmission channels detection: NO, YES	NO		enum	
MultiChannelEstimator	When set to TRUE, channel-by-channel timing estimation and compensation: NO, YES	NO		enum	
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,∞)

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 [5]. 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.
4. 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 %. For Release 99 and Release 4, the EVM measurement interval is one timeslot. For Release 5 and later releases where tests may include power changes, the measurement interval is further clarified

as being one timeslot except when the mean power between slots is expected to change whereupon the measurement interval is reduced by 25 μs(96 chips) at each end of the slot.

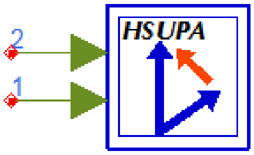
5. The available results from this measurement are:
    - Avg_Channel_EVM: average channel EVM rms in %
    - Avg_Channel_MagErr_rms_percent: average channel magnitude error rms in %
    - Avg_Channel_PhaseErr_deg: average channel phase error in degrees
    - Avg_EVM_dB: average composite EVM rms in 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
6. When 16QAM is not used on any of the uplink code channels, the EVM shall not exceed 17.5% for the parameters specified in Table 6.15 in Reference [5]. When 16QAM used on any of the uplink code channels, the EVM shall not exceed 14% for the parameters specified in Table 6.15 in Reference [5].
7. The alpha parameter specifies the alpha for 3GPP root raised cosine filtering and should be 0.22 in this testing.
8. The LongScrambleCodeNum parameter specifies the long scramble code index used. The short scramble code is not supported yet.
9. The syncModeSelection parameter specifies synchronization mode: DPCCH or PRACH_MESSAGE.
10. The DPCCHSlotFormat specifies the slot format for DPCCH, used for synchronization.
11. 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.
12. The AnalysisIQPart specifies which part you like to calculate the EVM for, because the modulation is separated between I and Q ports.
13. The ModScheme parameter specifies the modulation type for the selected code channel and IQ part: "BPSK", "4PAM" or you can choose "AutoDetect" to let the EVM model to detect the modulation type itself. However, if there exists strong interference, the auto detect result may be wrong.
14. The EVMLengthInSlot specifies the length of window in a slot for EVM calculation. It could be selected to calcualte EVM within "FullSlot", "FirstHalfSlot" or "SecondHalfSlot".
15. The ExcludeTransient specifies whether or not to exclude the 25 μs(96 chips) at each end of the slot when calculating the EVM.
16. 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.
17. The EVMIncludeIQOffset parameter specifies whether to pre-compensate for IQ origin offset or not when calculating EVM.

18. 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.
19. 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.
20. The Start parameter specifies the start time for data recording.
21. 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.
22. The SlotsToAverage parameter specifies the number of slots that will be averaged if AverageType is RMS Video.
23. 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).
24. 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.
25. 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.

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.
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, Sep. 2008.
6. 3GPP Technical Specification TS 25.104, "Base Station (BS) radio transmission and reception (FDD)," Version 7.10.0, Mar. 2008.
7. 3GPP Technical Specification TS 25.141, "Base station (BS) conformance testing (FDD)," V7.11.0, Mar. 2008.
8. 3GPP Technical Specification TS 34.121, "Radio transmission and reception (FDD)," Version 7.5.0, Jun. 2007.

HSUPA_EVM_Old



Description: EVM and Phase Discontinuity Measurements
Library: HSUPA, Measurement

Parameters

Name	Description	Default	Unit	Type	Range
LinkDir	link direction: Downlink, Uplink	Uplink		enum	
SlotFormat	slot format	0		int	†
ScrambleCode	index of scramble code	0		int	[0,512] for downlink; [0, 16777215] for uplink
ULScrambleType	uplink scramble code type: LONG, SHORT	LONG		enum	
ScrambleOffset	scramble code offset	0		int	[0,15]
DLScrambleType	downlink scramble code type: normal, right, left	normal		enum	
SpreadCode	index of spread code	0		int	[0,SF-1]; SF can be set by SlotFormat or equal to SpreadFactor; SF is 256 if for CPICH, PICH or uplink DPCCH
SampleRate	sample rate	8		int	[1,256]
StartSlot	number of slot to be ignored	0		int	[0,∞)
SlotNum	slot number	1		int	[1,15]
Correlator	correlator method: Coherent, NonCoherent	Coherent		enum	
SCH	switch for SCH: OFF, ON	ON		enum	
CPICH	switch for CPICH: OFF, ON	OFF		enum	
EVMValue	EVM value expression options: EVM_Ratio, EVM_Percent	EVM_Percent		enum	
Correct_IQ_Offset	switch for IQ offset correction: NO, YES	YES		enum	
DUT_DelayBound	DUT delay bound	0.00001 sec	sec	real	[0,(400.0/3840000)]
ExcludeTransition	select YES for predictable power changes: NO, YES	YES		enum	

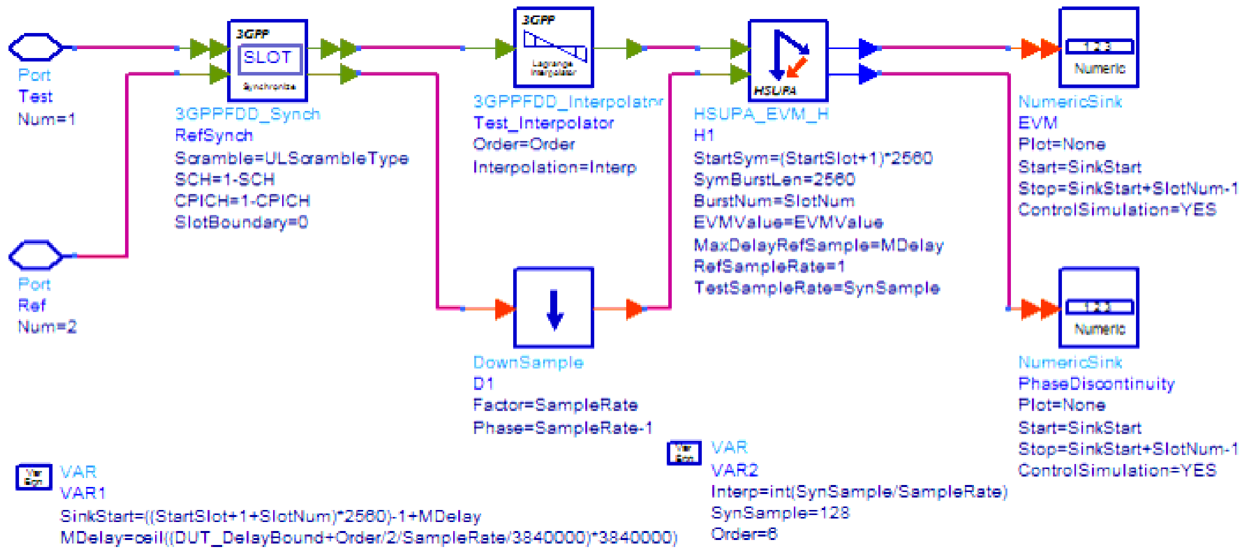
Pin Inputs

Pin	Name	Description	Signal Type
1	test	tested signals	complex
2	ref	reference signals	complex

Notes/Equations

- This component is obsolete for new design.
  Please use the improved *HSUPA_EVM* (hsupa) for new design work.

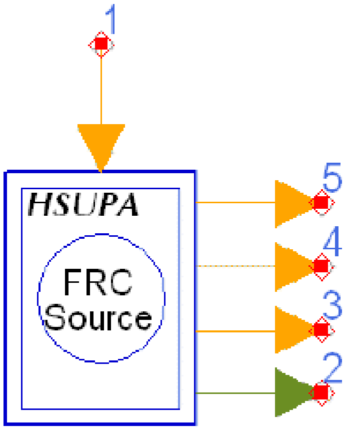
1. This subnetwork model measures EVM and Phase Discontinuity that are used to evaluate modulation accuracy.
2. The schematic for this subnetwork is shown below:



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.
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, Sep. 2008.
6. 3GPP Technical Specification TS 25.104, "Base Station (BS) radio transmission and reception (FDD)," Version 7.10.0, Mar. 2008.
7. 3GPP Technical Specification TS 25.141, "Base station (BS) conformance testing (FDD)," V7.11.0, Mar. 2008.
8. 3GPP Technical Specification TS 34.121, "Radio transmission and reception (FDD)," Version 7.5.0, Jun. 2007.

HSUPA_FRC



Description: HSUPA fixed reference channel
Library: HSUPA, Signal Sources

Parameters

Name	Description	Default	Type	Range
FRC	Fixed reference channel: FRC1, FRC2, FRC3, FRC4, FRC5, FRC6, FRC7, FRC8	FRC1	enum	
TestCase	Test case: E-DPDCH testing, E-DPCCH missed detection testing, E-DPCCH false alarm testing	E-DPDCH testing	enum	
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]
Scramble	scramble code type: LONG, SHORT	LONG	enum	
EDPCCH_Boosting	Setting to YES if E-DPCCH_Boosting is configured, otherwise NO: NO, YES	NO	enum	
ScrambleCode	Index of scramble code	0	int	[0,512] for downlink; [0, 16777215] for uplink

Pin Inputs

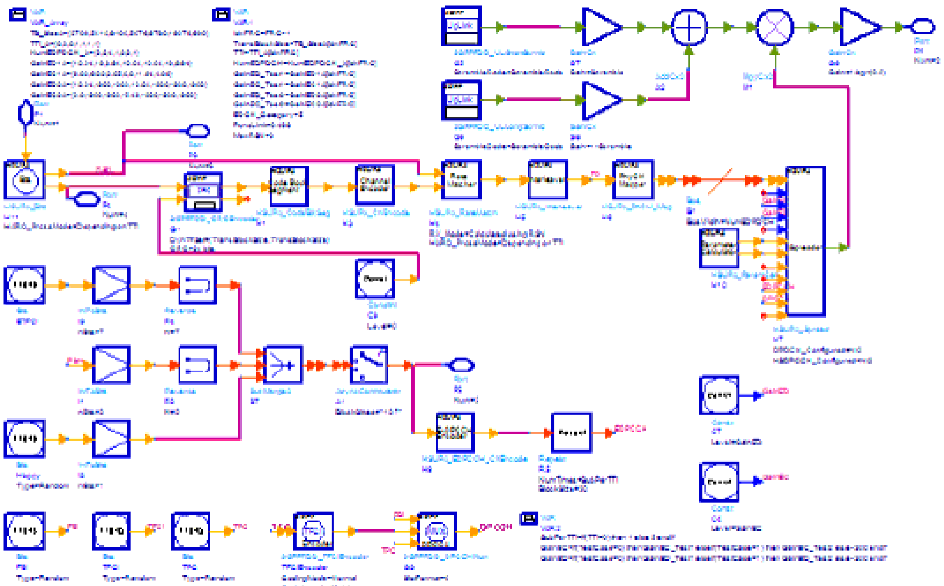
Pin	Name	Description	Signal Type
1	ARQ	automatic repeat request	int

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	output	complex
3	RSN	retransmission sequence number	int
4	BitED	bits of E-DPDCH	int
5	BitEC	bits of E-DPCCH	int

Notes/Equations

1. This subnetwork is used to implement fixed reference channels for HSUPA uplink.
2. The schematic of HSUPA_FRC is shown below:

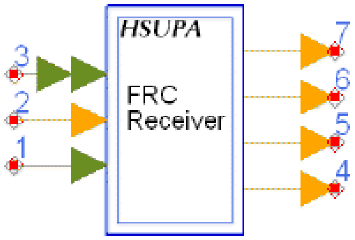


3. Fixed reference channels are defined in Annex A.9 – A.16[5]. TTI and TransBlockSize vs. FRC are implemented using equations in the schematic. GainEC and GainED vs. TestCase are also implemented using equations in the schematic.
4. DPDCH and HS-DPCCH is switched off.
5. MaxRSN is set to 3.
6. RV_Mode is set to "Calculated using RSN".
7. HARQ_PrcssMode is set to "Depending on TTI", that is NumHARQ is 8 for TTI=2 μs and is 4 for TTI=10 μs.
8. For more information on HARQ functions, please see *HSUPA_Bits* (hsupa) and *HSUPA_RateMatch* (hsupa).
9. For more information, please refer to documentation for the models used in this subnetwork.

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.
4. 3GPP Technical Specification TS 25.104, "Base Station (BS) radio transmission and reception (FDD)," Version 7.10.0, Mar. 2008.
5. 3GPP Technical Specification TS 25.141, "Base station (BS) conformance testing (FDD)," V7.11.0, Mar. 2008.

HSUPA_FRC_Receiver



Description: HSUPA receiver for fixed reference channel
Library: HSUPA, Receivers

Parameters

Name	Description	Default	Symbol	Type	Range
FRC	Fixed reference channel: FRC1, FRC2, FRC3, FRC4, FRC5, FRC6, FRC7, FRC8	FRC1		enum	
DPDCH_Configured	Setting to YES if DPDCH is configured, otherwise NO: NO, YES	NO		enum	
HSDPCCH_Configured	Setting to YES if HS-DPCCH is configured, otherwise NO: NO, YES	NO		enum	
Scramble	scramble code type: LONG, SHORT	LONG		enum	
ScrambleCode	Index of scramble code	0		int	[0,512] for downlink; [0, 16777215] for uplink
SamplesPerChip	Samples per chip	8	S	int	[2,32]
MaxDelaySample	Maximum delay boundary, in terms of samples	0		int	[0,2559] for RAKE receiver; [0,102400] in other models
ChannelType	Select the channel type to be processed: CH_GAUSSIAN, CH_FADING	CH_GAUSSIAN		enum	
ChannelInfo	Fading channel information source: Known, Estimated	Known		enum	
ChannelInfoOffset	Offset between spread code and channel information in terms of sample	0		int	[0,MaxDelaySample]
EstSlotsNum	Number of slots for channel estimation	1		int	[1,3]
UseMovingEstWindow	If use moving window in channel estimation: NO, YES	NO		enum	
PathSearch	Path search frequency:	Once		enum	

	EverySlot, Once				
SearchMethod	Path search method: Coherent, NonCoherent, Combined	Coherent		enum	
SearchSlotsNum	Number of slots for path search	1		int	[1,12]
PathNum	Number of Rake fingers	1		int	[1,6]
UsePastSearch	If use past samples for path search: NO, YES	NO		enum	
PathDelaySample	Delay for each finger, in terms of samples	0		int array	[0,MaxDelaySample]; array size shall be equal to PathNum
TC_Iteration	Turbo code decoder iteration number	4		int	[1,10]
TC_Alfa	Alfa of lowpass filter	0.4		real	[0,1.0)
Threshold_EDPCCH	Threshold for decoding E-DPCCH	-23.6		real	(-∞,∞)

Pin Inputs

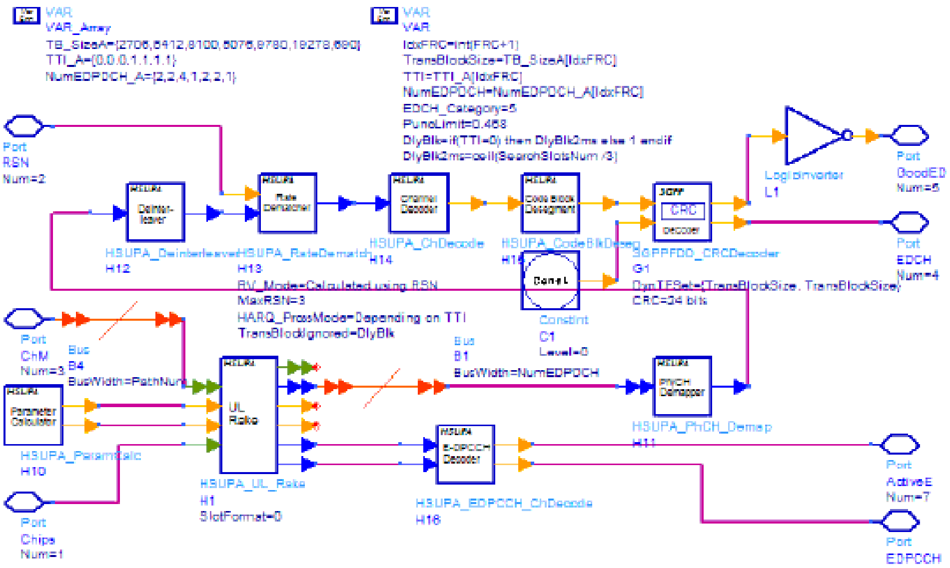
Pin	Name	Description	Signal Type
1	Input	input	complex
2	RSN	retransmission sequence number	int
3	CH_M	channel information	multiple complex

Pin Outputs

Pin	Name	Description	Signal Type
4	EDCH	received bits of E-DCH	int
5	GoodED	CRC parity bit of EDCH packet	int
6	EDPCCH	received bits of E-DPCCH	int
7	ActiveE	E-DPCCH flag, 1 for good frame, 0 for bad	int

Notes/Equations

1. This subnetwork is used to implement baseband receiver for FRCs in HSUPA uplink.
2. The schematic of this subnetwork is shown below:

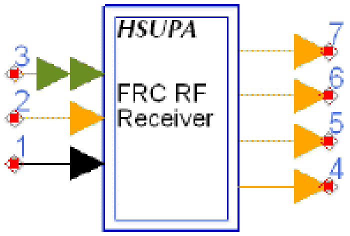


3. MaxRSN is set to 3.
4. RV_Mode is set to "Calculated using RSN".
5. HARQ_PrcssMode is set to "Depending on TTI", that is NumHARQ is 8 for TTI=2 ms and is 4 for TTI=10 ms.
6. For more information, see *HSUPA_FRC* (hsupa), *HSUPA_UL_Rake* (hsupa), *HSUPA_RateDematch* (hsupa), and *HSUPA_EDPCCH_ChDecode* (hsupa).

