Agilent Technologies

Advanced Design System 2011.01

Feburary 2011
3GPP2 UMB Design Library

Acknowledgments

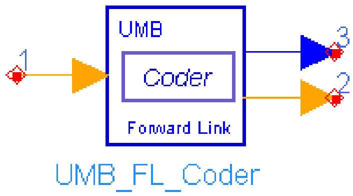
UMB Channel Coding Components

The 3GPP2 UMB channel coding models provide channel coding and scrambling in the transmitter end, and channel decoding in the receiving end.

- *UMB FL Coder* (3gpp2umb)
- *UMB FL CRC* (3gpp2umb)
- *UMB FL CRCDecoder* (3gpp2umb)
- *UMB FL Decoder* (3gpp2umb)
- *UMB FL Deinterleaver* (3gpp2umb)
- *UMB FL FEC* (3gpp2umb)
- *UMB FL FECDecoder* (3gpp2umb)
- *UMB FL Interleaver* (3gpp2umb)
- *UMB Interleaver S* (3gpp2umb)
- *UMB RL Coder* (3gpp2umb)
- *UMB RL CRC* (3gpp2umb)
- *UMB RL FEC* (3gpp2umb)
- *UMB RL Interleaver* (3gpp2umb)
- *UMB Scrambler* (3gpp2umb)
- *UMB TurboCoder* (3gpp2umb)
- *UMB TurboDecoder* (3gpp2umb)

UMB_FL_Coder

Symbol



Description: forward link coder (rate-1/3 CC and rate-1/5 TC)
Library: UMB, Channel Coding

Parameters

Name	Description	Default	Type	Range
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
RsChMuxMode	The mux mode for resource channels: Mode 1, Mode 2	Mode 2	enum	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
NumDRCHSubzones	the number of DRCH subzones	0	int	[0,FFTSize/SubzoneSize-1]
FDCH_PFIndex	the packet format index for the data packet transmitted in F-DCH	1	int	[0,14]
FDCH_NodeID	the array of NodeID allocated to the data packet transmitted in F-DCH	{31}	int array	
FDCH_NumFrames	the number of frames on which the data packet is allocated in F-DCH	1	int	[1,25]

Pin Inputs

Pin	Name	Description	Signal Type
1	UncodedData	input of uncoded data	int

Pin Outputs

Pin	Name	Description	Signal Type
2	CodedData	output of coded data	int
3	Information	output of calculated info	real

Notes/Equations

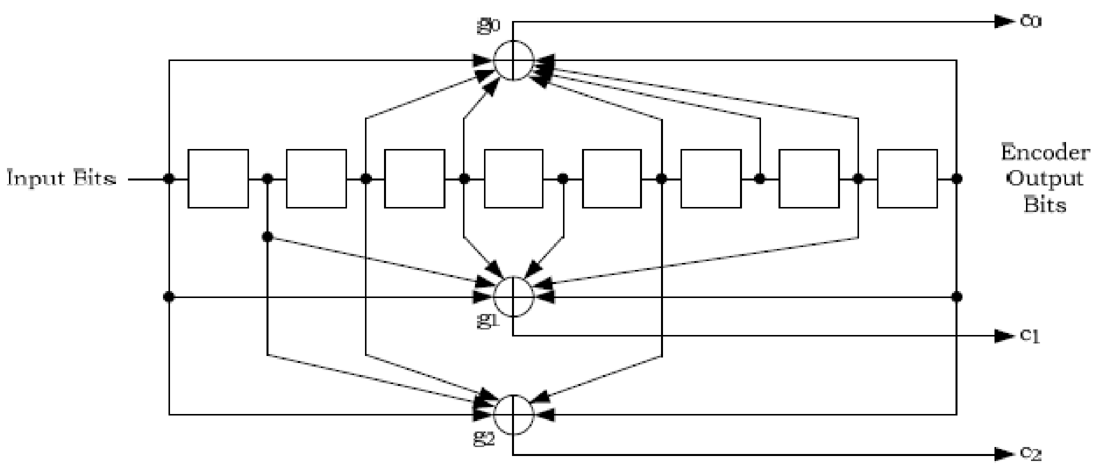
1. This model chooses and performs the corresponding coding scheme (rate-1/3 convolutional coder or rate-1/5 turbo coder) automatically according to each input subpacket size.
   Each firing,
   - $N_{PACKET\_BITS}+N_{SUBPACKETS}*N_{CRC}$ tokens are consumed at pin UncodedData;
   - When $N_{PACKET\_BITS}+N_{CRC}<=128$, $3*(N_{PACKET\_BITS}+N_{CRC}+8)$ tokens are produced at pin CodedData;

When $N_{PACKET\_BITS} - N_{CRC} > 128$, $\sum_{i=0}^{N_{SUBPACKETS}-1} 5 * (N_{SUBPACKET\_BITS}[i] + N_{CRC} + 18)$ tokens are produced at pin CodedData, where $N_{CRC}=24$; The input packet size N_{PACKET_BITS} is determined by the parameters FFTSize, GuardSize, RsChMuxMode, SubzoneSize, NumDRCHSubzones, FDCH_PFIndex, FDCH_NodeID and FDCH_NumFrames. For more information, refer to *Forward Link Packet Size Computation* (3gpp2umb); The input packet shall be split into $N_{SUBPACKETS}$ subpackets according to MaxPHYSubPacketSize, where $N_{SUBPACKET\_BITS}[i]$ is the number of information bits in the i^{th} subpacket. For more information on $N_{SUBPACKETS}$, refer to *Packet Splitting* (3gpp2umb).

- 3 tokens are produced at pin Information, where the first token is the number of usable hop-ports in the assignment at the first HARQ transmission (H); The second token is the spectral efficiency of the packet format at the first HARQ transmission (s); The third token is the number of bits in the packet including $N_{CRC}=24$ CRC bits.

2. For the i^{th} subpacket, when $N_{SUBPACKET\_BITS}[i] + N_{CRC} <= 128$, the rate-1/3 convolutional coder is employed; Otherwise the rate-1/5 turbo coder is employed.

- Rate-1/3 convolutional coder
  The generator functions for the rate-1/3 code shall be g0 equals 557 (octal), g1 equals 663 (octal), and g2 equals 711 (octal). This code generates three encoder output bits for each bit that is input to the encoder. These encoder output bits shall be output so that the bit (c0) encoded with generator function g0 is output first, the bit (c1) encoded with generator function g1 is output second, and the bit (c2) encoded with generator function g2 is output last. The state of the convolutional encoder, upon initialization, shall be the all-zero state. The first encoder output bit that is output after initialization shall be a bit encoded with generator function g0. Convolutional encoding involves the modulo - 2 addition of selected taps of a serially time-delayed data sequence. The length of the data sequence delay is equal to K - 1, where K is the constraint length of the code. The following figure illustrates the specific K-equals-9, rate-1/3 convolutional encoder that is used.



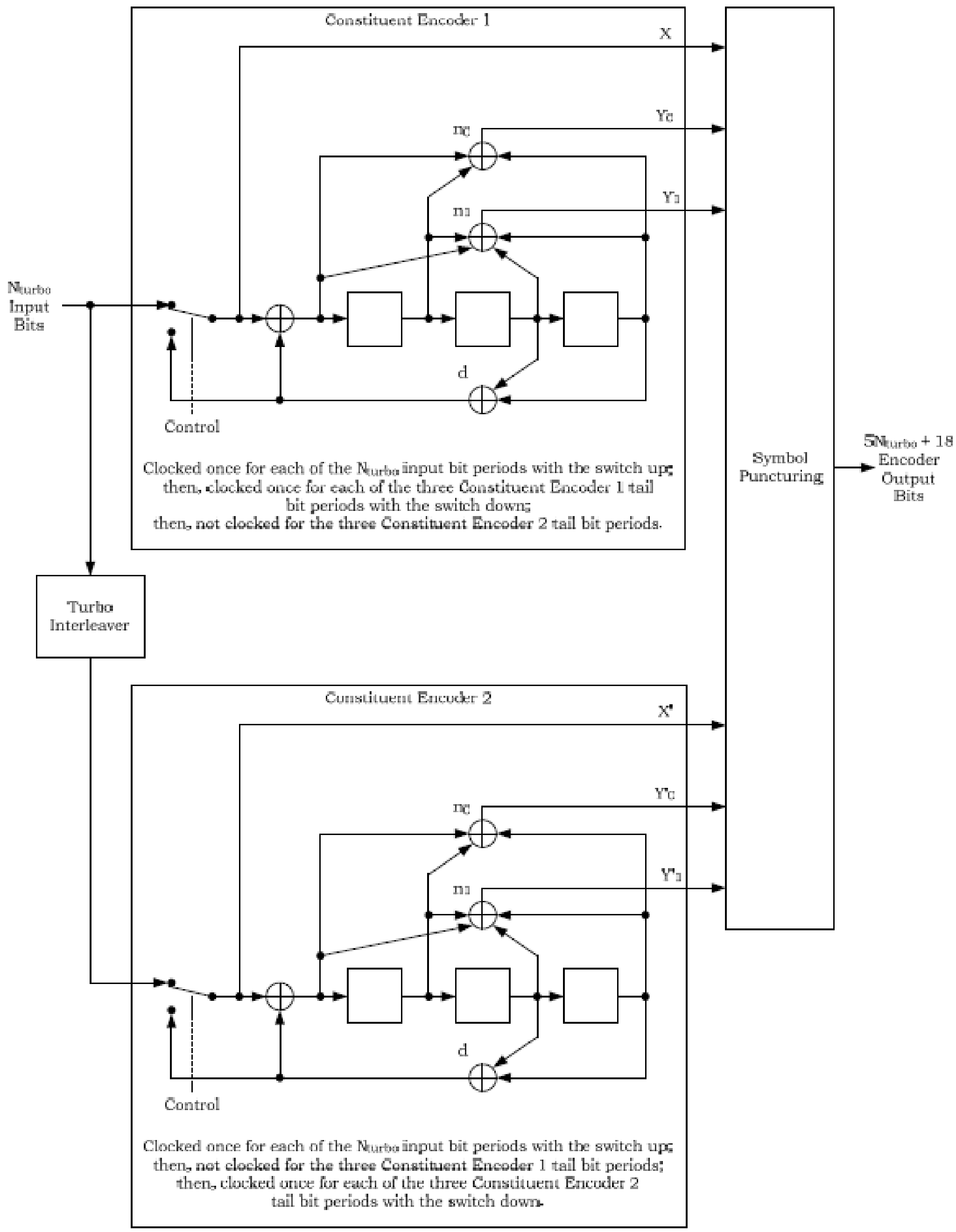
K = 9, Rate-1/3 Convolutional Encoder

- Rate-1/5 turbo coder
  The turbo code is a parallel concatenation of two constituent systematic, recursive, convolutional codes with a turbo interleaver preceding the second recursive convolutional encoder.
  The transfer function for the constituent codes shall be

$$G(D) = \left[1 \quad \frac{n_0(D)}{d(D)} \quad \frac{n_1(D)}{d(D)}\right]$$

where $d(D) = 1 + D^2 + D^3$, $n_0(D) = 1 + D + D^3$, and $n_1(D) = 1 + D + D^2 + D^3$.

The turbo encoder shall generate an output bit sequence that is identical to the one generated by the encoder shown in the following figure. Initially, the states of the constituent encoder registers in this figure are set to zero. Then, the constituent encoders are clocked with the switches in the positions noted.



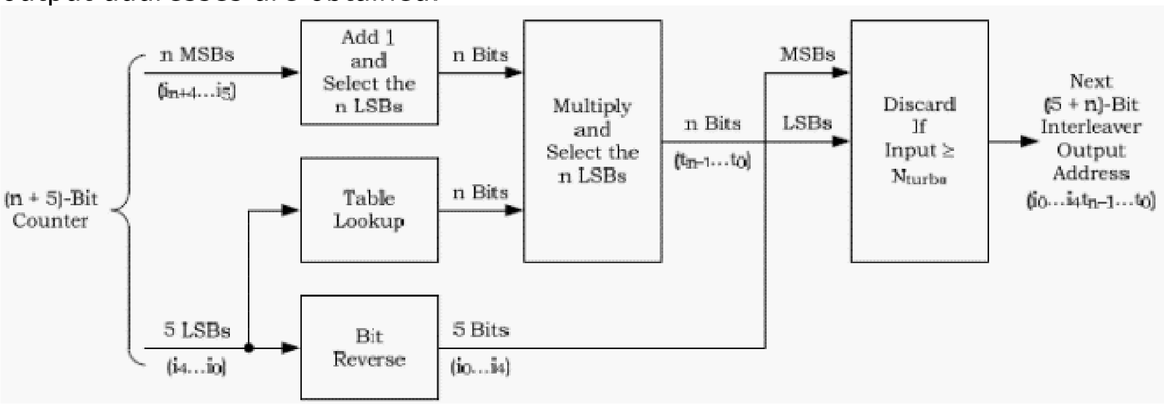
Rate-1/5 turbo coder

The turbo encoder generates $5N_{TURBO} + 18$ encoder output bits, where N_{TURBO} is the number of encoder input bits. The first $5N_{TURBO}$ encoder output bits shall be generated by clocking the constituent encoders once for each encoder input bit with the switches in the up positions and then puncturing the X' encoder output bits. The sequence of encoder output bits for each encoder input bit shall be XY0Y1Y'0Y'1 with the X bit output first.

The last 18 encoder output bits are called the encoder output tail bits. These tail bits shall be generated after the constituent encoders have been clocked N_{TURBO} times with the switches in the up positions. The first nine encoder output tail bits shall be generated by clocking Constituent Encoder 1 three times with its switches in the down position while Constituent Encoder 2 is not clocked. The sequence of encoder output bits for each clocking of Constituent Encoder 1 shall be XY0Y1. The last nine encoder output tail bits shall be generated by clocking Constituent Encoder 2 three times with its switches in the down position while Constituent Encoder 1 is not clocked. The sequence of encoder output bits for each clocking of Constituent Encoder 2 shall be X'Y'0Y'1.

Turbo Interleavers is illustrated in the following figure and described below:

- Determine the turbo interleaver parameter, n, where n is the smallest integer such that $N_{TURBO} <= 2^{n+5}$.
- Initialize an (n + 5)-bit counter to 0.
- Extract the n most significant bits (MSBs) from the counter and add one to form a new value. Then, discard all except the n least significant bits (LSBs) of this value.
- Obtain the n-bit output of the table lookup defined in Table 2.6.3.3.2-1 of Ref1 with a read address equal to the five LSBs of the counter. Note that this table depends upon the value of n.
- Multiply the values obtained in Steps 3 and 4, and discard all except the n LSBs.
- Bit-reverse the five LSBs of the counter.
- Form a tentative output address that has its MSBs equal to the value obtained in Step 6 and its LSBs equal to the value obtained in Step 5.
- Accept the tentative output address as an output address if it is less than N_{TURBO}; otherwise, discard it.
- Increment the counter and repeat Steps 3 through 8 until all N_{TURBO} interleaver output addresses are obtained.



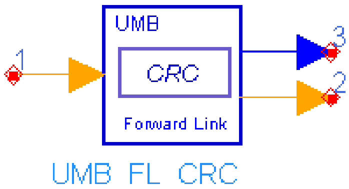
Turbo Interleaver Output Address Calculation Procedure

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_CRC

Symbol



Description: forward link CRC generator
Library: UMB, Channel Coding

Parameters

Name	Description	Default	Type	Range
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
RsChMuxMode	The mux mode for resource channels: Mode 1, Mode 2	Mode 2	enum	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
NumDRCHSubzones	the number of DRCH subzones	0	int	[0,FFTSize/SubzoneSize-1]
FDCH_PFIndex	the packet format index for the data packet transmitted in F-DCH	1	int	[0,14]
FDCH_NodeID	the array of NodeID allocated to the data packet transmitted in F-DCH	{31}	int array	
FDCH_NumFrames	the number of frames on which the data packet is allocated in F-DCH	1	int	[1,25]

Pin Inputs

Pin	Name	Description	Signal Type
1	WoCRCData	input of data without CRC padded	int

Pin Outputs

Pin	Name	Description	Signal Type
2	WCRCData	output of data with CRC padded	int
3	Information	output of calculated info	real

Notes/Equations

1. This model generates N_{CRC}=24 CRC bits and appends them to each subpacket of the Forward Data Channel.
   Each firing,
   - N_{PACKET_BITS} tokens are consumed at pin WoCRCData;
   - $N_{PACKET\_BITS}+N_{SUBPACKETS}*N_{CRC}$ tokens are produced at pin WCRCData, where the input packet size N_{PACKET_BITS} is determined by the parameters FFTSize,

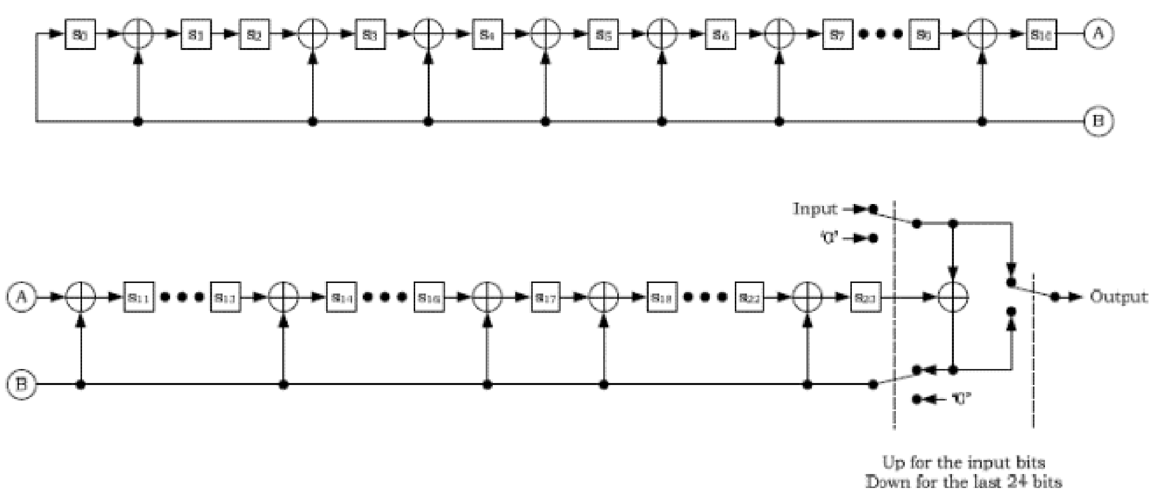
GuardSize, RsChMuxMode, SubzoneSize, NumDRCHSubzones, FDCH_PFIndex, FDCH_NodeID and FDCH_NumFrames. For more information, refer to *Forward Link Packet Size Computation* (3gpp2umb); The input packet shall be split into $N_{SUBPACKETS}$ subpackets according to MaxPHYSubPacketSize. For more information on $N_{SUBPACKETS}$, refer to *Packet Splitting* (3gpp2umb). This model will padd N_{CRC}=24 CRC bits at the end of each subpacket.

- 3 tokens are produced at pin Information, where the first token is the number of usable hop-ports in the assignment at the first HARQ transmission (H); The second token is the spectral efficiency of the packet format at the first HARQ transmission (s); The third token is the number of bits in the packet including N_{CRC}=24 CRC bits.

2. The 24 CRC bits shall be computed according to the following procedure
   - Initially, all the switches shall be set in the up position and the shift-register elements shall be set to logical one.
   - The register shall be clocked a number of times equal to the number of input bits in the subpacket with those bits as input.
   - The switches shall be set in the down position so that the output is a modulo - 2 addition with a `0' and the successive shift register inputs are `0's.
   - The register shall be clocked an additional number of times equal to the number of CRC bits.
   - These additional bits shall be the CRC bits.
   - The bits shall be transmitted in the order calculated.
3. The generator polynomial for the 24-bit CRC is given by

$$g(x) = x^{24} + x^{23} + x^{18} + x^{17} + x^{14} + x^{11} + x^{10} + x^{7} + x^{6} + x^{5} + x^{4} + x^{3} + x + 1$$

4. The Cyclic Redundancy Code of length 24 can be generated by the shift-register structure shown in the following figure.



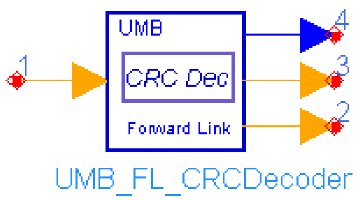
Calculations for the 24-Bit CRC

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_CRCDecoder

Symbol



Description: forward link CRC decoder
Library: UMB, Channel Coding

Parameters

Name	Description	Default	Type	Range
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
RsChMuxMode	The mux mode for resource channels: Mode 1, Mode 2	Mode 2	enum	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
NumDRCHSubzones	the number of DRCH subzones	0	int	[0,FFTSize/SubzoneSize-1]
FDCH_PFIndex	the packet format index for the data packet transmitted in F-DCH	1	int	[0,14]
FDCH_NodeID	the array of NodeID allocated to the data packet transmitted in F-DCH	{31}	int array	
FDCH_NumFrames	the number of frames on which the data packet is allocated in F-DCH	1	int	[1,25]

Pin Inputs

Pin	Name	Description	Signal Type
1	WCRCData	input of data with CRC padded	int

Pin Outputs

Pin	Name	Description	Signal Type
2	WoCRCData	output of data without CRC padded	int
3	CRCIndicator	CRC indicator	int
4	Information	output of calculated info	real

Notes/Equations

1. This model checks and removes N_{CRC}=24 CRC bits for each subpacket of the Forward Data Channel.
   Each firing,
   - $N_{PACKET\_BITS}+N_{SUBPACKETS}* N_{CRC}$ tokens are consumed at pin WCRCData;
   - N_{PACKET_BITS} tokens are produced at pin WoCRCData, where the input packet

size N_{PACKET_BITS} is determined by the parameters FFTSize, GuardSize, RsChMuxMode, SubzoneSize, NumDRCHSubzones, FDCH_PFIndex, FDCH_NodeID and FDCH_NumFrames. For more information, refer to *Forward Link Packet Size Computation* (3gpp2umb); The input packet shall be split into $N_{SUBPACKETS}$ subpackets according to MaxPHYSubPacketSize. For more information on $N_{SUBPACKETS}$, refer to *Packet Splitting* (3gpp2umb).

- $N_{SUBPACKETS}$ tokens are produced at pin CRCIndicator.
- 3 tokens are produced at pin Information, where the first token is the number of usable hop-ports in the assignment at the first HARQ transmission (H); The second token is the spectral efficiency of the packet format at the first HARQ transmission (s); The third token is the number of bits in the packet including N_{CRC}=24 CRC bits.

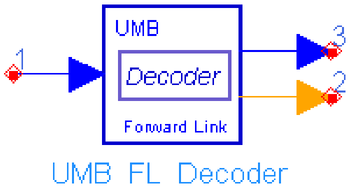
2. First, this model performs the CRC coder on the received infomration bits for each subpacket, the same as what is done in UMB_FL_CRC (see *CRC encoder* (3gpp2umb)). For the i^{th} subpacket, the generated N_{CRC}=24 CRC bits are compared to the received CRC bits. If they matches, a `1' is output to the $i^{th}$ token at pin CRCIndicator indicating that the CRC checking passes; Otherwise, a `0' is output the i^{th} token at pin CRCIndicator indicating that the CRC checking fails.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_Decoder

Symbol



Description: forward link decoder (rate-1/3 CC and rate-1/5 TC)
Library: UMB, Channel Coding

Parameters

Name	Description	Default	Type	Range
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
RsChMuxMode	The mux mode for resource channels: Mode 1, Mode 2	Mode 2	enum	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
NumDRCHSubzones	the number of DRCH subzones	0	int	[0,FFTSize/SubzoneSize-1]
FDCH_PFIndex	the packet format index for the data packet transmitted in F-DCH	1	int	[0,14]
FDCH_NodeID	the array of NodeID allocated to the data packet transmitted in F-DCH	{31}	int array	
FDCH_NumFrames	the number of frames on which the data packet is allocated in F-DCH	1	int	[1,25]
IterationNumber	number of iterations for turbo decoder	3	int	[1,16]

Pin Inputs

Pin	Name	Description	Signal Type
1	CodedData	input of coded data	real

Pin Outputs

Pin	Name	Description	Signal Type
2	UncodedData	output of uncoded data	int
3	Information	output of calculated info	real

Notes/Equations

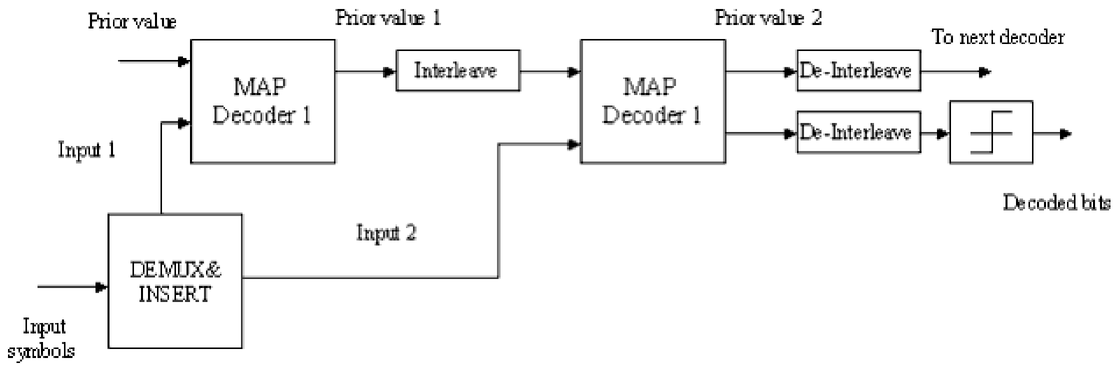
1. This model chooses and performs the corresponding decoding scheme (rate-1/3 convolutional decoder or rate-1/5 turbo decoder) automatically according to each input subpacket size.
   Each firing,
   - When $N_{PACKET\_BITS}+N_{CRC}<=128$, $3*(N_{PACKET\_BITS}+N_{CRC}+8)$ tokens are consumed at pin CodedData;

When $N_{PACKET\_BITS}-N_{CRC}>128$, $\sum_{i=0}^{N_{SUBPACKETS}-1} 5*(N_{SUBPACKET\_BITS}[i] + N_{CRC} + 18)$ tokens are consumed at pin CodedData, where N_{CRC}=24; The input packet size N_{PACKET_BITS} is determined by the parameters FFTSize, GuardSize, RsChMuxMode, SubzoneSize, NumDRCHSubzones, FDCH_PFIndex, FDCH_NodeID and FDCH_NumFrames. For more information, refer to *Forward Link Packet Size Computation* (3gpp2umb); The input packet shall be split into $N_{SUBPACKETS}$ subpackets according to MaxPHYSubPacketSize, where $N_{SUBPACKET\_BITS}[i]$ is the number of information bits in the i^{th} subpacket. For more information on $N_{SUBPACKETS}$, refer to *Packet Splitting* (3gpp2umb).

- $N_{PACKET\_BITS}+N_{SUBPACKETS}*N_{CRC}$ tokens are produced at pin UncodedData;
- 3 tokens are produced at pin Information, where the first token is the number of usable hop-ports in the assignment at the first HARQ transmission (H); The second token is the spectral efficiency of the packet format at the first HARQ transmission (s); The third token is the number of bits in the packet including N_{CRC}=24 CRC bits.

2. For the i^{th} subpacket, when $N_{SUBPACKET\_BITS}[i] + N_{CRC}<=128$, the rate-1/3 convolutional coder is employed in the transmitter and the convolutional decoder is perfomed in this model; Otherwise the rate-1/5 turbo coder is employed in the transmitter and the turbo decoder is perfomed in this model.

- Rate-1/3 convolutional decoder
  The same Viterbi decoder algorithm as the model ViterbiDecoder is employed for this rate-1/3 convolutional decoder. Please refer to the documentation of ViterbiDecoder for more information.
  Regarding the parameters in the model ViterbiDecoder, the following settings are employed in this model:
    - CodingRate is set to rate 1/3;
    - ConstraintLength is set to 9;
    - Polynomial is set to {0557, 0663, 0711};
    - ZeroTail is set to YES;
    - BitSequenceLength is set to $N_{SUBPACKET\_BITS}[i] + N_{CRC}$ for the i^{th} subpacket;
    - MaxSurvivorLength (maximum survivor length) is set to 72.
    - Polarity is set to Negative to logic 1;
    - InitialState is set to Zero state;
    - IgnoreNumber is set to 0.
- Rate-1/5 turbo decoder
  The turbo decoder employs the MAP(maximum a posteriori) algorithm. It is a modified BAHL et al. algorithm for RSC codes (see Ref3 and Ref4). Two parallel concatenated MAP decoders constitute the decoder of turbo code. The MAP decoder structure is shown in the following figure.



Turbo Code MAP Decoder Structure

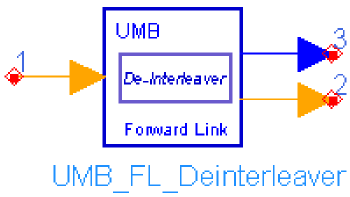
The parameter IterationNumber specifies the number of iterations for the turbo MAP decoder.
Note that the SNR estimation for the MAP deocder is not employed in this turbo decoder due to its mismatch in Rayleigh fading channels. Instead, the SNR is fixed to -6dB in this model.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
3. 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. March 1974, pp. 248-287.
4. C. Berrou, A. Glavieux, and P. Thitiumjshima, "Near Shannon limit error correcting coding: Turbo codes," IEEE International Conference on Communications, May 1993, pp. 1064-1070.

UMB_FL_Deinterleaver

Symbol



Description: forward link channel de-interleaver
Library: UMB, Channel Coding

Parameters

Name	Description	Default	Type	Range
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
RsChMuxMode	The mux mode for resource channels: Mode 1, Mode 2	Mode 2	enum	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
NumDRCHSubzones	the number of DRCH subzones	0	int	[0,FFTSize/SubzoneSize-1]
FDCH_PFIndex	the packet format index for the data packet transmitted in F-DCH	1	int	[0,14]
FDCH_NodeID	the array of NodeID allocated to the data packet transmitted in F-DCH	{31}	int array	
FDCH_NumFrames	the number of frames on which the data packet is allocated in F-DCH	1	int	[1,25]

Pin Inputs

Pin	Name	Description	Signal Type
1	IntlvdData	input of interleaved data	real

Pin Outputs

Pin	Name	Description	Signal Type
2	UnintlvdData	output of uninterleaved data	real
3	Information	output of calculated info	real

Notes/Equations

1. This model performs the channel de-interleaving on Forward Link Data channel. Each firing,
   - When $N_{PACKET\_BITS}+N_{CRC}<=128$, $3*(N_{PACKET\_BITS}+N_{CRC}+8)$ tokens are consumed at pin IntlvdData;

     When $N_{PACKET\_BITS}–N_{CRC}>128$, $\sum_{i=0}^{N_{SUBPACKETS}-1} 5*(N_{SUBPACKET\_BITS}[i] + N_{CRC} + 18)$ tokens are consumed at pin IntlvdData, where N_{CRC}=24; The input packet size N_{PACKET_BITS} is determined by the parameters FFTSize, GuardSize, RsChMuxMode, SubzoneSize, NumDRCHSubzones, FDCH_PFIndex, FDCH_NodeID and FDCH_NumFrames. For more information, refer to *Forward Link Packet Size Computation* (3gpp2umb); The input packet shall be split into $N_{SUBPACKETS}$ subpackets according to MaxPHYSubPacketSize, where $N_{SUBPACKET\_BITS}[i]$ is the number of information bits in the i^{th} subpacket. For more information on $N_{SUBPACKETS}$, refer to *Packet Splitting* (3gpp2umb).

- The number of tokens produced at pin UnintlvdData is the same as that at pin IntlvdData.
- 3 tokens are produced at pin Information, where the first token is the number of usable hop-ports in the assignment at the first HARQ transmission (H); The second token is the spectral efficiency of the packet format at the first HARQ transmission (s); The third token is the number of bits in the packet including N_{CRC}=24 CRC bits.

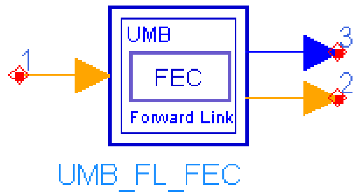
2. This model performs the reverse operations against the channel interleaving. Refer to *Channel Interleaving* (3gpp2umb).

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_FEC

Symbol



Description: forward link FEC
Library: UMB, Channel Coding

Parameters

Name	Description	Default	Type	Range
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
RsChMuxMode	The mux mode for resource channels: Mode 1, Mode 2	Mode 2	enum	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
NumDRCHSubzones	the number of DRCH subzones	0	int	[0,FFTSize/SubzoneSize-1]
FDCH_PFIndex	the packet format index for the data packet transmitted in F-DCH	1	int	[0,14]
FDCH_NodeID	the array of NodeID allocated to the data packet transmitted in F-DCH	{31}	int array	
FDCH_NumFrames	the number of frames on which the data packet is allocated in F-DCH	1	int	[1,25]

Pin Inputs

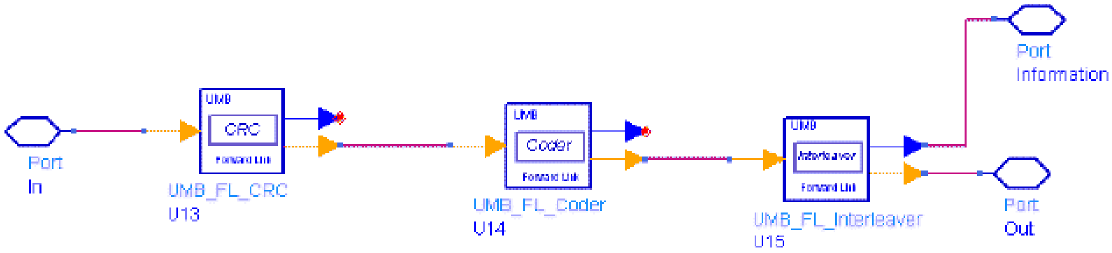
Pin	Name	Description	Signal Type
1	In	input uncoded data	int

Pin Outputs

Pin	Name	Description	Signal Type
2	Out	output coded data	int
3	Information	output of calculated info	real

Notes/Equations

1. This subnetwork includes three channel coding components for Forward Link Data Channel: CRC coder, channel coder (rate-1/3 convolutional coder or rate-1/5 turbo coder) and channel interleaver. The schematic for this subnetwork is shown in the following figure.



UMB_FL_FEC Schematic

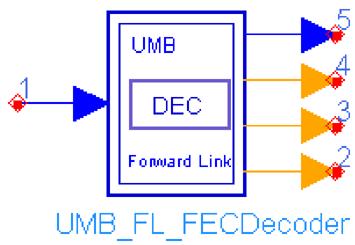
2. For the functionality of each component, please refer to the corresponding documentation.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_FECDecoder

Symbol



Description: forward link FEC decoder
Library: UMB, Channel Coding

Parameters

Name	Description	Default	Type	Range
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
RsChMuxMode	The mux mode for resource channels: Mode 1, Mode 2	Mode 2	enum	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
NumDRCHSubzones	the number of DRCH subzones	0	int	[0,FFTSize/SubzoneSize-1]
FDCH_PFIndex	the packet format index for the data packet transmitted in F-DCH	1	int	[0,14]
FDCH_NodeID	the array of NodeID allocated to the data packet transmitted in F-DCH	{31}	int array	
FDCH_NumFrames	the number of frames on which the data packet is allocated in F-DCH	1	int	[1,25]
IterationNumber	number of iterations for turbo decoder	3	int	[1,16]

Pin Inputs

Pin	Name	Description	Signal Type
1	In	input coded data	real

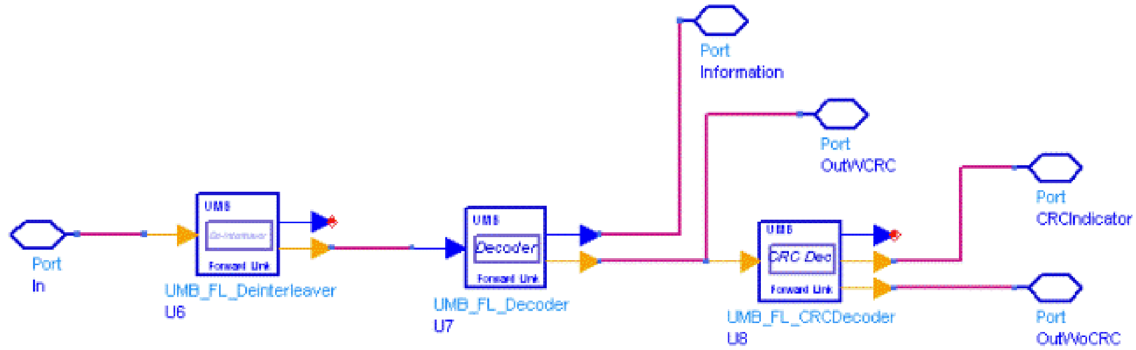
Pin Outputs

Pin	Name	Description	Signal Type
2	OutWoCRC	output data without CRC padded	int
3	OutWCRC	output data with CRC padded	int
4	CRCIndicator	CRC indicator	int
5	Information	output of calculated info	real

Notes/Equations

1. This subnetwork includes three channel decoding components for Forward Link Data Channel: channel de-interleaver, channel decoder (rate-1/3 convolutional decoder or rate-1/5 turbo decoder) and CRC decoder. The schematic for this subnetwork is

shown in the following figure.



UMB_FL_FECDecoder Schematic

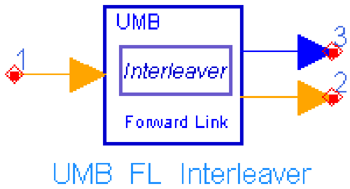
2. For the functionality of each component, please refer to the corresponding documentation.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_Interleaver

Symbol



Description: forward link channel interleaver
Library: UMB, Channel Coding

Parameters

Name	Description	Default	Type	Range
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
RsChMuxMode	The mux mode for resource channels: Mode 1, Mode 2	Mode 2	enum	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
NumDRCHSubzones	the number of DRCH subzones	0	int	[0,FFTSize/SubzoneSize-1]
FDCH_PFIndex	the packet format index for the data packet transmitted in F-DCH	1	int	[0,14]
FDCH_NodeID	the array of NodeID allocated to the data packet transmitted in F-DCH	{31}	int array	
FDCH_NumFrames	the number of frames on which the data packet is allocated in F-DCH	1	int	[1,25]

Pin Inputs

Pin	Name	Description	Signal Type
1	UnintlvdData	input of uninterleaved data	int

Pin Outputs

Pin	Name	Description	Signal Type
2	IntlvdData	output of interleaved data	int
3	Information	output of calculated info	real

Notes/Equations

1. This model performs the channel interleaving on Forward Link Data channel. Each firing,
   - When $N_{PACKET\_BITS}+N_{CRC}<=128$ (rate-1/3 convolutional encoder is employed), $3*(N_{PACKET\_BITS}+N_{CRC}+8)$ tokens are consumed at pin UnintlvdData;
     When $N_{PACKET\_BITS–}N_{CRC}>128$ (rate-1/5 turbo encoder is employed),

$\sum_{i=0}^{N_{SUBPACKETS}-1} 5 * (N_{SUBPACKET\_BITS}[i] + N_{CRC} + 18)$ tokens are consumed at pin UnintlvdData, where N_{CRC}=24; The input packet size N_{PACKET_BITS} is determined by the parameters FFTSize, GuardSize, RsChMuxMode, SubzoneSize, NumDRCHSubzones, FDCH_PFIndex, FDCH_NodeID and FDCH_NumFrames. For more information, refer to *Forward Link Packet Size Computation* (3gpp2umb); The input packet shall be split into $N_{SUBPACKETS}$ subpackets according to MaxPHYSubPacketSize, where $N_{SUBPACKET\_BITS}[i]$ is the number of information bits in the i^{th} subpacket. For more information on $N_{SUBPACKETS}$, refer to *Packet Splitting* (3gpp2umb).

- The number of tokens produced at pin IntlvdData is the same as that at pin UnintlvdData.
- 3 tokens are produced at pin Information, where the first token is the number of usable hop-ports in the assignment at the first HARQ transmission (H); The second token is the spectral efficiency of the packet format at the first HARQ transmission (s); The third token is the number of bits in the packet including N_{CRC}=24 CRC bits.

2. The channel interleaving is performed on each subpacket independently, and follows the convolutional or turbo encoding, consisting of a bit-demultiplexing operation followed by a bit permuting operation.
   - **Bit Demultiplexing**
     - The output bits generated by the rate-1/3 convolutional encoder or rate-1/3 tail-biting convolutional encoder shall be reordered according to the following procedure:
       - All of the convolutional encoder output bits shall be demultiplexed into three sequences denoted V0, V1, V2. The encoder output bits shall be sequentially distributed from the V0 sequence to the V2 sequence with the first bit going to the V0 sequence, the second bit going to the V1 sequence, the third to the V2 sequence, and the fourth to the V0 sequence, etc.
       - The V0, V1, and V2 sequences shall be ordered according to V0V1V2. That is, the V0 sequence shall be first, the V1 sequence shall be second, and the V2 sequence shall be last.
     - The output bits generated by the rate-1/5 turbo encoder shall be reordered according to the following procedure:
       - All of the turbo encoder output data bits (i.e., the $5N_{TURBO}$ bits output in the first N_{TURBO} clock periods) shall be demultiplexed into five sequences denoted U, V0, V1, V'0, and V'1. The encoder output bits shall be sequentially distributed from the U sequence to the V'1 sequence with the first encoder output bit going to the U sequence, the second to the V0 sequence, the third to the V1 sequence, the fourth to the V'0 sequence, the fifth to the V'1 sequence, the sixth to the U sequence, etc.
       - The 18 tail bits numbered 0 through 17 (i.e., the 18 bits generated during the last six clock periods) shall be distributed as follows: Tail bits numbered 0, 3, 6, 9, 12, and 15 shall go to the U sequence; the tail bits numbered 1, 4, and 7 shall go to the V0 sequence; the tail bits numbered 2, 5, and 8 shall go to the V1 sequence; the tail bits numbered 10, 13, and 16 shall go to the V'0 sequence; and the tail bits numbered 11, 14, and 17 shall go to the V'1 sequence.
   - **Bit Permuting**
     - A Pruned Bit Reversal Interleaver (PBRI) shall be used in bit permuting for the rate-1/3 convolutional code, the rate-1/3 tail-biting convolutional code,

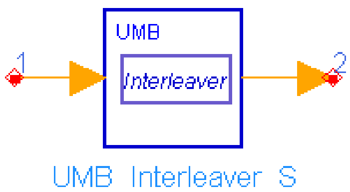
and the rate-1/5 turbo code. The Pruned Bit Reversal Interleaver takes in a sequence of inputs and outputs that sequence in interleaved order. The ith output of the Pruned Bit Reversal Interleaver of size M is equal to the j_{th} input, where j = PBRI(i, M), where the function PBRI is as defined in 2.5.2 of Ref1 and M is the length of the input sequence.
    - The demultiplexed bits shall be permuted into three separate interleaved blocks with turbo coding. The three blocks shall consist of the permuted U sequence, the permuted V0/V'0 sequence and the permuted V1/V'1 sequence.
      The permuted U block shall be equal to the U sequence permuted by a PBRI.
      The permuted V0/ V'0 sequence shall be generated according to the following procedure:
        - Let sequence A be the V0 sequence permuted by a PBRI and sequence B be the V'0 sequence permuted by a PBRI.
        - The permuted V0/V'0 sequence shall consist of alternate bits from sequence A and sequence B, i.e., the $2i^{th}$ entry in the permuted V0/ V'0 sequence shall be equal to the ith entry in sequence A and the $(2i + 1)^{th}$ entry in the permuted V0/V'0 sequence shall be equal to the i^{th} entry in sequence B.
          The permuted V1/ V'1 sequence shall be generated according to the following procedure:
        - Let sequence A be the V1 sequence permuted by a PBRI and sequence B be the V'1 sequence permuted by a PBRI.
        - The permuted V1/V'1 sequence shall consist of alternate bits from sequence A and sequence B i.e., the $2i^{th}$ entry in the permuted V1/ V'1 sequence shall be equal to the i^{th} entry in sequence A and the $(2i + 1)^{th}$ entry in the permuted V1/V'1 sequence shall be equal to the ith entry in sequence B.
3. For all channels on the Reverse Link and all Forward Link channels other than the Forward Data Channel, the output sequence shall consist of the permuted U sequence followed by the permuted V0/V'0 sequence followed by the permuted V1/V'1 sequence.
4. For the Forward Data Channel, the output sequence also consists of the permuted U sequence followed by the permuted V0/V'0 sequence followed by the permuted V1/V'1 sequence assuming the following condition is always true: N_{PACKET_BITS} <= MaxRateOneFifthPacketSize.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_Interleaver_S

Symbol



Description: UMB channel interleaver with simple input parameters
Library: UMB, Channel Coding

Parameters

Name	Description	Default	Type	Range
NumPacketBits	the number of packet bits from SFP MAC Protocol including CRC bits	100	int	[1,∞)

Pin Inputs

Pin	Name	Description	Signal Type
1	UnintlvdData	input of uninterleaved data	int

Pin Outputs

Pin	Name	Description	Signal Type
2	IntlvdData	output of interleaved data	int

Notes/Equations

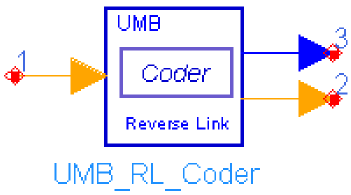
1. This model performs the channel interleaving on the input encoded sequence in which the number of uncoded bits (including CRC bits) is NumPacketBits.
   Each firing,
   - When NumPacketBits<=128, 3*(NumPacketBits+8) tokens are consumed at pin UnintlvdData;
     When NumPacketBits>128, (5*NumPacketBits+18) tokens are consumed at pin UnintlvdData;
   - The number of tokens produced at pin IntlvdData is the same as that at pin UnintlvdData.
2. This model performs the same channel interleaving as what is done in *UMB_FL_Interleaver* (3gpp2umb) with the exception that the packet size is determined by the parameter NumPacketBits. Refer to *Channel Interleaving* (3gpp2umb) for more information.
3. Note that only one subpacket is assumed in the input sequence .

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_RL_Coder

Symbol



Description: reverse link coder (rate-1/3 CC and rate-1/5 TC)
Library: UMB, Channel Coding

Parameters

Name	Description	Default	Type	Range
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
EnableCDMASubsegments	whether the allocation of CDMA subsegments is enabled: NO, YES	NO	enum	
NumCDMASubsegments	number of allocated CDMAsubsegmentsallocated, onlyvalid when EnableCDMASubsegments isYES	1	int	[1,∞)
RODCH_PFIndex	the packet format index for R-ODCH	1	int	[0,14]
RODCH_NodeID	the array of NodeID allocated to R-ODCH	{31}	int array	
RODCH_NumFrames	the number of PHY frames on which R-ODCH is allocated	1	int	[1,25]

Pin Inputs

Pin	Name	Description	Signal Type
1	UncodedData	input of uncoded data	int

Pin Outputs

Pin	Name	Description	Signal Type
2	CodedData	output of coded data	int
3	Information	output of calculated info	real

Notes/Equations

1. This model chooses and performs the corresponding coding scheme (rate-1/3 convolutional coder or rate-1/5 turbo coder) automatically according to each input subpacket size on Reverse Link OFDMA Data Channel.
   Each firing,
   - $N_{PACKET\_BITS}+N_{SUBPACKETS}*N_{CRC}$ tokens are consumed at pin UncodedData;
   - When $N_{PACKET\_BITS}+N_{CRC}<=128$, $3*(N_{PACKET\_BITS}+N_{CRC}+8)$ tokens are produced at pin CodedData;
     When $N_{PACKET\_BITS\_}N_{CRC}>128$, $\sum_{i=0}^{N_{SUBPACKETS}-1} 5*(N_{SUBPACKETBITS}[i]+N_{CRC}+18)$ tokens are

produced at pin CodedData, where N_{CRC}=24; The input packet size N_{PACKET_BITS} is determined by the parameters FFTSize, GuardSize, SubzoneSize, EnableCDMASubsegments, NumCDMASubsegments, RODCH_PFIndex, RODCH_NodeID and RODCH_NumFrames. For more information, refer to *Reverse Link Packet Size Computation* (3gpp2umb); The input packet shall be split into $N_{SUBPACKETS}$ subpackets according to MaxPHYSubPacketSize. For more information on $N_{SUBPACKETS}$, refer to *Packet Splitting* (3gpp2umb).

- 3 tokens are produced at pin Information, where the first token is the number of usable hop-ports in the assignment at the first HARQ transmission (H); The second token is the spectral efficiency of the packet format at the first HARQ transmission (s); The third token is the number of bits in the packet including N_{CRC}=24 CRC bits.

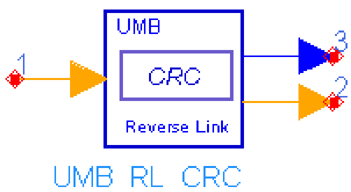
2. For the i^{th} subpacket, when $N_{SUBPACKET\_BITS}[i] + N_{CRC} <= 128$, the rate-1/3 convolutional coder is employed; Otherwise the rate-1/5 turbo coder is employed.
3. The convolutional coder is described in *Rate-1/3 Convolutional Coder* (3gpp2umb).
4. The turbo coder is described in *Rate-1/5 Turbo Coder* (3gpp2umb).

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_RL_CRC

Symbol



Description: reverse link CRC generator
Library: UMB, Channel Coding

Parameters

Name	Description	Default	Type	Range
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
EnableCDMASubsegments	whether the allocation of CDMA subsegments is enabled: NO, YES	NO	enum	
NumCDMASubsegments	number of allocated CDMAsubsegmentsallocated, onlyvalid when EnableCDMASubsegments isYES	1	int	[1,∞)
RODCH_PFIndex	the packet format index for R-ODCH	1	int	[0,14]
RODCH_NodeID	the array of NodeID allocated to R-ODCH	{31}	int array	
RODCH_NumFrames	the number of PHY frames on which R-ODCH is allocated	1	int	[1,25]

Pin Inputs

Pin	Name	Description	Signal Type
1	WoCRCData	input of data without CRC padded	int

Pin Outputs

Pin	Name	Description	Signal Type
2	WCRCData	output of data with CRC padded	int
3	Information	output of calculated info	real

Notes/Equations

1. This model generates N_{CRC}=24 CRC bits and appends them to each subpacket of the Reverse OFDMA Data Channel.
   Each firing,
   - N_{PACKET_BITS} tokens are consumed at pin WoCRCData;
   - $N_{PACKET\_BITS}+N_{SUBPACKETS}*N_{CRC}$ tokens are produced at pin WCRCData, where N_{CRC} = 24; The input packet size N_{PACKET_BITS} is determined by the parameters FFTSize, GuardSize, SubzoneSize, EnableCDMASubsegments, NumCDMASubsegments, RODCH_PFIndex, RODCH_NodeID and RODCH_NumFrames. For more information, refer to *Reverse Link Packet Size*

Computation (3gpp2umb); The input packet shall be split into $N_{SUBPACKETS}$ subpackets according to MaxPHYSubPacketSize. For more information on $N_{SUBPACKETS}$, refer to *Packet Splitting* (3gpp2umb). This model will padd N_{CRC}=24 CRC bits at the end of each subpacket.
- 3 tokens are produced at pin Information, where the first token is the number of usable hop-ports in the assignment at the first HARQ transmission (H); The second token is the spectral efficiency of the packet format at the first HARQ transmission (s); The third token is the number of bits in the packet including N_{CRC}=24 CRC bits.

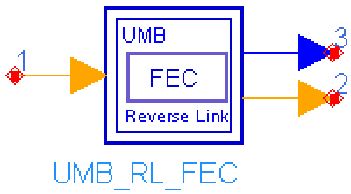
2. The calculation for the 24-Bit CRC is described in *CRC Coder* (3gpp2umb).

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_RL_FEC

Symbol



Description: reverse link FEC
Library: UMB, Channel Coding

Parameters

Name	Description	Default	Type	Range
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
EnableCDMASubsegments	whether the allocation of CDMA subsegments is enabled: NO, YES	NO	enum	
NumCDMASubsegments	number of allocated CDMAsubsegmentsallocated, onlyvalid when EnableCDMASubsegments isYES	1	int	[1,∞)
RODCH_PFIndex	the packet format index for R-ODCH	1	int	[0,14]
RODCH_NodeID	the array of NodeID allocated to R-ODCH	{31}	int array	
RODCH_NumFrames	the number of PHY frames on which R-ODCH is allocated	1	int	[1,25]

Pin Inputs

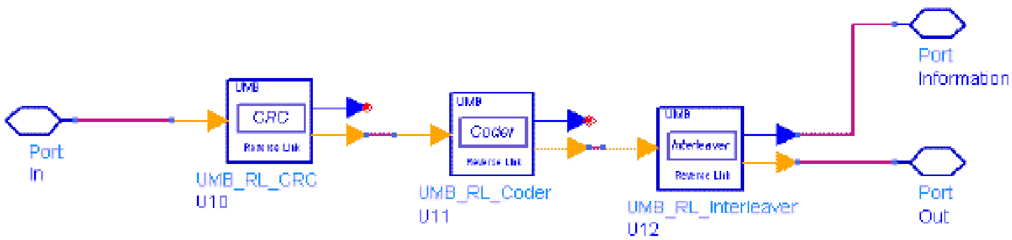
Pin	Name	Description	Signal Type
1	In	input uncoded data	int

Pin Outputs

Pin	Name	Description	Signal Type
2	Out	output coded data	int
3	Information	output of calculated info	real

Notes/Equations

1. This subnetwork includes three channel coding components for Reverse Link OFDMA Data Channel: CRC coder, channel coder (rate-1/3 convolutional coder or rate-1/5 turbo coder) and channel interleaver. The schematic for this subnetwork is shown in the following figure.



UMB_RL_FEC Schematic

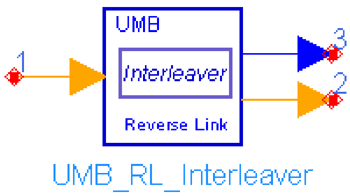
1. For the functionality of each component, please refer to the corresponding documentation.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_RL_Interleaver

Symbol



Description: reverse link channel interleaver
Library: UMB, Channel Coding

Parameters

Name	Description	Default	Type	Range
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
EnableCDMASubsegments	whether the allocation of CDMA subsegments is enabled: NO, YES	NO	enum	
NumCDMASubsegments	number of allocated CDMAsubsegmentsallocated, onlyvalid when EnableCDMASubsegments isYES	1	int	[1,∞)
RODCH_PFIndex	the packet format index for R-ODCH	1	int	[0,14]
RODCH_NodeID	the array of NodeID allocated to R-ODCH	{31}	int array	
RODCH_NumFrames	the number of PHY frames on which R-ODCH is allocated	1	int	[1,25]

Pin Inputs

Pin	Name	Description	Signal Type
1	UnintlvdData	input of uninterleaved data	int

Pin Outputs

Pin	Name	Description	Signal Type
2	IntlvdData	output of interleaved data	int
3	Information	output of calculated info	real

Notes/Equations

1. This model performs the channel interleaving on Reverse Link OFDMA Data channel. Each firing,
   - When $N_{PACKET\_BITS}+N_{CRC}<=128$ (rate-1/3 convolutional encoder is employed), $3*(N_{PACKET\_BITS}+N_{CRC}+8)$ tokens are consumed at pin UnintlvdData;
     When $N_{PACKET\_BITS}–N_{CRC}>128$ (rate-1/5 turbo encoder is employed), $\sum_{i=0}^{N_{SUBPACKETS}-1} 5*(N_{SUBPACKETBITS}[i] + N_{CRC} + 18)$ tokens are consumed at pin UnintlvdData, where $N_{CRC}=24$; The input packet size N_{PACKET_BITS} is determined by the parameters

FFTSize, GuardSize, SubzoneSize, EnableCDMASubsegments, NumCDMASubsegments, RODCH_PFIndex, RODCH_NodeID and RODCH_NumFrames. For more information, refer to *Reverse Link Packet Size Computation* (3gpp2umb); The input packet shall be split into $N_{SUBPACKETS}$ subpackets according to MaxPHYSubPacketSize. For more information on $N_{SUBPACKETS}$, refer to *Packet Splitting* (3gpp2umb).

- The number of tokens produced at pin IntlvdData is the same as that at pin UnintlvdData.
- 3 tokens are produced at pin Information, where the first token is the number of usable hop-ports in the assignment at the first HARQ transmission (H); The second token is the spectral efficiency of the packet format at the first HARQ transmission (s); The third token is the number of bits in the packet including N_{CRC}=24 CRC bits.

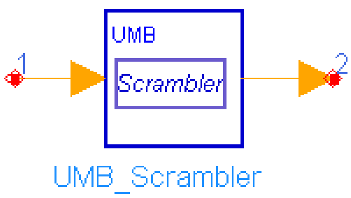
2. The channel interleaving is performed on each subpacket independently, and follows the convolutional or turbo encoding consisting of a bit-demultiplexing operation followed by a bit permuting operation. See *Channel Interleaving* (3gpp2umb) for more information.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_Scrambler

Symbol



Description: UMB data scrambler
Library: UMB, Channel Coding

Parameters

Name	Description	Default	Type	Range
NumBits	the number of input bits for data scrambling	100	int	[1,∞)
ScramblingType	the scrambing type employed: F-PBCCH, F-SBCCH, F-QPCH, R-CDCH	F-PBCCH	enum	
StartingSuperframe	the superframe index for the starting superframe	0	int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES	enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO	enum	
PilotPN	9-bit pilot PN for different sectors	0	int	[0,511]
SFNCellID	9-bit SFN cell ID	12	int	[0,511]
SBCCHScramblingSeed	F-SBCCH Scrambling Seed	1	int	[0,511]
QPCHScramblingSeed	F-QPCH Scrambling Seed	1	int	[0,511]
MACID	the MAC ID of the terminal in the target sector	0	int	[0,511]
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0	int	
NumFrames	the number of frames on which this model will allocate the data starting from Frame#StartingFrame	25	int	

Pin Inputs

Pin	Name	Description	Signal Type
1	UnscrambledData	input of unscrambled data	int

Pin Outputs

Pin	Name	Description	Signal Type
2	ScrambledData	output of scrambled data	int

Notes/Equations

1. This model performs the data scrambling operation on the Forward Primary Broadcast Control Channel (F-PBCCH), the Forward Secondary Broadcast Control Channel (F-SBCCH), the Forward Quick Paging Channel(F-QPCH) and the Reverse CDMA Data Channel(R-CDCH).
   Each firing,
   - NumBits tokens are consumed at pin UnscrambledData;
   - NumBits tokens are produced at pin ScrambledData.
2. The data scrambling operation involves the modulo-2 addition of the input

unscrambled data sequence and the common real scrambling sequence. The algorithm for generating the common real scrambling sequence is defined in 2.5.3 of Ref1, which uses a 20-bit seed as input and output a sequence of real scrambling symbols.

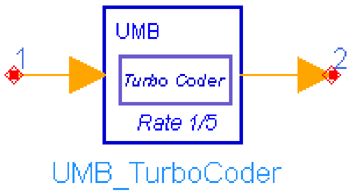
3. The parameter ScramblingType defines on which channel the scrambler is performed. Different channels have different 20-bit seeds:
   - Forward Primary Broadcast Control Channel (F-PBCCH)
     When GloballySynchronous is set to YES, a seed equal to $f_{PHY\text{-}HASH}(128\times p + 64 + 1)$ shall be used for the data scrambling operation; Otherwise, a seed of $f_{PHY\text{-}HASH}(128\times p + 4\times(\text{SuperframeIndex mod } 16) + 1)$ shall be used, where p denotes the PilotPhase of the sector. When GloballySynchronous is set to YES, the PilotPhase depends on the superframe index and is equal to (PilotPN + SuperframeIndex) mod 512. When GloballySynchronous is set to NO, the PilotPhase shall equal PilotPN. The function $f_{PHY\text{-}HASH}()$ is defined in 2.5.4 of Ref1.
   - Forward Secondary Broadcast Control Channel (F-SBCCH)
     When GloballySynchronous is set to YES, a seed equal to $f_{PHY\text{-}HASH}(2^{16}\times s + 2^{7}\times p + 64 + 2)$ shall be used for the data scrambling operation; Otherwise a seed of $f_{PHY\text{-}HASH}(2^{16}\times s + 2^{7}\times p + 4\times(\text{SuperframeIndex mod } 16) + 2)$ shall be used otherwise, where p denotes the PilotPhase of the sector, and s denotes the quantity SBCCHScramblingSeed.
   - Forward Quick Paging Channel (F-QPCH)
     When GloballySynchronous is set to YES, a seed equal to $f_{PHY\text{-}HASH}(216\times s + 27\times p + 64 + 3)$ shall be used for the data scrambling operation; Otherwise, a seed of $f_{PHY\text{-}HASH}(2^{16}\times s + 2^{7}\times p + 4\times(\text{SuperframeIndex mod } 16) + 3)$ shall be used, where p denotes the SFNPhase of the sector in the superframe of interest, and s denotes the quantity QPCHScramblingSeed.
   - Reverse CDMA Data Channel (R-CDCH)
     A seed equal to $f_{PHY\text{-}HASH}(7\times 2048\times \text{SectorSeed} + m \text{ mod } 2048)$ shall be used for the data scrambling operation, where m denotes the MACID assigned to the Access Terminal.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_TurboCoder

Symbol



Description: UMB rate-1/5 turbo coder
Library: UMB, Channel Coding

Parameters

Name	Description	Default	Type	Range
NumPacketBits	the number of packet bits from SFP MAC Protocol including CRC bits	200	int	[129,∞)

Pin Inputs

Pin	Name	Description	Signal Type
1	UncodedData	input of uncoded data	int

Pin Outputs

Pin	Name	Description	Signal Type
2	CodedData	output of coded data	int

Notes/Equations

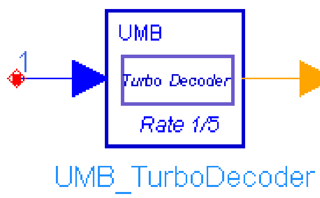
1. This model performs the rate-1/5 turbo coding on the input uncoded sequence in which the number of uncoded bits (including CRC bits) is NumPacketBits.
   Each firing,
   - NumPacketBits tokens are consumed at pin UncodedData;
   - When NumPacketBits<=128, 3*(NumPacketBits+8) tokens are produced at pin CodedData;
     When NumPacketBits>128, 5*NumPacketBits+18 tokens are produced at pin CodedData.
2. The functionality of this model is described in *Rate-1/5 turbo coder* (3gpp2umb).

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_TurboDecoder

Symbol



Description: UMB rate-1/5 turbo decoder)
Library: UMB, Channel Coding

Parameters

Name	Description	Default	Type	Range
NumPacketBits	the number of packet bits from SFP MAC Protocol including CRC bits	200	int	[129,∞)
IterationNumber	number of iterations for turbo decoder	3	int	[1,16]

Pin Inputs

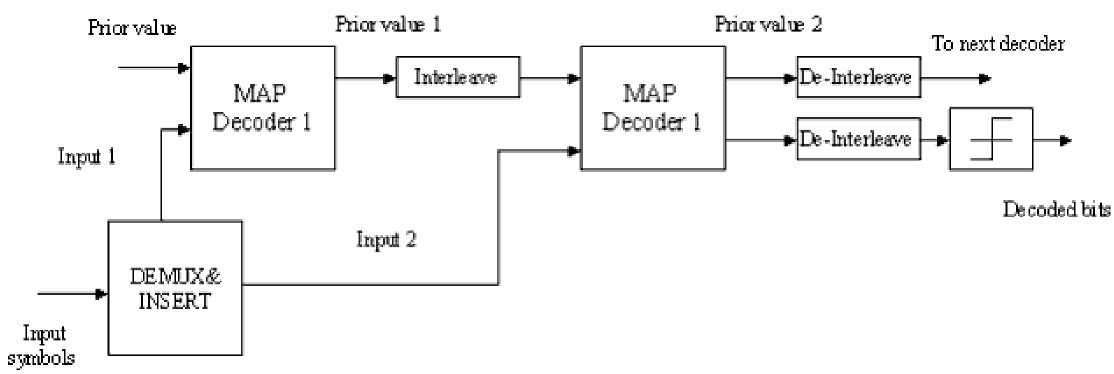
Pin	Name	Description	Signal Type
1	CodedData	input of coded data	real

Pin Outputs

Pin	Name	Description	Signal Type
2	UncodedData	output of uncoded data	int

Notes/Equations

1. This model performs the rate-1/5 turbo decoding on the input coded sequence in which the number of uncoded bits (including CRC bits) is NumPacketBits.
   Each firing,
   - When NumPacketBits<=128, 3*(NumPacketBits+8) tokens are consumed at pin CodedData;
     When NumPacketBits>128, 5*NumPacketBits+18 tokens are consumed at pin CodedData.
   - NumPacketBits tokens are produced at pin UncodedData;
2. The turbo decoder employs the MAP(maximum a posteriori) algorithm. It is a modified BAHL et al. algorithm for RSC codes (see *Ref3* (3gpp2umb) and *Ref4* (3gpp2umb)). Two parallel concatenated MAP decoders constitute the decoder of turbo code. The MAP decoder structure is shown in the following figure.



Turbo Code MAP Decoder Structure

The parameter IterationNumber specifies the number of iterations for the turbo MAP decoder.
Note that the SNR estimation for the MAP deocder is not employed in this turbo decoder due to its mismatch in Rayleigh fading channels. Instead, the SNR is fixed to -6dB in this model.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
3. 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. March 1974, pp. 248-287.
4. C. Berrou, A. Glavieux, and P. Thitiumjshima, "Near Shannon limit error correcting coding: Turbo codes," IEEE International Conference on Communications, May 1993, pp. 1064-1070.

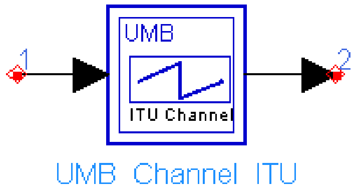
UMB Channel Model Components

The UMB channel models provide ITU 12.25 channel.

- *UMB Channel ITU* (3gpp2umb)

UMB_Channel_ITU

Symbol



Description: 3GPP2 UMB channel model
Library: UMB, Channel Model

Parameters

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

Pin Inputs

Pin	Name	Description	Signal Type
1	input	channel input signal	timed

Pin Outputs

Pin	Name	Description	Signal Type
2	output	channel output signal	timed

Notes/Equations

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

distribution and spectral power density.
The definition of the four specific ITU channels is shown in the following tables:

Outdoor to Indoor and Pedestrian Test Environment Tapped-delay-line Parameters

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

Vehicular Test Environment Tapped-delay-line Parameters

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

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

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

where
$f_0 = \dfrac{f}{f_m}$ and $f_m = \dfrac{v}{c}f$, v
is the mobile's velocity relative to base station.
The set of ITU channel models specify statistical parameters of microscopic effects. To simulate the real channel, these statistics have to be combined with macroscopic channel effects, i.e. the path loss (including shadowing) which will be introduced in the later section.
The COST 207 model with a correction term is used to simulate the path loss for both pedestrian and vehicular environments if the PathLoss is ON and other parameters are set according to the specific environment.

3. Parameter Details
    - *ModelType* specifies the type of ITU channel.
      The relationship of the channel type and the terrain type is shown in the following table.
      ModelType A and *B* are outdoor to indoor and pedestrian enviroment, while Type

C and *D* are vehicular environment. Type *User-Defined* is used to construct user defined channel model.

- *Velcocity* specifies the mobile's velocity relative to base station.
- *PropDistance* specifies the distance between base station and mobile station.
- *PathLoss* identifies whether the large-scale pathloss is included.
  if $PathLoss = NO$, the path loss is not included in this model and the parameters describing the environment are unused.
  if $PathLoss = YES$, the path loss for both urban and suburban environments is modeled by the COST 207 model with a correction term. There are three terms which make up the model:
  Path Loss model for outdoor to indoor and pedestriant test environment
  $$L = 40\log R + 30\log f + 49$$
  where R is the propogation distance and f is the frequency.
  Path Loss model for vehicular test enviroment
  $$L = [40(1 - 4 \times 10^{-3}\Delta h_b)]\log R - 18\log\Delta h_b + 21\log f + 80$$
  where R is the propogation distance and f is the frequency, Δh_b is the height between base station antenna and mobile.
- *Delay, Power* and *Ricean_factor* specify the delay, power and ricean factor for each path when *ModelType* selected as *UserDefined.*

4. Output delay
   A delay of 64 tokens is introduced in this model.

References

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

3GPP2 UMB Design Examples

This section includes the 3GPP2 UMB transmitter and receiver design examples.

3GPP2 UMB Transmitter Design Examples

The UMB_Tx_wrk workspace shows 3GPP2 UMB transmitter measurement characteristics. The frequency is set to 2500 MHz.

Designs for these measurements include:

- A Demo for constructing flexible UMB Forward Link Signals: UMB_FL_Demo
- A Demo for constructing flexible UMB Reverse Link Signals: UMB_RL_Demo
- Forward Link Transmitter CCDF, Waveform and Spectrum Measurements: UMB_FL_TxWaveform
- Reverse Link Transmitter CCDF, Waveform and Spectrum Measurements: UMB_RL_TxWaveform
- Forward Link EVM measurements: UMB_FL_TxEVM
- Reverse Link EVM measurements: UMB_RL_TxEVM

A Demo for How to Construct Flexible UMB Forward Link Signals

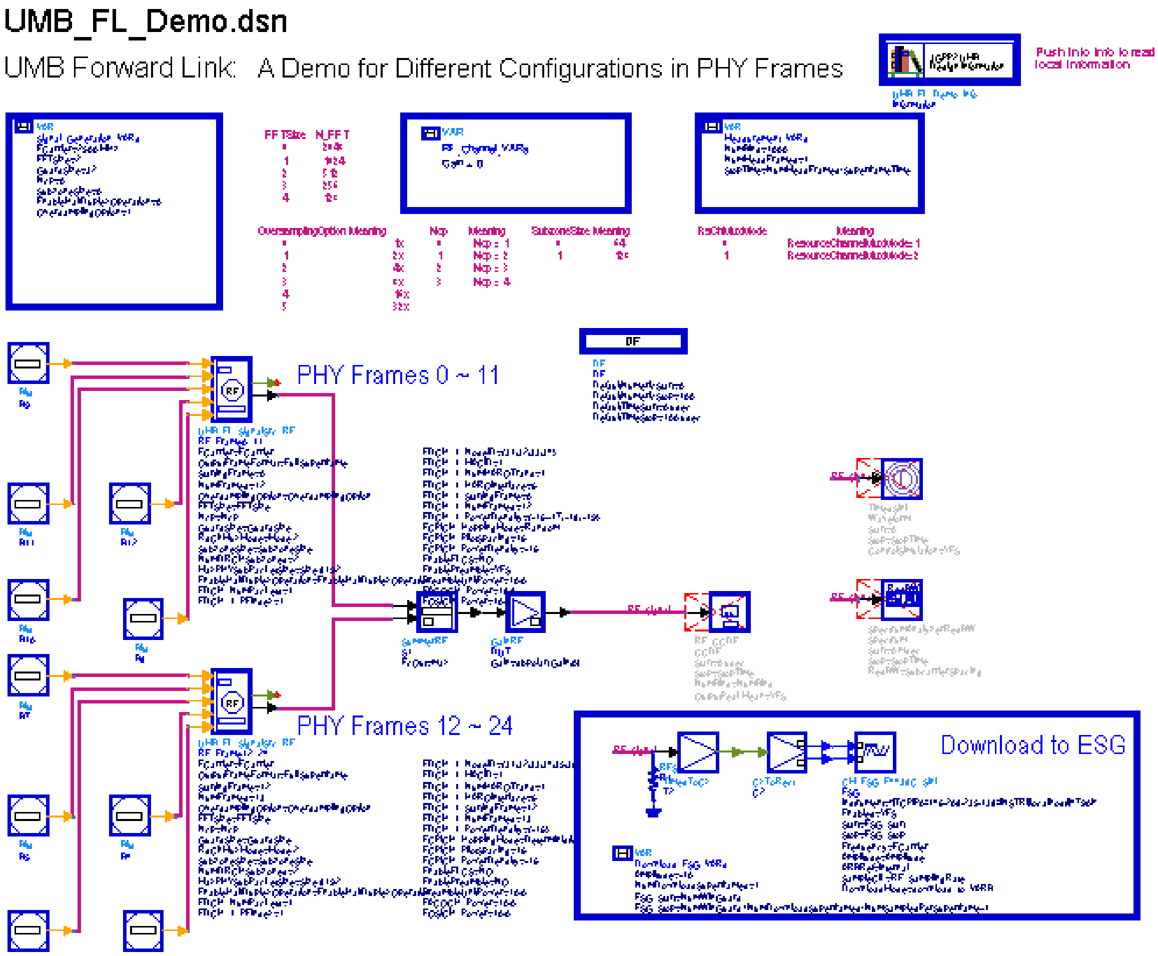
UMB_FL_Demo Design

Features

- An example for how to build flexible Forward Link superframe structure
- An example for downloading UMB Forward Link signals to ESG

Description

The schematic is shown in the following illustration.



UMB_FL_Demo Schematic

The detail information for the construction of flexible Forward Link superframe is described in *UMB_FL_Demo Example* (3gpp2umb).
To download to ESG, set proper ESG IP address. The variable NumDownloadSuperframes is used to set number of superframes downloaded into ESG. Note that the waveform downloaded to ESG by this design has some discontinuity (between the beginning and end part). More operations are needed in order to eliminate the discontinuity.