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.
4. 3GPP Technical Specification TS 25.104, "UTRA (BS) FDD: Radio transmission and Reception," Version 7.10.0, Mar. 2008.
5. 3GPP Technical Specification TS 25.141, "Base station conformance test," Version 7.11.0, Mar. 2008.

HSUPA_FRC_ReceiverRF



Description: HSUPA receiver for fixed reference channel
Library: HSUPA, Receivers

Parameters

Name	Description	Default	Symbol	Unit	Type	Range
RLoad	Input resistance	DefaultRLoad		Ohm	real	(0,∞)
FCarrier	Carrier frequency	1950MHz		Hz	real	(0,∞)
Phase	Reference phase in degrees	0.0		deg	real	(-∞,∞)
SamplesPerChip	Samples per chip	8	S		int	[2,32]
RRC_FilterLength	RRC filter length (chips)	16			int	[2,128]
ScrambleCode	Index of scramble code	0			int	[0,512] for downlink; [0, 16777215] for uplink
Scramble	scramble code type: LONG, SHORT	LONG			enum	
FRC	Fixed reference channel: FRC1, FRC2, FRC3, FRC4, FRC5, FRC6, FRC7, FRC8	FRC1			enum	
DPDCH_Configured	Setting to YES if DPDCH is configured, otherwise NO: NO, YES	NO			enum	
HSDPCCH_Configured	Setting to YES if HS-DPCCH is configured, otherwise NO: NO, YES	NO			enum	
MaxDelaySample	Maximum delay boundary, in terms of samples	0			int	[0,2559] for RAKE receiver; [0,102400] in other models
ChannelType	Select the channel type to be processed: CH_GAUSSIAN, CH_FADING	CH_GAUSSIAN			enum	
ChannelInfo	Fading channel information source: Known,	Known			enum	

	Estimated					
ChannelInfoOffset	Offset between spread code and channel information in terms of sample	0			int	[0,MaxDelaySample]
EstSlotsNum	Number of slots for channel estimation	1			int	[1,3]
UseMovingEstWindow	If use moving window in channel estimation: NO, YES	NO			enum	
PathSearch	Path search frequency: EverySlot, Once	Once			enum	
SearchMethod	Path search method: Coherent, NonCoherent, Combined	Coherent			enum	
SearchSlotsNum	Number of slots for path search	1			int	[1,12]
PathNum	Number of Rake fingers	1			int	[1,6]
UsePastSearch	If use past samples for path search: NO, YES	NO			enum	
PathDelaySample	Delay for each finger, in terms of samples	0			int array	[0,MaxDelaySample]; array size shall be equal to PathNum
TC_Iteration	Turbo code decoder iteration number	4			int	[1,10]
TC_Alfa	Alfa of lowpass filter	0.4			real	[0,1.0)
Threshold_EDPCCH	Threshold for decoding E-DPCCH	-23.6			real	(-∞,∞)

Pin Inputs

Pin	Name	Description	Signal Type
1	RF_In	input	timed
2	RSN	retransmission sequence number	int
3	CH_M	channel information	multiple complex

Pin Outputs

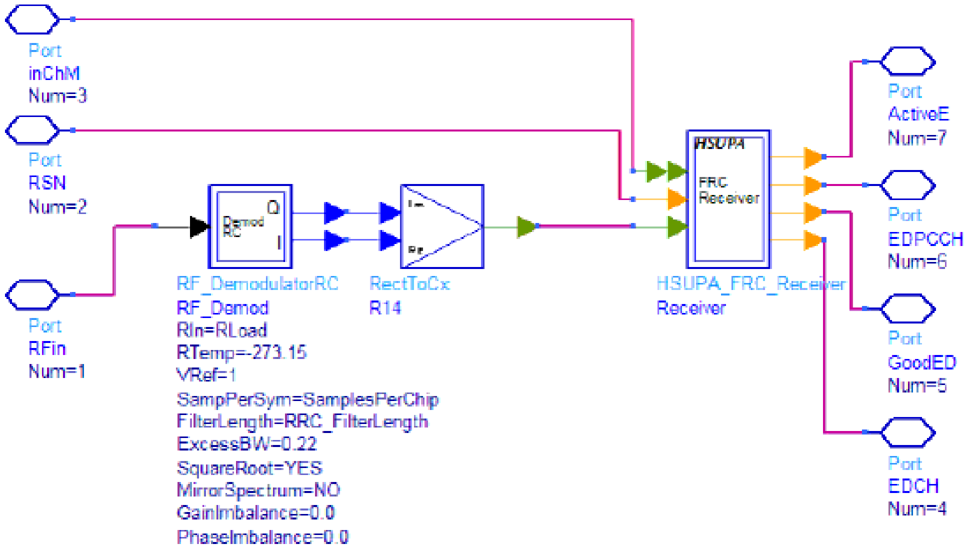
Pin	Name	Description	Signal Type
4	EDCH	received bits of E-DCH	int
5	GoodED	CRC parity bit of EDCH packet	int
6	EDPCCH	received bits of E-DPCCH	int
7	ActiveE	E-DPCCH flag, 1 for good frame, 0 for bad	int

Notes/Equations

1. This subnetwork is used to implement a fixed reference channel receiver in RF for

HSUPA uplink.

2. The schematic is shown below:

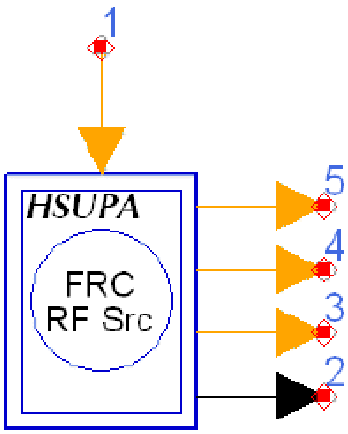


3. For more information, see *HSUPA_FRC_Receiver* (hsupa).

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.
4. 3GPP Technical Specification TS 25.104, "UTRA (BS) FDD: Radio transmission and Reception," Version 7.10.0, Mar. 2008.
5. 3GPP Technical Specification TS 25.141, "Base station conformance test," Version 7.11.0, Mar. 2008.

HSUPA_FRC_RF



Description: HSUPA fixed reference channel
Library: HSUPA, Signal Sources

Parameters

Name	Description	Default	Symbol	Unit	Type	Range
ROut	Source resistance	DefaultROut		Ohm	real	(0,∞)
RTemp	Temperature	DefaultRTemp		Celsius	real	[-273.15,∞)
TStep	Expression showing how TStep is related to the other source parameters	1/3.84 MHz/SamplesPerChip			string	
FCarrier	Carrier frequency	1950MHz		Hz	real	(0,∞)
Power	Power	dbmtow(24.0)		W	real	[0,∞)
MirrorSpectrum	Mirror spectrum about carrier?: NO, YES	NO			enum	
GainImbalance	Gain imbalance, Q vs I	0.0		dB	real	(-∞,∞)
PhaseImbalance	Phase imbalance, Q vs I	0.0		deg	real	(-∞,∞)
I_OriginOffset	I origin offset (percent)	0.0			real	(-∞,∞)
Q_OriginOffset	Q origin offset (percent)	0.0			real	(-∞,∞)
IQ_Rotation	IQ rotation	0.0		deg	real	(-∞,∞)
SamplesPerChip	Samples per chip	8	S		int	[2,32]
RRC_FilterLength	RRC filter length (chips)	16			int	[2,128]
ScrambleCode	Index of scramble code	0			int	[0,512] for downlink; [0, 16777215] for uplink
Scramble	scramble code type: LONG, SHORT	LONG			enum	
FRC	Fixed reference channel: FRC1, FRC2, FRC3, FRC4, FRC5, FRC6, FRC7, FRC8	FRC1			enum	
TestCase	Test case: E-DPDCH testing, E-DPCCH missed detection testing, E-DPCCH false alarm testing	E-DPDCH testing			enum	
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]
EDPCCH_Boosting	Setting to YES if E-DPCCH_Boosting is configured, otherwise NO: NO, YES	NO			enum	

Pin Inputs

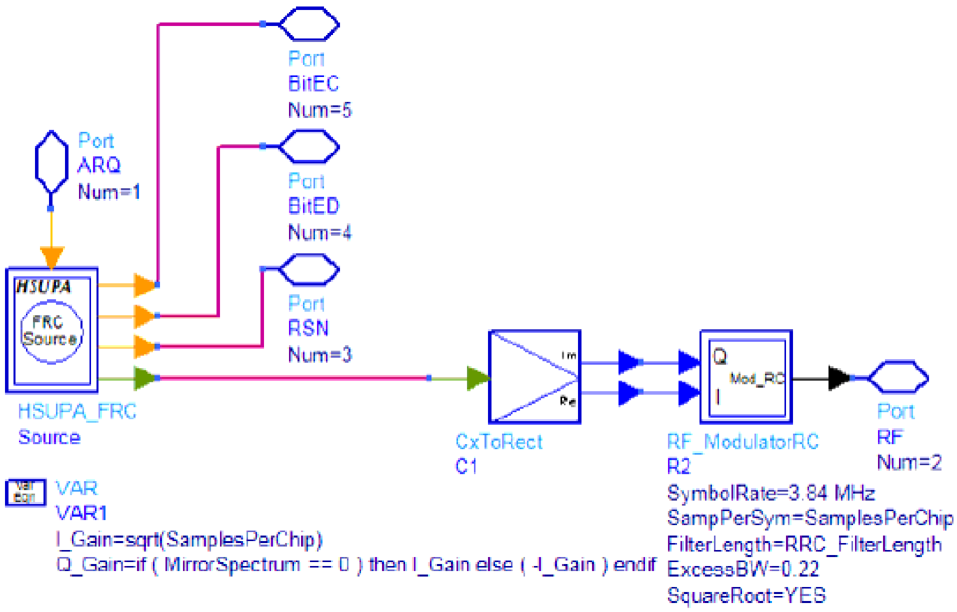
Pin	Name	Description	Signal Type
1	ARQ	automatic repeat request	int

Pin Outputs

Pin	Name	Description	Signal Type
2	RF	output	timed
3	RSN	retransmission sequence number	int
4	BitED	bits of E-DPDCH	int
5	BitEC	bits of E-DPCCH	int

Notes/Equations

1. This subnetwork is used to implement a fixed reference channel in RF for HSUPA uplink.
2. The schematic is shown below:

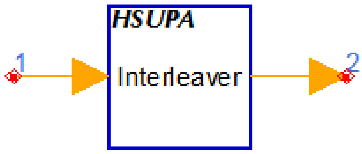


3. For more information about FRC in baseband, see *HSUPA_FRC* (hsupa).

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.
4. 3GPP Technical Specification TS 25.104, "Base Station (BS) radio transmission and reception (FDD)," Version 7.10.0, Mar. 2008.
5. 3GPP Technical Specification TS 25.141, "Base station (BS) conformance testing (FDD)," V7.11.0, Mar. 2008.

HSUPA_Interleaver



Description: EDCH interleaver
Library: HSUPA, Multiplexers & Coders

Parameters

Name	Description	Default	Symbol	Type	Range
EDCH_Category	FDD E-DCH physical layer categories: Category 1, Category 2, Category 3, Category 4, Category 5, Category 6, Category 7	Category 6		enum	
TransBlockSize	Transport block size	2706	L	int	[1,max transport block size]†
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms		enum	
PuncLimit	Puncturing limit for uplink	0.468		real	[PLmax , 1]‡
maxNumElement_Set0	maximum number of element in Set0	11		int	[1,11]

† Please refer to table of FDD E-DCH physical layer categories.
‡PLmax is 0.33 for Category 6 and is 0.44 for all other categories.

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	input	int

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	output	int

Notes/Equations

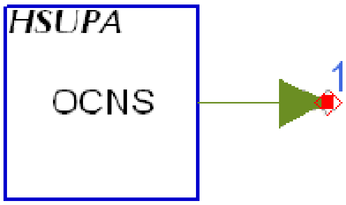
1. This model is used to implement channel segmentation and interleaving defined in 4.8.5 and 4.8.6 in [2].
2. Each firing, Ndata Output tokens are generated while Ndata Input tokens consumed. Determination of Ndata, spreading factor and number of E-DPDCH is described in 4.8.4.1 in [2].
3. A simple way to get the value of Ndata, spreading factor and number of E-DPDCH used with wanted TTI and TransBlockSize is to build and run a minimal test design of this model. The information will be displayed in the simulation window.

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.

4. 3GPP Technical Specification TS 25.306, "UE Radio Access capabilities," Version 7.8.0, Sep. 2008.

HSUPA_OCNS



Description: Flexible OCNS generator
Library: HSUPA, Signal Sources

Parameters

Name	Description	Default	Type	Range
DPCHNum	downlink DPCH number	16	int	[1,8] for other models; [1,512] for 3GPPHSUPA_OCNS and 3GPPHSUPA_DPCHs
ScrambleCode	index of scramble code	0	int	[0,512] for downlink; [0, 16777215] for uplink
ScrambleOffset	scramble code offset	0	int	[0,15]
ScrambleType	scramble code type: normal, right, left	normal	enum	
SpreadCodeArray	index array of spread codes	2 11 17 23 31 38 47 55 62 69 78 85 94 125 113 119	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
DataPatternArray	data pattern array: 0-random, 1-PN9, 2-PN15, 3-Repeat Bits	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	int array	[0,1,2,3]; array size shall be equal to code channel number
RepBitValueArray	bits value array to be filled in data sequence	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	int array	[0,255]; array size shall be equal to code channel number
PowerArray	channel power array in decibels	-1 -3 -3 -5 -2 -4 -8 -7 -4 -6 -5 -9 -10 -8 -6 0	real array	(-∞,∞); array size shall be equal to code channel number
tDPCHOffsetArray	DPCH channel offset array	86 134 52 45 143 112 59 23 1 88 30 18 30 61 128 143	int array	[0,149]; array size shall be equal to DPCH channel number
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 Outputs

Pin	Name	Description	Signal Type
1	out	output data	complex

Notes/Equations

1. This model is the flexible orthogonal channel noise simulator.
2. Each firing, this model outputs a slot of complex chips that consists of 2560 spread and scrambled complex data bits.
3. The number of dedicated channels can be set flexibly from 1 to 512. The dedicated channels of the OCNS signal should be evenly distributed in the code domain; timing

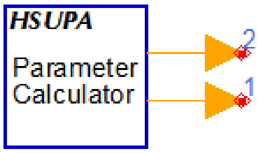
offset should be equidistantly distributed over the dedicated channels; level settings of dedicated channels should be similar.

4. The default OCNS model has 16 dedicated channels with channelization codes, timing offsets and level settings as specified in [7] for test model 1.
5. ScrambleCode i, ScrambleOffset k, and ScrambleType parameters determine the scrambling code n as follows:
   $n = (16 \times i) + k + m$
   - If ScrambleType is normal, m = 0
   - If ScrambleType is right, m = 16384
   - If ScrambleType is left, m = 8192
6. The output signal is normalized to make sure that its RMS value is 1.

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.
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, Sep. 2008.
6. 3GPP Technical Specification TS 25.104, "Base Station (BS) radio transmission and reception (FDD)," Version 7.10.0, Mar. 2008.
7. 3GPP Technical Specification TS 25.141, "Base station (BS) conformance testing (FDD)," V7.11.0, Mar. 2008.
8. 3GPP Technical Specification TS 34.121, "Radio transmission and reception (FDD)," Version 7.6.0, Sep. 2007.

HSUPA_ParamCalc



Description: EDCH parameter calculator
Library: HSUPA, Multiplexers & Coders

Parameters

Name	Description	Default	Symbol	Type	Range
EDCH_Category	FDD E-DCH physical layer categories: Category 1, Category 2, Category 3, Category 4, Category 5, Category 6, Category 7	Category 6		enum	
TransBlockSize	Transport block size	2706	L	int	[1,max transport block size]†
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms		enum	
PuncLimit	Puncturing limit for uplink	0.468		real	[PLmax , 1]‡
maxNumElement_Set0	maximum number of element in Set0	11		int	[1,11]

† Please refer to table of FDD E-DCH physical layer categories.
‡PLmax is 0.33 for Category 6 and is 0.44 for all other categories.

Pin Outputs

Pin	Name	Description	Signal Type
1	NumED	number of E-DPDCH	int
2	SltF_ED	slot format of E-DPDCH	int

Notes/Equations

1. This model is used to calculate E-DPDCH related parameters according to the setting of E-DCH. Each firing, one NumED and one SltF_ED tokens are produced.
2. According to [2], the parameters of E-DPDCH such as number of E-DPDCH, slot format of E-DPDCH cannot be inferred easily by parameters of E-DCH such as TTI, TransBlockSize, etc. This model can help get the parameters conveniently.
3. The number of E-DPDCH slot format are determined when determining the total number of bits available for the E-DCH transmission per TTI with transport format j: $N_{e,data,j}$. $N_{e,data,j}$ is determined by the following variables:
   - The total number of bits in a TTI before rate matching with transport format j: $N_{e,j}$. The calculation for $N_{e,j}$ will be described below in more detail.
   - The number of bits available to the CCTrCH of E-DCH type on all PhCHs: N_{data}.
   - In the design library, N_{data} are calculated as: NumOfSlots * Ndata
   - The results are listed in the first table below for all possible spreading factors and BPSK modulation scheme.
     NumOfSlots specifies the number of slots in a TTI, NumOfSlots=3 for TTI=2ms; NumOfSlots=15 for TTI=10ms. N_{data} is defined in the second table below.