Benchmark

- Hardware Platform: Pentium Centrino 2.0GHz, 2 GB memory
- Software Platform: Windows XP, ADS 2008A

A Demo for How to Construct Flexible UMB Reverse Link Signals

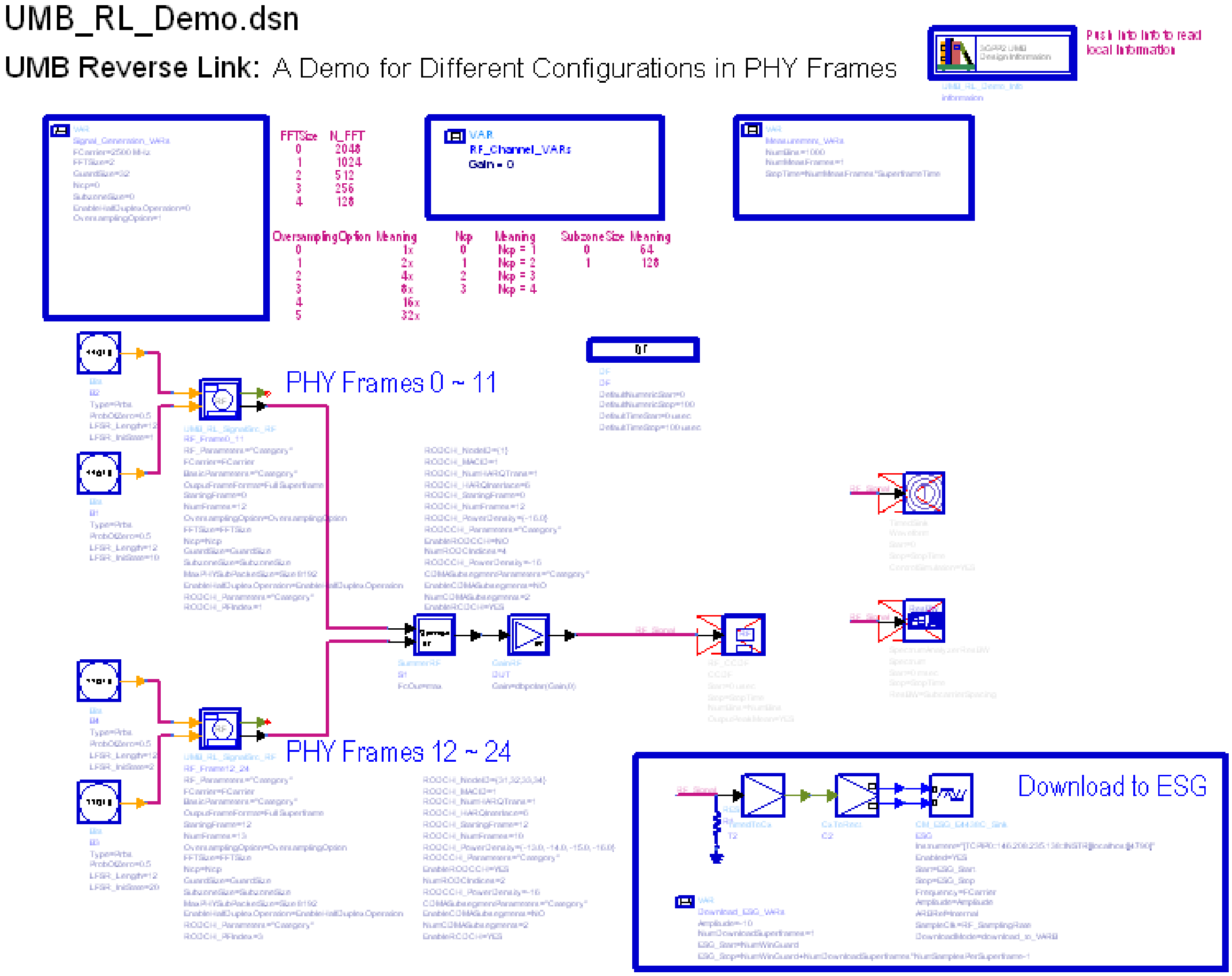
UMB_RL_Demo Design

Features

- An example for how to build flexible Reverse Link superframe structure
- An example for downloading UMB Reverse Link signals to ESG

Description

The schematic is shown in the following illustration.



UMB_RL_Demo Schematic

The detail information for the construction of flexible Reverse Link superframe is described in *UMB_RL_Demo Example* (3gpp2umb).
To download to ESG, set proper ESG IP address. The variable NumDownloadSuperframes is used to set number of superframes downloaded into ESG. Note that the waveform downloaded to ESG by this design has some discontinuity (between the beginning and end part). More operations are needed in order to eliminate the discontinuity.

Benchmark

- Hardware Platform: Pentium Centrino Duo 2.0GHz, 2 GB memory
- Software Platform: Windows XP, ADS 2008A

Forward Link Transmitter CCDF, Waveform and Spectrum Measurements

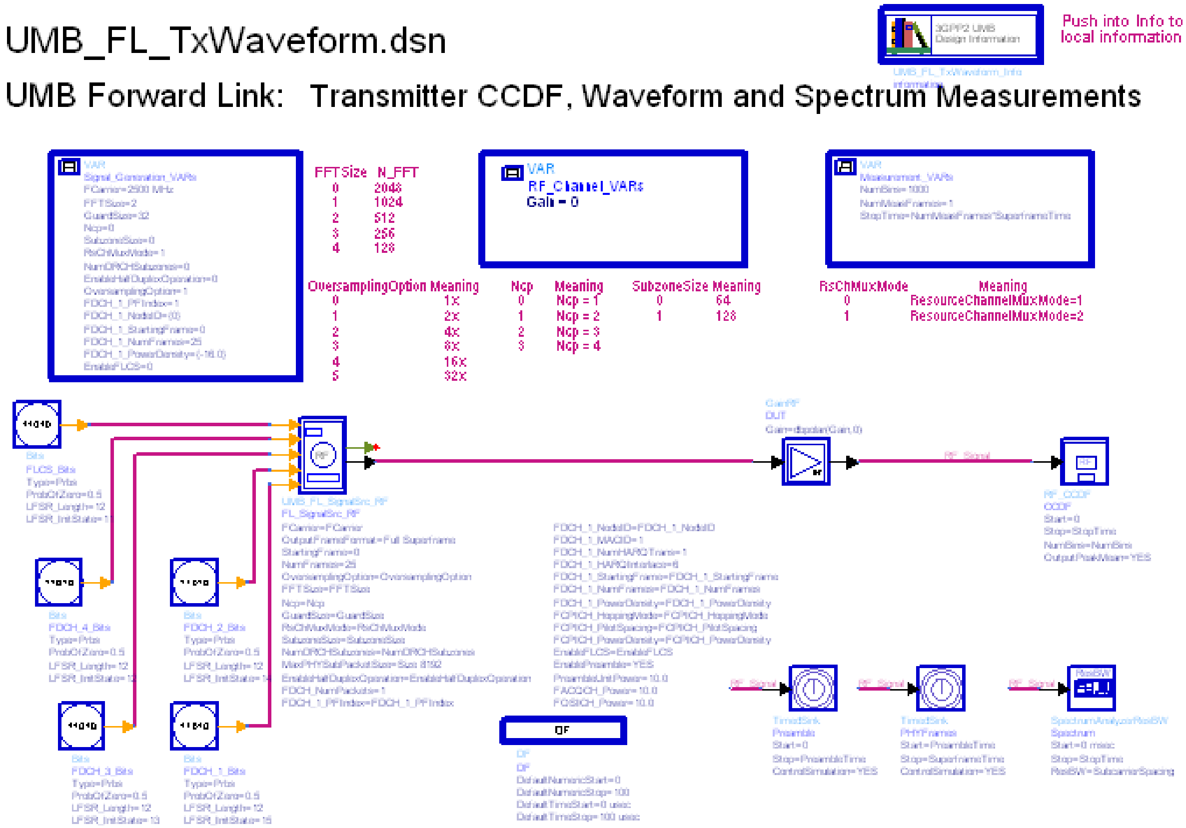
UMB_FL_TxWaveform Design

Features

- Waveform measurement
- Spectrum measurement
- CCDF measurement

Description

The schematic is shown in the following illustration.



UMB_FL_TxWaveform Schematic

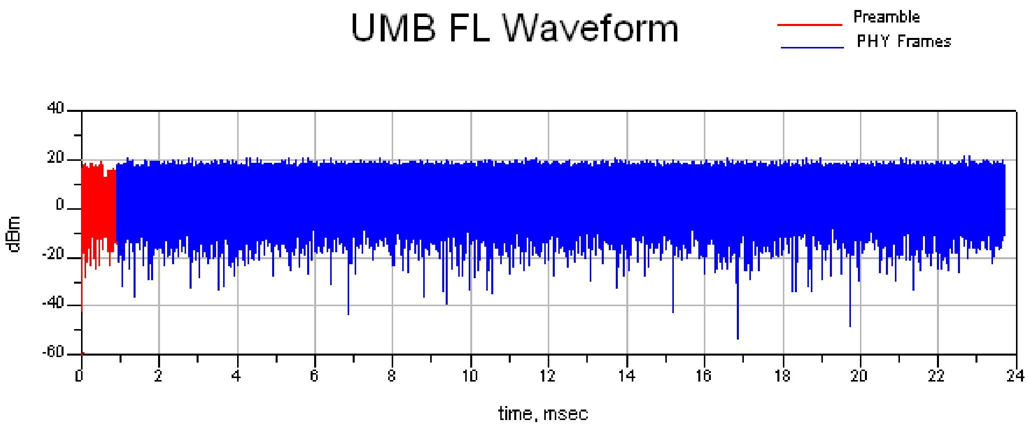
UMB_FL_TxWaveform is the test bench for 3GPP2 UMB transmission test. Most of the measurements are designed according to the specification of 3GPP2 C.S0084-001-0. The test signal generated by using 3GPP2 UMB Signal Source sends to device under test (DUT). The output of signal from DUT will be sent back in test bench for measurements. The measurements provided include:

- RF Signal envelope
- RF Signal spectrum
- Complementary Cumulative Distribution Function (CCDF)

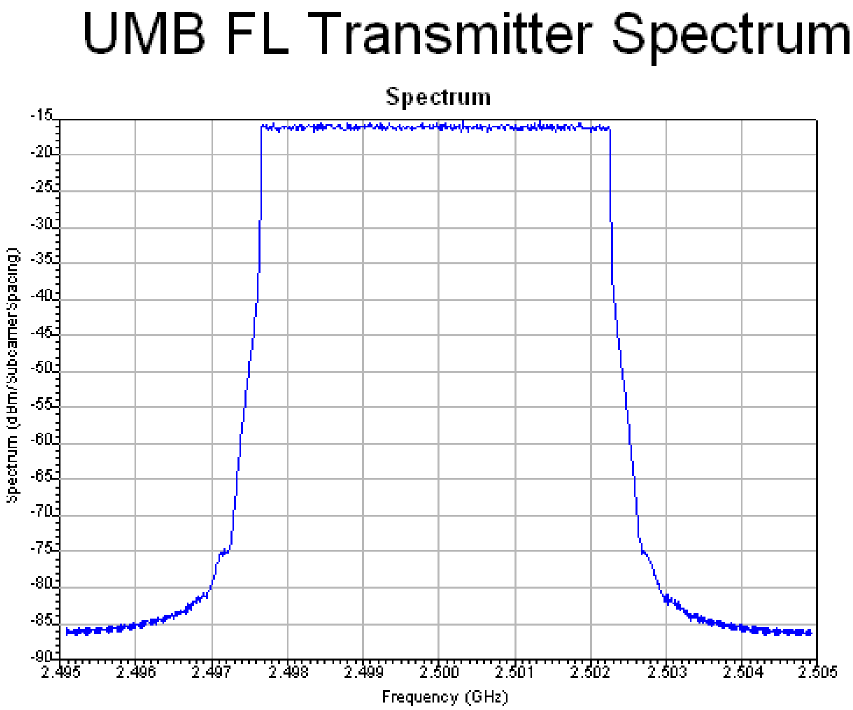
The variable NumMeasFrames controls the number of superframes for measurement. The variable NumBins is the number of points in the CCDF curve.
In DDS, MeanPower_dBm is the mean power in the NumMeasFrames superframes. The spectrum is measured with resolution bandwidth of one subcarrier spacing (i.e. 9.6KHz).

Simulation Results

The result of the UMB Forward Link waveform is shown in the following figure.

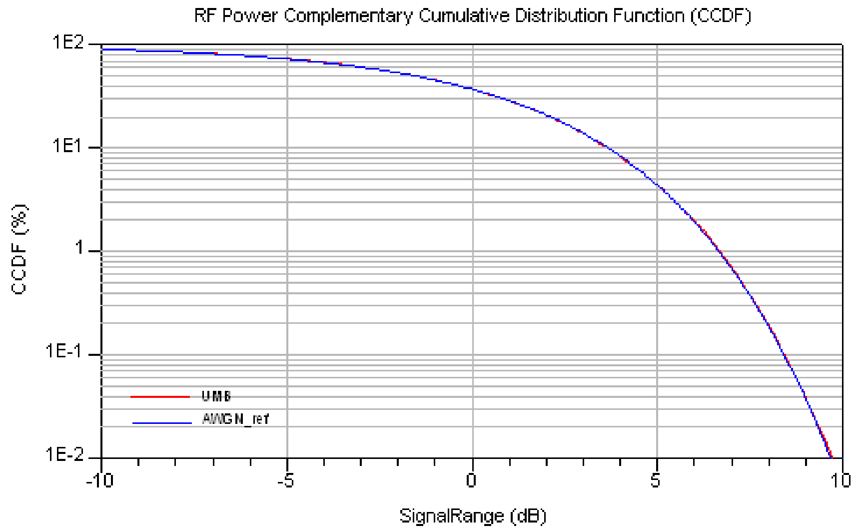


The result of the UMB Forward Link spectrum is shown in the following figure.



The result of the UMB Forward Link CCDF is shown in the following figure.

UMB FL Transmitter CCDF



MeanPower_dBm	PeakPower_dBm	RF_Peak_to_Avg_dB
10.74616925	19.18801362	8.44184437

Benchmark

- Hardware Platform: Pentium Centrino Duo 2.0GHz, 2 GB memory
- Software Platform: Windows XP, ADS 2008A
- Simulation Time: about 1 minute

Reverse Link Transmitter CCDF, Waveform and Spectrum Measurements

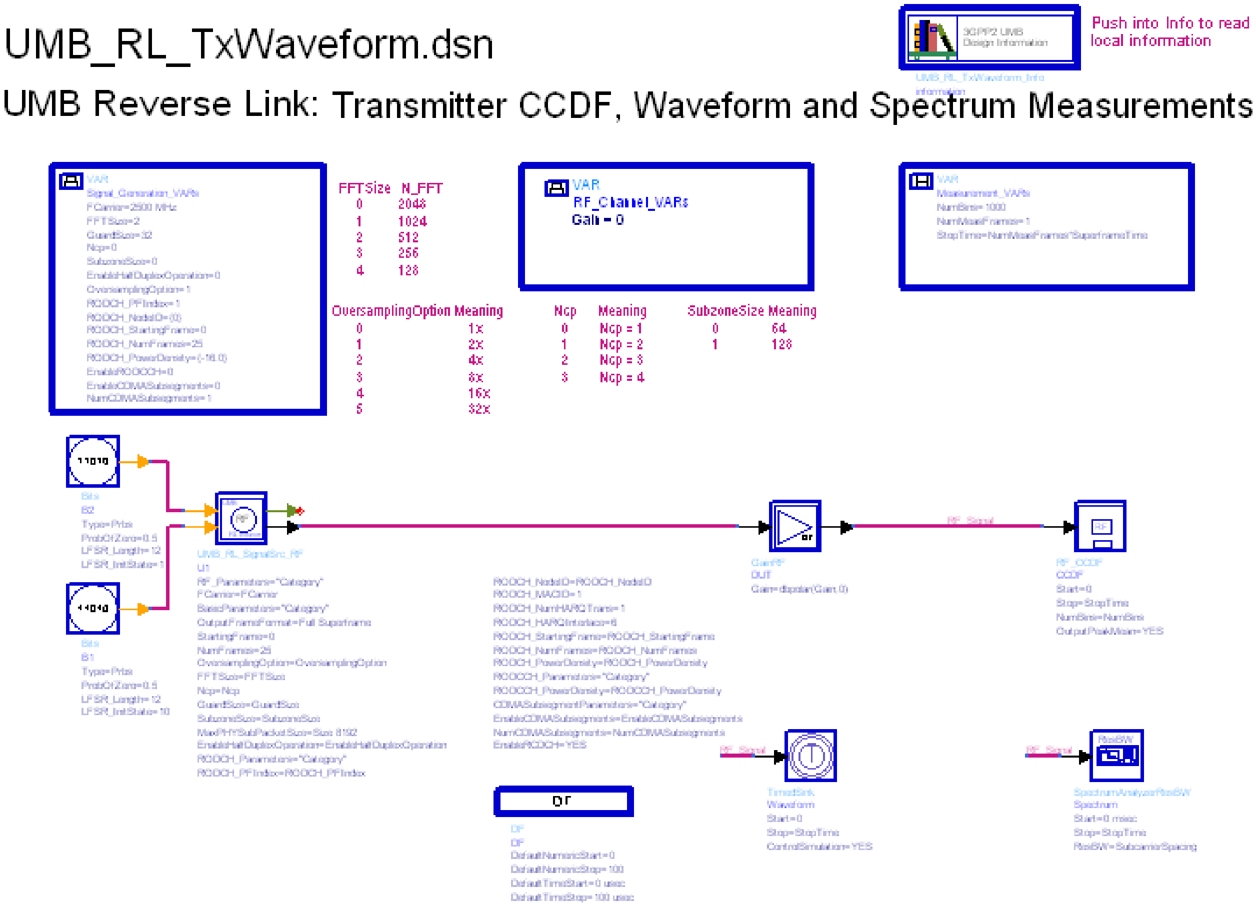
UMB_RL_TxWaveform Design

Features

- Waveform measurement
- Spectrum measurement
- CCDF measurement

Description

The schematic is shown in the following illustration.



UMB_RL_TxWaveform Schematic

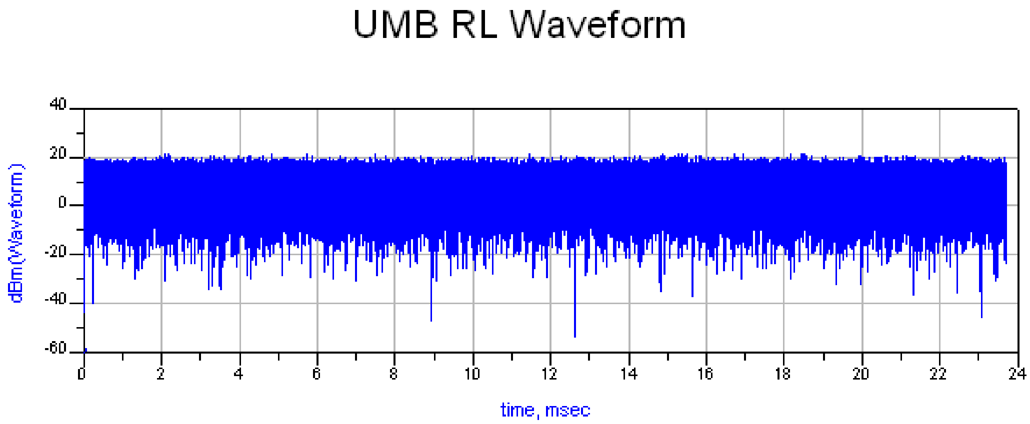
UMB_RL_TxWaveform is the test bench for 3GPP2 UMB transmission test. Most of the measurements are designed according to the specification of 3GPP2 C.S0084-001-0. The test signal generated by using 3GPP2 UMB Signal Source sends to device under test (DUT). The output of signal from DUT will be sent back in test bench for measurements. The measurements provided include:

- RF Signal envelope
- RF Signal spectrum
- Complementary Cumulative Distribution Function (CCDF)

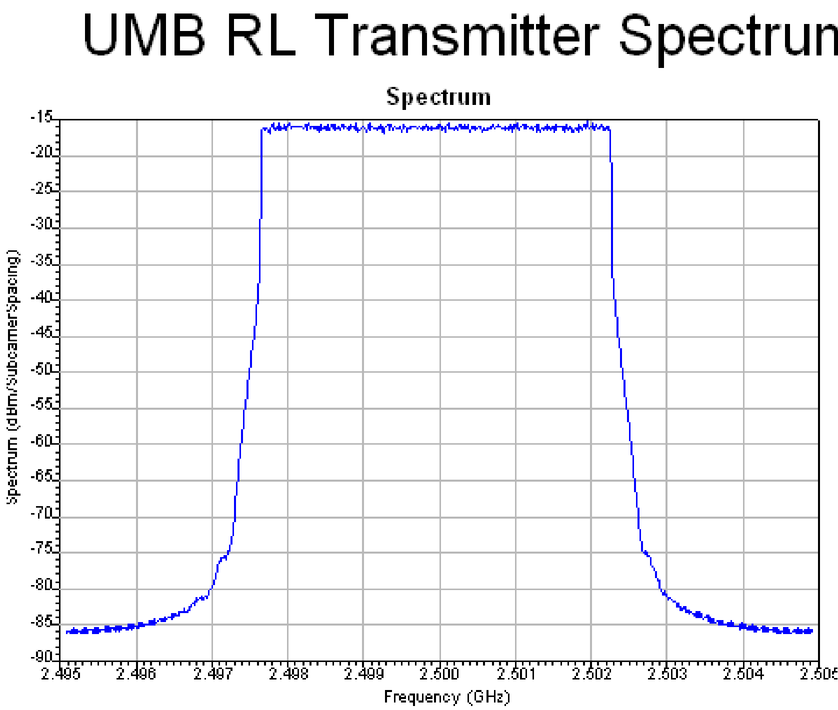
The variable NumMeasFrames controls the number of superframes for measurement. The variable NumBins is the number of points in the CCDF curve.
In DDS, MeanPower_dBm is the mean power in the NumMeasFrames superframes. The spectrum is measured with resolution bandwidth of one subcarrier spacing (i.e. 9.6KHz).

Simulation Results

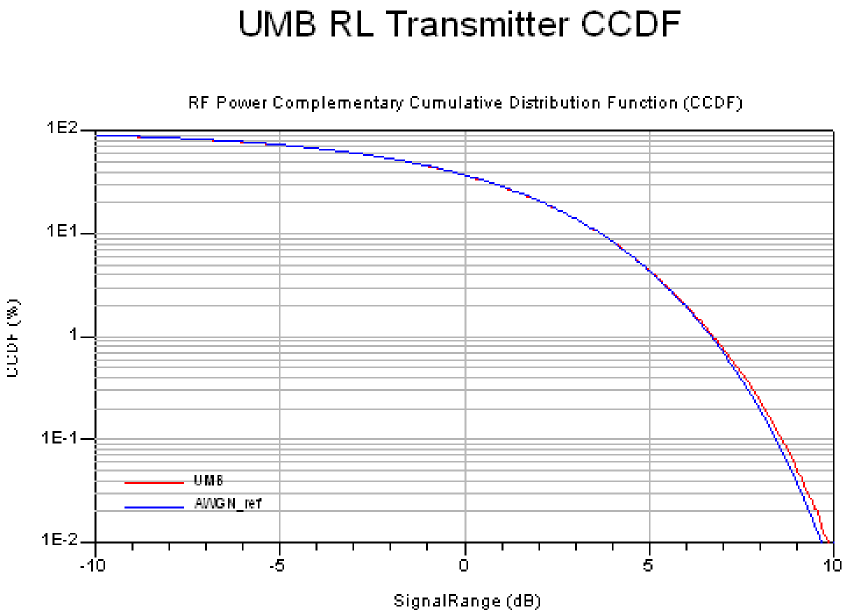
The result of the UMB Reverse Link waveform is shown in the following figure.



The result of the UMB Reverse Link spectrum is shown in the following figure.



The result of the UMB Reverse Link CCDF is shown in the following figure.



MeanPower_dBm	PeakPower_dBm	RF_Peak_to_Avg_dB
10.77758419	19.40236535	8.62478116

Benchmark

- Hardware Platform: Pentium Centrino Duo 2.0GHz, 2 GB memory
- Software Platform: Windows XP, ADS 2008A
- Simulation Time: about 1 minute

Forward Link EVM measurements

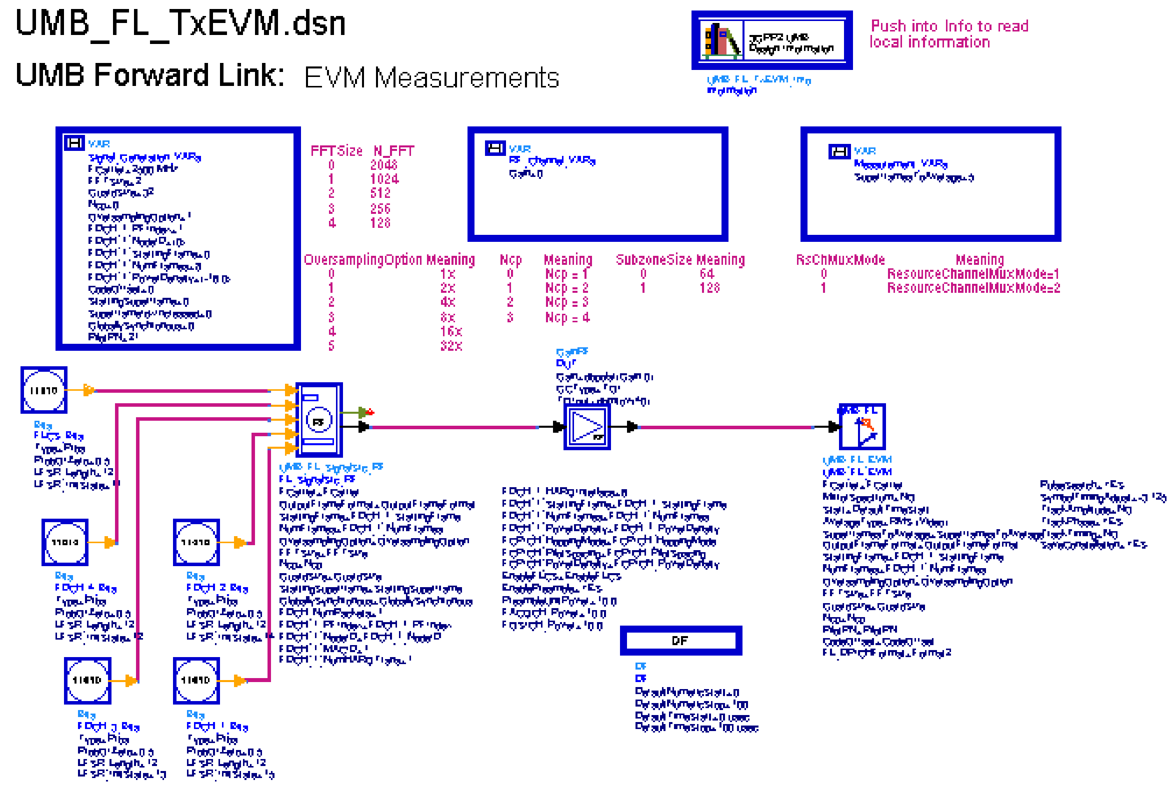
UMB_FL_TxEVM Design

Features

- Constellation
- EVM measurement for each subcarrier, for each tile and rms value

Description

The schematic is shown in the following illustration.



UMB_FL_TxEVM Schematic

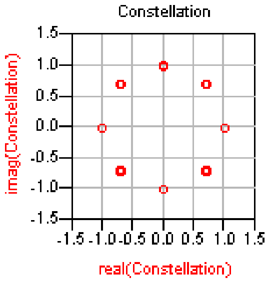
UMB_FL_TxEVM is the test bench for 3GPP2 UMB transmission test. Most of the measurements are designed according to the specification of 3GPP2 C.S0084-001-0. The test signal generated by using 3GPP2 UMB Signal Source sends to device under test (DUT). The output of signal from DUT will be sent back in test bench for measurements. The measurements provided include:

- Constellation of measured vector
- EVM value for each tile, EVM value for each subcarrier and EVM rms value

The variable SuperframesToAverage controls the number of superframes for measurement. The parameter SaveConstellation specifies whether the measured vector used for EVM calculation is saved to Data File.

Simulation Results

The result of the UMB Forward Link Constellation and EVM is shown in the following figure.



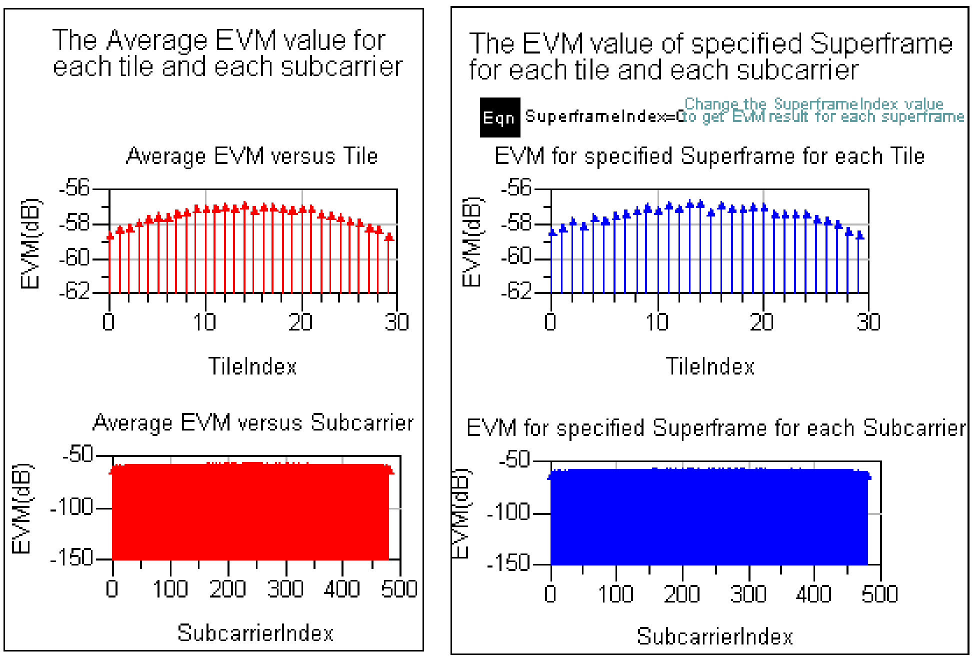
AvgEVMdB	AvgDataEVMdB	AvgPilotEVMdB
-57.226	-57.223	-57.240

AvgEVMPercent	AvgDataEVMPercent	AvgPilotEVMPercent
0.138	0.138	0.137

Index	EVMdB	DataEVMdB	PilotEVMdB
0	-57.224	-57.213	-57.273
1	-57.188	-57.185	-57.203
2	-57.277	-57.274	-57.292
3	-57.228	-57.223	-57.253
4	-57.213	-57.221	-57.179

Index	EVMPercent	DataEVMPercent	PilotEVMPercent
0	0.138	0.138	0.137
1	0.138	0.138	0.138
2	0.137	0.137	0.137
3	0.138	0.138	0.137
4	0.138	0.138	0.138

The result of the UMB Forward Link EVM for each tile and each subcarrier is shown in the following figure.



Benchmark

- Hardware Platform: Pentium Centrino Duo 2.0GHz, 2 GB memory
- Software Platform: Windows XP, ADS 2008A
- Simulation Time: about 18 seconds

Reverse Link EVM measurements

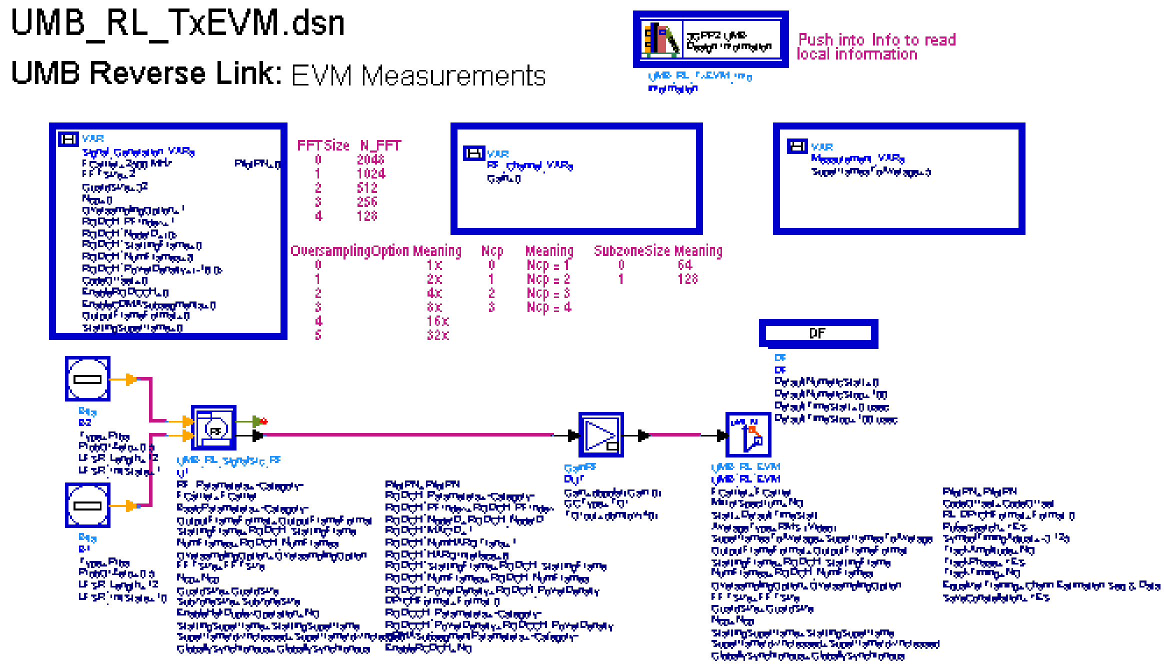
UMB_RL_TxEVM Design

Features

- Constellation
- EVM measurement for each tile, EVM for each subcarrier and rms value

Description

The schematic is shown in the following illustration.



UMB_RL_TxEVM Schematic

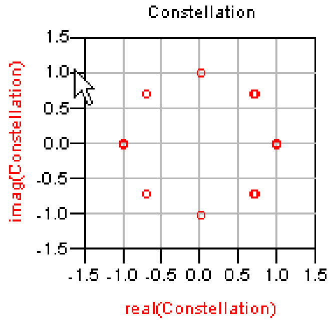
UMB_RL_TxEVM is the test bench for 3GPP2 UMB transmission test. Most of the measurements are designed according to the specification of 3GPP2 C.S0084-001-0. The test signal generated by using 3GPP2 UMB Signal Source sends to device under test (DUT). The output of signal from DUT will be sent back in test bench for measurements. The measurements provided include:

- Constellation of measured vector
- EVM value for each tile, EVM value for each subcarrier and EVM rms value

The variable SuperframesToAverage controls the number of superframes for measurement. The parameter SaveConstellation specifies whether the measured vector used for EVM calculation is saved to Data File.

Simulation Results

The result of the UMB Reverse Link Constellation and EVM is shown in the following figure.



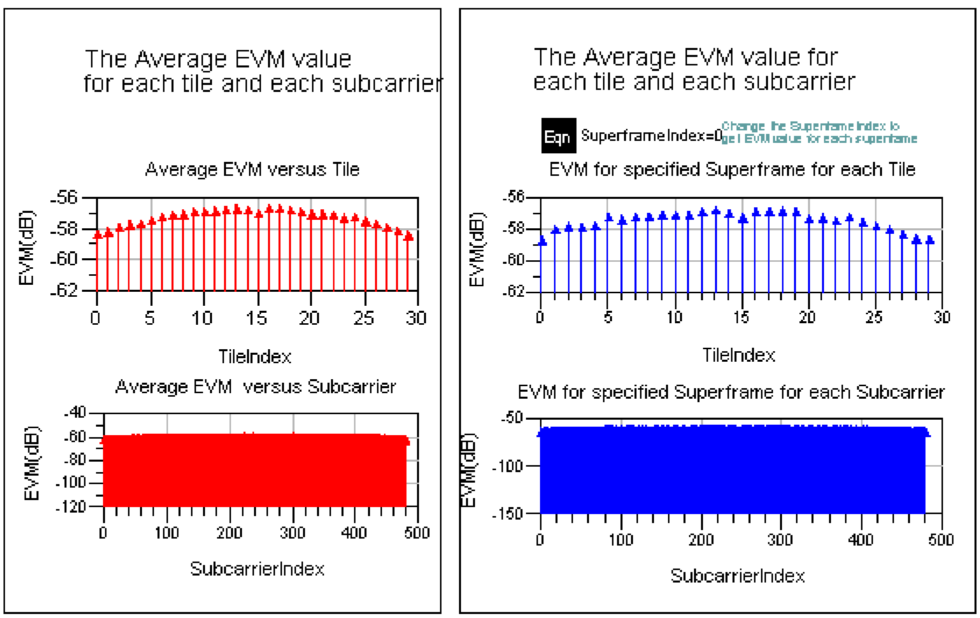
AvgEVMdB	AvgDataEVMdB	AvgPilotEVMdB
-56.988	-56.989	-56.978

AvgEVMPercent	AvgDataEVMPercent	AvgPilotEVMPercent
0.141	0.141	0.142

Index	EVMdB	DataEVMdB	PilotEVMdB
0	-57.112	-57.107	-57.144
1	-56.867	-56.855	-56.944
2	-56.999	-57.012	-56.920
3	-56.897	-56.882	-56.992
4	-57.064	-57.093	-56.893

Index	EVMPercent	DataEVMPercent	PilotEVMPercent
0	0.139	0.140	0.139
1	0.143	0.144	0.142
2	0.141	0.141	0.143
3	0.143	0.143	0.141
4	0.140	0.140	0.143

The result of the UMB Reverse Link EVM for each tile and each subcarrier is shown in the following figure.



Benchmark

- Hardware Platform: Pentium Centrino Duo 2.0GHz, 2 GB memory
- Software Platform: Windows XP, ADS 2008A
- Simulation Time: about 17 seconds

3GPP2 UMB Receiver Design Examples

The UMB_Rx_wrk workspace shows 3GPP2 UMB receiver measurement characteristics. The frequency is set to 2500 MHz.

Designs for these measurements include:

- BER and PER Measurements on AWGN Channel: UMB_FL_AWGN_BER
- BER and PER Measurements on Fading Channel: UMB_FL_Fading_BER

BER and PER Measurements on AWGN Channel

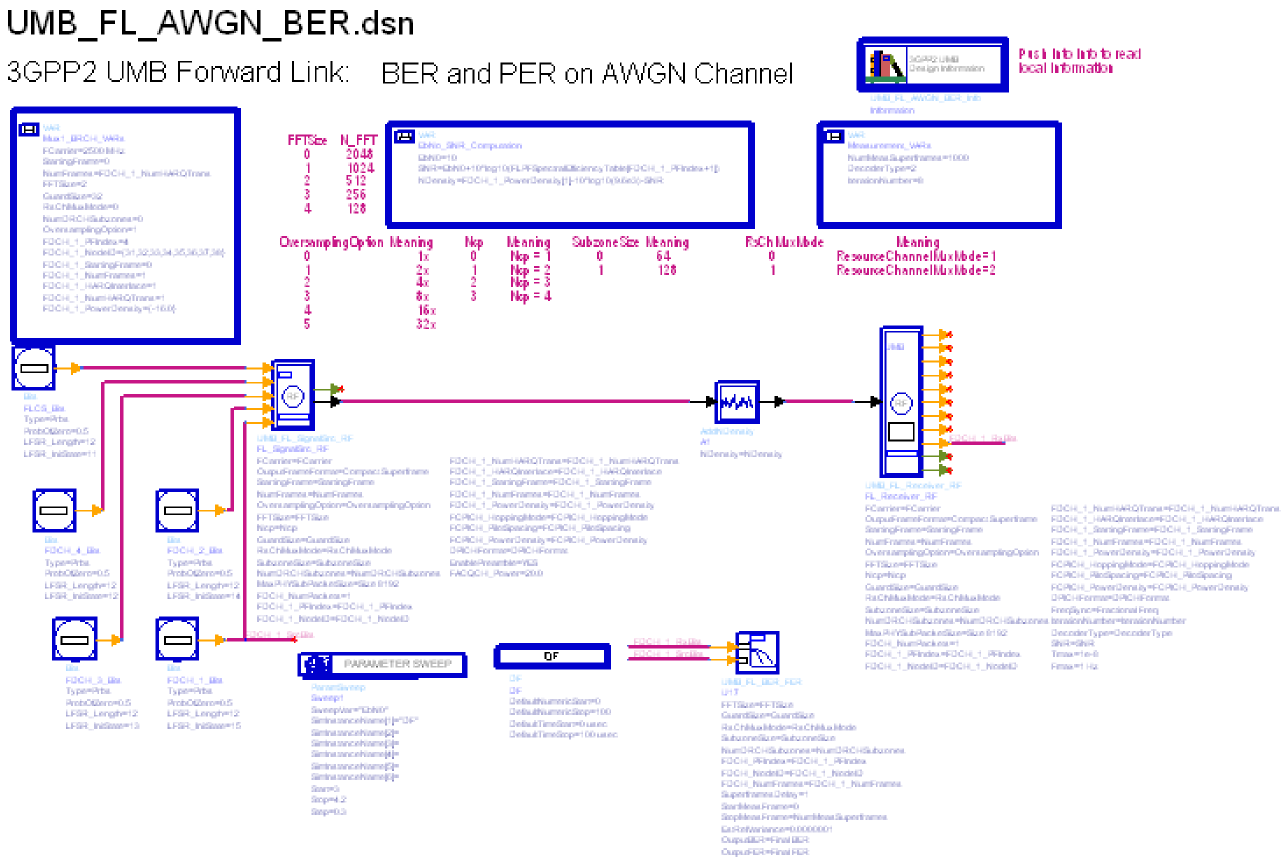
UMB_FL_AWGN_BER Design

Features

- BER and PER measurements on AWGN channel
- Three decoder types supported in downlink receiver: Hard, Soft or CSI
- Multiple Eb/N0 (and SNR) measurement points

Description

The schematic is shown in the following illustration.

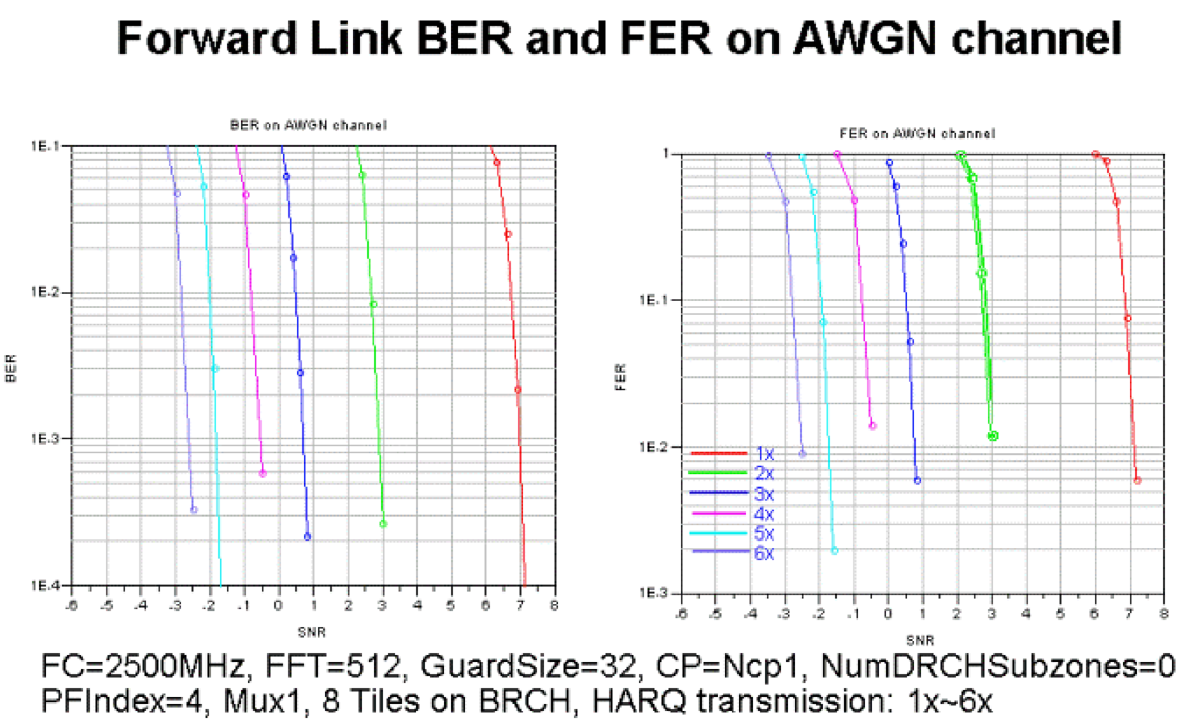


UMB_FL_AWGN_BER Schematic

UMB_FL_AWGN_BER is the test bench for 3GPP2 UMB Forward Link BER and FER test on

AWGN channel.
The UMB Forward Link source is generated according to the specification of 3GPP2 C.S0084-001-0.
In UMB Forward Link receiver, the parameters Tmax and Fmax are set to very small values to match the characters of AWGN channel.
Parameter NumMeasSuperframes deifnes the number of superframes for measuring BER and FER.
Two output options (FER vs. SNR and FER vs. EbN0) are provided.
In DDS UMB_FL_AWGN_BER, 6 curves for 1x to 6x HARQ transmissions are displayed. The simulation conditions are:
FC=2500MHz, FFT=512, GuardSize=32, CP=Ncp1, NumDRCHSubzones=0, PFIndex=4, Mux1, 8 Tiles on BRCH, HARQ transmission: 1x~6x
Note that in low SNR simulation, the timing and frequency synchronization may not work properly. It is suggested to
set the power of F-ACQCH (FACQCH_Power) to a bigger value in the source to avoid the synchronization failure in the receiver.

Simulation Results



Benchmark

- Hardware Platform: Pentium Centrino Duo 2.0GHz, 2 GB memory
- Software Platform: Windows XP, ADS 2008A
- Simulation Time: about 2 hours

BER and PER Measurements on Fading Channel

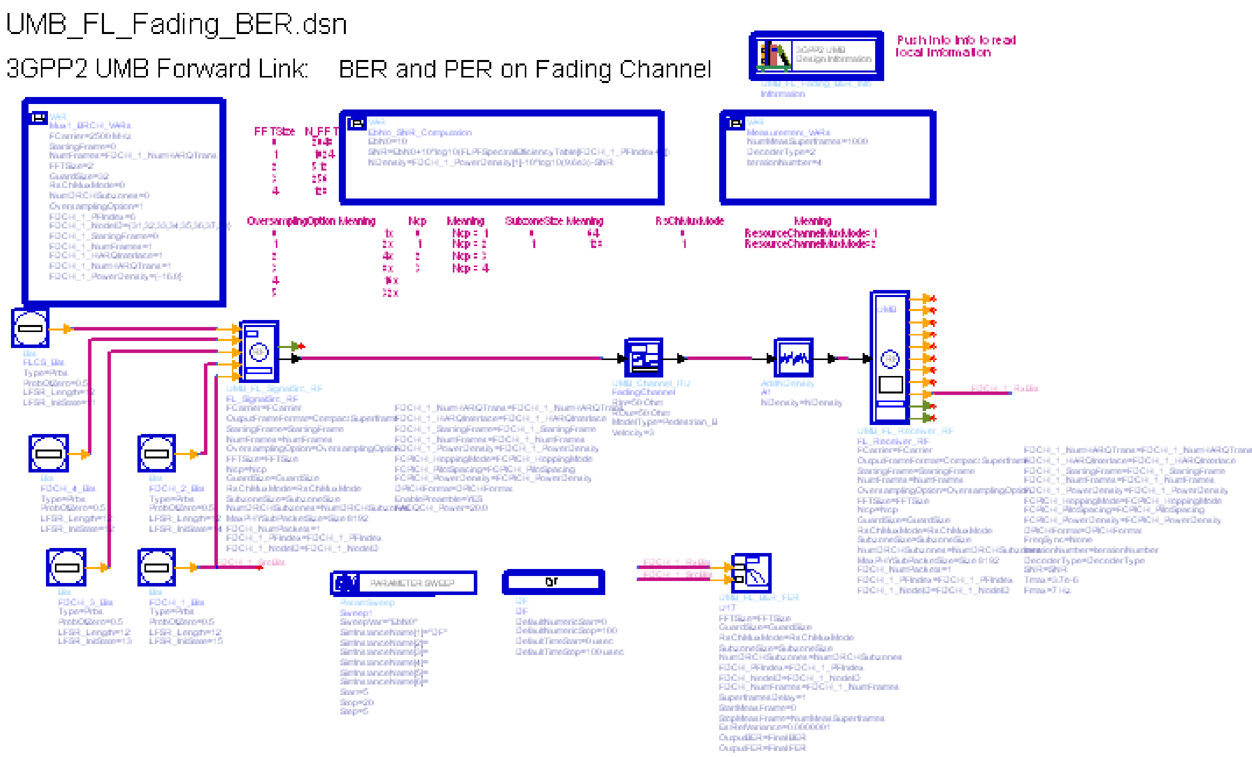
UMB_FL_Fading_BER Design

Features

- BER and PER measurements on ITU fading channel
- Three decoder types supported in downlink receiver: Hard, Soft or CSI
- Multiple Eb/N0 (and SNR) measurement points

Description

The schematic is shown in the following illustration.



UMB_FL_Fading_BER Schematic

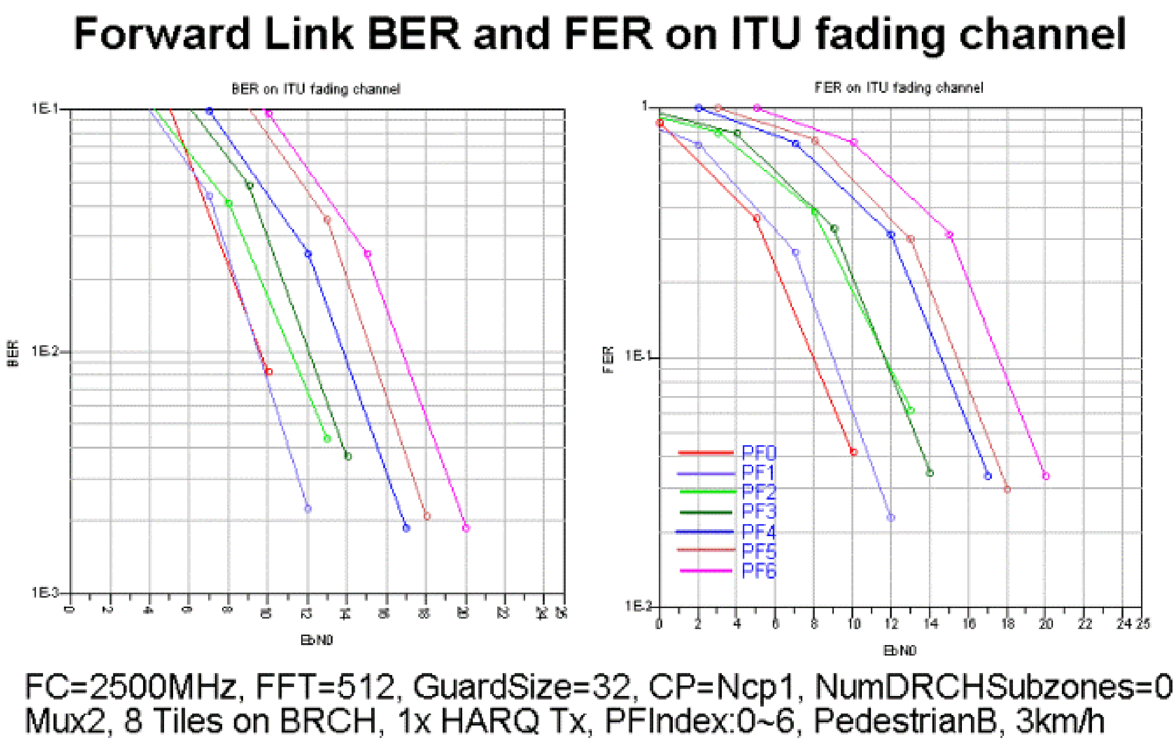
UMB_FL_Fading_BER is the test bench for 3GPP2 UMB Forward Link BER and FER test on ITU fading channel.
The UMB Forward Link source is generated according to the specification of 3GPP2 C.S0084-001-0.
In UMB Forward Link receiver, the parameters Tmax and Fmax are set to proper values according to the simulating ITU fading channel.
Tmax and Fmax in some typical fading channels with FCarrier=2.5GHz are given as follows:

Channel	Tmax	Fmax
ITU PedestrianB 3km/h	3.7 usec	7 Hz
ITU VehicularA 60km/h	2.51 usec	139 Hz
ITU VehicularA 120km/h	2.51 usec	278 Hz

Parameter NumMeasSuperframes defines the number of superframes for measuring BER and FER.
Two output options (FER vs. SNR and FER vs. EbN0) are provided.
In DDS UMB_FL_AWGN_BER, 6 curves for PFIndex 0 to PFIndex 6 are displayed. The simulation conditions are:
ITU PedestrianB 3km/h, FC=2500MHz, FFT=512, GuardSize=32, CP=Ncp1, NumDRCHSubzones=0, 1x HARQ transmission, Mux2, 8 Tiles on BRCH, PFIndex=0 to 6.
Note that in low SNR simulation, the timing and frequency synchronization may not work

properly. It is suggested to
set the power of F-ACQCH (FACQCH_Power) to a bigger value in the source to avoid the synchronization failure in the receiver.

Simulation Results



Benchmark

- Hardware Platform: Pentium Centrino Duo 2.0GHz, 2 GB memory
- Software Platform: Windows XP, ADS 2008A
- Simulation Time: about 5 hours

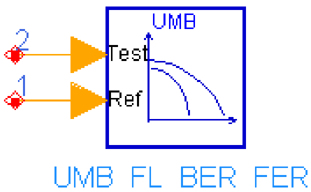
UMB Measurements Components

The UMB measurements models provide basic measurements (such as EVM, BER_FER and etc.).

- *UMB FL BER FER* (3gpp2umb)
- *UMB FL EVM* (3gpp2umb)
- *UMB RL EVM* (3gpp2umb)

UMB_FL_BER_FER

Symbol



Description: UMB Forward Bit Error Rate and Frame Error Rate estimation
Library: UMB,Measurements

Parameters

Name	Description	Default	Type	Range
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
RsChMuxMode	The mux mode for resource channels: Mode 1, Mode 2	Mode 2	enum	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
NumDRCHSubzones	the number of DRCH subzones	0	int	[0,FFTSize/SubzoneSize-1]
FDCH_PFIndex	the packet format index for the data packet transmitted in F-DCH	1	int	[0,14]
FDCH_NodeID	the array of NodeID allocated to the data packet transmitted in F-DCH	{31}	int array	
FDCH_NumFrames	the number of frames on which the data packet is allocated in F-DCH	1	int	[1,25]
SuperframesDelay	number of delay superframes introduced by the receiver	1	int	
StartMeasFrame	Start superframe index for data collection	0	int	[0,∞)
StopMeasFrame	Stop superframe index for data collection when EstRelVariance is not met	100	int	(Start,∞)
EstRelVariance	BER estimation relative variance	0.01	real	[0,1)
OutputBER	BER output: BER vs index, BER vs index every 10 bits, BER vs index every 100 bits, BER vs index every 1000 bits, BER vs index every BitsPerFrame bits, Final BER	Final BER	enum	
OutputFER	FER output: FER vs frame, FER vs frame every 10 frames, Final FER, No FER	Final FER	enum	
StatusUpdatePeriod	Status update period in number of bits	1000	int	[1,∞)

Pin Inputs

Pin	Name	Description	Signal Type
1	ref	reference bit stream	int
2	test	test bit stream	int

Notes/Equations

1. This model is used to measure the BER (bit error rate) and FER (frame error rate) of

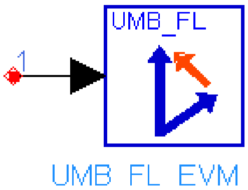
UMB Forward Link system, which has the same functionality as the model BER_FER with the following exceptions:
   - The parameter BitsPerFrame in the model BER_FER defines the number of bits in each frame for FER measurement; In UMB_FL_BER_FER, this value is calculated from the following input parameter: FFTSize, GuardSize, RsChMuxMode, SubzoneSize, NumDRCHSubzones, FDCH_PFIndex, FDCH_NodeID and FDCH_NumFrames. Refer to *Forward Link Packet Size Computation* (3gpp2umb) for more information.
   - In UMB_FL_BER_FER, before the data at pin ref and test are measured, *SuperframesDelay* superframe(s) delay will be introduced in the input data at pin ref. Since usually one superframe delay is introduced in UMB Forward Link receiver, the default value for the parameter SuperframesDelay is 1.
2. Regarding BER and FER measurement functionality, refer to the documentation of BER_FER.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_EVM

Symbol



Description: UMB Forwardlink EVM Measurement
Library: UMB, Measurements

Parameters

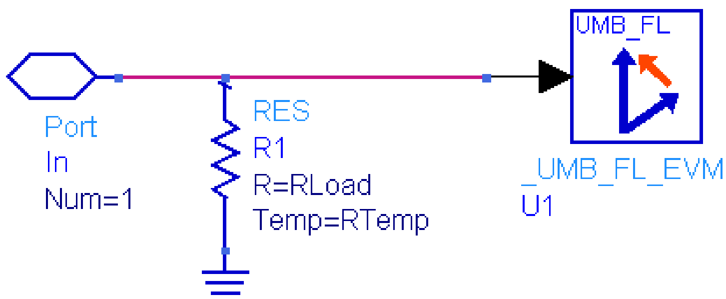
Name	Description	Default	Unit	Type	Range
RLoad	Load resistance	DefaultRLoad	Ohm	real	(0,∞)
RTemp	Load resistance physical temperature	DefaultRTemp	Celsius	real	[-273.15,∞)
FCarrier	Carrier frequency	3407 MHz	Hz	real	(0,∞)
MirrorSpectrum	Mirror frequency spectrum?: NO, YES	NO		enum	
Start	Data collection start time	DefaultTimeStart	sec	real	[0,∞)
AverageType	Average type: Off, RMS (Video)	Off		enum	
SuperframesToAverage	Superframes to average (if AverageType is not Off)	5		int	[1,∞)
OutputFrameFormat	output superframe format: Full Superframe, Compact Superframe	Full Superframe		enum	
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0		int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25		int	
OversamplingOption	Oversampling ratio option: Ratio 1, Ratio 2, Ratio 4, Ratio 8, Ratio 16, Ratio 32	Ratio 2		enum	
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512		enum	[0,4]
GuardSize	the size of guard subcarriers	32		int	
Ncp	the index for Cyclic Prefix (Tcp=Ncp*FFTSize*Tchip/16): Ncp 1, Ncp 2, Ncp 3, Ncp 4	Ncp 1		enum	
StartingSuperframe	the superframe index for the starting superframe	0		int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES		enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO		enum	
PilotPN	9-bit pilot PN for different sectors	0		int	[0,511]
CodeOffset	code offset between 0 and 2 for Forward Dedicated Pilot Channel	0		int	[0,2]
FL_DPICHFormat	the Forward Dedicated Pilot Channel format for Forward Data Channel: Format2	Format2		enum	
PulseSearch	Perform pulse search?: NO, YES	YES		enum	
SymbolTimingAdjust	Symbol timing adjustment (in % of FFT time)	-3.125		real	[-G*100,0]
TrackAmplitude	Track amplitude?: NO, YES	NO		enum	
TrackPhase	Track phase?: NO, YES	YES		enum	
TrackTiming	Track timing?: NO, YES	NO		enum	
EqualizerTraining	Equalizer training method: Chann Estimation Seq Only, Chann Estimation Seq & Data	Chann Estimation Seq Only		enum	
SaveConstellation	if set YES, the measured vector used for EVM calculation shall be saved to Data File: NO, YES	NO		enum	

Pin Inputs

Pin	Name	Description	Signal Type
1	input	input signal	timed

Notes/Equations

1. This subnetwork model is used to measure EVM for 3GPP2 UMB forword link transmitter. The input signal must be a timed RF (complex envelope) signal. The schematic for this subnetwork is shown in the following figure.



UMB_FL_EVM Schematic

2. 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. The EVM result is defined as the square root of the ratio of the mean error vector power to the mean reference power expressed as a %. The measurement interval for the EVM is one superframe. The available results from this measurement are:
   - AvgDataEVMdB: average data EVM rms in dB
   - AvgDataEVMPercent: average data magnitude error rms in %
   - AvgEVMdB: average EVM rms in dB
   - AvgEVMPercent: average EVM rms in %
   - AvgFreqError: average frequency error in Hz
   - AvgIQOffset: average IQ offset in dB
   - AvgPilotEVMdB: average pilot EVM rms in dB
   - AvgPilotEVMPercent: average pilot EVM rms in %
   - AvgSubcarrierEVMdB: EVM value in dB versus subcarrier averaged on successfully detected superframes
   - AvgSubcarrierEVMPercent: EVM value in % versus subcarrier averaged on successfully detected superframes
   - AvgTileEVMdB: EVM value in dB versus tile averaged on successfully detected superframes
   - AvgTileEVMPercent: EVM value in % versus tile averaged on successfully detected superframes
   - Constellation: the measured vector used to calculate EVM value
   - DataEVMdB: data EVM rms in dB versus superframe
   - DataEVMPercent: data EVM rms in dB versus superframe
   - EVMdB: EVM in dB versus superframe
   - EVMPercent: EVM rms in % versus superframe
   - FreqError: frequency error in Hz versus superframe
   - PilotEVMdB: pilot EVM rms in dB versus superframe
   - PilotEVMPercent: pilot EVM rms in % versus superframe
   - SubcarrierEVMdB: EVM value for each subcarrier in dB for each successfully detected superframes
   - SubcarrierEVMPercent: EVM value for each subcarrier in % for each successfully detected superframes
   - TileEVMdB: EVM value for each tile in dB for each successfully detected superframes
   - TileEVMPercent: EVM value for each tile in % for each successfully detected

superframes
The SubcarrierEVMXXX is averaged on one superframe. Assuming S subcarrier in one OFDM symbol excluding guard subcarriers, A superframes to be detected; the first S values(#0, #1,..., #(S-1)) are for the first superframe(superframe#0), the second S values(#S, #(S+1),...,#(2S-1)) are for the second superframe(superframe#1),...,the last S values(#(A-1)S, #((A-1)S+1), ... , #(AS-1)) are for the last superframe(superframe#(A-1)).
The TileEVMXXX is averaged on one superframe. Assuming T subcarrier in one OFDM symbol, A superframes to be detected, the first T values(#0, #1,..., #(T-1)) are for the first superframe(superframe#0), the second T values(#T, #(T+1),...,#(2T-1)) are for the second superframe(superframe#1),...,the last T values(#(A-1)T, #((A-1)T+1), ... , #(AT-1)) are for the last superframe(superframe#(A-1)).

3. 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.
   The FCarrier parameter sets the frequency of the internal local oscillator signal for the I and Q envelope extraction.
4. The Start parameter specifies the start time for data recording.
5. If AverageType is set to OFF, only one superframe (the first superframe) is detected, demodulated, and analyzed.
   If AverageType is set to RMS (Video), SuperframesToAverage superframes are processed.
6. The SuperframesToAverage parameter specifies the number of superframes that will be averaged if AverageType is RMS Video.
   If, for any reason, a superframe is mis-detected, the results from its analysis are discarded. The EVM results obtained from all the successfully superframes, demodulated, and analyzed superframes are averaged to give the final averaged results. The EVM results from each successfully analyzed superframes are also recorded (in the variables without the Avg prefix in their name).
   This signal segment is searched in order for a superframe 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.
7. OutputFrameFormat, StartingFrame, NumFrames, OversamplingOption, FFTSize, GuradSize, Ncp, StartingSuperframe, SuperframeIdxIncreased, GloballySynchronous, PilotPN, CodeOffset are parameters for the input signal source and described in *Basic Parameters* (3gpp2umb) in forward link signal source.
   FL_DPICHFormat specifies the Forward Dedicated Pilot Channel format for Forward Data Channel (F-DCH).
   The measurement only supported DPICH format2, BRCH structure, EnableHalfDuplexOperation = 0 and StartingFrame = 0. The following table lists the signal features supported by ADS in this release.

Features	EVM supported
OutputFrameFormat	Full, Compact
StartingFrame	0
NumFrames	Variable as in the UMB_FL_SignalSrc
OversamplingOption	1X ,2X, 4X, 8X, 16X, 32X
FFTSize	FFT128, FFT256, FFT512, FFT1024, FFT2048
GuardSize	Multiple of 16
Ncp	Ncp 1, Ncp 2, Ncp 3, Ncp 4
StartingSuperframe	Variable as in the UMB_FL_SignalSrc
SuperframeIdxIncreased	YES, NO
GloballySynchronous	YES, NO
PilotPN	0~511
CodeOffset	0, 1, 2
EnableHalfDuplexOperation	0
Control Segments	NO
Forward Data Channel F-CDH	YES (should occupy all the subcarriers in one OFDM symbol and the power density on each subcarrier should be the same)
DRCH Structure	NO
BRCH Structure	YES
FL_DPICHFormat	Format2
ModulationType	QPSK

8. The PulseSearch is used to demodulate UMB signals that do not exhibit RF Burst characteristics.If PulseSearch is set to YES, the signal segment is searched in order for an RF burst to be detected. If the signal has multiple RF bursts in a superframe duration then the first one detected is the one that will be analyzed. Some UMB signals do not have RF burst characteristics, rather they look like a series of bursts with no "off" time between them. These signals resemble a "continually on" signal with embedded preambles. To demodulate signals that do not appear to be made up of RF bursts, PulseSearch should be set to OFF and Start should be set to the beginning of the superframe you want to analyze. Otherwise, no pulse will be detected and no measurement will be performed.
9. The SymbolTimingAdjust parameter sets the percentage of symbol time by which we back away from the symbol end before we perform the FFT. Normally, when demodulating an OFDMA symbol, the cyclic prefix time (guard interval) is skipped and an FFT is performed on the last portion of the symbol time. However, this means that the FFT will include the transition region between this symbol and the following symbol. To avoid this, it is generally beneficial to back away from the end of the symbol time and use part of the guard interval. The SymbolTimingAdjust parameter controls how far the FFT part of the symbol is adjusted away from the end of the symbol time. The value is in terms of percent of the used (FFT) part of the symbol time. Note that this parameter value is negative, because the FFT start time is moved back by this parameter. The following figure explains this concept. When setting this parameter, be careful to not back away from the end of the symbol time too much because this may make the FFT include corrupt data from the transition region at the beginning of the symbol time.

SymbolTimgingAdjust Definition

10. The TrackAmplitude, TrackPhase, and TrackTiming parameters specify whether the analysis will track amplitude, phase, and timing changes in the pilot subcarriers. UMB performs demodulation relative to the data in pilot carriers embedded in the signal. These pilot carriers replace data-carrying elements of the signal and allow some kinds of impairments to be removed or "tracked out". Many impairments will be

common to all pilot carriers and can be measured as the "common pilot error". When these parameters are set to YES the analysis will track amplitude, phase, and timing changes in the pilot subcarriers and apply corrections to the pilot and data subcarriers.The flexibility to allow users to individually enable or disable tracking functions, provides useful troubleshooting capability, since modulation errors can be examined with and without the benefit of particular types of pilot tracking.

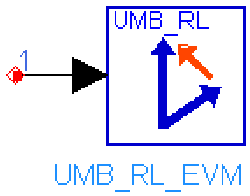
11. The EqualizerTraining parameter sets the type of training used for the equalizer. When demodulating an UMB signal, an equalizer is used to correct for linear impairments in the signal path, such as multi-path. When set to "Chan Estimation Seq Only", the equalizer is trained using the Channel Estimation Sequence in the first OFDM burst. After this initialization, the equalizer coefficients are held constant while demodulating the rest of the burst. When set to "Chan Estimation Seq & Data", the equalizer is trained using the entire OFDM burst including channel estimation sequences and data symbols. However, for signals whose impairments change during the burst it might result in measured RCE (EVM) values that are higher compared to if the equalizer were trained over the entire burst.
12. If the SaveConstellation is set to YES, the measured vector used to calculate EVM value will be recorded.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_RL_EVM

Symbol



Description: UMB Reverselink EVM Measurement
Library: UMB, Measurements

Parameters

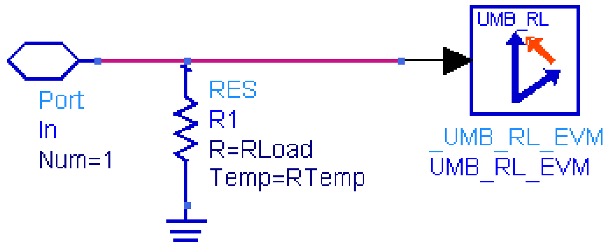
Name	Description	Default	Unit	Type	Range
RLoad	Load resistance	DefaultRLoad	Ohm	real	(0,∞)
RTemp	Load resistance physical temperature	DefaultRTemp	Celsius	real	[-273.15,∞)
FCarrier	Carrier frequency	3407 MHz	Hz	real	(0,∞)
MirrorSpectrum	Mirror frequency spectrum?: NO, YES	NO		enum	
Start	Data collection start time	DefaultTimeStart	sec	real	[0,∞)
AverageType	Average type: Off, RMS (Video)	Off		enum	
SuperframesToAverage	Superframes to average (if AverageType is not Off)	5		int	[1,∞)
OutputFrameFormat	output superframe format: Full Superframe, Compact Superframe	Full Superframe		enum	
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0		int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25		int	
OversamplingOption	Oversampling ratio option: Ratio 1, Ratio 2, Ratio 4, Ratio 8, Ratio 16, Ratio 32	Ratio 2		enum	
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512		enum	[0,4]
GuardSize	the size of guard subcarriers	32		int	
Ncp	the index for Cyclic Prefix (Tcp=Ncp*FFTSize*Tchip/16): Ncp 1, Ncp 2, Ncp 3, Ncp 4	Ncp 1		enum	
StartingSuperframe	the superframe index for the starting superframe	0		int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES		enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO		enum	
PilotPN	9-bit pilot PN for different sectors	0		int	[0,511]
CodeOffset	code offset between 0 and 2 for Forward Dedicated Pilot Channel	0		int	[0,2]
RL_DPICHFormat	the Reverse Dedicated Pilot Channel format for OFDMA Data Channels: Format 0, Format 1	Format 0		enum	[0,1]
PulseSearch	Perform pulse search?: NO, YES	YES		enum	
SymbolTimingAdjust	Symbol timing adjustment (in % of FFT time)	-3.125		real	[-G*100,0]
TrackAmplitude	Track amplitude?: NO, YES	NO		enum	
TrackPhase	Track phase?: NO, YES	YES		enum	
TrackTiming	Track timing?: NO, YES	NO		enum	
EqualizerTraining	Equalizer training method: Chann Estimation Seq Only, Chann Estimation Seq & Data	Chann Estimation Seq Only		enum	
SaveConstellation	if set YES, the measured vector used for EVM calculation shall be saved to Data File: NO, YES	NO		enum	

Pin Inputs

Pin	Name	Description	Signal Type
1	input	input signal	timed

Notes/Equations

1. This subnetwork model is used to measure EVM for 3GPP2 UMB reverse link transmitter. The input signal must be a timed RF (complex envelope) signal. The schematic for this subnetwork is shown in the following figure. |



UMB_RL_EVM Schematic

2. The Error Vector Magnitude is described in *Error Vector Magnitude* (3gpp2umb) in UMB forward link EVM.The FCarrier parameter sets the frequency of the internal local oscillator signal for the I and Q envelope extraction.
3. The MirrorSpectrum parameter is defined in *MirrorSpectrum* (3gpp2umb) in UMB forward link EVM.
4. The Start, AverageType, SuperframesToAverage parameters are defined in *Start, AverageType, SuperframesToAverage* (3gpp2umb) in UMB forward link EVM.
5. The OutputFrameFormat is described in *Superframe Structure Modes* (3gpp2umb) in UMB forward link signal source.
   The StartingFrame, NumFrames, OversamplingOption, FFTSize, GuardSize, Ncp, StartingSuperframe, SuperframeIdxIncreased, GloballySynchronous, PilotPN, CodeOffset are defined in *Basic Parameters* (3gpp2umb) in UMB forward link signal source.
   The RL_DPICHFormat is used for Reverse Dedicated Pilot Channel in the tiles belonging to the Reverse OFDMA Data Channel (R-ODCH). Only Format0 is supported in this release.
   The measurement only support OFDM subsegments, EnableHalfDuplexOperation = 0 and StartingFrame = 0. The following table lists the signal features supported by ADS in this release.

Features	EVM Supported
OutputFrameFormat	Full, Compact
StartingFrame	0
NumFrames	Variable as in the_UMB_RL_SignalSrc
OversamplingOption	1X ,2X, 4X, 8X, 16X, 32X
FFTSize	FFT128, FFT256, FFT512, FFT1024, FFT2048
GuardSize	Multiple of 16
Ncp	Ncp 1, Ncp 2, Ncp 3, Ncp 4
StartingSuperframe	Variable as in the UMB_RL_SignalSrc
SuperframeIdxIncreased	YES, NO
GloballySynchronous	YES, NO
PilotPN	0~511
CodeOffset	0, 1, 2
RL_DPICHFormat	Format0
EnableHalfDuplexOperation	0
CDMA Subsegments	NO
Reverse Acknowledgment Channel (R-ACKCH)	NO
Reverse OFDMA Dedicated Control Channel (R-ODCCH)	NO
Reverse OFDMA Data Channel (R-ODCH)	YES (should occupy all the subcarriers in one OFDM symbol and the power density on each subcarrier should be the same)
ModulationType	QPSK

6. The PulseSearch is described in *PulseSearch* (3gpp2umb) in UMB forward link EVM.
7. The SymbolTimingAdjust is described in *SymbolTimingAdjust* (3gpp2umb) in UMB forward link EVM.
8. The TrackAmplitude, TrackPhase, and TrackTiming are described in *TrackAmplitude, TrackPhase, TrackTiming* (3gpp2umb) in UMB forward link EVM.
9. The EqualizerTraining is described in *EqualizerTraining* (3gpp2umb) in UMB forward link EVM.
10. If the SaveConstellation is set to YES, the measured vector used to calculate EVM value will be recorded.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

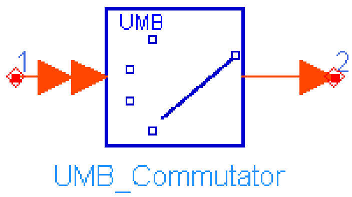
UMB Multiplex Components

The UMB multiplex models provide framing and de-framing in 3GPP2 UMB transceiver.