Table1. $N_{e,data}$ **for all possible spreading factors and BPSK modulation**

Index		0	1	2	3	4	5	6	7	8	9
Ne,data	TTI=2	30	60	120	240	480	960	1920	3840	7680	11520
	TTI=10	150	300	600	1200	2400	4800	9600	19200	38400	57600
SF		256	128	64	32	16	8	4	4	2	4 & 2
Channel Number		1	1	1	1	1	1	1	2	2	2*N4+2*N2

- The set of Ne,data values allowed by the UTRAN and supported by the UE: SET0.
  So for TTI=2ms, SET0 can be a subset of {30,60,120,240,480,960,1920,3840,7680,11520}
  For TTI=10ms, SET0 can be a subset of {150, 300,600,1200,2400,4800,9600,19200, 38400, 57600}.
- TTI defined by parameter TTI.
- PLnon-max defined by parameter PuncLimit.
- PLmax For BPSK modulation, PLmax =0.44 for E-DCH Category 1,2,3,4,5, and PLmax = 0.33 for E-DCH Category 6.
- PLmod,switch is equal to 0.468

4. Ne,data,j is determined by an algorithm as illustrated in the pseudocode example below:

SET1 = { $N_{e,data}$ in SET0 such that $N_{e,data} - N_{e,j}$ is non negative }

If SET1 is not empty and the smallest element of SET1 requires just one E-DPDCH then

$N_{e,data,j}$ = min SET1

Else

SET2 = { $N_{e,data}$ in SET0 such that $N_{e,data} - PL_{non\text{-}max} \times N_{e,j}$ is non negative }

If SET2 is not empty then

Sort SET2 in ascending order

$N_{e,data}$ = min SET2

While $N_{e,data}$ is not the max of SET2 and the follower of $N_{e,data}$ requires only one E-DPDCH do

$N_{e,data}$ = follower of $N_{e,data}$ in SET2

End while

If $N_{e,data}$ is equal to $2\times M_2+2\times M_4$ and $N_{e,data} / N_{e,j} \geq PL_{mod\_switch}$

$N_{e,data} = 2\times N_2+2\times N_4$

End if

If $N_{e,data}$ is equal to $2\times N_2+2\times N_4$ and $N_{e,data} / N_{e,j} < PL_{mod\_switch}$

$N_{e,data}$ = max SET0

End if

$N_{e,data,j} = N_{e,data}$

Else

$N_{e,data,j}$ = max SET0 provided that $N_{e,data,j} - PL_{max} \times N_{e,j}$ is non negative

End if

End if

5. Since the $N_{e,data,j}$ is determined, the number of E-DPDCH and the Spread Factor can be determined by the preceding table. The slot format can be determined by SF by the following table:

Table2 E-DPDCH slot formats

Slot Format #i	Channel Bit Rate (kbps)	Bits/Symbol M	SF	Bits/ Frame	Bits/ Subframe	Bits/Slot N_{data}
0	15	1	256	150	30	10
1	30	1	128	300	60	20
2	60	1	64	600	120	40
3	120	1	32	1200	240	80
4	240	1	16	2400	480	160
5	480	1	8	4800	960	320
6	960	1	4	9600	1920	640
7	1920	1	2	19200	3840	1280
8	1920	2	4	19200	3840	1280
9	3840	2	2	38400	7680	2560

Notes: when the number of E-DPDCH is 4 case 9 in table 1, the output pin SltF_ED is only 7.

6. Calculation for Ne,j: $N_{e,j}$ specifies the total number of bits in a TTI before rate

matching with transport format j and is calculated as:

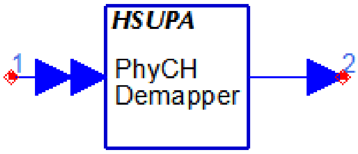
- $N_{e,j}$ = codeBlkNum * chCodedSize, where, codeBlkNum refers to the number of code block segmentation and calculated as: *codeBlkNum = ceil((TransBlockSize + Ncrc) / Z), Where Ncrc refer to the size of CRC, and fixed to 24 for E-DCH, Z refers to the maximum code block size and Z = 5114 for E-DCH (turbo coding).
- chCodedSize refers to number of bits in each code block after encoding and calculated as: chCodedSize = 3 * codeBlkSize + 12
- codeBlkSize refers to number of bits in each code block before encoding and calculated as:

  if (TransBlockSize + Ncrc) < 40
  codeBlkSize = 40
  else
  codeBlkSize = ceil((TransBlockSize + Ncrc) / codeBlkNum)

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 6.5.0, Mar. 2006.

HSUPA_PhCH_Demap



Description: EDCH physical channel demapper
Library: HSUPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Symbol	Type	Range
EDCH_Category	FDD E-DCH physical layer categories: Category 1, Category 2, Category 3, Category 4, Category 5, Category 6, Category 7	Category 6		enum	
TransBlockSize	Transport block size	2706	L	int	[1,max transport block size]†
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms		enum	
PuncLimit	Puncturing limit for uplink	0.468		real	[PLmax , 1]‡
maxNumElement_Set0	maximum number of element in Set0	11		int	[1,11]

† Please refer to table of FDD E-DCH physical layer categories.
‡PLmax is 0.33 for Category 6 and is 0.44 for all other categories.

Pin Inputs

Pin	Name	Description	Signal Type
1	InputM	data for physical channel(s)	multiple real

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	output	real

Notes/Equations

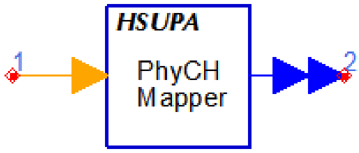
1. This model is used to implement physical channel demapping for HSUPA uplink.
2. Each firing, Ndata Output tokens are generated while 7680 InputM tokens are consumed if TTI=2ms is used, or 38400 InputM tokens are consumed if TTI=10ms is used. Determination of Ndata, spreading factor and number of E-DPDCH is described in 4.8.4.1 in [2].
3. A simple way to get the value of Ndata, spreading factor and number of E-DPDCH used with wanted TTI and TransBlockSize is to build and run a minimal test design of this model. The information will be displayed in the simulation window.
4. The model is the converse of model HSUPA_PhCH_Map. For more information, see *HSUPA_PhCH_Map* (hsupa).
5. All "spreading factor" input chips in each physical channel are averaged to get the symbols. The symbols are then combined to recover the transport channel block.

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 6.5.0, Mar. 2006.

HSUPA_PhCH_Map



Description: EDCH physical channel mapper
Library: HSUPA, Multiplexers & Coders

Parameters

Name	Description	Default	Symbol	Type	Range
EDCH_Category	FDD E-DCH physical layer categories: Category 1, Category 2, Category 3, Category 4, Category 5, Category 6, Category 7	Category 6		enum	
TransBlockSize	Transport block size	2706	L	int	[1,max transport block size]†
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms		enum	
PuncLimit	Puncturing limit for uplink	0.468		real	[PLmax , 1]‡
maxNumElement_Set0	maximum number of element in Set0	11		int	[1,11]

† Please refer to table of FDD E-DCH physical layer categories.
‡PLmax is 0.33 for Category 6 and is 0.44 for all other categories.

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	input	int

Pin Outputs

Pin	Name	Description	Signal Type
2	OutputM	data for physical channel(s)	multiple real

Notes/Equations

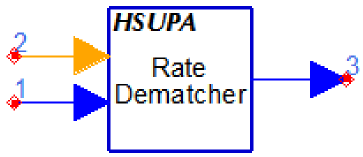
1. This model is used to map the interleaved data into each physical channel defined in 4.8.7 in [2].
2. Each firing, 7680 OutputM tokens are generated if TTI=2ms is used, or 38400 OutputM tokens are generated if TTI=10ms is used while Ndata Input token consumed. Determination of Ndata, spreading factor and number of E-DPDCH is described in 4.8.4.1 in [2].
3. A simple way to get the value of Ndata, spreading factor, and number of E-DPDCH used with wanted TTI and TransBlockSize is to build and run a minimal test design of this model. The information will be displayed in the simulation window.
4. Since synchronous data flow is employed, the input and output token involved in each firing are fixed. But the number of data for OutputM is different if the spreading factor is different. Since the chip rate after spreading is the same for all code channels, a convenient way to resolve this issue is just to repeat the data from symbol rate to chip rate. This way, when spreading code channels, the signal will be multiplied with spreading code directly.
5. The bus width of OuputM is the number of E-DPDCH.
6. If the number of E-DPDCH is 2, the spreading factor for the two channels are the

same and can only be 4 or 2. If the number of E-DPDCH is 4, the first two channels use spreading code Cch,2,1 and the last two channels use spreading code Cch,4,1 .

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 6.5.0, Mar. 2006.

HSUPA_RateDematch



Description: EDCH rate dematcher
Library: HSUPA, Demultiplexers & Decoders

Parameters

Name	Description	Default	Symbol	Type	Range
EDCH_Category	FDD E-DCH physical layer categories: Category 1, Category 2, Category 3, Category 4, Category 5, Category 6, Category 7	Category 6		enum	
TransBlockSize	Transport block size	2706	L	int	[1,max transport block size]†
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms		enum	
PuncLimit	Puncturing limit for uplink	0.468		real	[PLmax , 1]‡
RV_Mode	Redundancy version mode: Calculated using RSN, Only index 0	Calculated using RSN		enum	
MaxRSN	Maximum retransmission sequence number	3		int	[0,3]
HARQ_PrcssMode	Way to setting number of HARQ: Depending on TTI, User defined	Depending on TTI		enum	
NumHARQ	Number of HARQ processes	4		int	[2,8]
maxNumElement_Set0	maximum number of element in Set0	11		int	[1,11]
TransBlockIgnored	Transport block Ignored due to system delay	1		int	[0,5]
LLR_Bypass	Bypass LLR Combination or not: NO, YES	NO		enum	

† Please refer to table of FDD E-DCH physical layer categories.
‡PLmax is 0.33 for Category 6 and is 0.44 for all other categories.

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	input	real
2	RSN	retransmission sequence number	int

Pin Outputs

Pin	Name	Description	Signal Type
3	Output	output	real

Notes/Equations

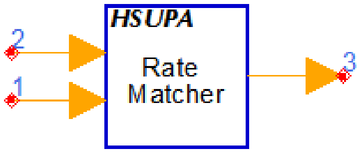
1. This model is used to implement rate dematch for HSUPA uplink.
2. Each firing, ((TransBlockSize + number of padding bits) * 3 + code block number * 12) Output tokens are generated while Ndata Input tokens are consumed. Determination of Ndata, spreading factor, and number of E-DPDCH is described in 4.8.4.1 in [2].

3. A simple way to get the value of code block number, code block size and the number of padding bits and their relationship with the value of TransBlockSize is just to run the model HSUPA_CodeBlkSeg with wanted TransBlockSize in a minimal runnable design. The information will then be displayed in the simulation window.
4. A simple way to get the value of Ndata, spreading factor and number of E-DPDCH used with wanted TTI and TransBlockSize is to build and run a minimal test design of this model. The information will be displayed in the simulation window.
5. This model implements the converse operation of HSUPA_RateMatch. For more information, see *HSUPA RateMatch* (hsupa).
6. The received signal for each HARQ process is buffered in this model. If the input of RSN is 0, current input data will be stored into the buffer of the current HARQ process directly. If the input of RSN is larger than 0, it means the received signal is a redundancy version and there is a previous version stored in the buffer of the current HARQ process. Versions of received signal are combined and then stored into the buffer of the current HARQ process. The data in the buffer for the current HARQ process are then fed into channel decoder(s).
7. 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. The value of delay shall be sent to this model by setting parameter TransBlockIgnored.

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.

HSUPA_RateMatch



Description: EDCH rate matcher
Library: HSUPA, Multiplexers & Coders

Parameters

Name	Description	Default	Symbol	Type	Range
EDCH_Category	FDD E-DCH physical layer categories: Category 1, Category 2, Category 3, Category 4, Category 5, Category 6, Category 7	Category 6		enum	
TransBlockSize	Transport block size	2706	L	int	[1,max transport block size]†
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms		enum	
PuncLimit	Puncturing limit for uplink	0.468		real	[PLmax , 1]‡
RV_Mode	Redundancy version mode: Calculated using RSN, Only index 0	Calculated using RSN		enum	
MaxRSN	Maximum retransmission sequence number	3		int	[0,3]
HARQ_PrcssMode	Way to setting number of HARQ: Depending on TTI, User defined	Depending on TTI		enum	
NumHARQ	Number of HARQ processes	4		int	[2,8]
maxNumElement_Set0	maximum number of element in Set0	11		int	[1,11]

† Please refer to table of FDD E-DCH physical layer categories.
‡PLmax is 0.33 for Category 6 and is 0.44 for all other categories.

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	input	int
2	RSN	retransmission sequence number	int

Pin Outputs

Pin	Name	Description	Signal Type
3	Output	output	int

Notes/Equations

1. This model is used to implement rate match defined in 4.8.4 in [2] for HSUPA uplink
2. Each firing, Ndata Output tokens are generated while ((TransBlockSize + number of padding bits) * 3 + code block number * 12) Input tokens consumed. Determination of Ndata, spreading factor, and number of E-DPDCH is described in 4.8.4.1 in [2].
3. A simple way to get the value of code block number, code block size, and the number of padding bits and their relationship with the value of TransBlockSize is to run the model HSUPA_CodeBlkSeg with wanted TransBlockSize in a minimal runnable design. The information will then be displayed in the simulation window.

4. A simple way to get the value of Ndata, spreading factor, and number of E-DPDCH used with wanted TTI and TransBlockSize is to build and run a minimal test design of this model. The information will be displayed in the simulation window.
5. If the value of RV_Mod is set to "Calculated using RSN", the RSN input, the NumHARQ value, and current TTI number will be used to calculate the RV value according to Table 16 of Relation between RSN value and E-DCH RV Index in 4.9.2.2 in [2].
6. The table shows the Relation between RSN value and E-DCH RV Index. If HARQ_PrcssMode is set to "Depending on TTI", NumHARQ is set to 8 for TTI 2ms and 4 for TTI 10 ms. Otherwise, the user can set the value of NumHARQ.

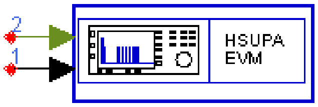
	$N_{sys} / N_{e,data,j}$ <1/2	**1/2 = $N_{sys} / N_{e,data,j}$**
RSN Value	E-DCH RV Index	E-DCH RV Index
0	0	0
1	2	3
2	0	2
3	[ÎTTIN/N_{ARQ} ° **mod** 2] x 2	ÎTTIN/N_{ARQ} ° **mod** 4

7. The process of bit separation, rate match with specific RV value, and bit collection can be found in 4.8.4.2-4.8.4.4 in [2].

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.

HSUPA_RF_EVM



Description: EVM and Phase Discontinuity Measurements
Library: HSUPA, Measurement

Parameters

Name	Description	Default	Unit	Type	Range
RLoad	input resistance	DefaultROut	Ohm	real	(0,∞)
RTemp	temperature of resistor, in celsius	DefaultRTemp		real	[-273.15,∞)
ExcessBW	excess bandwidth of raised cosine filters	0.22		real	(0.0,1.0)
FilterLength	length of raised cosine filters in number of symbols	16		int	[1,∞]
SamplesPerChip	samples per chip	8		int	[1,256]
LinkDir	link direction: Downlink, Uplink	Uplink		enum	
ScrambleCode	index of scramble code	0		int	[0,511] for downlink; [0,16777215] for uplink
ULScrambleType	uplink scramble code type: LONG, SHORT	LONG		enum	
ScrambleOffset	scramble offset in downlink channels	0		int	[0,15]
DLScrambleType	downlink scramble code type: Normal, RightAlternate, LeftAlternate	Normal		enum	
SpreadCode	index of spread code	0		int	[0,255] for uplink DPCCH; [0,SF-1] for downlink; SF is set by SlotFormat
SlotFormat	slot format	0		int	[0,5] for uplink DPCCH; [0,16] for downlink DPCH
StartSlot	number of slot to be ignored	0		int	[0,∞)
SlotNum	number of slots measured	2		int	[1,15]
SCH	switch for SCH: OFF, ON	ON		enum	
CPICH	switch for CPICH: OFF, ON	OFF		enum	
DUT_DelayBound	Search length	0.00001 sec	sec	real	(0,(400.0/3840000))
EVMValue	EVM value expression options: EVM_Ratio, EVM_Percent	EVM_Percent		enum	
Correct_IQ_Offset	switch for IQ offset correction: NO, YES	YES		enum	
ExcludeTransition	select YES for predictable power changes: NO, YES	YES		enum	

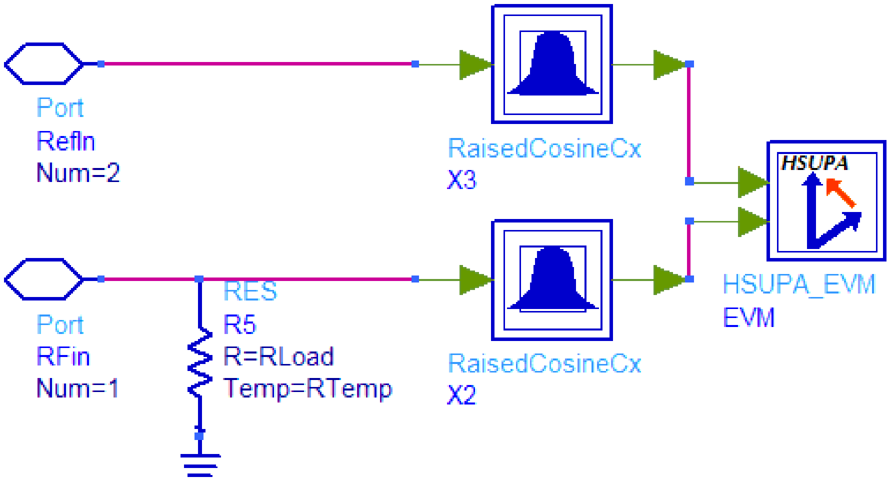
Pin Inputs

Pin	Name	Description	Signal Type
1	RFin	input RF signal	timed
2	ref	reference signals	complex

Notes/Equations

- This component is obsolete for new design.
  Please use the improved *HSUPA_EVM* (hsupa) for new design work.

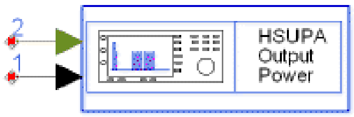
1. This subnetwork model measures EVM and Phase Discontinuity that are used to evaluate modulation accuracy.
   The schematic for this subnetwork is shown below.



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.
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, Sep. 2008.
6. 3GPP Technical Specification TS 25.104, "Base Station (BS) radio transmission and reception (FDD)," Version 7.10.0, Mar. 2008.
7. 3GPP Technical Specification TS 25.141, "Base station (BS) conformance testing (FDD)," V7.11.0, Mar. 2008.
8. 3GPP Technical Specification TS 34.121, "Radio transmission and reception (FDD)," Version 7.5.0, Jun. 2007.

HSUPA_RF_OutputPower



Description: HSUPA output power measurements
Library: HSUPA, Measurement

Parameters

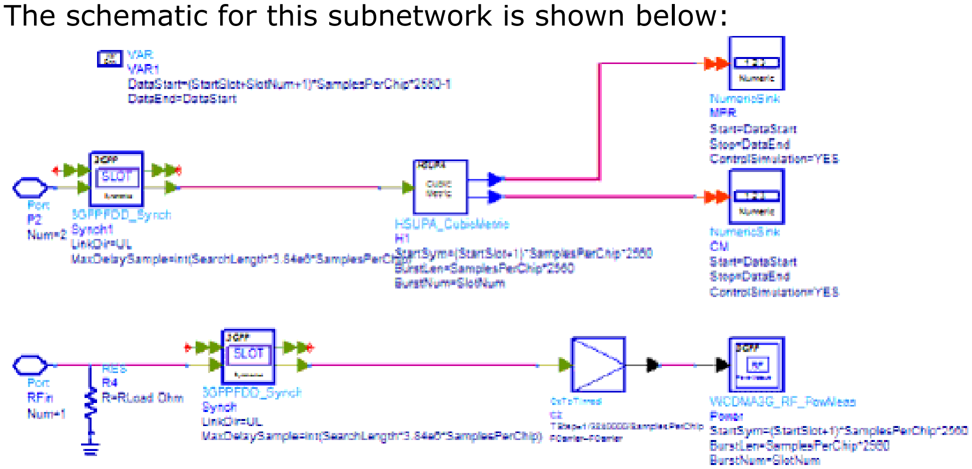
Name	Description	Default	Symbol	Unit	Type	Range
RLoad	Input resistance	DefaultRLoad		Ohm	real	(0,∞)
FCarrier	Carrier frequency	1950MHz		Hz	real	(0,∞)
SamplesPerChip	Samples per chip	8	S		int	[2,32]
ScrambleCode	Index of scramble code	0			int	[0,512] for downlink; [0, 16777215] for uplink
Scramble	scramble code type: LONG, SHORT	LONG			enum	
SlotFormat	Slot format	0			int	[0,5] for uplink DPCCH
CM_k	Slope factor for calculating cubic metric	1.56			real	[1.0,3.0]
SearchLength	Search length	.00001 sec		sec	real	(0,(400.0/3840000))
StartSlot	number of slot to be ignored	0			int	[0,∞)
SlotNum	number of slots measured	1			int	[1,30]

Pin Inputs

Pin	Name	Description	Signal Type
1	RF_In	input	timed
2	Ref	input	complex

Notes/Equations

1. This model is used to calculate output power and cubic metrics.
2. The average period is one slot; SlotNum specifies the number of slots to be measured.
3. Test signals are aligned at the specified slot boundary to ensure that the power average is based on a single slot.
4. The schematic for this subnetwork is shown below:



5. Cubic Metric (CM) is based on the UE transmit channel configuration and is given by

CM =CEIL{\ [20 * log10 ((v_norm ^{3}) $_{rms}$) - 20 * log10 ((v_norm_ref ^{3}) $_{rms}$)] / k, 0.5} where:

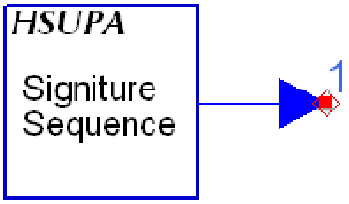
- CEIL{ x, 0.5 } means rounding upwards to closest 0.5dB, i.e. CMŒ[0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5]
- k is 1.85 for signals where all channelisation codes meet the following criteria $C_{SF, N}$ where N < SF/2
- k is 1.56 for signals where any channelisation code meet the following criteria $C_{SF, N}$ where N ≥ SF/2
- v_norm_ref is the normalized voltage waveform of the reference signal (12.2 kbps AMR Speech) and 20 * log10 ((v_norm_ref ^{3}) $_{rms}$ is 1.5237 dB.

6. MPR equals the larger value of CM-1 and 0.
7. For more information, see *3GPPFDD_Synch* (wcdma3g) and *WCDMA3G_RF_PowMeas* (wcdma3g) in the *3GPP W-CDMA Design Library* (wcdma3g) documentation.

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 6.5.0, Mar. 2006.
4. 3GPP Technical Specification TS 25.101, "UE Radio transmission and Reception (FDD)," Version 6.11.0, Mar. 2006.

HSUPA_SignatureSqn



Description: HSUPA signature sequence generator
Library: HSUPA, Multiplexers & Coders

Parameters

Name	Description	Default	Symbol	Type	Range
SequenceIndex	Signature sequence index	0	I	int	[0,39]

Pin Outputs

Pin	Name	Description	Signal Type
1	Output	output	real

Notes/Equations

1. This model generates the E-DCH Relative Grant Channel (E-RGCH) or the E-DCH Hybrid ARQ Indicator Channel (E-HICH) signature sequence according to SequenceIndex as defined in [1].
2. Each firing, one token is produced.
3. The orthogonal signature sequences Css,40,m(i) is given by the following table and the index m(i) in slot i is given by E-HICH and E-RGCH signature hopping pattern.

E-RGCH and E-HICH Signature Sequences

Css,40,0	-1	-1	-1	1	-1	1	-1	-1	1	1	-1	-1	1	-1	1	1	-1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	-1	1	-1	-1	1	1	1	1	1	-1	-1	-1
Css,40,1	-1	1	1	-1	-1	1	1	1	-1	-1	1	-1	1	1	-1	-1	-1	-1	1	1	1	-1	-1	-1	-1	1	-1	-1	-1	-1	-1	-1	-1	1	1	-1	1	1	-1	-1
Css,40,2	-1	-1	-1	1	-1	1	1	1	-1	-1	-1	-1	1	-1	-1	1	1	-1	-1	1	1	-1	1	1	1	-1	-1	1	1	1	-1	1	-1	-1	-1	-1	-1	-1	-1	-1
Css,40,3	1	-1	-1	-1	-1	-1	-1	1	1	1	-1	1	-1	1	-1	1	-1	-1	1	1	-1	1	-1	-1	1	1	-1	1	-1	-1	1	1	-1	-1	1	-1	-1	-1	-1	-1
Css,40,4	1	1	1	-1	-1	1	-1	1	-1	-1	1	1	1	-1	1	1	1	1	1	1	-1	1	1	1	-1	-1	-1	1	1	-1	1	-1	1	-1	1	1	-1	1	-1	-1
Css,40,5	-1	1	-1	-1	1	1	1	-1	1	1	-1	1	1	1	-1	1	1	1	-1	-1	1	-1	-1	1	-1	1	-1	1	-1	-1	1	-1	1	-1	-1	-1	-1	1	1	-1
Css,40,6	1	1	-1	-1	-1	1	1	-1	1	1	-1	-1	1	-1	-1	-1	-1	1	1	-1	1	1	1	-1	1	-1	1	-1	1	-1	-1	1	1	-1	1	-1	-1	1	-1	1
Css,40,7	-1	1	-1	1	1	1	-1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	1	-1	-1	-1	1	-1	1	1	-1	-1	1	1	1	1	-1	-1	1	1	-1	1	1	-1
Css,40,8	1	1	-1	1	1	-1	1	1	1	1	-1	-1	-1	-1	1	-1	1	-1	1	1	1	1	-1	1	-1	-1	-1	-1	-1	1	-1	-1	-1	-1	1	1	-1	1	1	-1
Css,40,9	-1	1	-1	-1	-1	-1	1	-1	-1	-1	-1	1	-1	-1	1	1	1	-1	1	-1	1	-1	-1	1	1	-1	1	1	-1	-1	1	1	-1	1	1	1	1	1	-1	1
Css,40,10	-1	1	1	-1	1	1	-1	1	1	1	1	-1	1	-1	1	1	-1	-1	-1	1	-1	-1	-1	-1	1	-1	1	1	-1	-1	-1	1	-1	-1	-1	1	-1	1	1	1

Css,40,11	-1	1	-1	-1	-1	-1	-1	1	1	1	-1	-1	-1	1	1	-1	1	1	-1	1	-1	-1	1	1	1	1	-1	-1	1	-1	-1	1	1	1	-1	1	1	1	-1	-1
Css,40,12	-1	-1	-1	-1	1	-1	1	1	-1	-1	-1	-1	-1	1	1	1	-1	1	1	1	1	-1	1	-1	-1	1	1	1	1	-1	-1	-1	1	-1	1	1	-1	-1	1	1
Css,40,13	1	1	1	1	-1	-1	1	-1	-1	-1	1	-1	-1	1	1	1	-1	1	-1	-1	1	1	-1	-1	1	1	-1	1	-1	1	-1	1	1	-1	-1	1	-1	1	-1	-1
Css,40,14	-1	1	1	1	-1	-1	-1	-1	1	1	1	-1	-1	1	-1	1	1	-1	1	-1	-1	-1	1	1	-1	1	1	1	1	1	-1	-1	-1	-1	1	-1	-1	1	-1	1
Css,40,15	-1	-1	1	1	-1	1	1	1	1	1	1	1	1	1	1	-1	1	1	1	1	1	-1	-1	1	1	1	1	-1	-1	1	1	1	1	-1	1	1	-1	-1	-1	1
Css,40,16	1	-1	-1	-1	-1	1	-1	-1	-1	-1	-1	-1	1	1	1	-1	1	-1	-1	-1	-1	1	-1	1	-1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	-1	-1	-1	1
Css,40,17	1	-1	1	-1	1	1	1	-1	1	1	1	-1	1	1	1	1	1	-1	1	-1	1	1	1	1	1	1	-1	1	1	-1	-1	1	-1	1	1	1	1	-1	1	-1
Css,40,18	1	1	-1	1	-1	1	1	1	1	1	-1	1	1	1	1	1	-1	-1	-1	1	1	1	1	-1	-1	1	1	1	1	1	1	-1	-1	1	-1	1	1	1	-1	1
Css,40,19	1	1	-1	1	1	1	-1	1	-1	-1	-1	-1	1	1	-1	1	1	1	1	1	-1	1	-1	1	1	1	1	1	-1	1	-1	1	1	1	1	-1	1	1	1	1
Css,40,20	1	1	1	-1	1	1	-1	1	-1	1	-1	1	-1	-1	-1	1	-1	-1	1	-1	1	-1	-1	1	1	1	1	-1	1	1	-1	-1	1	1	-1	1	-1	-1	-1	-1
Css,40,21	-1	1	1	-1	-1	-1	-1	1	-1	1	-1	-1	1	-1	-1	1	1	-1	-1	-1	1	1	1	-1	-1	1	-1	-1	-1	1	1	1	1	-1	1	1	1	-1	1	1
Css,40,22	-1	-1	-1	1	-1	-1	-1	1	-1	1	1	-1	1	1	-1	-1	-1	-1	1	-1	1	1	-1	1	1	-1	-1	1	1	-1	1	-1	1	1	-1	1	-1	1	1	1
Css,40,23	1	-1	-1	-1	-1	1	1	1	1	-1	1	1	-1	-1	-1	-1	1	-1	-1	-1	-1	-1	1	-1	1	1	-1	1	-1	1	-1	-1	1	1	1	1	-1	1	1	1
Css,40,24	-1	-1	-1	1	1	1	-1	-1	1	-1	1	-1	-1	-1	-1	1	1	-1	1	1	1	1	1	-1	1	1	1	-1	-1	-1	1	-1	1	-1	-1	1	1	1	-1	-1
Css,40,25	-1	1	-1	-1	1	-1	-1	-1	1	-1	1	1	1	-1	-1	-1	-1	1	1	1	1	1	1	1	-1	1	-1	1	-1	1	-1	1	-1	1	-1	1	-1	-1	-1	1
Css,40,26	-1	-1	1	1	1	1	1	1	-1	1	-1	1	-1	-1	1	-1	-1	-1	1	-1	-1	1	1	1	-1	1	-1	1	-1	-1	-1	1	1	-1	-1	-1	1	1	-1	1
Css,40,27	1	-1	1	-1	-1	1	-1	1	1	-1	-1	-1	-1	1	-1	-1	-1	1	1	-1	1	-1	1	1	-1	-1	1	1	-1	1	1	1	-1	-1	-1	1	1	1	1	-1
Css,40,28	1	1	-1	1	1	1	-1	1	1	-1	1	-1	-1	1	1	1	-1	-1	-1	-1	1	-1	1	1	-1	-1	-1	-1	-1	-1	1	1	1	1	1	-1	-1	-1	-1	1
Css,40,29	-1	1	-1	-1	-1	1	-1	-1	-1	1	1	1	-1	1	1	-1	-1	-1	-1	1	1	1	1	1	1	-1	1	1	-1	1	-1	-1	1	-1	1	-1	1	-1	1	-1
Css,40,30	-1	1	1	-1	1	-1	1	1	1	-1	-1	-1	1	1	1	-1	1	-1	1	-1	-1	1	1	-1	1	-1	1	1	-1	1	1	-1	1	1	-1	-1	-1	-1	-1	-1
Css,40,31	-1	1	-1	-1	-1	1	1	1	1	-1	1	-1	-1	-1	1	1	-1	1	1	-1	-1	1	-1	1	1	1	-1	-1	1	1	1	-1	-1	-1	-1	-1	1	-1	1	1
Css,40,32	1	1	1	1	-1	-1	1	-1	1	-1	-1	1	1	1	-1	1	-1	-1	1	1	-1	-1	1	1	1	-1	-1	-1	-1	-1	-1	-1	1	-1	-1	1	1	-1	1	1
Css,40,33	-1	-1	-1	-1	1	-1	1	1	1	-1	1	1	1	1	-1	1	-1	-1	-1	-1	-1	1	-1	1	-1	-1	1	-1	1	1	-1	1	1	-1	1	1	1	1	-1	-1
Css,40,34	1	-1	-1	-1	1	-1	-1	1	-1	1	1	1	1	1	1	1	1	1	1	-1	1	-1	1	-1	1	-1	-1	-1	-1	1	-1	-1	-1	-1	-1	-1	1	1	-1	1
Css,40,35	-1	-1	1	1	-1	-1	-1	1	1	-1	-1	1	1	-1	1	1	-1	1	-1	-1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	1	1	-1	-1	1	1	-1
Css,40,36	-1	1	1	1	1	1	-1	1	1	-1	-1	1	-1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	-1	-1	1	1	-1	-1	-1	-1	-1	1	1	1	-1	-1	1
Css,40,37	1	-1	1	-1	1	-1	-1	-1	1	-1	-1	-1	1	-1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	-1	1	1	1	1	-1	1	-1	1	-1	1	1	-1	1
Css,40,38	-1	-1	1	-1	1	1	1	-1	-1	1	-1	-1	-1	1	-1	1	-1	1	-1	1	-1	1	1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	-1	1	-1	1
Css,40,39	-	-	1	-	-	1	-	-	1	-	-	1	-	1	1	1	1	-	1	1	1	1	-	-	-	-	-	-	1	1	-	1	1	1	-	-	-	1	1	1

	1	1		1	1		1	1		1	1		1					1					1	1	1	1	1	1			1				1	1	1			

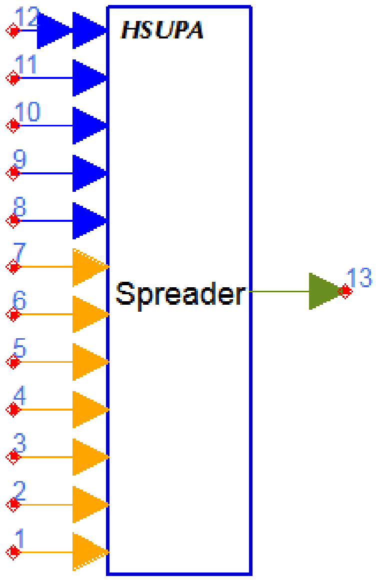
E-HICH and E-RGCH signature hopping pattern

Sequence index l	Row index m(i) for slot i		
	i mod 3 = 0	i mod 3 = 1	i mod 3 = 2
0	0	2	13
1	1	18	18
2	2	8	33
3	3	16	32
4	4	13	10
5	5	3	25
6	6	12	16
7	7	6	1
8	8	19	39
9	9	34	14
10	10	4	5
11	11	17	34
12	12	29	30
13	13	11	23
14	14	24	22
15	15	28	21
16	16	35	19
17	17	21	36
18	18	37	2
19	19	23	11
20	20	39	9
21	21	22	3
22	22	9	15
23	23	36	20
24	24	0	26
25	25	5	24
26	26	7	8
27	27	27	17
28	28	32	29
29	29	15	38
30	30	30	12
31	31	26	7
32	32	20	37
33	33	1	35
34	34	14	0
35	35	33	31
36	36	25	28
37	37	10	27
38	38	31	4
39	39	38	6

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.