- *UMB Commutator* (3gpp2umb)
- *UMB Distributor* (3gpp2umb)
- *UMB FL DemuxOFDMSym* (3gpp2umb)
- *UMB FL MuxOFDMSym* (3gpp2umb)
- *UMB OFDM Demodulator* (3gpp2umb)
- *UMB OFDM Modulator* (3gpp2umb)
- *UMB RL MuxOFDMSym* (3gpp2umb)

UMB_Commutator

Symbol



Description: Data commutator
Library: UMB, Multiplex

Parameters

Name	Description	Default	Type	Range
BlockSizes	Block sizes read from each input	{1}	int array	[0,∞)
BlockEnable	If each block is enabled to output (0: disable, 1: enable)	{1}	int array	[0,1]

Pin Inputs

Pin	Name	Description	Signal Type
1	input	input signal	multiple anytype

Pin Outputs

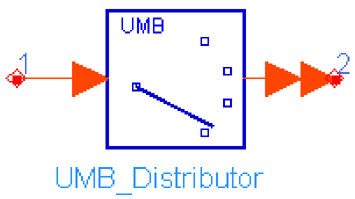
Pin	Name	Description	Signal Type
2	output	output signal	anytype

Notes/Equations

1. This model is used to take N input streams, where N is the input bus width, and asynchronously combines the streams into one output stream.
   Each firing, Bi input particles are consumed from input #i (i=1, ... , N), where Bi are the elements of the BlockSizes parameter. It produces $\sum_{i=1}^{N} BlockEnable[i] \times B_i$ particles on the output, where the particles from i-th input stream are put into the output stream if BlockEnable[i] is set to 1 (Yes) and the particles are discarded if BlockEnable[i] is set to 0 (No). The first B1 particles on the output come from the first input if BlockEnable[1] is 1, and the next B2 particles come from the second input if BlockEnable[2] is 1, and so on.

UMB_Distributor

Symbol



Description: Data distributor
Library: UMB, Multiplex

Parameters

Name	Description	Default	Type	Range
BlockSizes	Block sizes for each output	{1}	int array	[0,∞)
BlockEnable	If each block is enabled to output (0: disable, 1: enable)	{1}	int array	[0,1]

Pin Inputs

Pin	Name	Description	Signal Type
1	input	input signal	anytype

Pin Outputs

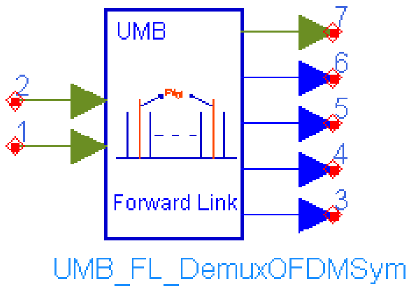
Pin	Name	Description	Signal Type
2	output	output signal	multiple anytype

Notes/Equations

1. This model is used to take one input streams and asynchronously splits it into N output streams, where N is the output bus width.
   Each firing,
   It consumes $\sum_{i=1}^{N} BlockEnable[i] \times B_i$ particles from the input, where Bi (i=1, ... , N) are the elements of the BlockSizes parameter. Bi output particles on output#i (i= 1, ... , N) are produced, where the Bi particles come from the input if BlockEnable[i] is set to 1 (Yes), and the Bi particles are set to zeros if BlockEnable[i] is set to 0 (No). The particles on the first output are the first B1 particles of the input if BlockEnable[1] is 1, and the particles on the second output are the next B2 particles of the input if BlockEnable[2] is 1, and so on.

UMB_FL_DemuxOFDMSym

Symbol



Description: forward link demux OFDM symbol
Library: UMB, Multiplex

Parameters

Name	Description	Default	Type	Range
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0	int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25	int	
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
RsChMuxMode	The mux mode for resource channels: Mode 1, Mode 2	Mode 2	enum	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
NumDRCHSubzones	the number of DRCH subzones	0	int	[0,FFTSize/SubzoneSize-1]
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
StartingSuperframe	the superframe index for the starting superframe	0	int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES	enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO	enum	
PilotPN	9-bit pilot PN for different sectors	0	int	[0,511]
FCPICH_HoppingMode	the hopping mode for F-CPICH: Random, Deterministic	Random	enum	
FCPICH_PilotSpacing	the subcarrier spacing for common pilots	16	int	[1,∞)
FCPICH_PowerDensity	the power density for F-CPICH (defined as power(dBm) per modulation symbol)	-16.0	real	[-∞,∞]
CodeOffset	code offset between 0 and 2 for Forward Dedicated Pilot Channel	0	int	[0,2]

DPICHFormat	the Forward Dedicated Pilot Channel format for Forward Data Channel: Format 0, Format 1, Format 2	Format 0	enum	[0,1]
EnableBRCHSubzoneCycling	whether the cycling for BRCH subzones is enabled: NO, YES	NO	enum	
EnableFLCS	whether the Forward Link Control Segment is enabled: NO, YES	NO	enum	
FLCS_NumBlocks	the number of blocks (tiles) allocated for FLCS, only valid when EnableFLCS is YES	3	int	[3,∞)
FLCS_UseDRCH	whether FLCS is on DRCH or on BRCH, only valid when EnableFLCS is YES: NO, YES	NO	enum	
FLCS_PowerDensity	the power density for FLCS (defined as power(dBm) per modulation symbol), only valid when EnableFLCS is YES	-16.0	real	[-∞,∞]
FDCH_NumPackets	number of data packets transmitted in F-DCH; At most four packets are supported	1	int	[1,4]
FDCH_1_PFIndex	the packet format index for the first data packet transmitted in F-DCH	1	int	[0,14]
FDCH_1_NodeID	the array of NodeID allocated to the first data packet transmitted in F-DCH	{31}	int array	
FDCH_1_MACID	the MAC ID of the first data packet (Access Terminal) transmitted in F-DCH	1	int	[0,511]
FDCH_1_NumHARQTrans	the number of HARQ transmissions for the first data packet transmitted in F-DCH	1	int	[1,25]
FDCH_1_HARQInterlace	the number of frames in HARQ interlace structure for the first data packet transmitted in F-DCH	6	int	[1,24]
FDCH_1_StartingFrame	the starting frame index for the first HARQ transmission from which the first data packet is allocated in F-DCH	0	int	[0,24]
FDCH_1_NumFrames	the number of frames for the first HARQ transmission on which the first data packet is allocated in F-DCH	25	int	[1,25]
FDCH_1_PowerDensity	the power density for the first data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}	real array	[-∞,∞]
FDCH_2_PFIndex	the packet format index for the second data packet transmitted in F-DCH	1	int	[0,14]
FDCH_2_NodeID	the array of NodeID allocated to the second data packet transmitted in F-DCH	{32}	int array	
FDCH_2_MACID	the MAC ID of the second data packet (Access Terminal) transmitted in F-DCH	2	int	[0,511]
FDCH_2_NumHARQTrans	the number of HARQ transmissions for the second data packet transmitted in F-DCH	1	int	[1,25]
FDCH_2_HARQInterlace	the number of frames in HARQ interlace structure for the second data packet transmitted in F-DCH	6	int	[1,24]
FDCH_2_StartingFrame	the starting frame index for the first	0	int	[0,24]

	HARQ transmission from which the second data packet is allocated in F-DCH			
FDCH_2_NumFrames	the number of frames for the first HARQ transmission on which the second data packet is allocated in F-DCH	25	int	[1,25]
FDCH_2_PowerDensity	the power density for the second data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}	real array	[-∞,∞]
FDCH_3_PFIndex	the packet format index for the third data packet transmitted in F-DCH	1	int	[0,14]
FDCH_3_NodeID	the array of NodeID allocated to the third data packet transmitted in F-DCH	{33}	int array	
FDCH_3_MACID	the MAC ID of the third data packet (Access Terminal) transmitted in F-DCH	3	int	[0,511]
FDCH_3_NumHARQTrans	the number of HARQ transmissions for the third data packet transmitted in F-DCH	1	int	[1,25]
FDCH_3_HARQInterlace	the number of frames in HARQ interlace structure for the third data packet transmitted in F-DCH	6	int	[1,24]
FDCH_3_StartingFrame	the starting frame index for the first HARQ transmission from which the third data packet is allocated in F-DCH	0	int	[0,24]
FDCH_3_NumFrames	the number of frames for the first HARQ transmission on which the third data packet is allocated in F-DCH	25	int	[1,25]
FDCH_3_PowerDensity	the power density for the third data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}	real array	[-∞,∞]
FDCH_4_PFIndex	the packet format index for the fourth data packet transmitted in F-DCH	1	int	[0,14]
FDCH_4_NodeID	the array of NodeID allocated to the fourth data packet transmitted in F-DCH	{34}	int array	
FDCH_4_MACID	the MAC ID of the fourth data packet (Access Terminal) transmitted in F-DCH	4	int	[0,511]
FDCH_4_NumHARQTrans	the number of HARQ transmissions for the fourth data packet transmitted in F-DCH	1	int	[1,25]
FDCH_4_HARQInterlace	the number of frames in HARQ interlace structure for the fourth data packet transmitted in F-DCH	6	int	[1,24]
FDCH_4_StartingFrame	the starting frame index for the first HARQ transmission from which the fourth data packet is allocated in F-DCH	0	int	[0,24]
FDCH_4_NumFrames	the number of frames for the first HARQ transmission on which the fourth data packet is allocated in F-DCH	25	int	[1,25]
FDCH_4_PowerDensity	the power density for the fourth data packet transmitted in F-DCH (defined as power(dBm) per modulation	{-16.0}	real array	[-∞,∞]

	symbol)			
DecoderType	Demapping type: Hard, Soft, CSI	CSI	enum	

Pin Inputs

Pin	Name	Description	Signal Type
1	FrameIn	intput frame data	complex
2	ChIn	intput channel estimation data	complex

Pin Outputs

Pin	Name	Description	Signal Type
3	FDCH_1_UnmodulatedData	output unmodulated data for the first data packet	real
4	FDCH_2_UnmodulatedData	output unmodulated data for the second data packet	real
5	FDCH_3_UnmodulatedData	output unmodulated data for the third data packet	real
6	FDCH_4_UnmodulatedData	output unmodulated data for the fourth data packet	real
7	FLCSData	input FL common segment data	complex

Notes/Equations

1. Generally, this model performs reverse operations against UMB_FL_MuxOFDMSym. Each firing,
   - N_{FRAME}*NumFrames*N_{FFT} tokens are consumed at pin FrameIn, where $N_{PHYFrames} = 25$, $N_{FRAME} = 8$.
   - N_{FRAME}*NumFrames*N_{FFT} tokens are consumed at pin ChIn.
   - For the first data packet in F-DCH, when $N_{PACKET\_BITS}–N_{CRC}<=128$, $3*(N_{PACKET\_BITS}–N_{CRC}–8)$ tokens are produced at pin FDCH_1_UnmodulatedData; When $N_{PACKET\_BITS}–N_{CRC}>128$, $\sum_{i=0}^{N_{SUBPACKETS}-1} 5*(N_{SUBPACKET\_BITS}[i] + N_{CRC} + 18)$ tokens are produced at pin FDCH_1_UnmodulatedData, where $N_{CRC}=24$; The input packet size N_{PACKET_BITS} is determined by the parameters FFTSize, GuardSize, RsChMuxMode, SubzoneSize, NumDRCHSubzones, FDCH_1_PFIndex, FDCH_1_NodeID and FDCH_1_NumFrames. For more information, refer to *Forward Link Packet Size Computation* (3gpp2umb); The input packet shall be split into $N_{SUBPACKETS}$ subpackets according to MaxPHYSubPacketSize, where $N_{SUBPACKET\_BITS}[i]$ is the number of information bits in the i^{th} subpacket. For more information on $N_{SUBPACKETS}$, refer to *Packet Splitting* (3gpp2umb).
   - For the second data packet in F-DCH, when FDCH_NumPackets < 2, one useless token is produced at pin FDCH_2_UnmodulatedData; Otherwise, when $N_{PACKET\_BITS}–N_{CRC}<=128$, $3*(N_{PACKET\_BITS}–N_{CRC}–8)$ tokens are produced at pin FDCH_2_UnmodulatedData; When $N_{PACKET\_BITS}–N_{CRC}>128$, $\sum_{i=0}^{N_{SUBPACKETS}-1} 5*(N_{SUBPACKET\_BITS}[i] + N_{CRC} + 18)$ tokens are produced at pin FDCH_2_UnmodulatedData, where $N_{CRC}=24$; The input packet size N_{PACKET_BITS} is determined by the parameters FFTSize, GuardSize, RsChMuxMode, SubzoneSize, NumDRCHSubzones, FDCH_2_PFIndex, FDCH_2_NodeID and FDCH_2_NumFrames.
   - For the third data packet in F-DCH, when FDCH_NumPackets < 3, one useless

token is produced at pin FDCH_3_UnmodulatedData; Otherwise, when $N_{PACKET\_BITS}-N_{CRC}<=128$, $3*(N_{PACKET\_BITS}-N_{CRC}-8)$ tokens are produced at pin FDCH_3_UnmodulatedData; When $N_{PACKET\_BITS}-N_{CRC}>128$,

$$\sum_{i=0}^{N_{SUBPACKETS}-1} 5*(N_{SUBPACKET\_BITS}[i] + N_{CRC} + 18)$$

tokens are produced at pin FDCH_3_UnmodulatedData, where $N_{CRC}=24$; The input packet size N_{PACKET_BITS} is determined by the parameters FFTSize, GuardSize, RsChMuxMode, SubzoneSize, NumDRCHSubzones, FDCH_3_PFIndex, FDCH_3_NodeID and FDCH_3_NumFrames.

- For the fourth data packet in F-DCH, when FDCH_NumPackets < 4, one useless token is produced at pin FDCH_4_UnmodulatedData; Otherwise, when $N_{PACKET\_BITS}-N_{CRC}<=128$, $3*(N_{PACKET\_BITS}-N_{CRC}-8)$ tokens are produced at pin FDCH_4_UnmodulatedData; When $N_{PACKET\_BITS}-N_{CRC}>128$,

  $$\sum_{i=0}^{N_{SUBPACKETS}-1} 5*(N_{SUBPACKET\_BITS}[i] + N_{CRC} + 18)$$

  tokens are produced at pin FDCH_4_UnmodulatedData, where $N_{CRC}=24$; The input packet size N_{PACKET_BITS} is determined by the parameters FFTSize, GuardSize, RsChMuxMode, SubzoneSize, NumDRCHSubzones, FDCH_4_PFIndex, FDCH_4_NodeID and FDCH_4_NumFrames.
- The pin FLCSData is reserved for future enhancement.

2. The Forward Data Channel (F-DCH) consists of one or more data packets which can span one or more Forward Link PHY Frames (At most four data packets are supported). In this model, each data packet is extracted from corresponding subcarriers in corresponding OFDM symbols for each HARQ transmission, described as follows.
   - First, the mapping from the hop-ports to the subcarriers is determined. See UMB_FL_MuxOFDMSym for more information.
   - For each data packet, the modulation symbols are extracted for corresponding subcarriers according to the hop-ports assigned to the packet.
   - The modulation symbols (QPSK, 8-PSK, 16-QAM or 64-QAM) shall be demapped to form the soft-bit sequence according to the modulation orders.
     - For QPSK, the input is multiplied by sqrt(2), and I is the real part of the product and Q is the imaginary part, the decision equations are:
       b0 = I;
       b1 = Q.
     - For 8-PSK, the input is multiplied by sqrt(2), and I is the real part of the product and Q is the imaginary part, and A is the amplitude of the product and PH is the phase, the decision equations are:

PH	**b0**
(PI/2,PI)	A*sin(PH-3.0/4*PI)
(0,PI/2)	-1*A*sin(PH-1.0/4*PI)
(-PI/2,0)	A*sin(PH+1.0/4*PI)
(-PI,-PI/2)	-1*A*sin(PH+3.0/4*PI)

       b1 = I;
       b2 = Q.
     - For 16-QAM, the input is multiplied by sqrt(10), and I is the real part of the product and Q is the imaginary part, the decision equations are:
       b0 = |I| - 2;
       b1 = I;
       b2 = |Q| - 2;
       b3 = Q.

- For 64-QAM, the input is multiplied by sqrt(42), and I is the real part of the product and Q is the imaginary part, the decision equations are:
  b0 = 0 - (2 - ||I| - 4|);
  b1 = 0 - (4 - |I|);
  b2 = I;
  b3 = 0 - (2 - ||Q| - 4.0|);
  b4 = 0 - (4 - |Q|);
  b5 = Q.

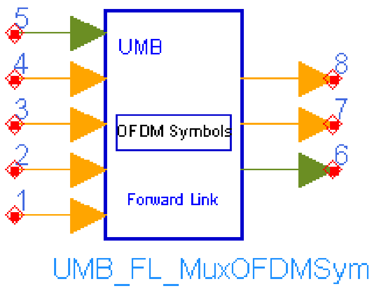
- Three decoding modes are supported to get the final bit sequence. Let b be one of the demapped soft-bits,
  - when DecoderType is set to Hard, if b < 0, -1.0 is output, otherwise 1.0 is output,.
  - when DecoderType is set to Soft, if b < -1.0, -1.0 is output; if b > 1.0, 1.0 is output, otherwise, b is output directly.
  - when DecoderType is set to CSI (channel status information), b is multiplied by normalized SNR (Signal Noise Ratio). The bits from the same modulation symbol have the same SNR. Assuming that the noise across all the subcarriers is the same (normalized to 1), and the signal is normalized to 1. The SNR is supposed to be H^2, where H (i.e. CSI) is the channel response from the pin ChIn. The normalization operation is to ensure that the maximum norm of the CSIs (H^2) over the tile to 1.
- Then the bit sequence shall be de-scrambled. The de-scrambled sequence is the final output data packet.
  - If the bit in the data packet is not transmitted in the received Forward Link PHY Frames, a value '0' is output in the bit sequence;
  - If the bit in the data packet is transmitted more than one time, the averaged value is output in the bit sequence.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_MuxOFDMSym

Symbol



Description: forward link PHY OFDM symbol multiplexer
Library: UMB, Multiplex

Parameters

Name	Description	Default	Type	Range
OutputFrameFormat	output superframe format: Full Superframe, Compact Superframe	Full Superframe	enum	
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0	int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25	int	
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
RsChMuxMode	The mux mode for resource channels: Mode 1, Mode 2	Mode 2	enum	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
NumDRCHSubzones	the number of DRCH subzones	0	int	[0,FFTSize/SubzoneSize-1]
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
StartingSuperframe	the superframe index for the starting superframe	0	int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES	enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO	enum	
PilotPN	9-bit pilot PN for different sectors	0	int	[0,511]
FCPICH_HoppingMode	the hopping mode for F-CPICH: Random, Deterministic	Random	enum	
FCPICH_PilotSpacing	the subcarrier spacing for common pilots	16	int	[1,∞)
FCPICH_PowerDensity	the power density for F-CPICH (defined as power(dBm) per modulation symbol)	-16.0	real	[-∞,∞]

CodeOffset	code offset between 0 and 2 for Forward Dedicated Pilot Channel	0	int	[0,2]
DPICHFormat	the Forward Dedicated Pilot Channel format for Forward Data Channel: Format 0, Format 1, Format 2	Format 0	enum	[0,1]
EnableBRCHSubzoneCycling	whether the cycling for BRCH subzones is enabled: NO, YES	NO	enum	
EnableFLCS	whether the Forward Link Control Segment is enabled: NO, YES	NO	enum	
FLCS_NumBlocks	the number of blocks (tiles) allocated for FLCS, only valid when EnableFLCS is YES	3	int	[3,∞)
FLCS_UseDRCH	whether FLCS is on DRCH or on BRCH, only valid when EnableFLCS is YES: NO, YES	NO	enum	
FLCS_PowerDensity	the power density for FLCS (defined as power(dBm) per modulation symbol), only valid when EnableFLCS is YES	-16.0	real	[-∞,∞]
FDCH_NumPackets	number of data packets transmitted in F-DCH; At most four packets are supported	1	int	[1,4]
FDCH_1_PFIndex	the packet format index for the first data packet transmitted in F-DCH	1	int	[0,14]
FDCH_1_NodeID	the array of NodeID allocated to the first data packet transmitted in F-DCH	{31}	int array	
FDCH_1_MACID	the MAC ID of the first data packet (Access Terminal) transmitted in F-DCH	1	int	[0,511]
FDCH_1_NumHARQTrans	the number of HARQ transmissions for the first data packet transmitted in F-DCH	1	int	[1,25]
FDCH_1_HARQInterlace	the number of frames in HARQ interlace structure for the first data packet transmitted in F-DCH	6	int	[1,24]
FDCH_1_StartingFrame	the starting frame index for the first HARQ transmission from which the first data packet is allocated in F-DCH	0	int	[0,24]
FDCH_1_NumFrames	the number of frames for the first HARQ transmission on which the first data packet is allocated in F-DCH	25	int	[1,25]
FDCH_1_PowerDensity	the power density for the first data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}	real array	[-∞,∞]
FDCH_2_PFIndex	the packet format index for the second data packet transmitted in F-DCH	1	int	[0,14]
FDCH_2_NodeID	the array of NodeID allocated to the second data packet transmitted in F-DCH	{32}	int array	
FDCH_2_MACID	the MAC ID of the second data packet (Access Terminal) transmitted in F-DCH	2	int	[0,511]
FDCH_2_NumHARQTrans	the number of HARQ	1	int	[1,25]

	transmissions for the second data packet transmitted in F-DCH			
FDCH_2_HARQInterlace	the number of frames in HARQ interlace structure for the second data packet transmitted in F-DCH	6	int	[1,24]
FDCH_2_StartingFrame	the starting frame index for the first HARQ transmission from which the second data packet is allocated in F-DCH	0	int	[0,24]
FDCH_2_NumFrames	the number of frames for the first HARQ transmission on which the second data packet is allocated in F-DCH	25	int	[1,25]
FDCH_2_PowerDensity	the power density for the second data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}	real array	[-∞,∞]
FDCH_3_PFIndex	the packet format index for the third data packet transmitted in F-DCH	1	int	[0,14]
FDCH_3_NodeID	the array of NodeID allocated to the third data packet transmitted in F-DCH	{33}	int array	
FDCH_3_MACID	the MAC ID of the third data packet (Access Terminal) transmitted in F-DCH	3	int	[0,511]
FDCH_3_NumHARQTrans	the number of HARQ transmissions for the third data packet transmitted in F-DCH	1	int	[1,25]
FDCH_3_HARQInterlace	the number of frames in HARQ interlace structure for the third data packet transmitted in F-DCH	6	int	[1,24]
FDCH_3_StartingFrame	the starting frame index for the first HARQ transmission from which the third data packet is allocated in F-DCH	0	int	[0,24]
FDCH_3_NumFrames	the number of frames for the first HARQ transmission on which the third data packet is allocated in F-DCH	25	int	[1,25]
FDCH_3_PowerDensity	the power density for the third data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}	real array	[-∞,∞]
FDCH_4_PFIndex	the packet format index for the fourth data packet transmitted in F-DCH	1	int	[0,14]
FDCH_4_NodeID	the array of NodeID allocated to the fourth data packet transmitted in F-DCH	{34}	int array	
FDCH_4_MACID	the MAC ID of the fourth data packet (Access Terminal) transmitted in F-DCH	4	int	[0,511]
FDCH_4_NumHARQTrans	the number of HARQ transmissions for the fourth data packet transmitted in F-DCH	1	int	[1,25]
FDCH_4_HARQInterlace	the number of frames in HARQ interlace structure for the fourth data packet transmitted in F-DCH	6	int	[1,24]
FDCH_4_StartingFrame	the starting frame index for the first HARQ transmission from	0	int	[0,24]

	which the fourth data packet is allocated in F-DCH			
FDCH_4_NumFrames	the number of frames for the first HARQ transmission on which the fourth data packet is allocated in F-DCH	25	int	[1,25]
FDCH_4_PowerDensity	the power density for the fourth data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}	real array	[-∞,∞]

Pin Inputs

Pin	Name	Description	Signal Type
1	FDCH_1_UnmodulatedData	input unmodulated data for the first data packet	int
2	FDCH_2_UnmodulatedData	input unmodulated data for the second data packet	int
3	FDCH_3_UnmodulatedData	input unmodulated data for the third data packet	int
4	FDCH_4_UnmodulatedData	input unmodulated data for the fourth data packet	int
5	FLCSData	input FL common segment data	complex

Pin Outputs

Pin	Name	Description	Signal Type
6	FrameOut	output data	complex
7	HopportInfo	Information for each hop-port	int
8	SubcarrierInfo	Information for each subcarrier	int

Notes/Equations

1. This model performs the following operations on up to four data packets in Forward Link Data Channel (F-DCH).
   - Sequence repetition as defined in 2.7.5 of Ref1;
   - Data scrambling as defined in 2.7.6 of Ref1;
   - QPSK, 8-PSK, 16-QAM and 64-QAM as defined in 2.7.7 of Ref1;
   - Mapping of modulation symbols to corresponding subcarriers as defined in 4.1.3.5.4.2 of Ref1.
2. Meanwhile, this model inserts the Forward Common Pilot Channel (F-CPICH), the Forward Dedicated Pilot Channel (F-DPICH) into Forward Link PHY Frames. And the modulated symbols at pin FLCSData are mapped into Forward Link Control Segment. Each firing,
   - For the first data packet in F-DCH, when $N_{PACKET\_BITS} – N_{CRC}$<=128, $3*(N_{PACKET\_BITS} – N_{CRC} – 8)$ tokens are consumed at pin FDCH_1_UnmodulatedData;

     When $N_{PACKET\_BITS} – N_{CRC}$>128, $\sum_{i=0}^{N_{SUBPACKETS}-1} 5*(N_{SUBPACKETBITS}[i] + N_{CRC} + 18)$ tokens are consumed at pin FDCH_1_UnmodulatedData, where N_{CRC}=24; The input packet size N_{PACKET_BITS} is determined by the parameters FFTSize, GuardSize, RsChMuxMode, SubzoneSize, NumDRCHSubzones, FDCH_1_PFIndex, FDCH_1_NodeID and FDCH_1_NumFrames. For more information, refer to *Forward Link Packet Size Computation* (3gpp2umb); The input packet shall be split into $N_{SUBPACKETS}$ subpackets according to MaxPHYSubPacketSize, where $N_{SUBPACKET\_BITS}[i]$ is the number of information bits in the i^{th} subpacket. For more information on $N_{SUBPACKETS}$, refer to *Packet Splitting* (3gpp2umb).
   - For the second data packet in F-DCH, when FDCH_NumPackets < 2, one useless

token is consumed at pin FDCH_2_UnmodulatedData; Otherwise, when $N_{PACKET\_BITS} - N_{CRC} <= 128$, $3*(N_{PACKET\_BITS} - N_{CRC} - 8)$ tokens are consumed at pin FDCH_2_UnmodulatedData; When $N_{PACKET\_BITS} - N_{CRC} > 128$,

$$\sum_{i=0}^{N_{SUBPACKETS}-1} 5 * (N_{SUBPACKETBITS}[i] + N_{CRC} + 18)$$

tokens are consumed at pin FDCH_2_UnmodulatedData, where $N_{CRC}=24$; The input packet size N_{PACKET_BITS} is determined by the parameters FFTSize, GuardSize, RsChMuxMode, SubzoneSize, NumDRCHSubzones, FDCH_2_PFIndex, FDCH_2_NodeID and FDCH_2_NumFrames.

- For the third data packet in F-DCH, when FDCH_NumPackets < 3, one useless token is consumed at pin FDCH_3_UnmodulatedData; Otherwise, when $N_{PACKET\_BITS} - N_{CRC} <= 128$, $3*(N_{PACKET\_BITS} - N_{CRC} - 8)$ tokens are consumed at pin FDCH_3_UnmodulatedData; When $N_{PACKET\_BITS} - N_{CRC} > 128$,

  $$\sum_{i=0}^{N_{SUBPACKETS}-1} 5 * (N_{SUBPACKETBITS}[i] + N_{CRC} + 18)$$

  tokens are consumed at pin FDCH_3_UnmodulatedData, where $N_{CRC}=24$; The input packet size N_{PACKET_BITS} is determined by the parameters FFTSize, GuardSize, RsChMuxMode, SubzoneSize, NumDRCHSubzones, FDCH_3_PFIndex, FDCH_3_NodeID and FDCH_3_NumFrames.
- For the fourth data packet in F-DCH, when FDCH_NumPackets < 4, one useless token is consumed at pin FDCH_4_UnmodulatedData; Otherwise, when $N_{PACKET\_BITS} - N_{CRC} <= 128$, $3*(N_{PACKET\_BITS} - N_{CRC} - 8)$ tokens are consumed at pin FDCH_4_UnmodulatedData; When $N_{PACKET\_BITS} - N_{CRC} > 128$,

  $$\sum_{i=0}^{N_{SUBPACKETS}-1} 5 * (N_{SUBPACKETBITS}[i] + N_{CRC} + 18)$$

  tokens are consumed at pin FDCH_4_UnmodulatedData, where $N_{CRC}=24$; The input packet size N_{PACKET_BITS} is determined by the parameters FFTSize, GuardSize, RsChMuxMode, SubzoneSize, NumDRCHSubzones, FDCH_4_PFIndex, FDCH_4_NodeID and FDCH_4_NumFrames.
- When EnableFLCS = NO, one useless token is consumed at pin FLCSData; Otherwise, when UseDRCHForFLCS = NO, 36*FLCS_NumBlocks*NumFrames tokens are consumed at pin FLCSData; when UseDRCHForFLCS = YES, 42*FLCS_NumBlocks*NumFrames tokens are consumed at pin FLCSData.
- When OutputFrameFormat = Full Superframe, $N_{FRAME}*N_{PHYFrames}*N_{FFT}$ tokens are produced at pin FrameOut; When OutputFrameFormat = Compact Superframe, N_{FRAME}*NumFrames*N_{FFT} tokens are produced at pin FrameOut, where $N_{PHYFrames} = 25$, $N_{FRAME} = 8$.
- The number of tokens produced at pin SubcarrierInfo is the same as the number at pin FrameOut. SubcarrierInfo specifies the property of each subcarrier. The format of each token at pin SubcarrierInfo is specified as

  MSB ... LSB

Reserved 0 (13bits)	HopPortIndex (12bits)	CommonSegmentIndex (1bit)	DedicPilotIndex (1bit)	CommonPilotIndex (1bit)	DRCHIndex (1bit)	BRCHIndex (1bits)	ReservedIndex (1bit)	GuardIndex (1bit)

  where the value '1' in CommonSegmentIndex, DedicPilotIndex, CommonPilotIndex, DRCHIndex, BRCHIndex, ReservedIndex and GuardIndex means YES; '0' means NO.
- When OutputFrameFormat = Full Superframe, $N_{FRAME}*N_{PHYFrames}*N_{HOPPORT}$ tokens are produced HopportInfo; When OutputFrameFormat = Compact

Superframe, N_{FRAME}*NumFrames*$N_{HOPPORT}$ tokens are produced HopportInfo, where $N_{HOPPORT}$ = (N_{DRCH} + N_{FFT}) in ResourceChannelMuxMode 1 and equal to N_{FFT} in ResourceChannelMuxMode 2, where N_{DRCH} is equal to $N_{SUBZONE, MAX\_FL} \times N_{DRCH-SUBZONES}$. HopportInfo specifies the property of each hop-port.

The format of each token at pin HopportInfo is specified as

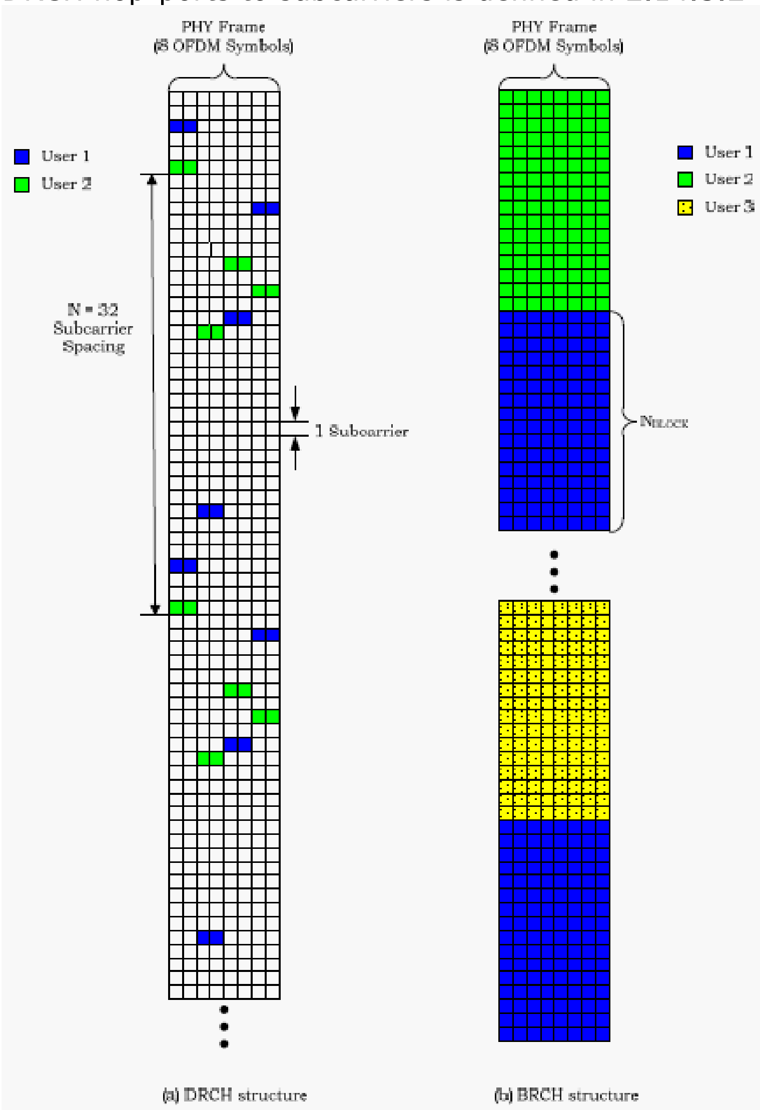
MSB ... LSB

Reserved 0 (5bits)	SubcarrierIndex (11bits)	StructureType (1bit)	q (2bits)	s (5bits)	b (3bits)	r (4bits)	usable (1bit)

where the value '1' in StructureType means DRCH; '0' means BRCH. The value '1' in usable means YES; '0' means NO.