HSUPA_Spread



Description: HSUPA spreader
Library: HSUPA, Multiplexers & Coders

Parameters

Name	Description	Default	Type
DPDCH_Configured	Setting to YES if DPDCH is configured, otherwise NO: NO, YES	NO	enum
HSDPCCH_Configured	Setting to YES if HS-DPCCH is configured, otherwise NO: NO, YES	NO	enum

Pin Inputs

Pin	Name	Description	Signal Type
1	DPDCH	DPDCH	int
2	DPCCH	DPCCH	int
3	EDPCCH	E-DPCCH	int
4	HSDPCCH	HS-DPCCH	int
5	SltF_D	slot format of DPDCH	int
6	NumED	number of E-DPDCH	int
7	SltF_ED	slot format of E-DPDCH, only valid when number of E-DPDCH is 1 or 2.	int
8	GainD	gain factor of DPDCH over DPCCH, in dB	real
9	GainED	gain factor of E-DPDCH over DPCCH, in dB	real
10	GainEC	gain factor of E-DPCCH over DPCCH, in dB	real
11	GainHS	gain factor of HS-DPCCH over DPCCH, in dB	real
12	EDPDCH	E-DPDCH	multiple real

Pin Outputs

Pin	Name	Description	Signal Type
13	Output	output	complex

Notes/Equations

1. This model is used to spread, power-scale, and multiplex uplink signals according to [3].

2. Each firing, 2560 Output tokens are generated when 2560 DPDCH tokens, 10 DPCCH tokens, 10 EDPCCH tokens, 10 HSDPCCH tokens, 1 SltF_D token, 1 NumED token, 1 SltF_ED token, 1 GainD token, 1 GainED token, 1 GainEC token, 1 GainHS token and 2560 EDPDCH tokens are consumed.
3. The input of DPDCH and E-DPDCH must be repeated to chip rate before it is fed into this model. The spreading code will be multiplied directly with input signal.
4. Table 0 of Maximum number of simultaneous uplink dedicated channels in [3] is copied here in **Maximum number of simultaneous uplink dedicated channels** as shown below. Since whenever there are enhanced uplink channels, the maximum number of DPDCH is less than 2, the input of DPDCH is not designed as a multiple port.

Configuration #	DPDCH	HS-DPCCH	E-DPDCH	E-DPCCH
1	6	1	-	-
2	1	1	2	1
3	-	1	4	1

5. SltF_D is the slot format for DPDCH, which can be found in 5.2.1.1[1]. This input is used to determine SF of DPDCH. It determines the spreading code at the same time because according to [3], when only one DPDCH is to be transmitted, DPDCH1 shall be spread by code cd,1 = $C_{ch,SF,k}$ where SF is the spreading factor of DPDCH1 and k = SF / 4.
6. Num_ED and SltF_ED are the number and slot format of E-DPDCH, which can be found in 5.2.1.3[1]. SltF_ED is used to determine SF of each E-DPDCH. When Num_ED is 4, SltF_ED is ignored and the spreading code of E-DPDCH1 and E-DPDCH2 is $C_{ch,2,1}$. The spreading code of E-DPDCH3 and E-DPDCH4 is always $C_{ch,4,1}$.
7. If parameter DPDCH_Configured is set to YES, $N_{max-dpdch}$ is 1, while if it is set to NO, $N_{max-dpdch}$ is 0. Table 1E of Channelisation code for E-DPDCH in [3] is copied into **Channelisation code for E-DPDCH** as shown below:

$N_{max-dpdch}$	E-DPDCH $_k$	Channelisation code $C_{ed,k}$
0	E-DPDCH $_1$	$C_{ch,SF,SF/4}$ if SF ≥ 4 $C_{ch,2,1}$ if SF = 2
	E-DPDCH $_2$	$C_{ch,4,1}$ if SF = 4 $C_{ch,2,1}$ if SF = 2
	E-DPDCH $_3$ E-DPDCH $_4$	$C_{ch,4,1}$
1	E-DPDCH $_1$	$C_{ch,SF,SF/2}$
	E-DPDCH $_2$	$C_{ch,4,2}$ if SF = 4 $C_{ch,2,1}$ if SF = 2

8. Related information in Table 1D of Channelisation code of HS-DPCCH in [3] is copied into **Channelisation code of HS-DPCCH** as shown below:

Nmax-dpdch	Channelisation code chs
0	$C_{ch,256,33}$
1	$C_{ch,256,64}$

9. The DPCCH is defined as power reference of other uplink channels in this model. For example, GainED is the gain of power level of E-DPDCH over DPCCH in dB units. The factor multiplied to the data of DPCCH is 1, while the factor multiplied to the data of each E-DPDCH is 20*log(GainED).
10. GainED is gain for each E-DPDCH. If there are four E-DPDCHs, GainED is the gain for E-DPDCH $_3$ and E-DPDCH $_4$. The gain for E-DPDCH $_1$ and E-DPDCH $_2$ is GainED+3dB. For more information, please refer to 5.1.2.5B.2.3 in [4].
11. After spreading and power scaling, the uplink channels will be mapped to IQ

branches. DPCCH is always transmitted in Q branch; E-DPCCH is always transmitted in I branch; HS-DPCCH is always transmitted in Q branch; DPDCH $_1$ is always transmitted in I branch; Table 1C of the IQ branch mapping for E-DPDCH in [3] is copied into **IQ branch mapping for E-DPDCH** as shown below:

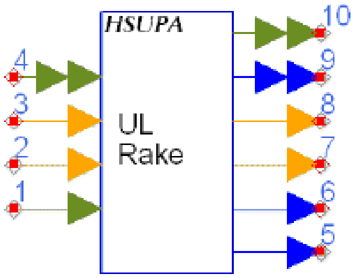
N $_{max-dpdch}$	**HS-DSCH configured**	**E-DPDCH $_k$**	**iq $_{ed,k}$**
0	No/Yes	E-DPDCH $_1$	1
		E-DPDCH $_2$	j
		E-DPDCH $_3$	1
		E-DPDCH $_4$	j
1	No	E-DPDCH $_1$	j
		E-DPDCH $_2$	1
1	Yes	E-DPDCH $_1$	1
		E-DPDCH $_2$	j

12. The uplink signal is normalized to ensure its RMS value is 1.

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.
4. 3GPP Technical Specification TS 25.214, "Physical layer procedures (FDD)," Version 7.9.0, May 2008.

HSUPA_UL_Rake



Description: HSUPA uplink receiver
Library: HSUPA, Receivers

Parameters

Name	Description	Default	Type	Range
SlotFormat	slot format	0	int	†
ScrambleCode	index of scramble code	0	int	[0,512] for downlink; [0, 16777215] for uplink
Scramble	scramble code type: LONG, SHORT	LONG	enum	
SampleRate	sample rate	8	int	[1,256]
MaxDelaySample	maximum delay boundary, in terms of samples	0	int	[0,2559] for RAKE receiver; [0,102400] in other models
ChannelType	select the channel type to be processed: CH_GAUSSIAN, CH_FADING	CH_GAUSSIAN	enum	
ChannelInfo	fading channel information source: Known, Estimated	Known	enum	
ChannelInfoOffset	offset between spread code and channel information in terms of sample	0	int	[0,MaxDelaySample]
PathSearch	path search frequency: EverySlot, Once	Once	enum	
SearchMethod	path search method: Coherent, NonCoherent, Combined	Coherent	enum	
SearchSlotsNum	number of slots for path search	1	int	[1,12]
PathNum	number of Rake fingers	1	int	[1,6]
PathDelaySample	delay for each finger, in terms of samples	0	int array	[0,MaxDelaySample]; array size shall be equal to PathNum
EstSlotsNum	Number of slots for channel estimation	1	int	[1,3]
UseMovingEstWindow	If use moving window in channel estimation: NO, YES	NO	enum	
UsePastSearch	If use past samples for path searching: NO, YES	NO	enum	
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms	enum	
DPDCH_Configured	Setting to YES if DPDCH is configured, otherwise NO: NO, YES	NO	enum	
HSDPCCH_Configured	Setting to YES if HS-DPCCH is configured, otherwise NO: NO, YES	NO	enum	

† [0:5] for uplink DPCCH;
[0:16] for downlink DPCH;
[0:17] for downlink SCCPCH;
[0:5] for uplink PCPCH (Ver 03_00);
[0:2] for uplink PCPCH (Ver 12_00);
[0:1] for uplink PCPCH (Ver 03_02).

Pin Inputs

Pin	Name	Description	Signal Type
1	inChip	input data stream	complex
2	NumED	number of E-DPDCH	int
3	SltF_ED	slot format of E-DPDCH	int
4	inChM	input known channel information	multiple complex

Pin Outputs

Pin	Name	Description	Signal Type
5	EDPCCH	E-DPCCH	real
6	PwrN	power of noise estimated from DPCCH	real
7	SlotIndex	slot number	int
8	Delay	path delay	int
9	EDPDCH	E-DPDCH	multiple real
10	outChM	output estimated channel information	multiple complex

Notes/Equations

1. This model is used to demodulate and despread HSUPA uplink signals at a 3.84MHz chip rate. Such signals can be corrupted by multipath fading channel and additive Gaussian noise.
2. Each firing, 2560 EDPDCH tokens, 10 EDPCCH tokens, 1 DPCCH tokens, 1 SlotIndex token, 1 Delay token, and 2560 outChM tokens are produced when 2560*SamplesPerChip inChip and inChM tokens, 1 Num_ED token, and 1 SltF_ED token are consumed.
3. For information about the parameters related to the configuration of uplink channels, see *HSUPA_Spread* (hsupa).
4. 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.
5. The signal processing flow inside the model is:
    - Input data until slots specified by SearchSlotsNum are received
    - Slot index identification
    - IQ offset correction to eliminate any DC component.
    - Multipath search
    - Channel estimation for each path
    - Decode and despread of individual path
    - SNR estimation for individual path
    - Multipath combination
    - Output decoded data and SlotIndex to align at the frame boundary
    - Output Delay and channel information (slots delayed are specified by SearchSlotsNum)
6. This model can be configured to work under ideal conditions; in other words, the real time channel information can be input from input pin and the path delay information can be set by the PathDelaySample parameter.
7. The ChannelInfo parameter selects the channel information source from input or estimated inside the model. The delay for each path is expressed in terms of samples as individual elements in the array.
8. f path delay is specified, the SearchSlotsNum is 1.
   If the first element in PathDelaySample is 0, the path search is performed inside the receiver model. Otherwise, the numbers specified by PathDelaySample are taken as the delays for each path.
9. The path search 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 and the top ones are assumed to be the offsets where the paths could occur.
10. If SearchMethod = Coherent, the correlation will be performed at the pilot bits only.

If SearchMethod = NonCoherent, the correlation will be performed on the data field. Note that the coherent correlation obtained over pilot bits is unbiased, while the non-coherent correlation is biased. If SearchMethod = Combined, the coherent and non-coherent correlations are summed as the matrix for path resolution.

11. Another factor that impacts the correlation is the SearchSlotsNum parameter. This parameter sets the number of slots over which the correlation is accumulated. More slots are necessary for a reliable path resolution for signals with noise contamination. Usually, six slots are required if E_b/N_o is 2 dB. The user must determine the appropriate slot number and search method for the best trade-off between accuracy and speed.
12. If UsePastSearch = YES, the slots used for searching will use previous slots. For example, if SearchSlotsNum is set to 3 and the index of current slot is 0, then slot -1, 0, 1 will be used for path searching. If SearchSlotsNum is set to 4, slot -1, 0, 1, 2 will be used. slot -1 is the previous slot of slot 0, while slot 1 is the next slot of slot 0,...; If UsePastSearch = NO, slot 0, 1, 2, 3 will be used for path searching.
13. The estimated path delay is output from the pin Delay after slots specified by SearchSlotsNum are received.
14. Because path search results could be biased when channel noise is large, the path delay should be determined before simulation.
15. For example, if a path delay is 552 nsec and channel gain is -20 dB, if channel noise is large it could be difficult for the Rake receiver to correctly resolve this path. In this case, simply increase channel gain to a larger value and decrease the noise level to a very small level. (These changes do not change the channel delay profile.)
16. The first value of PathDelaySample is set to 0. At start of simulation, the path delay is displayed in the simulation window.

```
DF: Simulation started.
DF: Scheduler finished scheduling
G3: Number of paths is 1.
G3:
Path no. 0 is at sample no.145.
```

17. The path delay determined by the Rake receiver is 145. This value has high credibility because it is obtained under large signal-to-noise level. Specify this delay in PathDelaySample and the Rake receiver will use this value during simulation. (The channel gain and noise level will be restored to the original level after the channel delay is fixed.)
18. If the path delay is fixed, the path search is necessary only at the start of simulation; in this case, set PathSearch to Once to save simulation time. Otherwise, PathSearch must be performed for each slot received to update the path delay information that could be dynamic.
19. Channel estimation varies according to channel type as described below:
    - If ChannelType = CH_GAUSSIAN, the channel is assumed to be time-invariant and the IQ phase shift is estimated using the pilot field of the signals received so far.
    - If ChannelType = CH_FADING, channel characteristics are assumed to be time-variant and more complicated channel estimation must be used. A simple channel estimation is used that takes the fading characteristic averaged over the pilot field of the current slot as the channel information for the entire slot.
20. Generally the pilot in current slots is enough for channel estimation. But if E_b/N_0 is very low, while channel status varies relatively slowly, more slots are necessary for a reliable channel estimation. EstSlotsNum can be used to set the number of slots used for channel estimation.
21. If UsingMovingWindow = YES and ChannelType = CH_FADING, a more complex channel estimation will be used to get more precise channel estimation. The algorithm is as follows:
    - Use channel estimation algorithm described in the second paragraph in Note 14

to get initial channel information.
- Despread and decode data transmitted in the DPCCH using the channel information.
- Use the decode data as know information so that all the symbols in DPCCH can be can be think as pilot and used in channel estimation.
- Set estimation window to be 21 DPCCH symbols centered at each DPCCH symbol of current slot.
- Moving-average 21 fading characteristics in estimation window to get 10 channel coefficients and each of them used as channel information of correspond symbol interval.

22. Channel information that is estimated or known from input pins is output from the pin outChM for reference. Each firing, 2560 tokens are produced as the channel information for the chips in the slot indicated by SlotIndex.
23. All paths are combined assuming that all the paths are useful in improving the decoding reliability. Some paths with low SNR are actually harmful to the final SNR improvement. The user must determine the PathNum setting for better decoding performance in multipath conditions.
24. Each firing, input tokens is 2560 ×
SampleRate. There is a delay in terms of slots associated with the decoded information. The outputs are aligned at the TTI boundary; for example, if the first received slot index is 0 and TTI is 2ms, the decoded bit stream will be output after three slots.
25. If the HSUPA signal is S(t), this signal may be delayed t1 by some filters (such as the Tx RC filters). So, the delayed signal is S(t-t1) and the signal from 0 to t1 is zero and the real 3GPP signal transmission starts from t1. When the delayed signals pass through a fading channel, the fading factor is applied to the overall signals starting from time 0. The offset t1 must be known if the receiver of the channel information is input from outside; this offset is expressed in terms of samples. The following description provides more details.
    - Denote the signal source output as:

      $S_1, S_2, S_3, \ldots, S_i, \ldots$ These signals are fed to the transmitter module,

      and the transmitter module introduces delay (for example, the square root raised-cosine filter introduces the delay that is related with the filter length); denote this delay as *N* .
    - The output signals from transmitter module are:

      $0, 0, 0, \ldots, 0, S_1, S_2, S_3, \ldots, S_i, \ldots$ The number of 0s is N. These

      signals are fed to the fading channel model.
    - The fading channel module generates the fading factors, that can be denoted as:

      $f_1, f_2, f_3, \ldots, f_i, \ldots$ These factors will be applied to the input signals.

      They can also be input to the Rake receiver as phase reference.
    - The resultant faded signals are:

      $f_{1\times} 0, f_{2\times} 0, f_{3\times} 0, \ldots, f_{N\times} 0, \ldots, f_{N+1\times} S_1, f_{N+2\times} S_2$ Note that

      the faded signal must pass the receiver module that introduces additional delay; this does not impact the channel information offset setting.
    - The channel information being input to the Rake receiver is:

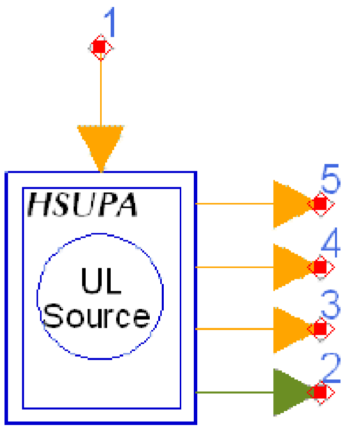
      $f_1, f_2, f_3, \ldots, f_i, \ldots$ The Rake receiver must know the offset between

      the faded signal and the known channel information. In this case, the offset is *N*, and the Rake receiver will take the *Nth* input from the channel information input and correlate it with the signal start point. The signal start point is determined by the synchronization module implemented inside the Rake receiver.

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.
4. 3GPP Technical Specification TS 25.104, "UTRA (BS) FDD: Radio transmission and Reception," Version 7.10.0, Mar. 2008.
5. 3GPP Technical Specification TS 25.141, "Base station conformance test," Version 7.11.0, Mar. 2008.

HSUPA_UL_Source



Description: HSUPA uplink signal source
Library: HSUPA, Signal Sources

Parameters

Name	Description	Default	Symbol	Unit	Type	Range
EDCH_Category	FDD E-DCH physical layer categories: Category 1, Category 2, Category 3, Category 4, Category 5, Category 6, Category 7	Category 6			enum	
TransBlockSize	Transport block size	2706	L		int	[1,max transport block size]†
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms			enum	
PuncLimit	Puncturing limit for uplink	0.468			real	[PLmax , 1]‡
RV_Mode	Redundancy version mode: Calculated using RSN, Only index 0	Calculated using RSN			enum	
MaxRSN	Maximum retransmission sequence number	3			int	[0,3]
HARQ_PrcssMode	Way to setting number of HARQ: Depending on TTI, User defined	Depending on TTI			enum	
NumHARQ	Number of HARQ processes	4			int	[4,8]
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]
DPDCH_Configured	Setting to YES if DPDCH is configured, otherwise NO: NO, YES	NO			enum	
HSDPCCH_Configured	Setting to YES if HS-DPCCH is configured, otherwise NO: NO, YES	NO			enum	
GainD	channel gain of DPDCH over DPCCH	-300		dB	real	[-∞, +∞)
GainED	channel gain of E-DPDCH over DPCCH	12.04		dB	real array	[-∞, +∞)
GainEC	channel gain of E-DPCCH over DPCCH	6.02		dB	real array	[-∞, +∞)
GainHS	channel gain of HS-DPCCH over DPCCH	-300		dB	real array	[-∞, +∞)
SlotF_DPDCH	slot format index of DPDCH	2			int	[0,6]
Scramble	scramble code type: LONG, SHORT	LONG			enum	
ScrambleCode	Index of scramble code	0			int	[0,512] for downlink; [0, 16777215] for uplink

Pin Inputs

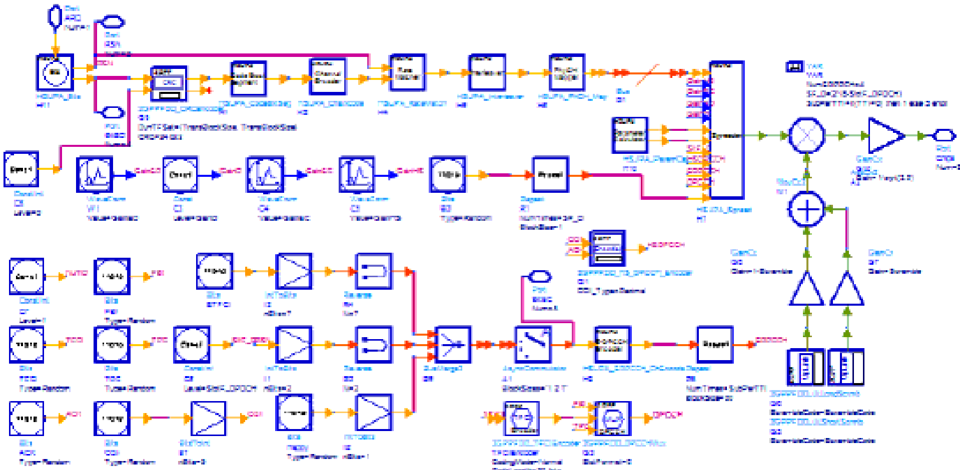
Pin	Name	Description	Signal Type
1	ARQ	automatic repeat request	int

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	output	complex
3	RSN	retransmission sequence number	int
4	BitED	bits of E-DPDCH	int
5	BitEC	bits of E-DPCCH	int

Notes/Equations

1. This subnetwork is used to implement baseband uplink source for HSUPA.
2. The schematic is shown below:

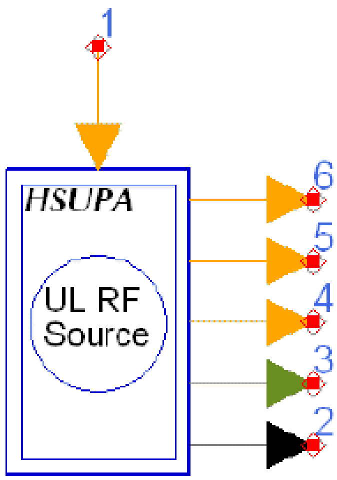


3. For more information about E-DCH parameters, see *HSUPA_RateMatch* (hsupa).
4. For more information about HARQ function, see *HSUPA_Bits* (hsupa) and *HSUPA_RateMatch* (hsupa).
5. For more information, please refer to the documentation for models used in this subnetwork.

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.

HSUPA_UL_SourceRF



Description: HSUPA RF uplink signal source
Library: HSUPA, Signal Sources

Parameters

Name	Description	Default	Symbol	Unit	Type	Range
ROut	Source resistance	DefaultROut		Ohm	real	(0,∞)
RTemp	Temperature	DefaultRTemp		Celsius	real	[-273.15,∞)
TStep	Expression showing how TStep is related to the other source parameters	1/3.84 MHz/SamplesPerChip			string	
FCarrier	Carrier frequency	1950MHz		Hz	real	(0,∞)
Power	Power	dbmtow(24.0)		W	real	[0,∞)
MirrorSpectrum	Mirror spectrum about carrier?: NO, YES	NO			enum	
GainImbalance	Gain imbalance, Q vs I	0.0		dB	real	(-∞,∞)
PhaseImbalance	Phase imbalance, Q vs I	0.0		deg	real	(-∞,∞)
I_OriginOffset	I origin offset (percent)	0.0			real	(-∞,∞)
Q_OriginOffset	Q origin offset (percent)	0.0			real	(-∞,∞)
IQ_Rotation	IQ rotation	0.0		deg	real	(-∞,∞)
SamplesPerChip	Samples per chip	8	S		int	[2,32]
RRC_FilterLength	RRC filter length (chips)	16			int	[2,128]
ExcessBW	Excess bandwidth of raised cosine filters	0.22			real	(0.0,1.0)
RV_Mode	Redundancy version mode: Calculated using RSN, Only index 0	Calculated using RSN			enum	
MaxRSN	Maximum retransmission sequence number	3			int	[0,3]

HARQ_PrcssMode	Way to setting number of HARQ: Depending on TTI, User defined	Depending on TTI			enum	
NumHARQ	Number of HARQ processes	4			int	[2,8]
ScrambleCode	Index of scramble code	0			int	[0,512] for downlink; [0, 16777215] for uplink
Scramble	scramble code type: LONG, SHORT	LONG			enum	
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]
EDCH_Category	FDD E-DCH physical layer categories: Category 1, Category 2, Category 3, Category 4, Category 5, Category 6, Category 7	Category 6			enum	
TransBlockSize	Transport block size	2706	L		int	[1,max transport block size]†
TTI	Transmission time interval: TTI 2ms, TTI 10ms	TTI 2ms			enum	
PuncLimit	Puncturing limit for uplink	0.468			real	[PLmax , 1]‡
DPDCH_Configured	Setting to YES if DPDCH is configured, otherwise NO: NO, YES	NO			enum	
HSDPCCH_Configured	Setting to YES if HS-DPCCH is configured, otherwise NO: NO, YES	NO			enum	
GainD	channel gain of DPDCH over DPCCH	-300		dB	real	[-∞, +∞)
GainED	channel gain of E-DPDCH over DPCCH	12.04		dB	real array	[-∞, +∞)
GainEC	channel gain of E-DPCCH over DPCCH	6.02		dB	real array	[-∞, +∞)
GainHS	channel gain of HS-DPCCH over DPCCH	-300		dB	real array	[-∞, +∞)
SlotF_DPDCH	slot format index of DPDCH	2			int	[0,6]

Pin Inputs

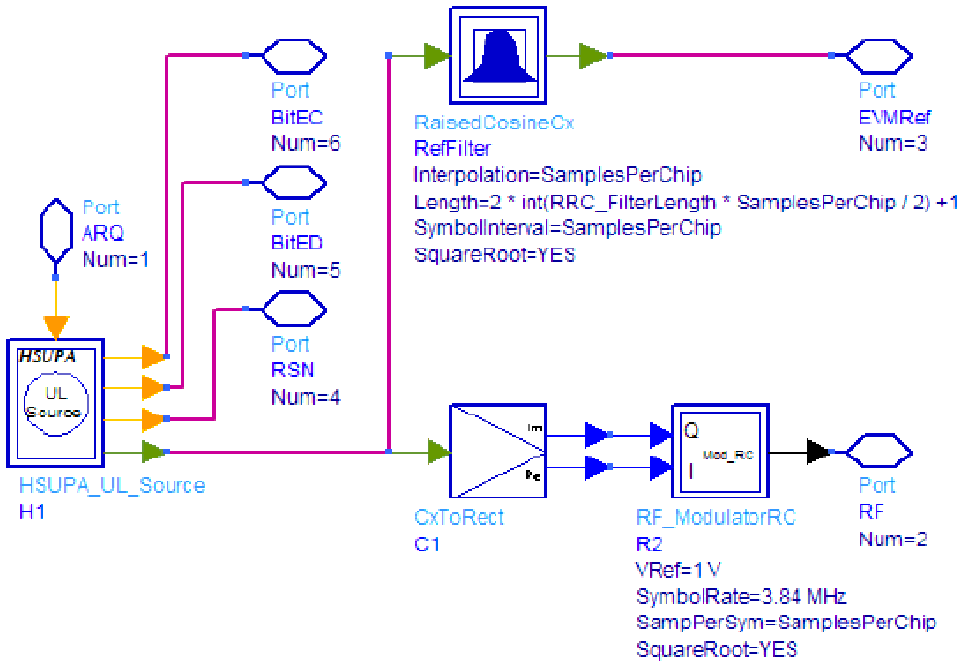
Pin	Name	Description	Signal Type
1	ARQ	automatic repeat request	int

Pin Outputs

Pin	Name	Description	Signal Type
2	RF	RF output	timed
3	EVM_Ref	reference signal for EVM	complex
4	RSN	retransmission sequence number	int
5	BitED	bits of E-DPDCH	int
6	BitEC	bits of E-DPCCH	int

Notes/Equations

1. This model is used to implement uplink source for HSUPA in RF.
2. The schematic is shown below:



3. The output of EVMRef is ideal uplink signal and can be used as reference signal for EVM and output power measurement.
4. For more information, see *HSUPA_UL_Source* (hsupa).

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.

HSUPA User Equipment Receiver Design Examples

The HSUPA_UE_Rx_wrk workspace shows user equipment receiver measurement performances, including E-AGCH demodulation performance, E-HICH detection performance, and E-RGCH detection performance.

Designs for these measurements are described in the following sections; they include:

- E-AGCH demodulation performance:
  - UE_Rx_EAGCH_Demodulation
  - UE_Rx_EAGCH_DemodulationFading
- E-HICH detection performance:
  - UE_Rx_EHICH_Detection
  - UE_Rx_EHICH_DetectionFading
- E-RGCH detection performance:
  - UE_Rx_ERGCH_Detection
  - UE_Rx_ERGCH_DetectionFading

Designs under this workspace consist of:

- Downlink RF band signal source: HSUPA_DL_SourceRF is used to provide an RF HSUPA 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 E_c/I_{or} at certain levels, which are required by various performance measurements.
- User Equipment RF receiver: HSUPA_DL_ReceiverRF is used to provide a receiver of RF HSUPA downlink signals.

E-AGCH Demodulation Performance Measurements

Design: UE_Rx_EAGCH_DemodulationFading, UE_Rx_EAGCH_Demodulation

Features:

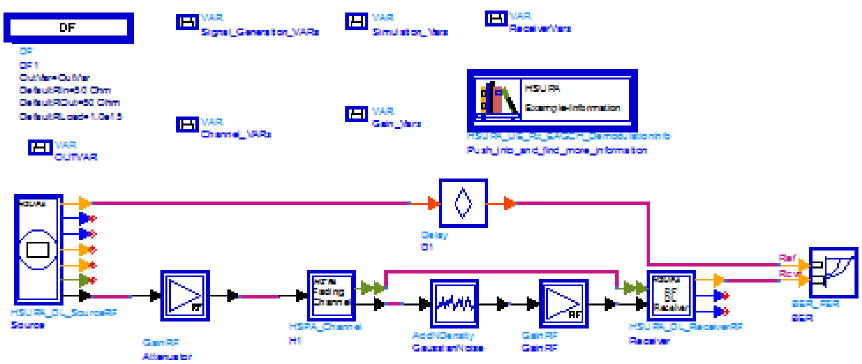
- User equipment E-AGCH demodulation performance measurements
- Integrated RF models
- Multi-path fading propagation conditions

Description:

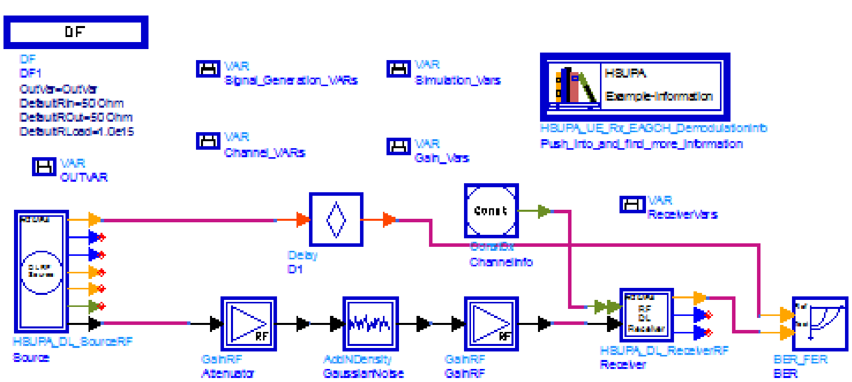
- UE_Rx_EAGCH_DemodulationFading measures user equipment receiver E-AGCH demodulation performance according to section 10.4.1 in TS 25.101.
- UE_Rx_EAGCH_Demodulation measures user equipment receiver E-AGCH demodulation performance over AWGN condition to provide the baseline reference.

The schematics for fading and AWGN conditions are shown in *UE_Rx_EAGCH_DemodulationFading Schematic* and *UE_Rx_EAGCH_Demodulation Schematic* respectively.

UE_Rx_EAGCH_DemodulationFading Schematic



UE_Rx_EAGCH_Demodulation Schematic



Simulation Results:
Simulation results are shown in *User Equipment E-AGCH Demodulation Performance Results (Fading)* and *User Equipment E-AGCH Demodulation Performance Results (AWGN)*.

User Equipment E-AGCH Demodulation Performance Results (Fading)

HSUPA E-AGCH Single Link Performance Fading--Tables

real(FCarrier)/(1 MHz)	real(Ior)	real(Ioc)	real(SignalPower_dBm)
2140.000	-60.000	-60.000	10.000

Missed detection probability vs. E-AGCH Ec/Ior(dB)

real(EAGCH_EcIor)	BER	FER
-23.200	2.500E-4	5.000E-4

3GPP Specification TS 25.101 (2006-3) Section 10.4.1

Specification requirements	Test results
Missed detection probability is 1% at given Ec/Ior For VA30 channel simulation, E-AGCH Ec/Ior are -23.2 dB.	Passed

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

User Equipment E-AGCH Demodulation Performance Results (AWGN)

HSUPA E-AGCH Single Link Performance--Tables

real(FCarrier)/(1 MHz)	real(Ior)	real(Ioc)	real(SignalPower_dBm)
2140.000	-60.000	-60.000	10.000

Missed detection probability vs. E-AGCH Ec/Ior(dB)

real(EAGCH_EcIor)	BER	FER
-29.500	0.001	0.003

3GPP Specification TS 25.101 (2006-3) Section 10.4.1

Specification requirements	Test results
Missed detection probability is 1% at given Ec/Ior For AWGN ideal simulation, E-AGCH Ec/Ior are -29.5 dB.	Passed

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

Benchmark:
Simulation time is about 30 hours (fading) and 3 hours (AWGN) for 2000 10μs TTI, on a P4/2.6GHz 512M PC running ADS 2005A on Microsoft Windows 2000.