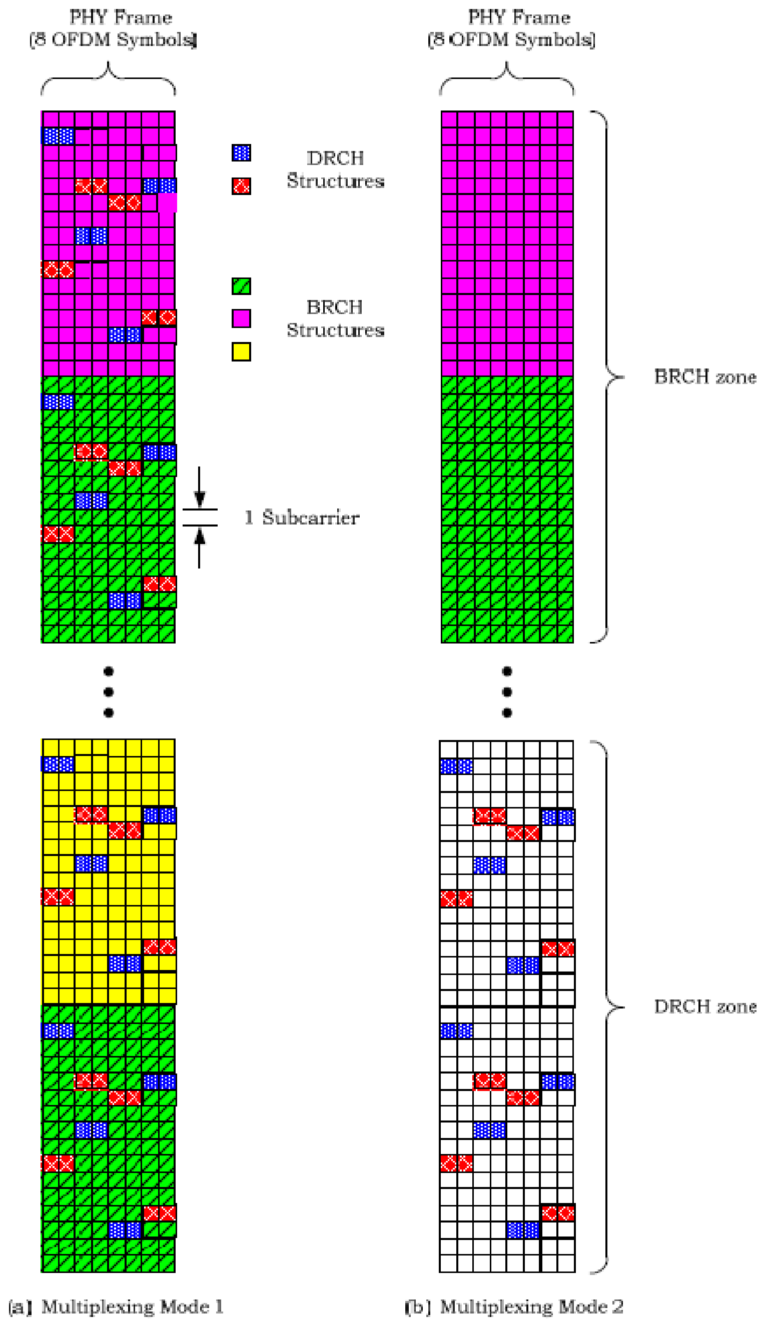
3. Forward Link Data Channel (F-DCH)
    - The Forward Data Channel (F-DCH) consists of one or more data packets which can span one or more Forward Link PHY Frames (At most four data packets are supported in the library). Each data packet is associated with MAC ID (FDCH_i_MACID), a set of Forward Link PHY Frames (FDCH_i_StartingFrame and FDCH_i_NumFrames) on which the packet is transmitted, a set of hop-ports in each PHY Frame (FDCH_i_NodeID), the number of HARQ transmissions (FDCH_i_NumHARQTrans), the HARQ interlace structure (FDCH_i_HARQInterlace), spectral efficiency and modulation order for each HARQ transmission (FDCH_i_PFIndex) and the power density (FDCH_i_PowerDensity).
    - In this model, the input interleaved data packet is repeated if possible, then the data scrambling operation is performed. A seed equal to $f_{PHY-HASH}$(SectorSeed + MACID$\times 2^{20}$) shall be used for the data scrambling operation. At last the scrambled data shall be converted to modulation symbols according to the modulation order for each HARQ transmission as defined in 2.6.7 of Ref1, then these symbols are modulated onto the hop-ports in the assigned OFDM symbols of the assigned PHY Frames for each HARQ transmission according to 4.1.3.5.4.2 of Ref1.
    - When the modulation symbol is mapped to the subcarrier eventually, the mapping of hop-port to subcarrier is needed. In Forward Link, a usable hop-port is mapped to an available subcarrier that is not a guard or a reserved subcarrier. BRCH hop-port mapping is performed first, followed by DRCH hop-port mapping.
        - For BRCH hop-port mapping, a hop-port block of N_{BLOCK} contiguous hop-ports is mapped to a block of contiguous subcarriers of the same size. The mapping function consists of a sector- and subzone-specific permutation function $H^{its}_{SECTOR,BRCH}$. It permutes the hop-port blocks locally within a subzone. $H^{its}_{SECTOR,BRCH}$ changes every frame and repeats every 16 superframes i.e., the permutation in OFDM symbol t in the superframe i is the same as the permutation in OFDM symbol t of superframe (i + 16). Examples of BRCH hop-port to subcarrier mapping for ResourceChannelMuxMode = 1 and ResourceChannelMuxMode = 2 are shown in Figure 2.14.5-1. and Figure 2.14.5-2. of Ref1 respectively. The detail mapping of BRCH hop-ports to subcarriers is defined in 2.14.5.1 of Ref1.
        - The DRCH hop-port mapping is defined by a sector and subzone-specific offset $InnerOffset_{DRCH}$ and pruned bit reversal interleaver. $InnerOffset_{DRCH}$ changes every 2 OFDM symbols and repeats every 16 superframes. It maps a hop-port block of N_{BLOCK} contiguous hop-ports to N_{BLOCK} subcarriers regularly spaced over the entire DRCH available subcarriers. The starting subcarriers of the DRCH blocks within the DRCH zone are chosen in pruned

bit-reversed order. The sector and subzone-specific offset is applied to the starting subcarriers of the DRCH blocks within a subzone to randomize interference from other sectors in that DRCH subzone. The starting subcarrier of the entire DRCH zone changes every 2 OFDM symbols in order to sample the whole set of available subcarriers. The detail mapping of DRCH hop-ports to subcarriers is defined in 2.14.5.2 of Ref1.



Examples of DRCH and BRCH Structures

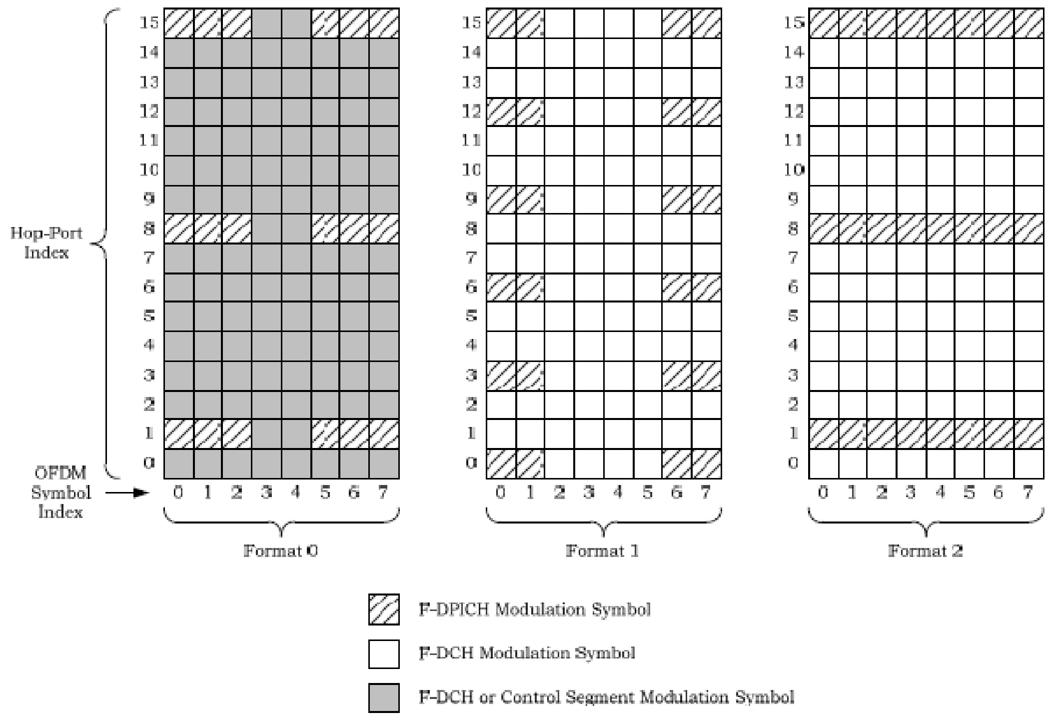
- If ResourceChannelMuxMode = 1, the DRCH available subcarriers are all subcarriers except for the guard subcarriers or the subcarriers mapped by reserved hop-ports. If ResourceChannelMuxMode = 2, the DRCH available subcarriers are subcarriers within a DRCH zone, separated from the BRCH zone. If ResourceChannelMuxMode = 1, a subcarrier mapped by both a BRCH hop-port and a DRCH hop-port shall be mapped to the DRCH hop-port. In this case, the BRCH subcarrier block is punctured by this DRCH subcarrier. Figure 2.14.5-1. and Figure 2.14.5-2. of Ref1 show an example of a DRCH hop-port to subcarrier mapping for ResourceChannelMuxMode = 1 and ResourceChannelMuxMode = 2, respectively.



Example of Multiplexing Resource Structure

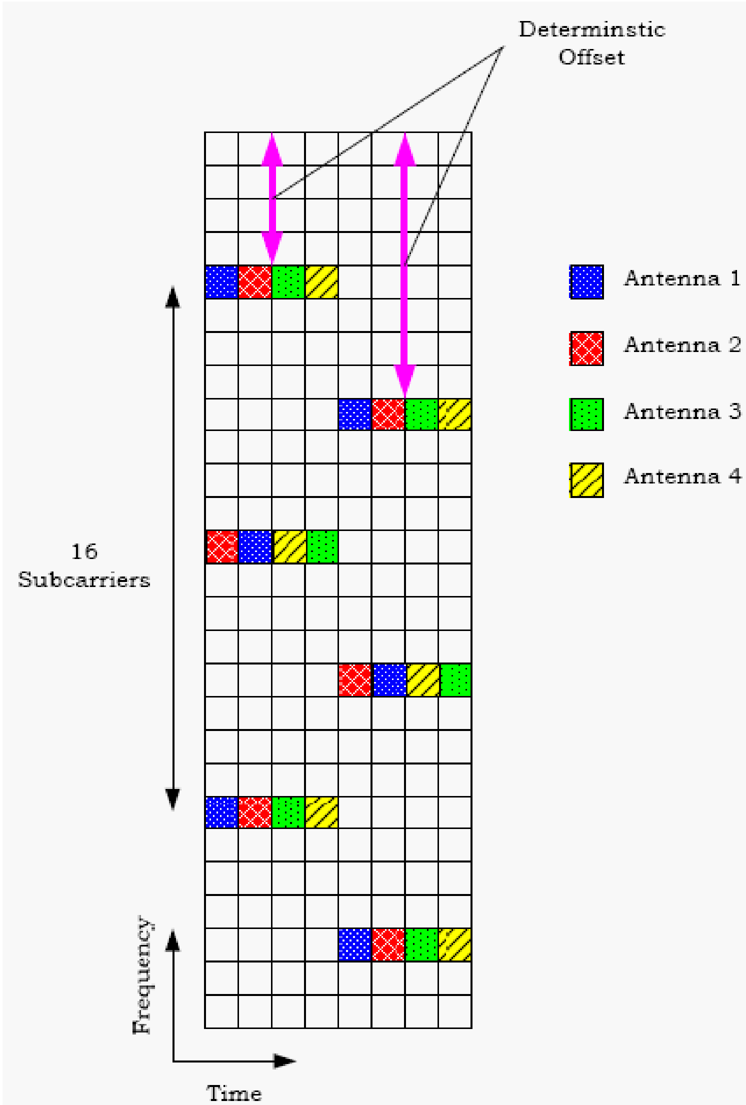
4. A set of $N_{FLCS\text{-}BLOCKS}$ hop-port blocks of size N_{BLOCK} is allocated to the Forward Link Control Segment within each Forward Link PHY Frame. These hop-port blocks shall be located within the DRCH zone if the value of UseDRCHForFLCS field is '1' and shall be located within the BRCH zone otherwise. The detail mapping of Forward Link Control Segment to subcarriers is defined in 2.15 of Ref1.
5. Pilot Channels
   - When RsChMuxMode = Mode 1, the Forward Common Pilot Channel (F-CPICH) is present in every Forward Link PHY Frame and spans the entire usable bandwidth. The Forward Common Pilot Channel is designed to be used as a channel estimation pilot in this case. The Forward Dedicated Pilot Channel (F-DPICH) is absent in this case.
   - When RsChMuxMode = Mode 2, the Forward Common Pilot Channel (F-CPICH) is transmitted in every Forward Link PHY Frame over the DRCH subzones. The Forward Dedicated Pilot Channel (F-DPICH) is transmitted in every Forward Link

PHY Frame over the BRCH subzones. The Forward Common Pilot Channel (F-CPICH) and the Forward Dedicated Pilot Channel (F-DPICH) are designed to be used for channel estimation in DRCH and BRCH zones respectively.
- The Forward Common Pilot Channel (F-CPICH) shall be transmitted from disjoint sets of subcarriers from each of NumEffectiveAntennas effective antennas, where NumEffectiveAntennas is fixed to be 1 in ADS UMB library. FCPICH_HoppingMode determines the CommonPilotFreqInterlace taking values from 0 to 15 for all the PHY frames. The subcarrier spacing between two consecutive pilots is defined by FCPICH_PilotSpacing. All the common pilots across the whole band have the same power density determined by the parameter FCPICH_PowerDensity.



An Example of Forward Common Pilot Channel Placement for the Case where CPICHHoppingMode = Deterministic and NumCommonPilotTransmitAntennas = 4

- The Forward Dedicated Pilot Channel (F-DPICH) shall be present in BRCH subzones only when RsChMuxMode = Mode 2. The number of tile-antennas nt is always equal to 1 in ADS UMB library. Three different Forward Dedicated Pilot Channel formats are available for Forward Data Channel (F-DCH) which is defined in the parameter DPICHFormat. For Forward Data Channel (F-DCH), the power density used to transmit the Forward Dedicated Pilot Channel in a given tile is equal to the power density used to transmit the Forward Data Channel in that tile. CodeOffset may take a value between 0 and 3 for Forward Data Channel (F-DCH). For the tiles assigned to the Forward Link Control Segment, the Forward Dedicated Pilot Channel format 0 is employed, and the same power density for the data modulation symbols (subcarriers) defined in the parameter FLCS_PowerDensity is employed in the pilot subcarriers. CodeOffset takes the value 0 for tiles belonging to the Forward Link Control Segment.



Forward Dedicated Pilot Channel Subcarriers for the Different Forward Dedicated Pilot Channel Formats

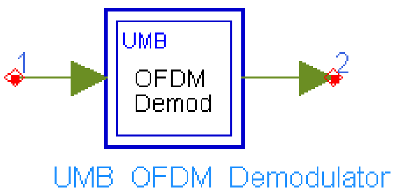
- The Forward Channel Quality Indicator Pilot Channel (F-CQIPICH) is not supported in ADS UMB library.
- **Note that** for F-DPICH defined in 4.1.3.3.2.4.2, the seed of Scrambling Sequence is modified as follow according to the latest specification: seed = $f_{PHY-HASH}[3x2^{20}x128 + SectorSeedx128 + Tile mod 128]$.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_OFDM_Demodulator

Symbol



Description: OFDM demodulator
Library: UMB, Multiplex

Parameters

Name	Description	Default	Type	Range
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
OversamplingOption	Oversampling ratio option: Ratio 1, Ratio 2, Ratio 4, Ratio 8, Ratio 16, Ratio 32	Ratio 2	enum	

Pin Inputs

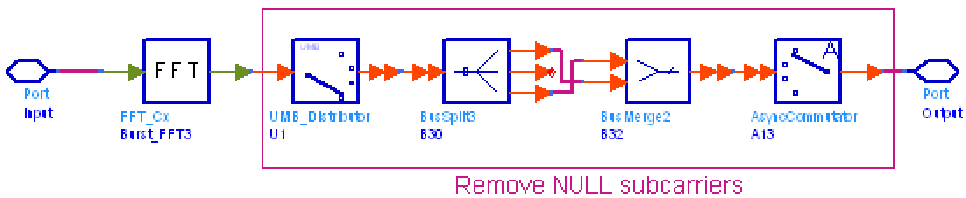
Pin	Name	Description	Signal Type
1	In	input complex data	complex

Pin Outputs

Pin	Name	Description	Signal Type
2	Out	output complex data	complex

Notes/Equations

1. This subnetwork is to implement OFDM demodulator. The schematic for this subnetwork is shown in the following figure.



UMB_OFDM_Demodulator Schematic

2. The input data are the OFDM time-domain signals without the cyclic prefix (CP) and Windowing guard interval (WGI) padded; The output data are the modulation symbols in frequency subcarriers indexed from 0 to N_{FFT}-1. The following operations are performed in this subnetwork:
   - FFT operation;
   - Removal of null subcarriers if oversampling is employed (i.e. the parameter OversamplingOption > 0);
   - Frequency subcarriers re-organization.

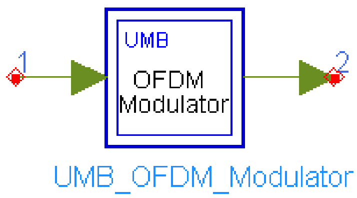
References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air

Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_OFDM_Modulator

Symbol



Description: OFDM modulator
Library: UMB, Multiplex

Parameters

Name	Description	Default	Type	Range
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
OversamplingOption	Oversampling ratio option: Ratio 1, Ratio 2, Ratio 4, Ratio 8, Ratio 16, Ratio 32	Ratio 2	enum	
Ncp	the index for Cyclic Prefix (Tcp=Ncp*FFTSize*Tchip/16): Ncp 1, Ncp 2, Ncp 3, Ncp 4	Ncp 1	enum	
GuardSize	the size of guard subcarriers	32	int	

Pin Inputs

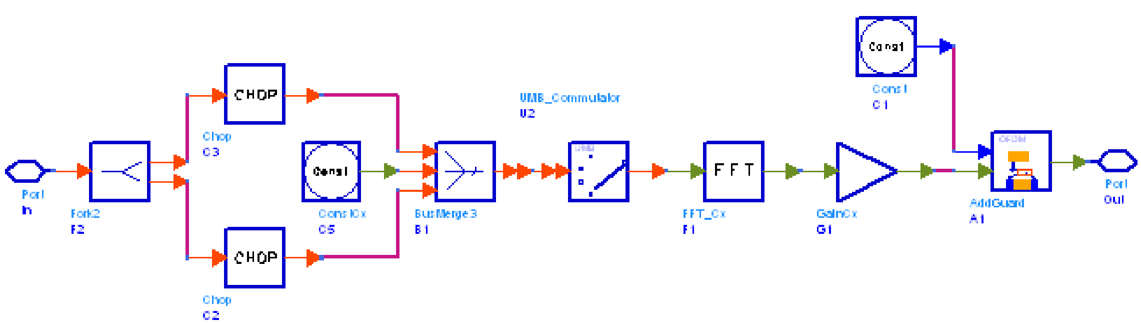
Pin	Name	Description	Signal Type
1	In	input complex data	complex

Pin Outputs

Pin	Name	Description	Signal Type
2	Out	output complex data	complex

Notes/Equations

1. This subnetwork is to implement OFDM modulator. The schematic for this subnetwork is shown in the following figure.



UMB_OFDM_Modulator Schematic

2. The input data are the modulation symbols in frequency subcarriers indexed from 0 to N_{FFT}-1; The output data are the OFDM waveform in time domain with the cyclic prefix (CP) and Windowing guard interval (WGI) padded. The following operations are performed in this subnetwork:
   - Frequency subcarriers re-organization;

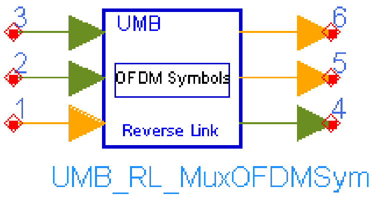
- IFFT operation;
- Gain adjustment;
- Cyclic prefix (CP) and Windowing guard interval (WGI) padding.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_RL_MuxOFDMSym

Symbol



Description: reverse linkPHYOFDM symbol multiplexer
Library: UMB,Multiplex

Parameters

Name	Description	Default	Type	Range
OutputFrameFormat	output superframe format: Full Superframe, Compact Superframe	Full Superframe	enum	
StartingFrame	the startingframe indexin eachsuperframe fromwhich this model will allocate the data	0	int	
NumFrames	the number of frameson which this modelwill allocate the data startingfrom the StartingFrame	25	int	
FFTSize	the sizeof total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the sizeof guard subcarriers	32	int	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size64, Size 128	Size64	enum	
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
StartingSuperframe	the superframe indexforthestarting superframe	0	int	[0,∞)
SuperframeIdxIncreased	whether the superframe indexis increased from superframe tosuperframe: NO, YES	YES	enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO	enum	
PilotPN	9-bit pilot PN for differentsectors	0	int	[0,511]
EnableHalfDuplexOperation	whether the halfduplex operation isenabled: NO, YES	NO	enum	
EnableRODCCH	whether the allocation of R-ODCCH is enabled: NO, YES	YES	enum	
NumRODCIndices	the number of Indices for R-ODCCH (the number of tiles for R-ODCCH is max(2,NumRODCIndices/2)	4	int	[0,∞]
RODCResourceIndex	the resource index for each R-ODCCH	{0}	int array	[0,2]
RODCCH_PowerDensity	the power density for R-ODCCH (defined as power(dBm) per modulation symbol)	-16.0	real	[-∞,∞]
EnableCDMASubsegments	whether the allocation of CDMA	NO	enum	

	subsegments is enabled: NO, YES			
NumCDMASubsegments	number of allocated CDMAsubsegmentsallocated, onlyvalid when EnableCDMASubsegments isYES	1	int	[1,∞)
RODCH_PFIndex	the packet format index for R-ODCH	1	int	[0,14]
RODCH_NodeID	the array ofNodeID allocated toR-ODCH	{31}	int array	
RODCH_MACID	the MAC ID of the Access Terminal as associated with the RLSS	1	int	[0,511]
RODCH_NumHARQTrans	the number of HARQ transmissions for the R-ODCH	1	int	[1,25]
RODCH_HARQInterlace	the number of PHY frames in HARQ interlace structure for the R-ODCH	6	int	[1,24]
RODCH_StartingFrame	the startingframe indexfrom which R-ODCH is allocated	0	int	[0,24]
RODCH_NumFrames	the number of frameson which R-ODCHis allocated	3	int	[1,25]
RODCH_PowerDensity	the power density for R-ODCH (defined as power(dBm) per modulation symbol)	{-16.0}	real array	[-∞,∞]
CodeOffset	codeoffset between 0 and 2 for Reverse Dedicated Pilot Channel	0	int	[0,2]
DPICHFormat	the Reverse Dedicated Pilot Channel format for OFDMAData Channels: Format 0, Format1	Format 0	enum	[0,1]
FL_SubzoneSize	the number of hop-ports in a FL subzone for determining hopping structures in RL PHY Frames: FL Size 64, FL Size 128	FL Size 64	enum	
NumDRCHSubzones	the number of DRCH subzones in FL for determining hopping structures in RL PHY Frames	4	int	[0,FFTSize/SubzoneSize-1]

Pin Inputs

Pin	Name	Description	Signal Type
1	RODCH_UnmodulatedData	input modulated dataforR-ODCH	int
2	RODCCH_ModulatedData	input modulated dataforR-ODCCH	complex
3	RCDMA_ModulatedData	input modulated dataforCDMA subsegments	complex

Pin Outputs

Pin	Name	Description	Signal Type
4	FrameOut	output data	complex
5	HopportInfo	Information for each hop-port	int
6	SubcarrierInfo	Information for each subcarrier	int

Notes/Equations

1. This model performs the following operations on the data packet in Reverse Link OFDMA Data Channel (R-ODCH).
   - Sequence repetition as defined in 2.7.5 of Ref1;
   - Data scrambling as defined in 2.7.6 of Ref1;
   - QPSK, 8-PSK, 16-QAM and 64-QAM as defined in 2.7.7 of Ref1;

- Mapping of modulation symbols to corresponding subcarriers as defined in 4.1.3.5.4.2 of Ref1.

2. Meanwhile, this model also inserts Reverse Dedicated Pilot Channel (R-DPICH) into Reverse Link PHY Frames; The modulated symbols at pin RODCCH_ModulatedData are mapped into Reverse OFDMA Dedicated Control Channel (R-ODCCH); The modulated symbols at pin RCDMA_ModulatedData are mapped into Reverse CDMA Subsegments.
   Each firing,
   - For the data packet in R-ODCH, when N_{PACKET_BITS}–N_{CRC}<=128, 3*(N_{PACKET_BITS}–N_{CRC}–8) tokens are consumed at pin RODCH_UnmodulatedData;
     When N_{PACKET_BITS}–N_{CRC}>128, $\sum_{i=0}^{N_{SUBPACKETS}-1} 5*(N_{SUBPACKETBITS}[i] + N_{CRC} + 18)$ tokens are consumed at pin RODCH_UnmodulatedData, where N_{CRC}=24; The input packet size N_{PACKET_BITS} is determined by the parameters FFTSize, GuardSize, SubzoneSize, EnableCDMASubsegments, NumCDMASubsegments, RODCH_PFIndex, RODCH_NodeID and RODCH_NumFrames. For more information, refer to *Reverse Link Packet Size Computation* (3gpp2umb); The input packet shall be split into $N_{SUBPACKETS}$ subpackets according to MaxPHYSubPacketSize. For more information on $N_{SUBPACKETS}$, refer to *Packet Splitting* (3gpp2umb).
   - When EnableRODCCH = YES, 48*NumRODCResourceIndex*NumFrames tokens are consumed at pin RODCCH_ModulatedData, where NumRODCResourceIndex = size(RODCResourceIndex). Otherwise one useless token is consumed at pin RODCCH_ModulatedData
   - When EnableCDMASubsegments = YES, N_{FRAME}*$N_{CDMA\text{-}SUBSEGMENT}$ *NumCDMASubsegments*NumFrames tokens are consumed at pin RCDMA_ModulatedData, where N_{FRAME} = 8; $N_{CDMA\text{-}SUBSEGMENT}$ = 128. Otherwise one useless token is consumed at pin RCDMA_ModulatedData.
   - When OutputFrameFormat = Full Superframe, N_{FRAME}*($N_{PHYFrames}$+1)*N_{FFT} tokens are produced at pin FrameOut; When OutputFrameFormat = Compact Superframe, N_{FRAME}*(NumFrames+1)*N_{FFT} tokens are produced at pin FrameOut if StartingFrame=0, Otherwise N_{FRAME}*NumFrames*N_{FFT} tokens are produced at pin FrameOut, where $N_{PHYFrames}$ = 25.
   - The number of tokens produced at pin SubcarrierInfo is the same as the number at pin FrameOut. SubcarrierInfo specifies the property of each subcarrier.
     The format of each token at pin SubcarrierInfo is specified as

MSB ... LSB

Reserved 0 (3bits)	HopPortIndex (11bits)	NewlyFreedSubcarrier (11bits)	DisplacedIndex (1bit)	NomCDMAHopZone (1bit)	DCCHIndex (1bit)	CDMASubsegm (1bits)	DedicPilot (1bit)	ReservedIndex (1bit)	GuardIndex (1bit)

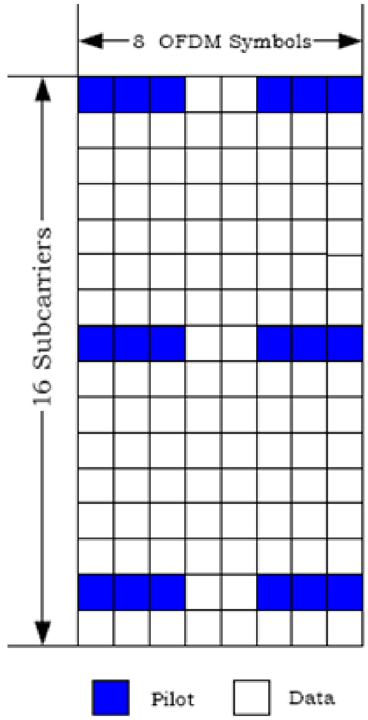
     where value '1' in DisplacedIndex, NomCDMAHopzoneIndex, DCCHIndex, CDMASubsegm, DedicPilot, ReservedIndex and GuardIndex means YES; '0' means NO.
   - The number of tokens produced at pin HopportInfo is the same as the number at pin FrameOut. HopportInfo specifies the property of each hop-port.
     The format of each token at pin HopportInfo is specified as

MSB ... LSB

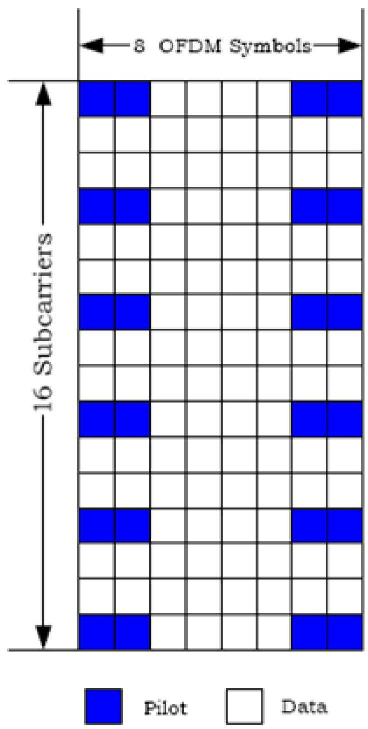
Reserved 0 (5bits)	SubcarrierIndex (11bits)	Reserved 0 (1bit)	q (2bits)	s (5bits)	b (3bits)	r (4bits)	usable (1bit)

     where value '1' in usable means YES; value '0' means NO.

3. Reverse Link OFDMA Data Channel (R-ODCH)
    - The Reverse Link OFDMA Data Channel (R-ODCH) consists of one data packet which can span one or more Reverse Link PHY Frames (Only one data packet is supported in ADS UMB library). The data packet is associated with MAC ID (RODCH_MACID), a set of Reverse Link PHY Frames (RODCH_StartingFrame and RODCH_NumFrames) on which the packet is transmitted, a set of hop-ports in each PHY Frame (RODCH_NodeID), the number of HARQ transmissions (RODCH_NumHARQTrans), the HARQ interlace structure (RODCH_HARQInterlace), spectral efficiency and modulation order for each HARQ transmission (RODCH_PFIndex) and the power density (RODCH_PowerDensity).
    - In this model, the interleaved data packet will be repeated if possible, then the data scrambling operation is performed. A seed equal to $f_{PHY\text{-}HASH}$ (7x2048xSectorSeed + MACID mod 2048) shall be used for the data scrambling operation. At last the scrambled data shall be converted to modulation symbols according to the modulation order for each HARQ transmission as defined in 2.6.7 of Ref1 (see *Reverse Link Packet Format* (3gpp2umb)), then these symbols are modulated on to the hop-ports in the assigned OFDM symbols of the assigned PHY Frames for each HARQ transmission according to 3.1.3.4.4.2 of Ref1.
    - When the modulation symbol is mapped to the subcarrier eventually, the mapping of hop-port to subcarrier is needed. In Reverse Link, a usable hop-port is mapped to an available subcarrier that is not a guard, CDMA or a reserved subcarrier. Reverse Link hop pattern generation is a two-step process:
      Step 1. Mapping hop-ports to subcarriers assuming nominal locations of CDMA subsegments.
      Setp 2. Relocating subcarriers that are displaced when their nominal locations to actual locations.
      The mapping of CDMA Subsegments is described in 2.10.3 of Ref1.
      The Reverse OFDMA Data Channel supports Global Hopping (GH) and Local Hopping (LH) structures. A given Reverse Link PHY Frame uses either the GH structure or the LH structure. The primary difference between GH and LH structures is that in the LH structure, a hop-port is constrained to hop within a "subzone", while in the GH structure, a hop-port may hop over the entire bandwidth. The determination of Hopping structures is related to the parameters FL_SubzoneSize and NumDRCHSubzones. Refer to 2.10.4.3 of Ref1 for more information.
4. Reverse Dedicated Pilot Channel (R-DPICH)
    - On the Reverse Link, a group of N_{BLOCK} hop-ports gets mapped to a contiguous group of N_{BLOCK} subcarriers. This mapping remains fixed for the duration of a Reverse Link PHY Frame. The group of hop-ports shall be referred to as a "hop-port block" and the group of NBLOCK subcarriers shall be referred to as a "subcarrier block." The group of N_{BLOCK} = 16 hop-ports for the duration of N_{FRAME} = 8 OFDM symbols is also referred to as a "tile."
    - The Reverse Dedicated Pilot Channel shall be present only in tiles assigned to the OFDMA segment on which the Reverse OFDMA Data Channel or the Reverse OFDMA Dedicated Control Channel could be assigned. R-DPICH provides dedicated pilots for the Reverse OFDMA Dedicated Control Channel and Reverse OFDMA Data Channel in order to allow an Access Point to perform channel estimation. Two Reverse Dedicated Pilot Channel formats are supported:



Reverse Dedicated Pilot Channel format 0



Reverse Dedicated Pilot Channel format 1

- The detail information for R-DPICH is described in 3.1.3.4.1 of Ref1.

5. Note that The Reverse Acknowledgment Channel is not supported in ADS UMB library.
6. Reverse OFDMA Dedicated Control Channel (R-ODCCH)
   The Reverse OFDMA Dedicated Control Channel exsits if EnableRODCCH = YES.
   The Reverse OFDMA Dedicated Control Channel (R-ODCCH) payload multiplexes several logical channels, namely the r-cqich, the r-reqch, the r-mqich, the r-sfch and

the r-bfch. In this model, the data for R-ODCCH are input from pin RODCCH_ModulatedData.
Each Reverse OFDMA Dedicated Control Channel packet shall be modulated on the two quarter-tiles which are determined as a function of RODCResourceIndex. The size of the array parameter RODCResourceIndex defines the number of Reverse OFDMA Dedicated Control Channel packets allocated. The first 48 data are mapped to the two quarter-tiles allocated to the first packet in the first PHY Frame (i.e Frame#StartingFrame). When all the packets in the first PHY Frame are mapped, the two quarter-tiles allocated to the first packet in the second PHY Frame will be mapped, and so on.

7. Reverse CDMA Subsegments
The CDMA Subsegments exsit if EnableCDMASubsegments = YES.
The input modulated time-domain sequence at pin RCDMA_ModulatedData is mapped to the *NumFrames* PHY Frames. Each PHY Frame has *NumCDMASubsegments* CDMA Subsegments; Each CDMA Subsegment has N_{FRAME} = 8 different subsequences of length $N_{CDMA\text{-}SUBSEGMENT}$ = 128. The first $N_{FRAME} x N_{CDMA\text{-}SUBSEGMENT}$ data are mapped to the first CDMA Subsegment in the first PHY Frame (i.e Frame#StartingFrame). When all the CDMA Subsegments in the first PHY Frame are mapped, the first CDMA Subsegment in the second PHY Frame will be mapped, and so on.
8. **Note that** for R-DPICH defined in 3.1.3.4.1.1.2.2, the seed of Scrambling Sequence is modified as follow according to the latest specification: seed = $f_{PHY\text{-}HASH}$ [4×2^20×128 + SectorSeed×128 + Tile mod 128].

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

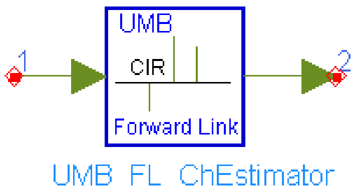
UMB Receiver Components

The UMB receiver models provide channel estimator, frame synchronization and frequency synchronization, top level baseband receivers and top level RF receivers.

- *UMB FL ChEstimator* (3gpp2umb)
- *UMB FL DemuxFrame* (3gpp2umb)
- *UMB FL FrameSync* (3gpp2umb)
- *UMB FL FreqSync* (3gpp2umb)
- *UMB FL Receiver* (3gpp2umb)
- *UMB FL Receiver RF* (3gpp2umb)

UMB_FL_ChEstimator

Symbol



Description: Forward link channel estimator
Library: UMB, Receiver

Parameters

Name	Description	Default	Unit	Type	Range
SuperframesDelay	the number of delay superframes introduced by the receiver	0		int	
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0		int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25		int	
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512		enum	[0,4]
Ncp	the index for Cyclic Prefix (Tcp=Ncp*FFTSize*Tchip/16): Ncp 1, Ncp 2, Ncp 3, Ncp 4	Ncp 1		enum	
GuardSize	the size of guard subcarriers	32		int	
RsChMuxMode	The mux mode for resource channels: Mode 1, Mode 2	Mode 2		enum	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64		enum	
NumDRCHSubzones	the number of DRCH subzones	0		int	[0,FFTSize/SubzoneSize-1]
StartingSuperframe	the superframe index for the starting superframe	0		int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES		enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO		enum	
PilotPN	9-bit pilot PN for different sectors	0		int	[0,511]
FCPICH_HoppingMode	the hopping mode for F-CPICH: Random, Deterministic	Random		enum	
FCPICH_PilotSpacing	the subcarrier spacing for common pilots	16		int	[1,∞)
CodeOffset	code offset between 0 and 2 for Forward Dedicated Pilot Channel	0		int	[0,2]
DPICHFormat	the Forward Dedicated Pilot Channel format for Forward Data Channel: Format 0, Format 1, Format 2	Format 0		enum	[0,1]
EnableBRCHSubzoneCycling	whether the cycling for BRCH subzones is enabled: NO, YES	NO		enum	
SNR	SNR in dB	15		real	(-∞,∞)
Tmax	The maximum delay of multi-path channel	1e-6		real	[0,∞)
Fmax	The maximum doppler frequency	100 Hz	Hz	real	[0,∞)

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	output signals from FFT	complex

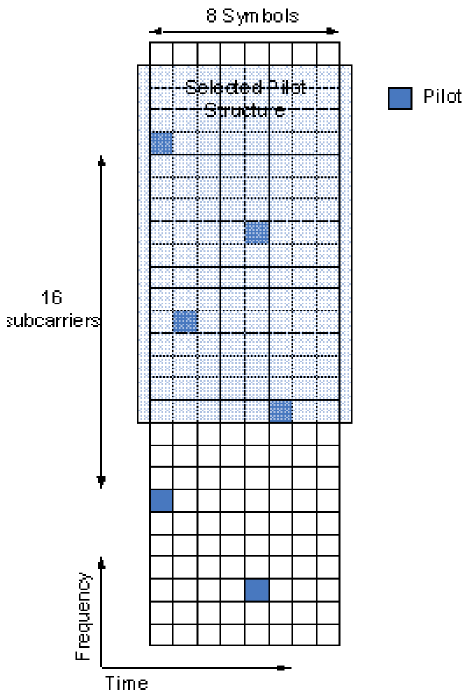
Pin Outputs

Pin	Name	Description	Signal Type
2	Coef	channel coefficient	complex

Notes/Equations

1. This model is used to estimate Forward Link channel responses with the pilot symbols assisted.
2. Each firing,
   - NumFrames* N_{FRAME} * N_{FFT} tokens are consumed at pin data Input, where N_{FRAME} = 8.
   - NumFrames* N_{FRAME} * N_{FFT} tokens are produced at pin data Coef.
3. When RsChMuxMode = Mode 1, the Forward Common Pilot Channel (F-CPICH) is present in every Forward Link PHY Frame and spans the entire usable bandwidth. The Forward Common Pilot Channel is designed to be used as a channel estimation pilot in this case. The Forward Dedicated Pilot Channel (F-DPICH) is absent in this case. When RsChMuxMode = Mode 2, the Forward Common Pilot Channel (F-CPICH) is transmitted in every Forward Link PHY Frame over the DRCH subzones. The Forward Dedicated Pilot Channel (F-DPICH) is transmitted in every Forward Link PHY Frame over the BRCH subzones. The Forward Common Pilot Channel (F-CPICH) and the Forward Dedicated Pilot Channel (F-DPICH) are designed to be used for channel estimation in DRCH and BRCH zones respectively.
4. The channle estimation follows the following steps:
   - Estimation of pilots
     The least-squares (LS) method is employed to estimate the channel response at the pilot location, obtained as:
     $$H_i = \frac{Y_i}{X_i}$$
     where Y_i is the received Pilot symbol and X_i is the transmitted Pilot symbol on the i^{th} subcarrier.
   - A interpolation algorithm is employed to estimate the channel responses at data subcarriers.
     - When the Forward Dedicated Pilot Channel (F-DPICH) exsits, the pilots are assinged tile by tile. Three pilot formats are defined as shown in the following figure.