E-HICH Detection Performance Measurements

Design: UE_Rx_EHICH_DetectionFading, UE_Rx_EHICH_Detection

Features:

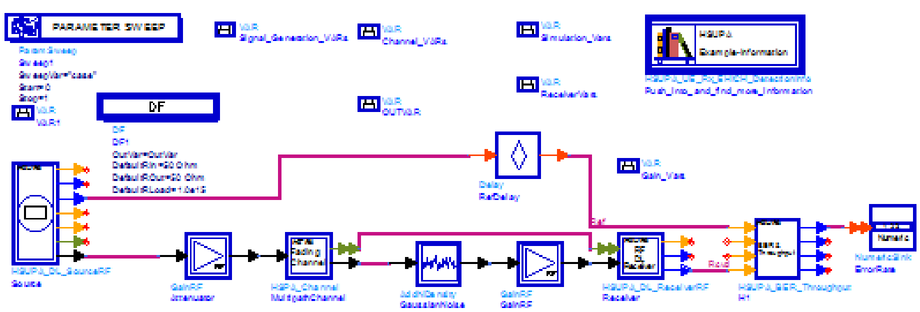
- User equipment E-HICH demodulation performance measurements
- Integrated RF models
- Multi-path fading propagation conditions

Description:

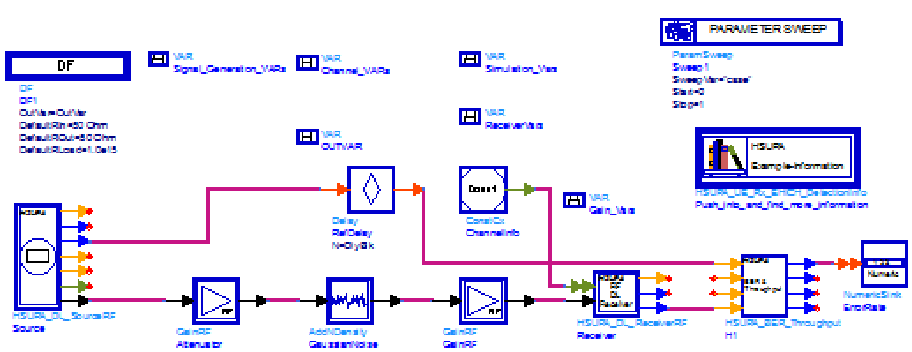
- UE_Rx_EHICH_DetectionFading measures user equipment receiver E-HICH detection performance according to section 10.2.1 in TS 25.101.
- UE_Rx_EHICH_Detection measures user equipment receiver E-HICH detection performance over AWGN condition to provide the baseline reference.

The schematics of fading and AWGN conditions are shown in *UE_Rx_EHICH_DetectionFading Schematic* and *UE_Rx_EHICH_Detection Schematic* respectively.

UE_Rx_EHICH_DetectionFading Schematic



UE_Rx_EHICH_Detection Schematic



Simulation Results:
Simulation results are shown in *User Equipment E-HICH Detection Performance Results (Fading)* and *User Equipment E-HICH Detection Performance Results (AWGN)*.

User Equipment E-HICH Detection Performance Results (Fading)

HSUPA E-HICH Single Link Performance Fading--Tables

...al(FCarrier[0,0])/(1 MHz)	real(Ior[0,0])	real(Ioc[0,0])	...SignalPower_dBm[0,0])
2140.000	-60.000	-60.000	10.000

Missed detection probability vs. E-HICH Ec/Ior(dB)

real(EHICH_Ec[0,0])	ErrorRate[0,0]
-28.300	0.008

False detection probability

ErrorRate[1,0]
0.436

3GPP Specification TS 25.101 (2006-3) Section 10.2.1

Specification requirements

Missed and false detection probability are 1% and 50% at given Ec/Ior
For VA30 channel simulation, EHICH Ec/Ior is -28.3 dB.

Test results

Passed

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

User Equipment E-HICH Detection Performance Results (AWGN)

HSUPA E-HICH Single Link Performance--Tables

...al(FCarrier[0,0])/(1 MHz)	real(Ior[0,0])	real(Ioc[0,0])	...SignalPower_dBm[0,0])
2140.000	-60.000	-60.000	10.000

Missed detection probability vs. E-HICH Ec/Ior(dB)

real(EHICH_Ec[0,0])	ErrorRate[0,0]
-32.000	0.009

False detection probability

ErrorRate[1,0]
0.467

3GPP Specification TS 25.101 (2006-3) Section 10.2.1

Specification requirements

Missed and false detection probability are 1% and 50% at given Ec/Ior
For AWGN ideal simulation, EHICH Ec/Ior is -32 dB.

Test results

Passed

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

Benchmark:
Simulation time is about 9.7 hours (fading, VA30) and 3 hours (AWGN) for 11000 2μs TTI, on a P4/2.6GHz 512MB PC running ADS 2005A on Microsoft Windows 2000.

E-RGCH Detection Performance Measurements

Design: UE_Rx_ERGCH_Detection, UE_Rx_ERGCH_DetectionFading

Features:

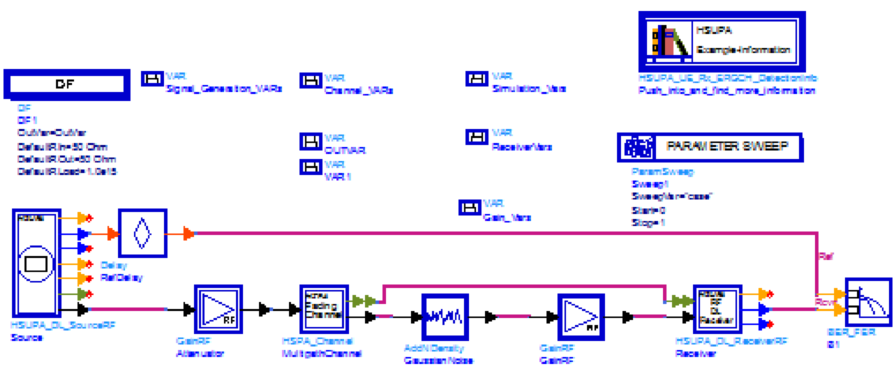
- User equipment E-RGCH demodulation performance measurements
- Integrated RF models
- Multi-path fading propagation conditions

Description:

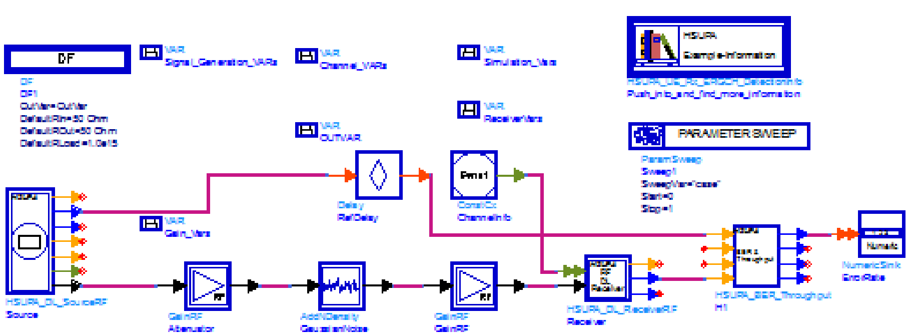
- UE_Rx_ERGCH_DetectionFading measures user equipment receiver E-RGCH detection performance according to section 10.3.1 in TS 25.101.
- UE_Rx_ERGCH_Detection measures user equipment receiver E-RGCH detection performance over AWGN condition to provide the baseline reference.

The schematics for fading and AWGN conditions are shown in *UE_Rx_ERGCH_DetectionFading Schematic* and *UE_Rx_ERGCH_Detection Schematic*.

UE_Rx_ERGCH_DetectionFading Schematic



UE_Rx_ERGCH_Detection Schematic



Simulation Results:
Simulation results are shown in *User Equipment E-RGCH Detection Performance Results (Fading)* and *User Equipment E-RGCH Detection Performance Results (AWGN)*.

User Equipment E-RGCH Detection Performance Results (Fading)

HSUPA E-RGCH Single Link Performance Fading--Tables

...al(FCarrier[0,0])/(1 MHz)	real(Ior[0,0])	real(Ioc[0,0])	...SignalPower_dBm[0,0])
2140.000	-60.000	-60.000	10.000

Missed detection probability(Using 3 slots) vs. E-RGCH Ec/Ior(dB)

real(ERGCH_Ec[0,0])	BER[0,0]
-24.400	0.003

False detection probability

BER[1,0]
0.080

3GPP Specification TS 25.101 (2006-3) Section 10.3.1

Specification requirements

Missed and false detection probability are 5% and 10% at given Ec/Ior
For VA30 channel simulation, E-RGCH Ec/Ior is -24.4 dB.

Test results

Passed

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

User Equipment E-RGCH Detection Performance Results (AWGN)

HSUPA E-RGCH Single Link Performance--Tables

...al(FCarrier[0,0])/(1 MHz)	real(Ior[0,0])	real(Ioc[0,0])	...SignalPower_dBm[0,0])
2140.000	-60.000	-60.000	10.000

Missed detection probability(Using 3 slots) vs. E-RGCH Ec/Ior(dB)

real(ERGCH_Ec[0,0])	ErrorRate[0,0]
-31.000	0.031

False detection probability

ErrorRate[1,0]
0.091

3GPP Specification TS 25.101 (2006-3) Section 10.3.1

Specification requirements

Missed and false detection probability are 5% and 10% at given Ec/Ior
For AWGN ideal simulation, E-RGCH Ec/Ior is -31 dB.

Test results

Passed

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

Benchmark:
Simulation time is about 10 hours (fading) and 1.5 hours (AWGN) for 6000 2µs TTI, on a P4/2.6GHz 512MB PC running ADS 2005A on Microsoft Windows 2000.

References

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

HSUPA User Equipment Transmitter Design Examples

The HSUPA_UE_Tx_wrk workspace shows user equipment transmitter measurement characteristics, including adjacent channel leakage power ratio (ACLR), complementary cumulative distribution function (CCDF), error vector magnitude (EVM), maximum power, and spectrum emission mask. Designs for these measurements are described in the following sections; they include:

- Adjacent channel leakage power ratio measurements: **UE_Tx_ACLR**
- CCDF and peak-to-mean information measurements: **UE_Tx_CCDF**
- Error vector magnitude measurements: **UE_Tx_EVM**
- Maximum power measurements: **UE_Tx_Max_Power**
- Spectrum emission mask measurements: **UE_Tx_SpecEmissions**

Adjacent Channel Leakage Power Ratio Measurements

Design: UE_Tx_ACLR

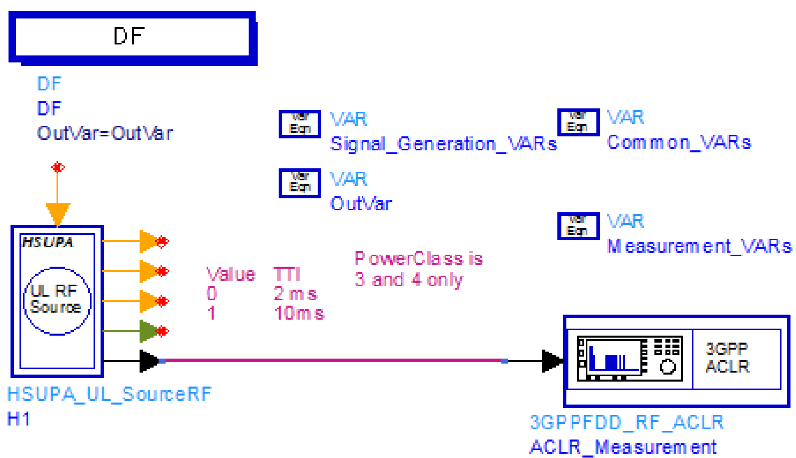
HSUPA_UL_SourceRF is used to provide an RF HSUPA uplink signal source for the designs under this workspace.

Features:

- HSUPA uplink RF signal source
- signal source including DPCCH, DPDCH, E-DPCCH, E-DPDCH, and HSDPCCH
- power in an adjacent channel measured using FFT

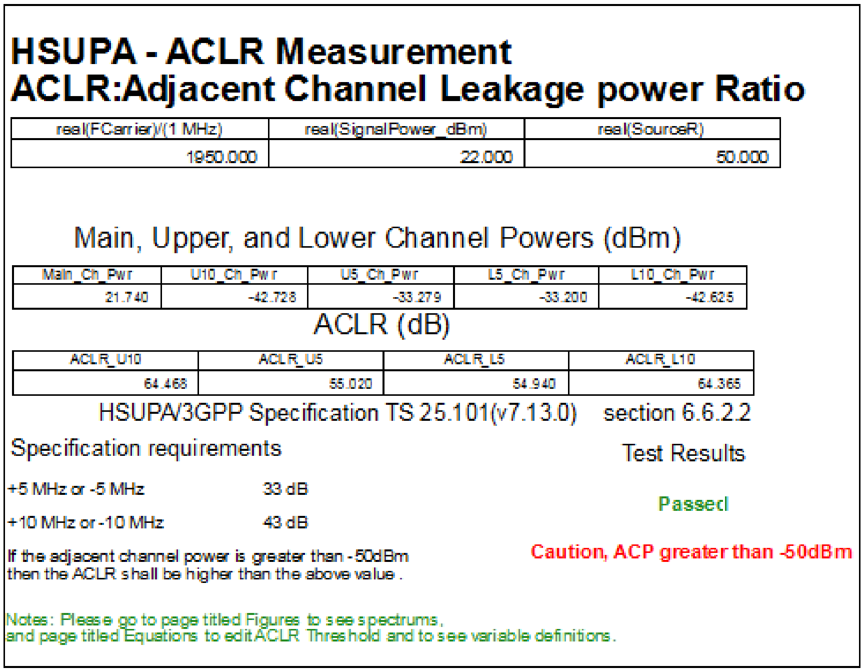
Description:

- This design measures user equipment transmitter adjacent channel leakage power ratio (ACLR) characteristics according to section 6.6.2.2 in TS 25.101.
- ACLR is the ratio of the transmitted power to the power measured in an adjacent channel. Both the transmitted power and the adjacent channel power are measured with a filter that has a root-raised cosine (RRC) filter response with a rolloff of 0.22 and a bandwidth equal to the chip rate. 3GPPFDD_RF_ACLR is used to measure output power.
- Frequency domain power in 4 adjacent channels is measured: 2 above and 2 below the center frequency of the measured signal.
- 3GPPFDD_RF_ACLR is used to measure output power
- The schematic is shown below:



Simulation Results:
Simulation results are shown below:

- **User Equipment ACLR Measurement Results - Table:**



HSUPA - ACLR Measurement
ACLR:Adjacent Channel Leakage power Ratio

real(FCarrier)/(1 MHz)	real(SignalPower_dBm)	real(SourceR)
1950.000	22.000	50.000

Main, Upper, and Lower Channel Powers (dBm)

Main_Ch_Pwr	U10_Ch_Pwr	U5_Ch_Pwr	L5_Ch_Pwr	L10_Ch_Pwr
21.740	-42.728	-33.279	-33.200	-42.625

ACLR (dB)

ACLR_U10	ACLR_U5	ACLR_L5	ACLR_L10
64.468	55.020	54.940	64.365

HSUPA/3GPP Specification TS 25.101(v7.13.0) section 6.6.2.2

Specification requirements | Test Results

+5 MHz or -5 MHz 33 dB

+10 MHz or -10 MHz 43 dB

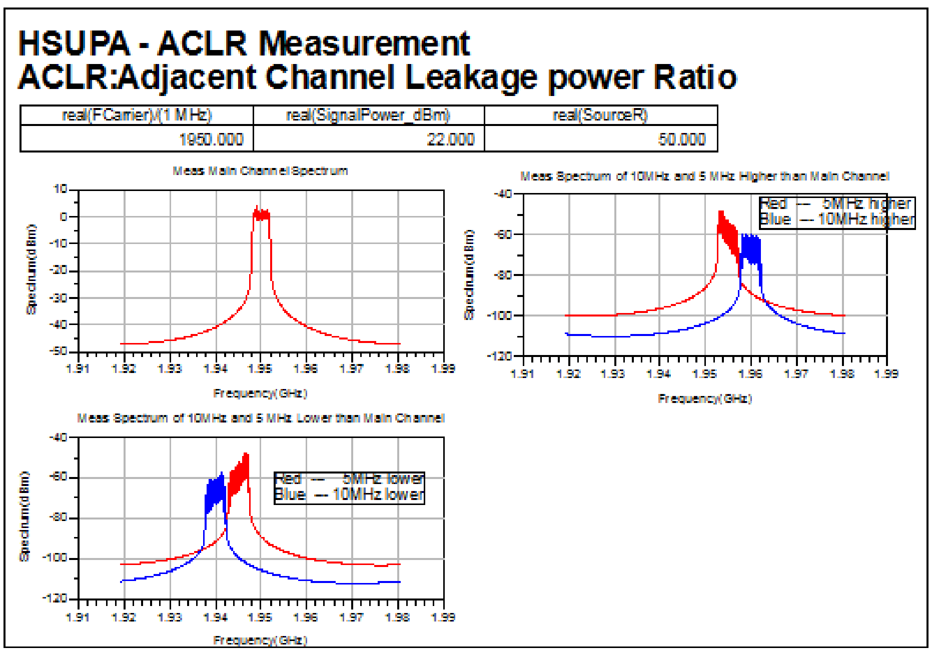
Passed

If the adjacent channel power is greater than -50dBm then the ACLR shall be higher than the above value.