       The interpolation is performed tile by tile by employing the well-known two-dimensional MMSE estimator (Ref3), described as:
       - First, the Wiener filter coefficients (W) are calculated based on maximum Doppler frequency (Fmax), maximum echo delay (Tmax) and SNR.
       - The channel responses in all the subcarriers are the product of Wiener filter and the channel responses in the pilot subcarriers.
     - When the Forward Common Pilot Channel (F-CPICH) exsits, the pilots are scattered over DRCH zones or the entire usable bandwidth. The interpolation method depends on the input parameter Tmax.
       - When Tmax > 1e-8 sec
         To simplify implementation structure, the interpolation operation is performed independently on every pilot pattern structure(16 subcarriers by 8 symbols as illustrated in the following figure) of the F-CPICH. The same two-dimensional MMSE interpolation (Ref3) is employed.



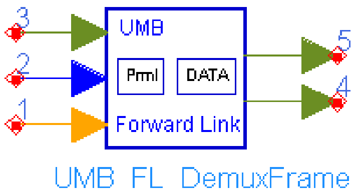
- When Tmax <= 1e-8 sec
  For each OFDM symbols containing F-CPICH, the entire usable bandwidth when RsChMuxMode = Mode 1 (or the DRCH frequnecy sequence when RsChMuxMode = Mode 2) shall be converted into time domain by IFFT operation. Then all the taps in time domain sequence except the first set of taps with the maximum energy are set to zero. These time domain sequences in the same PHY Frame shall be filtered by a equal-tap filter. At last it shall be converted back into frequency domain by FFT operation.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
3. P. Hoeher, S. Kaiser, and P. Robertson. "Two-Dimensional Pilot-Symbol-Aided Channel Estimation by Wiener Filtering". Proc. IEEE ICASSP '97, Munich, Germany, pp. 1845-1848, Apr. 1997.

UMB_FL_DemuxFrame

Symbol



Description: Forward link frame demultiplexer
Library: UMB, Receiver

Parameters

Name	Description	Default	Type	Range
OutputFrameFormat	output superframe format: Full Superframe, Compact Superframe	Full Superframe	enum	
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0	int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25	int	
OversamplingOption	Oversampling ratio option: Ratio 1, Ratio 2, Ratio 4, Ratio 8, Ratio 16, Ratio 32	Ratio 2	enum	
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
Ncp	the index for Cyclic Prefix (Tcp=Ncp*FFTSize*Tchip/16): Ncp 1, Ncp 2, Ncp 3, Ncp 4	Ncp 1	enum	
EnableHalfDuplexOperation	whether the half duplex operation is enabled: NO, YES	NO	enum	

Pin Inputs

Pin	Name	Description	Signal Type
1	index	synchronization index	int
2	freq	carrier frequency offset	real
3	input	input of forward frame	complex

Pin Outputs

Pin	Name	Description	Signal Type
4	preamble	output preamble for channel estimation	complex
5	data	output data sequence	complex

Notes/Equations

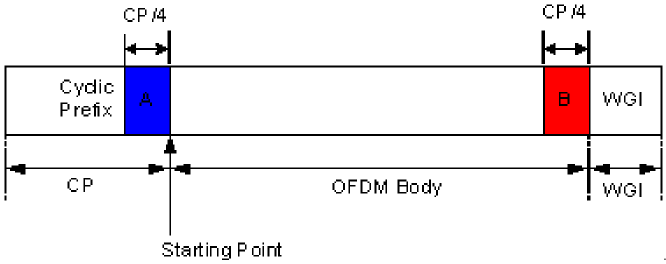
1. This model is used to demultiplex Forward Link superframe into Superframe Preamble and PHY Frames. In each OFDM symbol of Superframe Preamble and PHY Frames, the Cyclic Prefix and Windowing Guard Interval are removed, and timing (including coarse and fine) and carrier frequency offsets are compensated before demultiplexing.
2. Each firing,
   - 1 token is consumed at pin index which indicates the coarse starting index for TDM Pilot 1 (F-ACQCH) of Preamble.

- 2 tokens are consumed at pin DeltaF. The first indicates the value of carrier frequency offset and the second indicates the phase difference between adjacent subcarriers caused by coarse timing synchronization.
- When OutputFrameFormat = Full Superframe, one full superframe($(N_{PHYFrames}+1)*N_{FRAME}*N_{SAMPLE}+$ EnableHalfDuplexOperation$*N_{PHYFrames}*N_{TG}*2^{OversamplingRatio}$) tokens are consumed at pin input, where $N_{PHYFrames}$ = 25 is the number of PHY Frames in one superframe, N_{FRAME} = 8 is the number of OFDM symbols in one PHY Frame, N_{SAMPLE} is the number of samples in one OFDM symbol: $N_{SAMPLE} = N_{FFT}*(1+(Ncp+1)/16+1/32)*2^{OversamplingRatio}$, where Ncp is the value from the parameter Ncp, 1/32 is the ratio of Windowing Guard Interval, $N_{TG} = N_{FFT}*3/4$.
  When OutputFrameFormat = Compact Superframe, one compact superframe($(NumFrames+1)*N_{FRAME}*N_{SAMPLE}+$ EnableHalfDuplexOperation$*NumFrames*N_{TG}*2^{OversamplingRatio}$) tokens are consumed at pin input.
- $N_{FRAME}*N_{FFTSamples}$ tokens are produced at pin preamble, where $N_{FFTSamples}$ is the number of useful samples in one OFDM symbol: $N_{FFTSamples}= N_{FFT}*2^{OversamplingRatio}$.
- $N_{PHYFrames}*N_{FRAME}*N_{FFTSamples}$ tokens are produced at pin data.

3. The following steps are perfomed in this model.
   - Read two superframes data from pin data and only consume one superframe data. Because of transmission delay, a detected superframe usually falls into 2 consecutive received blocks, so the buffer length for pin input is two superframes, and only one superframe data is consumed. Note that only after receiving the second input block, this model can output one actual superframe. So one superframe delay is caused in this model.
   - Identify the final timing index for the starting point of the superframe, and pick up the complete superframe sequence.
     The final timing index for the starting point of the superframe is as follows: $Final_{INDEX} = max(0, Coarse_{INDEX} + round(PhaseOffset*N_{FFT}*2^{OversamplingRatio}/(2*PI)))$, where PhaseOffset is the second value from pin DeltaF, $Coarse_{INDEX}$ is the coarse index for the starting point of the superframe: $Coarse_{INDEX} = Index_{TDMPilot1} - 5*N_{SAMPLE}$.
   - Apply carrier frequency offset compensation on the complete superframe sequence.
     $$y_k = x_k \times e^{-j2\pi\Delta f_i k T_{Step}}$$
     where x_k is the sequence before frequency offset compensation, y_k is the sequence after frequency offset compensation. Δf_i is frequency offset of the i^{th} received superframe at pin DeltaF. T_{Step} is the sample time interval;
     $$T_{Step} = \frac{1}{SubcarrierSpacing * N_{FFT} * 2^{OversamplingOption}}$$
     where SubcarrierSpacing is 9.6KHz in UMB system.
   - Pick up Preamble and PHY Frames respectively from the complete superframe sequence.
     The first N_{FRAME} OFDM symbols in the complete superframe sequence is for

Preamble; The rests are for PHY Frames. Note that only the active PHY Frames (PHY Frame#StartingFrame to PHY Frame#(StartingFrame+NumFrames-1)) are output at pin data when OutputFrameFormat = Full Superframe. When picking up the output data in each OFDM symbol for both Preamble and PHY Frames, the following rules are applied.

- Only the OFDM useful data are output; The Cyclic Prefix and Windowing Guard Interval are discarded.
- The first output data is illustrated in the following figure. Note that the last CP/4 data are extracted from Part A instead of from Part B. The benefit is that the OFDM useful data can still be extracted correctly even when the estimated timing index has the CP/4 (or less) delay compared to the actual timing index.



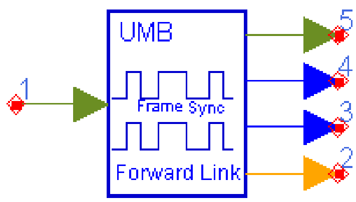
Extraction of OFDM useful data

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_FrameSync

Symbol



UMB_FL_FrameSync

Description: Forward link frame synchronization
Library: UMB, Receiver

Parameters

Name	Description	Default	Type	Range
OutputFrameFormat	output superframe format: Full Superframe, Compact Superframe	Full Superframe	enum	
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0	int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25	int	
OversamplingOption	Oversampling ratio option: Ratio 1, Ratio 2, Ratio 4, Ratio 8, Ratio 16, Ratio 32	Ratio 2	enum	
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
Ncp	the index for Cyclic Prefix (Tcp=Ncp*FFTSize*Tchip/16): Ncp 1, Ncp 2, Ncp 3, Ncp 4	Ncp 1	enum	
EnableHalfDuplexOperation	whether the half duplex operation is enabled: NO, YES	NO	enum	

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	downlink frame	complex

Pin Outputs

Pin	Name	Description	Signal Type
2	OutIndex	synchronization frame start position	int
3	Corr	correlation result	real
4	DeltaFreq	frequency offset	real
5	OutACQCH	output of F-ACQCH	complex

Notes/Equations

1. This model is used to achieve Forward Link superframe synchronization and estimate fractional frequency offset based on TDM Pilot 1 (F-ACQCH) of Preamble.
2. Each firing,
   - When OutputFrameFormat = Full Superframe, one full superframe(($N_{PHYFrames}$ +1)*N_{FRAME}*N_{SAMPLE}+ EnableHalfDuplexOperation*$N_{PHYFrames}$*N_{TG}*2

OversamplingRatio) tokens are consumed at pin Input, where $N_{PHYFrames}$ = 25 is the number of PHY Frames in one superframe, N_{FRAME} = 8 is the number of OFDM symbols in one PHY Frame, N_{SAMPLE} is the number of samples in one OFDM symbol: $N_{SAMPLE} = N_{FFT}*(1+(Ncp+1)/16+1/32)*2^{OversamplingRatio}$, where Ncp is the value from the parameter Ncp, 1/32 is the ratio of Windowing Guard Interval, $N_{TG} = N_{FFT}*3/4$.

When OutputFrameFormat = Compact Superframe, one compact superframe($(NumFrames+1)*N_{FRAME}*N_{SAMPLE}+$ $EnableHalfDuplexOperation*NumFrames*N_{TG}*2^{OversamplingRatio}$) tokens are consumed at pin Input.

- The number of tokens produced at pin Corr is the same as that at pin Input.
- 1 token is produced at pin OutIndex which indicates the starting index of TDM Pilot 1 (F-ACQCH) in superframe Preamble.
- 1 token is produced at pin DeltaFreq which indicates the carrier fractional frequency offset.
- One OFDM useful data ($N_{FFT}*2^{OversamplingRatio}$) are produced at pin OutACQCH which is the OFDM useful time sequence of F-ACQCH.

3. TDM Pilot 1 (F-ACQCH) is modulated over every fourth subcarriers in frequency domain resulting in that a waveform with the duraion of 1/(4*SubcarrierSpacing) sec is repeated four times in the time domain, where SubcarrierSpacing is the subcarrier spacing (9.6KHz). This model searchs this kind of character accross all the received sequence and tries to locate the beginning of the first repeated waveform.
4. The timing synchronization is operated as follows:
   - Firstly, the correlation is calculated as

     $$Correlation_i = \left|\sum_{k=0}^{2}\sum_{l=0}^{L-1} Sample_{i+kL+l} \times conj(Sample_{i+(k+1)L+l})\right|.$$

     where i = 0, ..., $NumSamplesIn-N_{FFT}*2^{OversamplingRatio}-1$ for the first firing; L is the length of repeated waveform: $L = N_{FFT}*2^{OversamplingRatio}/4$.
   - Then the index with the maximun value in the array Correlation is gotten, marked as MaxIndex=IndexOf(max(Correlation)). Further, the array Sum over the range of Cyclic Prefix and Windowing Guard Interval is calculated as follows to search better synchronization index.

     $$Sum_i = \left|\sum_{l=0}^{N} Correlation_{MaxIndex-i+l}\right|$$

     where i = 0, ..., N-1; N is the length of summary operation: $N = (N_{CP}+N_{WGI})*2^{OversamplingOption}$.
   - The final output index MaxIndx is updated as MaxIndx = MaxIndx-IndexOf(max(Sum)).
   - After the first firing (initial timing synchronization), only the range of Correlation (i.e. the range of i) is narrowed as: i = (MaxIndx-Left), ..., (MaxIndx+Right), where Left = Right = $2*N_{SAMPLE}$ (two OFDM symbols).
5. When the timing synchronization is finished, the fractional frequency offset is calculated as follows

$$DeltaF = \arg(\sum_{k=0}^{2}\sum_{l=0}^{L-1} Sample_{start+(k+1)L+l} \times conj(Sample_{start+kL+l}))*F_s/(2\pi * L)$$

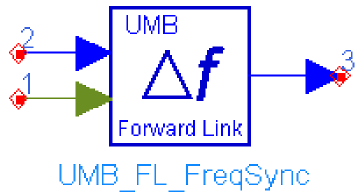
where $Start = MaxIndex+N_{CP}*2^{OversamplingOption}$; F_S is the sampling frequency: $F_S = SubcarrierSpacing*N_{FFT}*2^{OversamplingOption}$. Note that the final frequency offset output (DeltaF) is DeltaF = DeltaF - mod(DeltaF,SubcarrierSpacing) to ensure that only the fractional frequency offset is estimated.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_FreqSync

Symbol



Description: Forward link frequency synchronizer
Library: UMB, Receiver

Parameters

Name	Description	Default	Type	Range
OversamplingOption	Oversampling ratio option: Ratio 1, Ratio 2, Ratio 4, Ratio 8, Ratio 16, Ratio 32	Ratio 2	enum	
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
Ncp	the index for Cyclic Prefix (Tcp=Ncp*FFTSize*Tchip/16): Ncp 1, Ncp 2, Ncp 3, Ncp 4	Ncp 1	enum	
GuardSize	the size of guard subcarriers	32	int	
FreqSync	frequency sync mode: None, Fractional Freq, Integeral and Fractional Freq	Fractional Freq	enum	

Pin Inputs

Pin	Name	Description	Signal Type
1	facqch	F-ACQCH	complex
2	DeltaFreq	fractional frequency offset	real

Pin Outputs

Pin	Name	Description	Signal Type
3	freq	frequency offset	real

Notes/Equations

1. This model is used to estimate integral frequency offset and fine timing synchronization in Forward Link based on the input TDM Pilot 1 (F-ACQCH).
2. Each firing,
   - $N_{FFT}*2^{OversamplingRatio}$ tokens are consumed at pin facqch. Fraction frequency offset has been corrected before F-ACQCH sequence enters into this model.
   - 1 token is consumed at DeltaFreq which is the fractional frequency offset.
   - 2 tokens are produced at pin freq. The first value is final frequency offset depending on the parameter FreqSync; The second value indicates the phase difference between adjacent subcarriers caused by coarse timing synchronization, and is used to achieve fine timing synchronization.
3. The final frequency offset output depends on the parameter FreqSync.
   - FreqSync = **None**
     0 (i.e. no frequency offset) is ouput to the first value at pin freq.
   - FreqSync = **Fractional Freq**
     Fractional frequency offset from pin DeltaFreq is ouput directly to the first value at pin freq.

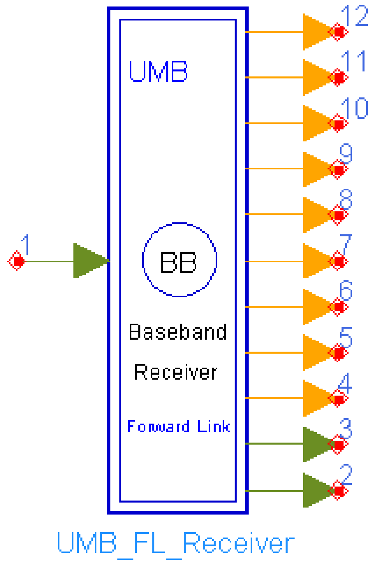
- FreqSync = **Integeral and Fractional Freq**
  The sum of fractional frequency offset from pin DeltaFreq and integeral frequency offset calculated in this model is ouput to the first value at pin freq. The remaining integeral frequency offset may cause the subcarrier rotation in frequency domain. Correlation between local TDM Pilot 1 sequence and received TDM Pilot 1 sequence in frequency domain may be utilized to estimate integer frequency offset. To eliminate the influence of selective fading channel, differential correlation is utilized in this model.

4. The phase offset between adjacent subcarriers is performed after the carrier integeral frequency offset is compensated. The phase offset is calculated as
   $$PhaseOffset = \arg\left(\sum_{l=0}^{L-2}\left(\frac{Y_{l+1}}{X_{l+1}} \times conj\left(\frac{Y_l}{X_l}\right)\right)\right)/4$$
   where X_l is the sequence for local TDM Pilot 1 active subcarriers (in every four subcarriers, only one subcarrier is modulated); Y_l is the sequence for frequency-offset-compensated TDM Pilot 1 active subcarriers; L is the number of TDM Pilot 1 active subcarriers.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB FL Receiver



Description: 3GPP2 UMB Forward Link Receiver
Library: UMB,Receiver

Parameters

Name	Description	Default	Unit	Type	Range
OutputFrameFormat	output superframe format: Full Superframe, Compact Superframe	Full Superframe		enum	
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0		int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25		int	
OversamplingOption	Oversampling ratio option: Ratio 1, Ratio 2, Ratio 4, Ratio 8, Ratio 16, Ratio 32	Ratio 2		enum	
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512		enum	[0,4]
Ncp	the index for Cyclic Prefix (Tcp=Ncp*FFTSize*Tchip/16): Ncp 1, Ncp 2, Ncp 3, Ncp 4	Ncp 1		enum	
GuardSize	the size of guard subcarriers	32		int	
RsChMuxMode	The mux mode for resource channels: Mode 1, Mode 2	Mode 2		enum	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64		enum	
NumDRCHSubzones	the number of DRCH subzones	0		int	[0,FFTSize/SubzoneSize-1]
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size	Size 8192		enum	[0,1]

	4096, Size 8192				
EnableBRCHSubzoneCycling	whether the cycling for BRCH subzones is enabled: NO, YES	NO		enum	
EnableHalfDuplexOperation	whether the half duplex operation is enabled: NO, YES	NO		enum	
StartingSuperframe	the superframe index for the starting superframe	0		int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES		enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO		enum	
PilotPN	9-bit pilot PN for different sectors	0		int	[0,511]
FDCH_NumPackets	number of data packets transmitted in F-DCH; At most four packets are supported	1		int	[1,4]
FDCH_1_PFIndex	the packet format index for the first data packet transmitted in F-DCH	1		int	[0,14]
FDCH_1_NodeID	the array of NodeID allocated to the first data packet transmitted in F-DCH	{31}		int array	
FDCH_1_MACID	the MAC ID of the first data packet (Access Terminal) transmitted in F-DCH	1		int	[0,511]
FDCH_1_NumHARQTrans	the number of HARQ transmissions for the first data packet transmitted in F-DCH	1		int	[1,25]
FDCH_1_HARQInterlace	the number of frames in HARQ interlace structure for the first data packet transmitted in F-DCH	6		int	[1,24]
FDCH_1_StartingFrame	the starting frame index from which the first data packet is allocated in F-DCH	0		int	[0,24]
FDCH_1_NumFrames	the number of frames on which the first data packet is allocated in F-DCH	25		int	[1,25]
FDCH_1_PowerDensity	the power density for the first data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}		real array	[-∞,∞]
FDCH_2_PFIndex	the packet format index for the second data packet transmitted in F-DCH	1		int	[0,14]
FDCH_2_NodeID	the array of NodeID allocated to the second data packet transmitted in F-DCH	{32}		int array	
FDCH_2_MACID	the MAC ID of the second data packet (Access Terminal) transmitted in F-DCH	2		int	[0,511]
FDCH_2_NumHARQTrans	the number of HARQ transmissions for the second data packet transmitted in F-DCH	1		int	[1,25]
FDCH_2_HARQInterlace	the number of frames in HARQ interlace structure for the second data packet	6		int	[1,24]

	transmitted in F-DCH				
FDCH_2_StartingFrame	the starting frame index from which the second data packet is allocated in F-DCH	0		int	[0,24]
FDCH_2_NumFrames	the number of frames on which the second data packet is allocated in F-DCH	25		int	[1,25]
FDCH_2_PowerDensity	the power density for the second data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}		real array	[-∞,∞]
FDCH_3_PFIndex	the packet format index for the third data packet transmitted in F-DCH	1		int	[0,14]
FDCH_3_NodeID	the array of NodeID allocated to the third data packet transmitted in F-DCH	{33}		int array	
FDCH_3_MACID	the MAC ID of the third data packet (Access Terminal) transmitted in F-DCH	3		int	[0,511]
FDCH_3_NumHARQTrans	the number of HARQ transmissions for the third data packet transmitted in F-DCH	1		int	[1,25]
FDCH_3_HARQInterlace	the number of frames in HARQ interlace structure for the third data packet transmitted in F-DCH	6		int	[1,24]
FDCH_3_StartingFrame	the starting frame index from which the third data packet is allocated in F-DCH	0		int	[0,24]
FDCH_3_NumFrames	the number of frames on which the third data packet is allocated in F-DCH	25		int	[1,25]
FDCH_3_PowerDensity	the power density for the third data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}		real array	[-∞,∞]
FDCH_4_PFIndex	the packet format index for the fourth data packet transmitted in F-DCH	1		int	[0,14]
FDCH_4_NodeID	the array of NodeID allocated to the fourth data packet transmitted in F-DCH	{34}		int array	
FDCH_4_MACID	the MAC ID of the fourth data packet (Access Terminal) transmitted in F-DCH	4		int	[0,511]
FDCH_4_NumHARQTrans	the number of HARQ transmissions for the fourth data packet transmitted in F-DCH	1		int	[1,25]
FDCH_4_HARQInterlace	the number of frames in HARQ interlace structure for the fourth data packet transmitted in F-DCH	6		int	[1,24]
FDCH_4_StartingFrame	the starting frame index from which the fourth data packet is allocated in F-DCH	0		int	[0,24]
FDCH_4_NumFrames	the number of frames on which the fourth data packet is	25		int	[1,25]

	allocated in F-DCH				
FDCH_4_PowerDensity	the power density for the fourth data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}		real array	[-∞,∞]
FCPICH_HoppingMode	the hopping mode for F-CPICH: Random, Deterministic	Random		enum	
FCPICH_PilotSpacing	the subcarrier spacing for common pilots	16		int	[1,∞)
FCPICH_PowerDensity	the power density for F-CPICH (defined as power(dBm) per modulation symbol)	-16.0		real	[-∞,∞]
CodeOffset	code offset between 0 and 2 for Forward Dedicated Pilot Channel	0		int	[0,2]
DPICHFormat	the Forward Dedicated Pilot Channel format for Forward Data Channel: Format 0, Format 1, Format 2	Format 0		enum	[0,1]
EnableFLCS	whether the Forward Link Control Segment is enabled: NO, YES	NO		enum	
FLCS_NumBlocks	the number of blocks (tiles) allocated for FLCS, only valid when EnableFLCS is YES	3		int	[3,∞)
FLCS_UseDRCH	whether FLCS is on DRCH or on BRCH, only valid when EnableFLCS is YES: NO, YES	NO		enum	
FLCS_PowerDensity	the power density for FLCS (defined as power(dBm) per modulation symbol), only valid when EnableFLCS is YES	-16.0		real	[-∞,∞]
FreqSync	frequency sync mode: None, Fractional Freq, Integeral and Fractional Freq	Fractional Freq		enum	
IterationNumber	number of iterations for turbo decoder	3		int	[1,16]
DecoderType	Demapping type: Hard, Soft, CSI	CSI		enum	
SNR	SNR in dB	15		real	(-∞,∞)
Tmax	The maximum delay of multi-path channel	1e-6		real	[0,∞)
Fmax	The maximum doppler frequency	100 Hz	Hz	real	[0,∞)

Pin Inputs

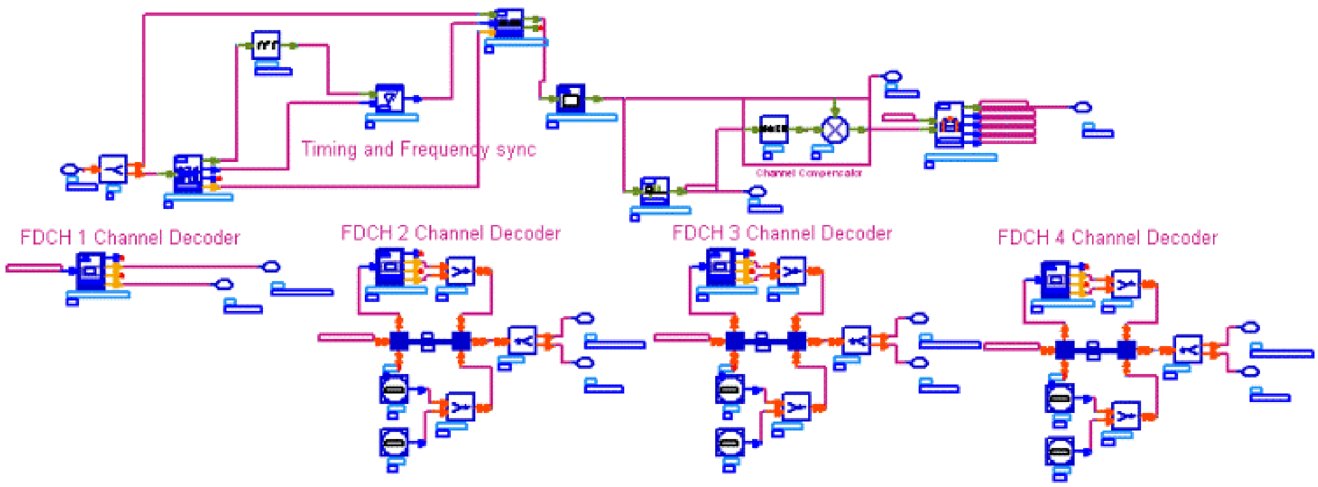
Pin	Name	Description	Signal Type
1	FrameData	input data	complex

Pin Outputs

Pin	Name	Description	Signal Type
2	ChEstimation	output of channel estimation	complex
3	Constellation	output of Modulated data for EVM	complex
4	FDCH_1_Data	output data for the first data packet in F-DCH	int
5	FDCH_1_CRCIndicator	output CRC indicator for the first packet (1: CRC passed; 0: CRC faild)	int
6	FDCH_2_Data	output data for the second data packet in F-DCH	int
7	FDCH_2_CRCIndicator	output CRC indicator for the second packet (1: CRC passed; 0: CRC faild)	int
8	FDCH_3_Data	output data for the third data packet in F-DCH	int
9	FDCH_3_CRCIndicator	output CRC indicator for the third packet (1: CRC passed; 0: CRC faild)	int
10	FDCH_4_Data	output data for the fourth data packet in F-DCH	int
11	FDCH_4_CRCIndicator	output CRC indicator for the fourth packet (1: CRC passed; 0: CRC faild)	int
12	FLCS_Data	output data for FLCS	int

Notes/Equations

1. This subnetwork is to implement 3GPP2 UMB Forward Link baseband receiver. The schematic for this subnetwork is shown in the following figure.



UMB_FL_Receiver Schematic

2. The ouput data at pin ChEstimation are the channel responses at all subcarriers including guard subcarriers for active PHY Frames (Frame#StartingFrame to Frame#(StartingFrame+NumFrames-1)).
The ouput data at pin Constellation are the modulation symbols at all subcarriers including guard subcarriers for active PHY Frames (Frame#StartingFrame to Frame#(StartingFrame+NumFrames-1)).
The ouput data at pin FDCH_i_Data are the information bits excluding CRC bits for the i^{th} data packet in F-DCH.
The ouput data at pin FDCH_i_CRCIndicator are the indicator of CRC decoder for the i^{th} data packet in F-DCH where a '1' indicates that the CRC checking passes; Otherwise, a `0' indicates that the CRC checking fails.
3. The following functionality is included in this baseband receiver.
   - Timing and frequency synchronization based on Forward Acquisition Channel (F-ACQCH);
   - Superframe demultiplexing, FFT operation;
   - Channel estimation and compensation based on Forward Dedicated Pilot Channel or Forward Common Pilot Channel;
   - HARQ demodulation for at most four data packets in Forward Link Data Channel;

- Subpacket merging, CRC decoder, rate-1/3 convolutional and rate-1/5 turbo decoder, channel deinterleaving, data descrambling and modulation symbol demapper for Forward Link Data Channel.

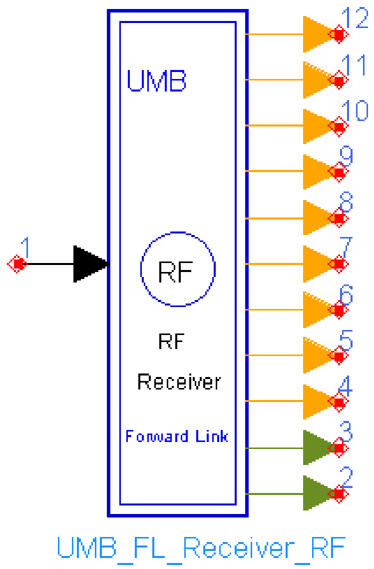
4. The coarse superframe timing synchronization and fractional frequency offset are estimated in UMB_FL_FrameSync by searching TDM Pilot 1 (F-ACQCH) of Preamble. Then the TDM Pilot 1 (F-ACQCH) without fractional frequency offset is passed to UMB_FL_FreqSync to estimate the integral frequency offset and the phase offset between adjacent subcarriers due to the timing synchronization mismath. These results are passed to UMB_FL_DemuxFrame where the total frequency offset is compensated and the final timing index is calculated. UMB_FL_DemuxFrame demultiplexes the input signal into the Superframe Preamble and active PHY Frames without Cyclic Prefix and Windowing Guard Interval.
5. The active PHY Frames will convert into the frequence domain by FFT operation in UMB_OFDM_Demodulator. Then the channel responses are estimated in UMB_FL_ChEstimator, and the received data are equalized by a simple divider. In UMB_FL_DemuxOFDMSym, the modulation symbols for each data packet are extracted from corresponding subcarriers respectively, which are then demapped into soft bits with one of three methods (Hard, Soft and CSI (Channel Status Information)). The demapped bits shall be also de-scrambled in UMB_FL_DemuxOFDMSym.
6. In UMB_FL_FECDecoder, channel de-interleaving, rate-1/3 convolutional or rate-1/5 turbo decoder, CRC decoder and subpacket merging are operated.
7. Note that one superframe delay is caused in this baseband receiver.
8. Parameter Details
   - The basic parameters are described in *Basic Parameters* (3gpp2umb).
   - The parameters for Forward Data Channel (F-DCH) are described in *F-DCH Parameters* (3gpp2umb).
   - The parameters for pilot channels are described in *Pilot Parameters* (3gpp2umb).
   - The parameters for Forward link Control Segment (FLCS) are described in *FLCS Parameters* (3gpp2umb).
   - FreqSync specifies the frequency synchronization method. No frequency offset estimation, only fractional frequency offset estimation, and integeral and fractional frequency offset estimation are supported.
   - IterationNumber specifies the number of iterations for turbo decoder. This parameter is only valid when the coding type for the data packet is turbo coder depending on the packe size.
   - DecoderType specifies the channel decoder type chosen from CSI, Soft and Hard. CSI (Channel State Information) is a channel estimate profile. Generally, the decoder with CSI has best performance while the decoder with Hard has worst performance.
   - SNR specifies the signal noise ratio at receiver antenna in dB for F-DCH. This parameter is useful for the channel estimator.
   - Tmax specifies the maximum echo delay in multi-path channel. This parameter is useful for the channel estimator.
   - Fmax specifies the maximum Doppler frequency. This parameter is useful for the channel estimator.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_Receiver_RF

Symbol



Description: 3GPP2 UMB Forward Link RF Receiver
Library: UMB,Receiver

Parameters

Name	Description	Default	Unit	Type	Range
RIn	Input resistance	DefaultRIn	Ohm	int	(0,∞)
RTemp	Temperature, in degrees C	DefaultRTemp	Celsius	real	[-273.15,∞]
FCarrier	Carrier frequency	3407 MHz	Hz	real	(0,∞)
Sensitivity	voltage output sensitivity, Vout/Vin	1		real	(-∞,∞)
Phase	Reference phase in degrees	0.0	deg	real	(-∞,∞)
GainImbalance	Gain imbalance in dB, Q channel relative to I channel	0.0		real	(-∞,∞)
PhaseImbalance	Phase imbalance in degrees, Q channel relative to I channel	0.0		real	(-∞,∞)
OutputFrameFormat	output superframe format: Full Superframe, Compact Superframe	Full Superframe		enum	
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0		int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25		int	
OversamplingOption	Oversampling ratio option: Ratio 1, Ratio 2, Ratio 4, Ratio 8, Ratio 16, Ratio 32	Ratio 2		enum	
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256,	FFT 512		enum	[0,4]

	FFT 128				
Ncp	the index for Cyclic Prefix (Tcp=Ncp*FFTSize*Tchip/16): Ncp 1, Ncp 2, Ncp 3, Ncp 4	Ncp 1		enum	
GuardSize	the size of guard subcarriers	32		int	
RsChMuxMode	The mux mode for resource channels: Mode 1, Mode 2	Mode 2		enum	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64		enum	
NumDRCHSubzones	the number of DRCH subzones	0		int	[0,FFTSize/SubzoneSize-1]
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192		enum	[0,1]
EnableBRCHSubzoneCycling	whether the cycling for BRCH subzones is enabled: NO, YES	NO		enum	
EnableHalfDuplexOperation	whether the half duplex operation is enabled: NO, YES	NO		enum	
StartingSuperframe	the superframe index for the starting superframe	0		int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES		enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO		enum	
PilotPN	9-bit pilot PN for different sectors	0		int	[0,511]
FDCH_NumPackets	number of data packets transmitted in F-DCH; At most four packets are supported	1		int	[1,4]
FDCH_1_PFIndex	the packet format index for the first data packet transmitted in F-DCH	1		int	[0,14]
FDCH_1_NodeID	the array of NodeID allocated to the first data packet transmitted in F-DCH	{31}		int array	
FDCH_1_MACID	the MAC ID of the first data packet (Access Terminal) transmitted in F-DCH	1		int	[0,511]
FDCH_1_NumHARQTrans	the number of HARQ transmissions for the first data packet transmitted in F-DCH	1		int	[1,25]
FDCH_1_HARQInterlace	the number of frames in HARQ interlace structure for the first data packet transmitted in F-DCH	6		int	[1,24]
FDCH_1_StartingFrame	the starting frame index from which the first data packet is allocated in F-DCH	0		int	[0,24]
FDCH_1_NumFrames	the number of frames on which the first data packet is allocated in F-DCH	25		int	[1,25]
FDCH_1_PowerDensity	the power density for the first data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}		real array	[-∞,∞]