Caution, ACP greater than -50dBm

Notes: Please go to page titled Figures to see spectrums, and page titled Equations to edit ACLR Threshold and to see variable definitions.

- And **User Equipment ACLR Measurement Results - Figure:**



Benchmark:
Simulation time is about 12 seconds on a Pentium M/1.6GHz 1024MB PC running ADS 2005A on Microsoft Windows XP.

CCDF and Peak-to-Mean Information Measurements

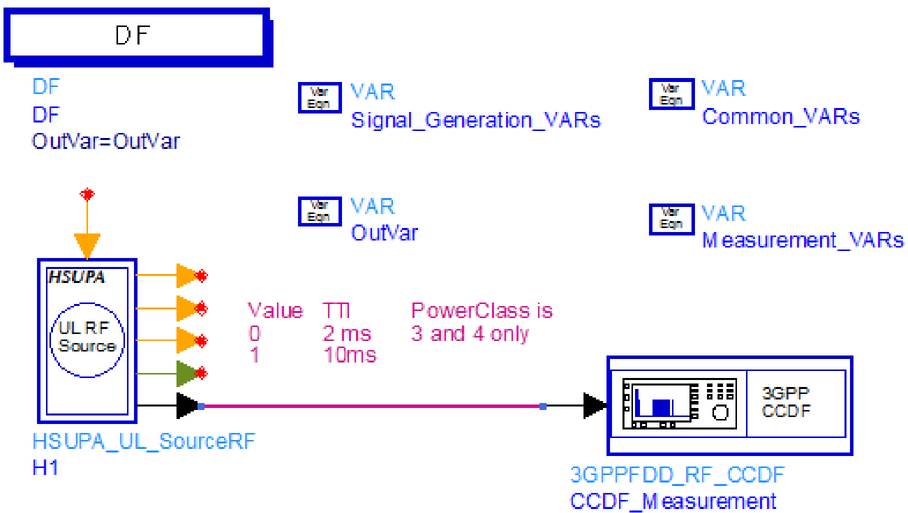
Design: UE_Tx_CCDF

Features:

- HSUPA uplink RF signal source
- signal source including DPCCH, DPDCH, E-DPCCH, E-DPDCH, and HSDPCCH
- CCDF and peak-to-mean information measured by the CCDF model

Description:

- CCDF measurement is *not* defined in the 3GPP specification. However, the complementary cumulative distribution function (CCDF) and peak-to-mean information are very useful for analyzing amplifier performance.
- The schematic is shown below:



Simulation Results:
Simulation results are shown below:

- **User Equipment CCDF Measurement Results - Table:**

HSUPA - CCDF Measurement
CCDF: Complementary Cumulative Distribution Function

real(FCarrier)/(1 MHz)	real(SignalPower_dBm)	real(SourceR)
1950.000	22.000	50.000

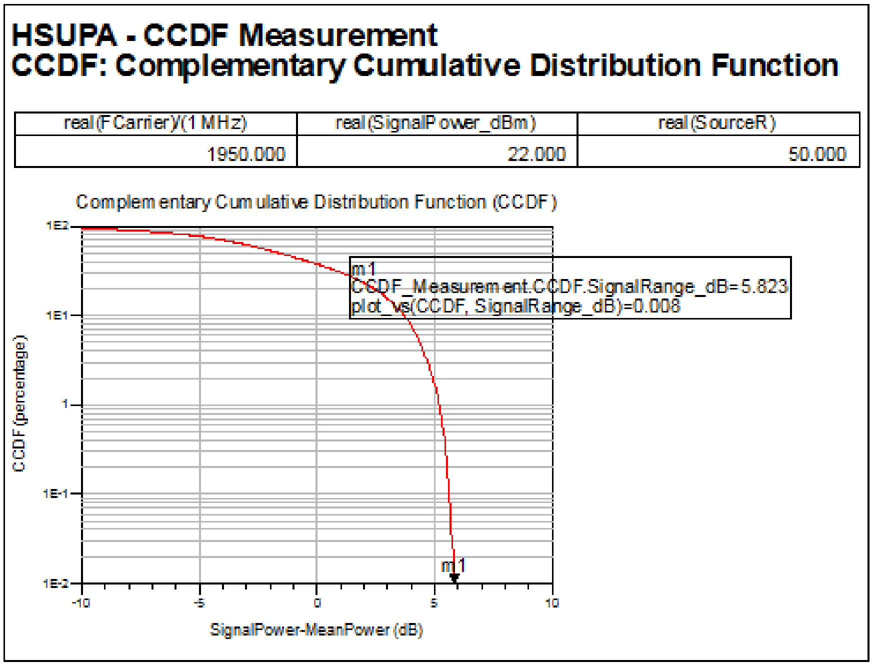
Power Measurement

Peak_to_Mean_dB	MeanPower_dBm	PeakPower_dBm
5.616	21.999	27.614

Not defined in 3GPP/HSUPA FDD Specification

Notes: Please go to page titled Figures to see CCDF curve, and page titled Equations to see variable definitions.

- And **User Equipment CCDF Measurement Results - Figure:**



Benchmark:
Simulation time is about 3 seconds on a Pentium M/1.6GHz 1024MB PC running ADS 2005A on Microsoft Windows XP.

Error Vector Magnitude Measurements

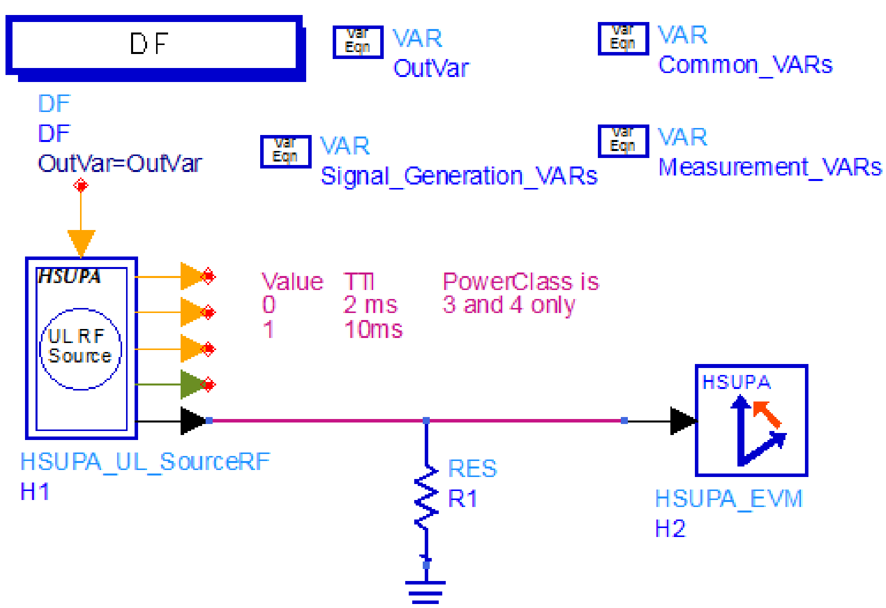
Design: UE_Tx_EVM

Features:

- HSUPA uplink RF signal source
- signal source including DPCCH, DPDCH, E-DPCCH, E-DPDCH, and HSDPCCH
- error vector magnitude is measured by the EVM model
- phase discontinuity is measured by the EVM model
- reference signal is used

Description:

- This design measures user equipment transmitter error vector magnitude (EVM) and phase discontinuity characteristics according to section 6.8.2 and 6.8.4 in TS 25.101 respectively.
- EVM is a measure of the difference between the measured waveform and the theoretical modulated waveform (the error vector). It is the square root of the ratio of the mean error vector power to the mean reference signal power expressed as a percentage.
- For Release 99 and Release 4, the EVM measurement interval is one timeslot. For Release 5 and later releases where tests may include power changes, the measurement interval is further clarified as being one timeslot except when the mean power between slots is expected to change whereupon the measurement interval is reduced by 25 ms at each end of the slot.
- The phase discontinuity is always made in the measurement interval of one timeslot reduced by 25 ms at each end of the slot, then extrapolated in both directions onto the timeslot boundaries.
- The schematic is shown in below:



Simulation Results:
Simulation results are shown in **User Equipment EVM Measurement Results** below:

HSUPA - EVM Measurement
EVM: Error Vector Magnitude

real(FCarrier)/(1 MHz)	real(SignalPower_dBm)	real(SourceR)
1950.000	22.000	50.000

Avg_EVM (%)	Avg_EVM (dB)
0.993	-40.06

3GPP Specification TS 25.101, V7.13.0, section 6.8.2

Specification requirements	Test results
According to TS 25.101, V7.13.0, section 6.8.2, when 16QAM is not used on any of the uplink code channels, the EVM shall not exceed 17.5% for the parameters specified in Table 6.15. When 16QAM used on any of the uplink code channels, the EVM shall not exceed 14% for the parameters specified in Table 6.15.	Passed

Notes: Please go to page titled Equations to edit the EVM threshold or to see variable definitions.

Benchmark

Simulation time is about 30 seconds on a Pentium M/1.6GHz 1024MB PC running ADS 2005A on Microsoft Windows XP.

Maximum Power Measurements

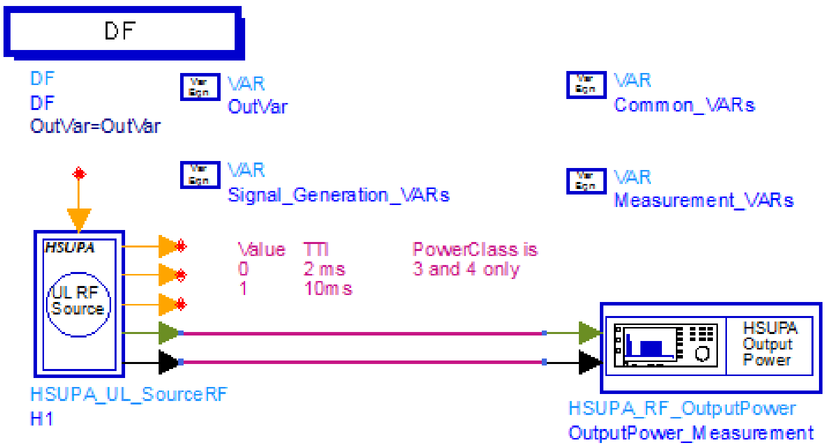
Design: UE_Tx_Max_Power

Features:

- HSUPA uplink RF signal source
- signal source including DPCCH, DPDCH, E-DPCCH, E-DPDCH, and HSDPCCH
- output power is measured by the HSUPA RF output power model

Description:

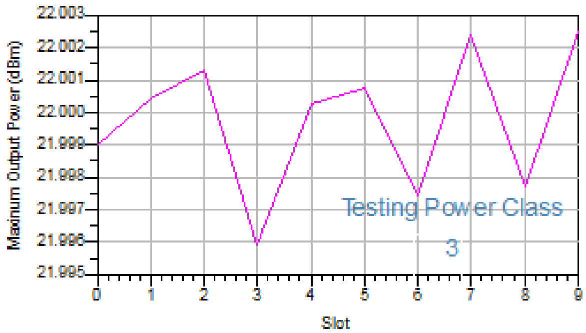
- This design measures user equipment transmitter maximum output power characteristics according to section 6.2.2 in TS 25.101.
- The schematic is shown in below:



Simulation Results:
Simulation results are shown in **User Equipment Maximum Output Power Measurement Results** below:

HSUPA - Maximum output power

real(FCarrier)/(1 MHz)	real(SignalPower_dBm)	MPR	CM
1950.000	24.000	2.000	3.000



HSUPA/3GPP Specification TS 25.101(v7.13.0) Section 6.2.2

Specification requirements

Power Class	Nominal maximum output power	Tolerance
3	+24-MPR dBm	+1+MPR/-3 dB
4	+21-MPR dBm	+2+MPR/-2 dB

Test results

Passed

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

Benchmark:
Simulation time is about 8 seconds on a Pentium M/1.6GHz 1024MB PC running ADS 2005A on Microsoft Windows XP.

Spectrum Emission Mask Measurements

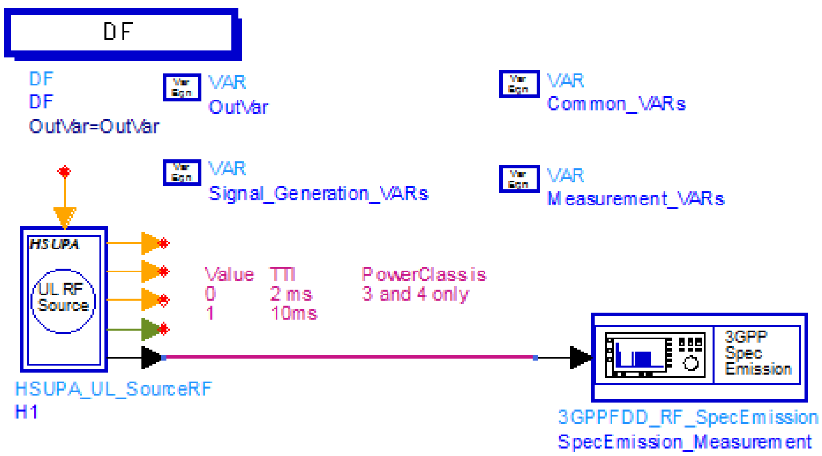
Design: UE_Tx_SpecEmissions

Features:

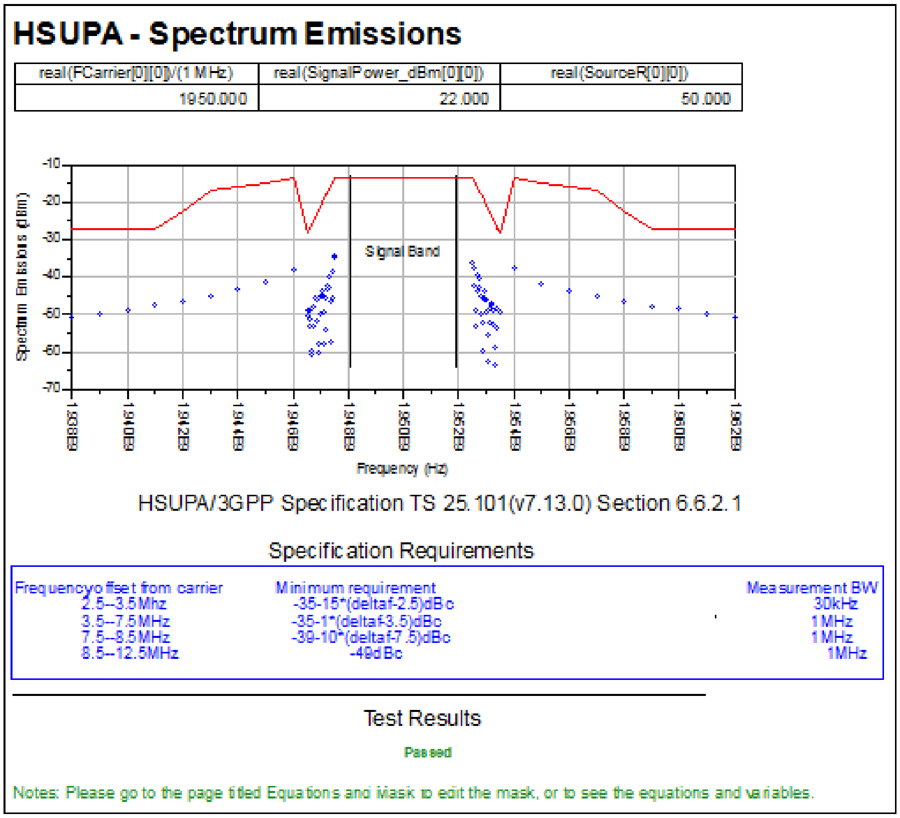
- HSUPA uplink RF signal source
- signal source including DPCCH, DPDCH, E-DPCCH, E-DPDCH, and HSDPCCH
- ParamSweep and SweepPlan is used

Description:

- This design measures user equipment transmitter out-of-band emission characteristics according to section 6.6.2.1 in TS 25.101.
- The spectrum emission mask of the UE applies to frequencies, which are between 2.5 MHz and 12.5 MHz away from the UE center carrier frequency. The out of channel emission is specified relative to the RRC filtered mean power of the UE carrier.
- The schematic is shown in below:



Simulation Results:
Simulation results are shown in *User Equipment Spectrum Emission Mask Measurement Results below:



Benchmark

Simulation time is about 25 minutes on a Pentium M/1.6GHz 1024MB PC running ADS 2005A on Microsoft Windows XP.

References

1. 3GPP Technical Specification TS 25.101, "UE Radio transmission and Reception (FDD)," Version 6.11.0, Mar. 2006.