FDCH_2_PFIndex	the packet format index for the second data packet transmitted in F-DCH	1		int	[0,14]
FDCH_2_NodeID	the array of NodeID allocated to the second data packet transmitted in F-DCH	{32}		int array	
FDCH_2_MACID	the MAC ID of the second data packet (Access Terminal) transmitted in F-DCH	2		int	[0,511]
FDCH_2_NumHARQTrans	the number of HARQ transmissions for the second data packet transmitted in F-DCH	1		int	[1,25]
FDCH_2_HARQInterlace	the number of frames in HARQ interlace structure for the second data packet transmitted in F-DCH	6		int	[1,24]
FDCH_2_StartingFrame	the starting frame index from which the second data packet is allocated in F-DCH	0		int	[0,24]
FDCH_2_NumFrames	the number of frames on which the second data packet is allocated in F-DCH	25		int	[1,25]
FDCH_2_PowerDensity	the power density for the second data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}		real array	[-∞,∞]
FDCH_3_PFIndex	the packet format index for the third data packet transmitted in F-DCH	1		int	[0,14]
FDCH_3_NodeID	the array of NodeID allocated to the third data packet transmitted in F-DCH	{33}		int array	
FDCH_3_MACID	the MAC ID of the third data packet (Access Terminal) transmitted in F-DCH	3		int	[0,511]
FDCH_3_NumHARQTrans	the number of HARQ transmissions for the third data packet transmitted in F-DCH	1		int	[1,25]
FDCH_3_HARQInterlace	the number of frames in HARQ interlace structure for the third data packet transmitted in F-DCH	6		int	[1,24]
FDCH_3_StartingFrame	the starting frame index from which the third data packet is allocated in F-DCH	0		int	[0,24]
FDCH_3_NumFrames	the number of frames on which the third data packet is allocated in F-DCH	25		int	[1,25]
FDCH_3_PowerDensity	the power density for the third data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}		real array	[-∞,∞]
FDCH_4_PFIndex	the packet format index for the fourth data packet transmitted in F-DCH	1		int	[0,14]
FDCH_4_NodeID	the array of NodeID allocated to the fourth data packet	{34}		int array	

	transmitted in F-DCH				
FDCH_4_MACID	the MAC ID of the fourth data packet (Access Terminal) transmitted in F-DCH	4		int	[0,511]
FDCH_4_NumHARQTrans	the number of HARQ transmissions for the fourth data packet transmitted in F-DCH	1		int	[1,25]
FDCH_4_HARQInterlace	the number of frames in HARQ interlace structure for the fourth data packet transmitted in F-DCH	6		int	[1,24]
FDCH_4_StartingFrame	the starting frame index from which the fourth data packet is allocated in F-DCH	0		int	[0,24]
FDCH_4_NumFrames	the number of frames on which the fourth data packet is allocated in F-DCH	25		int	[1,25]
FDCH_4_PowerDensity	the power density for the fourth data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}		real array	[-∞,∞]
FCPICH_HoppingMode	the hopping mode for F-CPICH: Random, Deterministic	Random		enum	
FCPICH_PilotSpacing	the subcarrier spacing for common pilots	16		int	[1,∞)
FCPICH_PowerDensity	the power density for F-CPICH (defined as power(dBm) per modulation symbol)	-16.0		real	[-∞,∞]
CodeOffset	code offset between 0 and 2 for Forward Dedicated Pilot Channel	0		int	[0,2]
DPICHFormat	the Forward Dedicated Pilot Channel format for Forward Data Channel: Format 0, Format 1, Format 2	Format 0		enum	[0,1]
EnableFLCS	whether the Forward Link Control Segment is enabled: NO, YES	NO		enum	
FLCS_NumBlocks	the number of blocks (tiles) allocated for FLCS, only valid when EnableFLCS is YES	3		int	[3,∞)
FLCS_UseDRCH	whether FLCS is on DRCH or on BRCH, only valid when EnableFLCS is YES: NO, YES	NO		enum	
FLCS_PowerDensity	the power density for FLCS (defined as power(dBm) per modulation symbol), only valid when EnableFLCS is YES	-16.0		real	[-∞,∞]
FreqSync	frequency sync mode: None, Fractional Freq, Integeral and Fractional Freq	Fractional Freq		enum	
IterationNumber	number of iterations for turbo decoder	3		int	[1,16]
DecoderType	Demapping type: Hard, Soft, CSI	CSI		enum	
SNR	SNR in dB	15		real	(-∞,∞)
Tmax	The maximum delay of multi-	1e-6		real	[0,∞)

	path channel				
Fmax	The maximum doppler frequency	100 Hz	Hz	real	[0,∞)

Pin Inputs

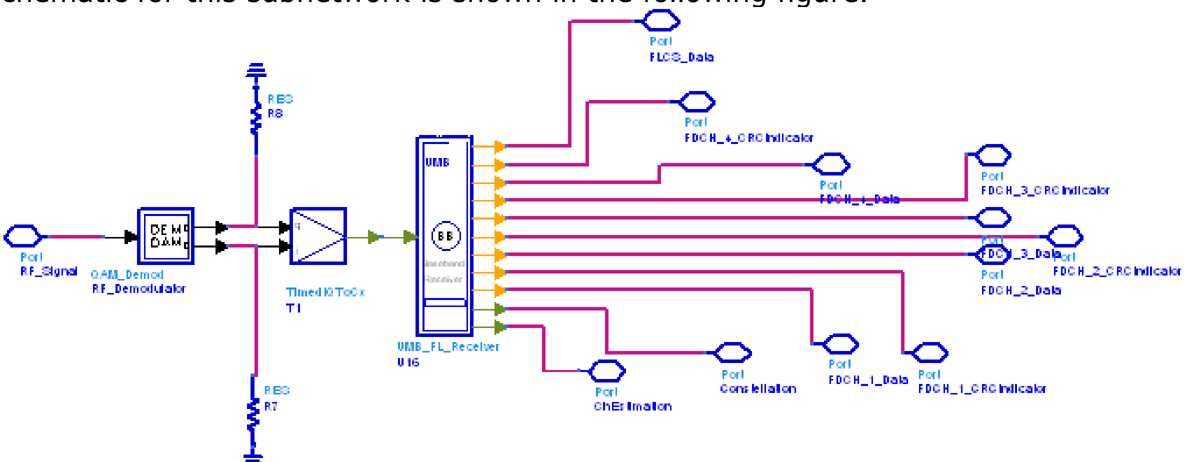
Pin	Name	Description	Signal Type
1	RF_Signal	input of RF signal	timed

Pin Outputs

Pin	Name	Description	Signal Type
2	ChEstimation	output of channel estimation	complex
3	Constellation	output of Modulated data for EVM	complex
4	FDCH_1_Data	output data for the first data packet in F-DCH	int
5	FDCH_1_CRCIndicator	output CRC indicator for the first packet (1: CRC passed; 0: CRC faild)	int
6	FDCH_2_Data	output data for the second data packet in F-DCH	int
7	FDCH_2_CRCIndicator	output CRC indicator for the second packet (1: CRC passed; 0: CRC faild)	int
8	FDCH_3_Data	output data for the third data packet in F-DCH	int
9	FDCH_3_CRCIndicator	output CRC indicator for the third packet (1: CRC passed; 0: CRC faild)	int
10	FDCH_4_Data	output data for the fourth data packet in F-DCH	int
11	FDCH_4_CRCIndicator	output CRC indicator for the fourth packet (1: CRC passed; 0: CRC faild)	int
12	FLCS_Data	output data for FLCS	int

Notes/Equations

1. This subnetwork is to implement 3GPP2 UMB Forward Link RF receiver. The schematic for this subnetwork is shown in the following figure.



UMB_FL_Receiver_RF Schematic

2. The implementation of 3GPP2 UMB Forward Link baseband receiver is described in *Forward Link baseband receiver* (3gpp2umb).
3. Parameter Details
   - RF Parameters
     - RIn is the RF input resistance.
     - RTemp is the RF output resistance temperature in Celsius and sets the noise density in the RF output signal to (k(RTemp+273.15)) Watts/Hz,

where k is Boltzmann's constant.
  - FCarrier is the RF output signal frequency.
  - Sensitivity is the voltage output sensitivity (Vout/Vin) of the internal oscillator that generates the reference carrier signal used to demodulate the RF signal.
  - Phase is the reference phase in degrees of the reference carrier signal.
  - GainImbalance and PhaseImbalance add certain impairments to the ideal output RF signal. Impairments are added as described here.
    The unimpaired RF I and Q envelope voltages have gain and phase imbalance applied. The RF is given by:

    $$V_3(t) = A\left(V_1(t)\cos(\omega_c t) - gV_2(t)\sin\left(\omega_c t + \frac{\Phi\pi}{180}\right)\right)$$

    where A is a scaling factor based on the Power and ROut parameters specified by the user, $V_1(t)$ is the in-phase RF envelope, $V_2(t)$ is the quadrature phase RF envelope, g is the gain imbalance

    $$g = 10^{\frac{GainImbalance}{20}}$$

    and Φ (in degrees) is the phase imbalance.
- The baseband parameters are described in *Baseband Parameters* (3gpp2umb).

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

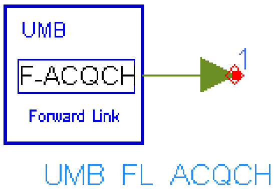
UMB Signal Source Components

The 16e signal source models provide models to generate Forward and Reverse Link signal sources.

- *UMB FL ACQCH* (3gpp2umb)
- *UMB FL OSICH* (3gpp2umb)
- *UMB FL PBCCH* (3gpp2umb)
- *UMB FL Preamble* (3gpp2umb)
- *UMB FL QPCH* (3gpp2umb)
- *UMB FL SBCCH* (3gpp2umb)
- *UMB FL SignalSrc* (3gpp2umb)
- *UMB FL SignalSrc RF* (3gpp2umb)
- *UMB RL CDMA ACH* (3gpp2umb)
- *UMB RL CDMA AuxPICH* (3gpp2umb)
- *UMB RL CDMA DCCH* (3gpp2umb)
- *UMB RL CDMA PICH* (3gpp2umb)
- *UMB RL CDMASubsegment* (3gpp2umb)
- *UMB RL SignalSrc* (3gpp2umb)
- *UMB RL SignalSrc RF* (3gpp2umb)
- *UMB SymWindow* (3gpp2umb)

UMB_FL_ACQCH

Symbol



Description: forward link ACQCH generator
Library: UMB, Signal Source

Parameters

Name	Description	Default	Type	Range
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
Ncp	the index for Cyclic Prefix (Tcp=Ncp*FFTSize*Tchip/16): Ncp 1, Ncp 2, Ncp 3, Ncp 4	Ncp 1	enum	
FACQCH_Power	transmit unit power for F-ACQCH in units of dBm	10.0	real	[-∞,∞]

Pin Outputs

Pin	Name	Description	Signal Type
1	SymbolOut	output data	complex

Notes/Equations

1. This model generates the frequency domain sequence of the Forward Acquisition Channel (F-ACQCH) which is transmitted on the OFDM symbol with index 5 (TDM Pilot 1) in the superframe preamble.
   Each firing, N_{FFT} tokens are produced at pin SymbolOut.
2. For FFT sizes of 128, 256 and 512, TDM Pilot 1 is modulated over every fourth subcarrier in this OFDM symbol. For FFT sizes of 1024 and 2048, TDM Pilot 1 spans only the central 480 subcarriers of this OFDM symbol, and occupies every fourth subcarrier over this span.
   More precisely, define sc_start = max($N_{GUARD,LEFT}$, 16, N_{FFT}/2-240), sc_end = min(sc_start + 4*N_P, N_{FFT} - $N_{GUARD,RIGHT}$, N_{FFT}/2 + 240), and sc_offset = 16 + max(0, N_{FFT}/2 - 256).
   The values of the complex modulation symbols, X_i, i = 0 to N_{FFT} - 1, for the TDM Pilot 1 OFDM symbol shall be given by
   $X_i = A \times \exp\left(-j2\pi u \frac{k(k+1)}{2N_G}\right)$ when i = 4k_sc_offset,
   $\left(\frac{start - offset}{4}\right) \le k < \left(\frac{end - offset}{4}\right)$; Otherwise, $X_i = 0$.
   Here, the values of N_G and N_P depend on the FFT size and are specified in
   Specification for the N_G and N_P Parameters

N_{FFT}	N_G	N_P
128	23	23
256	59	56
>=512	127	120

The value of u depends on both the FFT size and the cyclic prefix duration and is specified in Specification for the u Parameter

N_{CP}	N_{FFT}=128	N_{FFT}=256	N_{FFT}>=512
1	8	13	17
2	12	22	39
3	14	39	110
4	22	47	112

3. The transmit power of F-ACQCH is defined by the parameter FACQCH_Power. Note that the amplitude A of X_i is derived from FACQCH_Power:

$$A = sqrt(0.001 * 10^{(FACQCH\_Power/10)} / n_{sc})$$

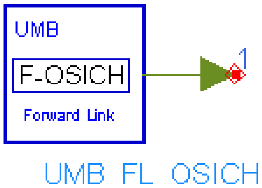
where n_{sc} is the number of occupied subcarriers.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_OSICH

Symbol



Description: forward link OSICH generator
Library: UMB, Signal Source

Parameters

Name	Description	Default	Type	Range
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
StartingSuperframe	the superframe index for the starting superframe	0	int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES	enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	YES	enum	
PilotPN	9-bit pilot PN for different sectors	0	int	[0,511]
K_OSI	the OSIValue from the SFP MAC Protocol	0	int	[0,2]
K_SD	the 9-bit AcqInfo block provided by the SFP MAC Protocol	0	int	[0,511]
FOSICH_Power	transmit unit power for F-OSICH in units of dBm	10.0	real	[-∞,∞]

Pin Outputs

Pin	Name	Description	Signal Type
1	SymbolOut	output data	complex

Notes/Equations

1. This model generates the frequency domain sequence of the Forward Other Sector Interference Channel (F-OSICH) which is transmitted on the last two OFDM symbols (i.e., the OFDM symbols with indices 6 and 7) in the superframe preamble. These OFDM symbols are also known as TDM Pilot 2 and TDM Pilot 3 respectively and are used in the initial acquisition process.
   Each firing, 2*N_{FFT} tokens are produced at pin SymbolOut.
2. The modulation of TDM Pilots 2 and 3 depends on the value of PilotPhase and the OSIValue (K_{OSI}). In the global synchronous mode, PilotPhase is equal to (PilotPN + SuperframeIndex) mod 512; In the global asynchronous mode, PilotPhase is equal PilotPN. For FFT sizes of 128, 256 and 512, TDM Pilots 2 and 3 occupy all usable subcarriers. For FFT sizes of 1024 and 2048, TDM Pilots 2 and 3 only occupy the central 512 subcarriers.
   - **TDM Pilot 2**
     First, a time-domain sequence x(n) of length $N_{FFT,TDMPilot}$ shall be generated where $N_{FFT,TDMPILOT}$ is defined as $N_{FFT,TDMPILOT}$ = min(N_{FFT}, 512). This sequence is given by the Walsh sequence of length $N_{FFT,TDMPilot}$ with index p mod N

$_{FFT,TDMPilot}$, where p denotes the PilotPhase of the sector in the superframe of interest.
The sequence x(n) shall then be scrambled by a sequence s(n) of length $N_{FFT,TDMPilot}$, and shall further be multiplied by the complex value $\exp(j \times 2\pi \times K_{OSI}/3)$ to generate a sequence y(n) :

$$y(n) = A \times x(n) \times s(n) \times \exp(j \times 2\pi \times k_{OSI} / 3)$$

where the amplitude A of y(n) is derived from the transmit power of F-OSICH (FOSICH_Power):

$$A = sqrt(0.001 * 10^{(FOSICH\_Power/10)} / n_{sc})$$

where n_{sc} is the number of occupied subcarriers.

The sequence y(n) shall then be converted to the frequency domain by applying a DFT operation of size $N_{FFT,TDMPilot}$ to generate a sequence Y(n) . TDM pilot 2 shall be generated by modulating the value Y(i) to the subcarrier with index $N_{FFT}/2 + i - N_{FFT,TDMPilot}/2$, 0<= i < $NF_{FT,TDMPilot}$, if this subcarrier is not a guard subcarrier.

- **TDM Pilot 3**
  TDM Pilot 3 shall carry information from the AcqInfo block (9-bit integer k_{SD} between 0 and 511) which is then mapped to a time-domain sequence x(n) of length $N_{FFT,TDMPILOT}$. This sequence is given by the Walsh sequence of length $N_{FFT,TDMPilot}$ with index k_{SD} mod $N_{FFT,TDMPilot}$.
  The sequence x(n) shall then be scrambled by a sequence s(n) of length $N_{FFT,TDMPilot}$, and shall further be multiplied by the complex value $\exp(j \times 4\pi \times K_{OSI}/3)$ to generate a sequence y(n) :

$$y(n) = A \times x(n) \times s(n) \times \exp(j \times 4\pi \times k_{OSI} / 3)$$

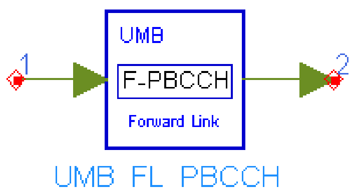
  where the amplitude A of y(n) is derived from the transmit power of F-OSICH (FOSICH_Power), the same as the amplitude A in TDM Pilot 2.
  The sequence y(n) shall then be converted to the frequency domain by applying a DFT operation of size $N_{FFT,TDMPilot}$ to generate a sequence Y(n). TDM pilot 3 shall be generated by modulating the value Y(i) to the subcarrier with index $N_{FFT}/2 + i - N_{FFT,TDMPilot}/2$, 0 <= i < $N_{FFT,TDMPilot}$, if this subcarrier is not a guard subcarrier.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_PBCCH

Symbol



Description: forward link PBCCH generator
Library: UMB, Signal Source

Parameters

Name	Description	Default	Type	Range
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
StartingSuperframe	the superframe index for the starting superframe	0	int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES	enum	
EnablePreambleFrequencyReuse	whether Preamble Frequency Reuse is enabled: NO, YES	NO	enum	
PilotPN	9-bit pilot PN for different sectors	0	int	[0,511]
PreambleUnitPower	transmit unit power for these channels in the first five OFDM symbols in units of dBm	10.0	real	[-∞,∞]

Pin Inputs

Pin	Name	Description	Signal Type
1	ModulatedData	input modulated data	complex

Pin Outputs

Pin	Name	Description	Signal Type
2	SymbolOut	output data	complex

Notes/Equations

1. This model maps the QPSK modulation symbols of F-PBCCH onto the first OFDM symbol of the superframe preamble.
   Each firing,
   - When EnablePreambleFrequencyReuse = NO, $N_{FFT,TDMPilot}$ are consumed at pin ModulatedData where $N_{FFT,TDMPILOT}$ is defined as $N_{FFT,TDMPILOT} = \min(N_{FFT}, 512)$; Otherwise $N_{FFT,TDMPilot}/8$ are consumed at pin ModulatedData.
   - N_{FFT} tokens are output at pin SymbolOut.
2. The modulation of the Forward Primary Broadcast Control Channel depends on the value of EnablePreambleFrequencyReuse. If this parameter is set to YES, the transmission of the Forward Primary Broadcast Control Channel from different sectors occupy different subcarrier sets (i.e., frequency reuse is enabled). Otherwise, the Forward Primary Broadcast Control Channel from different sectors occupies the same set of subcarriers and hence interfere with each other.
   - EnablePreambleFrequencyReuse = NO
     The i^{th} modulation symbol at the output of the modulator shall be mapped to the

subcarrier with index $N_{FFT}/2$ - $N_{FFT,TDMPilot}/2$ + i of the OFDM symbol with index 0 in the superframe preamble, if this subcarrier is not a guard subcarrier. Any subcarrier not modulated via the above procedure shall also remain unmodulated by the Forward Primary Broadcast Control Channel. The value of i ranges from 0 to $N_{FFT,TDMPILOT}$ - 1.

- EnablePreambleFrequencyReuse = YES
  This option is only allowed in Synchronous mode.
  The i^{th} modulation symbol at the output of the modulator shall be mapped to the subcarrier with index $N_{FFT}/2$ - $N_{FFT,TDMPilot}/2$ + ReuseIndex*$N_{FFT,TDMPilot}/8$ + i of the OFDM symbol with index 0 in the superframe preamble, if this subcarrier is not a guard subcarrier. Guard subcarriers shall not be modulated, where ReuseIndex is defined as PilotPhase mod 8. Any subcarrier not modulated via the above procedure shall remain unmodulated by the Forward Primary Broadcast Control Channel. The value of i shall go from 0 to $N_{FFT,TDMPILOT}/8$ - 1.

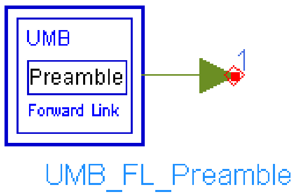
3. The ouput power of the Forward Primary Broadcast Control Channel is defined by the parameter PreambleUnitPower in dBm. Further, let n_{sc} denote the number of subcarriers which are mapped to F-PBCCH modulated data, then the power density at each modulation Subcarrier is (PreambleUnitPower-10*log10(n_{sc})) dBm/Subcarrier.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_Preamble

Symbol



Description: forward link preamble generator
Library: UMB, Signal Source

Parameters

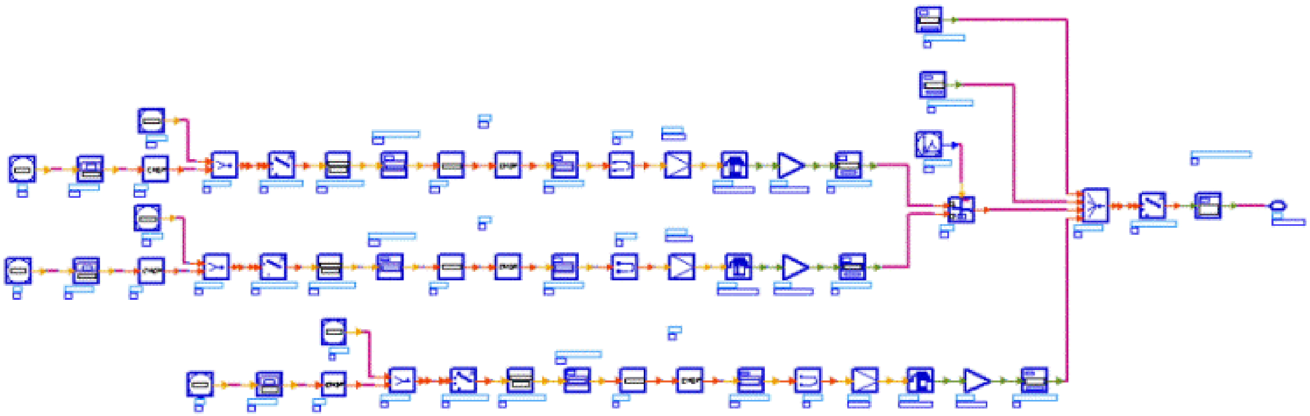
Name	Description	Default	Type	Range
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
OversamplingOption	Oversampling ratio option: Ratio 1, Ratio 2, Ratio 4, Ratio 8, Ratio 16, Ratio 32	Ratio 2	enum	
Ncp	the index for Cyclic Prefix (Tcp=Ncp*FFTSize*Tchip/16): Ncp 1, Ncp 2, Ncp 3, Ncp 4	Ncp 1	enum	
GuardSize	the size of guard subcarriers	32	int	
StartingSuperframe	the superframe index for the starting superframe	0	int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES	enum	
EnablePreambleFrequencyReuse	whether Preamble Frequency Reuse is enabled: NO, YES	NO	enum	
EnableExpandedQPCH	whether QPCH is expanded: NO, YES	NO	enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO	enum	
PilotPN	9-bit pilot PN for different sectors	11	int	[0,511]
SFNCellID	9-bit SFN cell ID	12	int	[0,511]
K_OSI	the OSIValue from the SFP MAC Protocol	0	int	[0,2]
K_SD	the 9-bit AcqInfo block provided by the SFP MAC Protocol	0	int	[0,511]
SBCCHScramblingSeed	F-SBCCH Scrambling Seed	1	int	[0,511]
QPCHScramblingSeed	F-QPCH Scrambling Seed	1	int	[0,511]
PreambleUnitPower	transmit unit power for these channels in the first five OFDM symbols in units of dBm	10.0	real	[-∞,∞]
FACQCH_Power	transmit unit power for F-ACQCH in units of dBm	10.0	real	[-∞,∞]
FOSICH_Power	transmit unit power for F-OSICH in units of dBm	10.0	real	[-∞,∞]

Pin Outputs

Pin	Name	Description	Signal Type
1	PreambleData	output complex data	complex

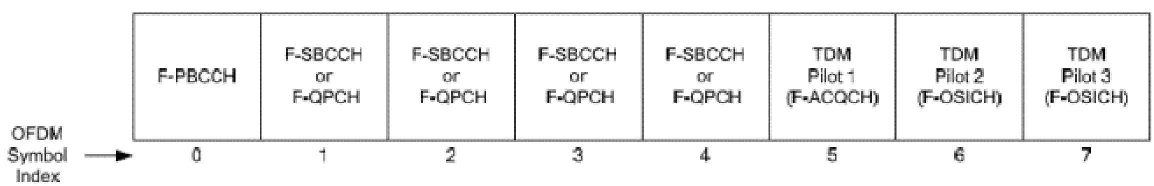
Notes/Equations

1. This subnetwork generates the time-domain waveform of the Superframe Preamble. The schematic for this subnetwork is shown in the following figure.



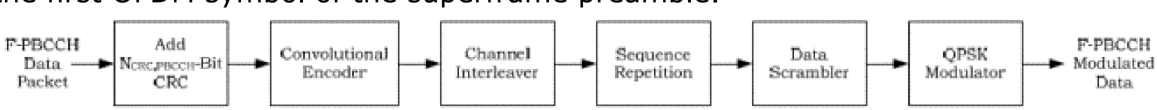
UMB_FL_Preamble Schematic

2. The superframe preamble shall consist of $N_{PREAMBLE}$ = 8 OFDM symbols, which are indexed 0 through 7. The last three of these OFDM symbols (OFDM symbols 5 through 7) are TDM pilots, which are used for initial acquisition. These three OFDM symbols are denoted as TDM Pilot 1, TDM Pilot 2, and TDM Pilot 3 respectively. TDM Pilots 2 and 3 are additionally used to transmit the Other Sector Interference Channel (F-OSICH) as well. The TDM Pilot 1 OFDM symbol forms the Forward Acquisition Channel (F_ACQCH), and the TDM Pilot 2 and 3 OFDM symbols form the Other Sector Interference Channel (F-OSICH). The first OFDM symbol in the superframe preamble (i.e., the OFDM symbol with index 0) is used to transmit the Primary Broadcast Control Channel (F-PBCCH) while the next four OFDM symbols (OFDM symbols indexed 1 through 4) are used to transmit the Secondary Broadcast Control Channel (F-SBCCH) and the Quick Paging Channel (F-QPCH) in alternate superframes. The Forward Preamble Pilot Channel (F-PPICH) shall be present only on OFDM symbols with index 1 and 2 within the preamble.



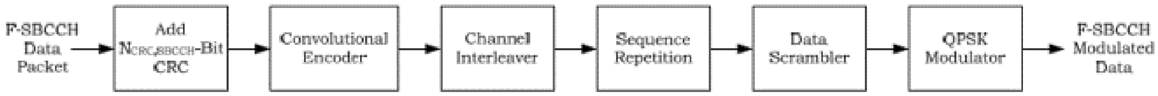
Superframe Preamble Structure

All the channels in the first five OFDM symbols of the superframe preamble are transmitted at unit power which is determined by the parameter PreambleUnitPower. The channel structure for F-PBCCH is given in Channel Structure for Forward Primary Broadcast Control Channel in which a convolutional encoder is employed on the information bits after 12-bit CRC padded. The QPSK modulated data are mapped on the first OFDM symbol of the superframe preamble.



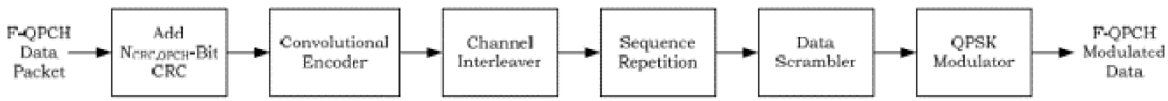
Channel Structure for Forward Primary Broadcast Control Channel (F-PBCCH)

The channel structure for F-SBCCH is given in Channel Structure for Forward Secondary Broadcast Control Channel in which a convolutional encoder is employed on the information bits after 12-bit CRC padded. The QPSK modulated data are then mapped on the OFDM symbols with indices 1 through 4 of the superframe preamble with odd superframe.



Channel Structure for Forward Secondary Broadcast Control Channel (F-SBCCH)

The channel structure for F-QPCH is given in Channel Structure for Forward Quick Paging Channel in which a convolutional encoder is employed on the information bits after 12-bit CRC padded. The QPSK modulated data are then mapped on the OFDM symbols with indices 1 through 4 of the superframe preamble with even superframe. Note that EnableExpandedQPCH=1 is not supported in this subnetwork which means only one single Forward Quick Paging Channel packet could be transmitted in each Forward Quick Paging Channel (F-QPCH).



Channel Structure for Forward Quick Paging Channel (F-QPCH)

The TDM Pilot 1 (i.e. F-ACQCH) are transmitted at the power which is determined by the parameter FACQCH_Power. Note that the parameter FACQCH_Power defines the final output power in F-ACQCH combining the effects of the values $G_{LOWPAR\text{-}GAIN}$ and $P_{GAINPREAMBLE,TDMPilot1}$ as defined in 4.1.3.2.1 of Ref1.

The TDM Pilot 2 and Pilot 3 OFDM symbols (i.e. F-OSICH) are transmitted at the power which is determined by the parameter FOSICH_Power. Note that the parameter FOSICH_Power defines the final output power in F-OSICH combining the effects of the values $G_{LOWPAR\text{-}GAIN}$ and $A_{PREAMBLE}$ as defined in 4.1.3.2.2 of Ref1.

3. An example for how to get the power density in the subcarrier for superframe preamble.
    - Input Parameters:
        - N_{FFT} =512 (FFTSize =2)
        - N_{GUARD} =32 (GuardSize =32)
        - EnablePreambleFrequencyReuse =0
        - EnableExpandedQPCH =0
        - PreambleUnitPower =10.0 dBm
        - FACQCH_Power =10.0 dBm
        - FOSICH_Power =10.0 dBm
    - Then we can get,
        - $N_{FFT,TDMPilot}$ =512
        - NumOccupiedPreambleSubcarriers =N_{FFT}-N_{GUARD} =480
        - Transmit power density of the channels the first five OFDM symbols ($Density_{UNIT}$):

          $Density_{UNIT}$ = PreambleUnitPower/NumOccupiedPreambleSubcarriers =-16.8 dBm/Subcarrier
        - The number of pilots transmitted in the OFDM symbol with index 5 for F-ACQCH (N_P) =120
        - Transmit power density of F-ACQCH ($Density_{F\text{-}ACQCH}$):

          $Density_{F\text{-}ACQCH}$ =FACQCH_Power/N_P = -10.8 dBm/Subcarrier

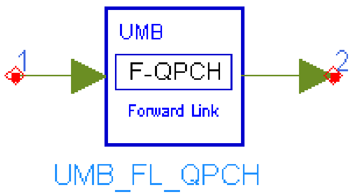
- The number of usable subcarriers transmitted in the OFDM symbols with index 6 and 7 for F-OSICH:
  NumOccupiedSubcarriersFOSICH =NumOccupiedPreambleSubcarriers =480
- Transmit power of F-OSICH ($Density_{F\text{-}OSICH}$):
  $Density_{F\text{-}OSICH}$ =FOSICH_Power/NumOccupiedSubcarriersFOSICH =-16.8 dBm/Subcarrier

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_QPCH

Symbol



Description: forward link QPCH (Quick Paging Channel) generator
Library: UMB, Signal Source

Parameters

Name	Description	Default	Type	Range
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
StartingSuperframe	the superframe index for the starting superframe	0	int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES	enum	
EnablePreambleFrequencyReuse	whether Preamble Frequency Reuse is enabled: NO, YES	NO	enum	
EnableExpandedQPCH	whether QPCH is expanded: NO, YES	NO	enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO	enum	
PilotPN	9-bit pilot PN for different sectors	10	int	[0,511]
SFNCellID	9-bit SFN cell ID	11	int	[0,511]
PreambleUnitPower	transmit unit power for these channels in the first five OFDM symbols in units of dBm	10.0	real	[-∞,∞]

Pin Inputs

Pin	Name	Description	Signal Type
1	ModulatedData	input modulated data	complex

Pin Outputs

Pin	Name	Description	Signal Type
2	SymbolOut	output data	complex

Notes/Equations

1. This model maps the QPSK modulation symbols of F-QPCH onto the OFDM symbols with indices 1 through 4 in the superframe preamble in superframes with an even value of SuperframeIndex.
   Each firing,
   - When EnablePreambleFrequencyReuse = NO and EnableExpandedQPCH = NO, $4*N_{FFT,TDMPilot}$ are consumed at pin ModulatedData where $N_{FFT,TDMPILOT}$ is defined as $N_{FFT,TDMPILOT} = \min(N_{FFT}, 512)$;
     When EnablePreambleFrequencyReuse = YES and EnableExpandedQPCH = NO, $N_{FFT,TDMPilot}/2$ are consumed at pin ModulatedData;
     When EnablePreambleFrequencyReuse = NO and EnableExpandedQPCH = YES,

$4*N_{FFT,TDMPilot}$ are consumed at pin ModulatedData;

When EnablePreambleFrequencyReuse = YES and EnableExpandedQPCH = YES, $N_{FFT,TDMPilot}$ /2 are consumed at pin ModulatedData.

- $4*N_{FFT}$ tokens are output at pin SymbolOut.

2. The modulation of the Forward Quick Paging Channel packet onto subcarriers depends on the value of EnablePreambleFrequencyReuse. If this parameter is set to YES, the Forward Quick Paging Channel transmission from different sectors occur different subcarrier sets (i.e., frequency reuse is enabled). Otherwise, the Forward Quick Paging Channel from different sectors occupies the same set of subcarriers and hence interfere with each other.
3. The modulation of the Forward Quick Paging Channel also depends on the value of EnableExpandedQPCH. This variable determines how many Forward Quick Paging Channel packets are transmitted in a single superframe. EnableExpandedQPCH may not be set to 1 unless floor((N_{FFT} - N_{GUARD} + 128)/512) > 1. If EnableExpandedQPCH is set to NO, then a single Forward Quick Paging Channel packet shall be transmitted in each superframe preamble containing the Forward Quick Paging Channel. If EnableExpandedQPCH is set to YES, then the number of Forward Quick Paging Channel packets transmitted in each superframe preamble shall be given by floor((N_{FFT} - N_{GUARD} + 128)/512).
   - EnablePreambleFrequencyReuse = NO and EnableExpandedQPCH = NO
     The i^{th} modulation symbol at the output of the modulator shall be mapped to the subcarrier with index $N_{FFT}/2 - N_{FFT,TDMPilot}/2 + (i \bmod N_{FFT,TDMPilot})$ of the OFDM symbol with index floor(i / $N_{FFT,TDMPilot}$) + 1 in the superframe preamble, if this subcarrier is a usable subcarrier and is additionally not a pilot subcarrier. The value of i ranges from 0 to $4*N_{FFT,TDMPILOT}$ - 1.
   - EnablePreambleFrequencyReuse = YES and EnableExpandedQPCH = NO
     This option is only allowed in Synchronous mode. The i^{th} modulation symbol at the output of the modulator shall be mapped to the subcarrier with index $N_{FFT}/2 - N_{FFT,TDMPilot}/2 + (ReuseIndex*N_{FFT,TDMPilot}/8) + (i \bmod N_{FFT,TDMPilot}/8)$ of the OFDM symbol with index floor(8*i/$N_{FFT,TDMPilot}$) + 1 in the superframe preamble, if this subcarrier is a usable subcarrier and is not a pilot subcarrier. The value of i ranges from 0 to ($N_{FFT,TDMPILOT}$)/2 - 1.
   - EnablePreambleFrequencyReuse = NO and EnableExpandedQPCH = YES
     The i^{th} modulation symbol at the output of the modulator of the k^{th} packet shall be mapped to the subcarrier with index 512*k + (i mod 512) of the OFDM symbol with index floor(i/512) + 1 in the superframe preamble, if this subcarrier is a usable subcarrier and is additionally not a pilot subcarrier. The value of i ranges from 0 to $4*N_{FFT,TDMPILOT}$ - 1.
   - EnablePreambleFrequencyReuse = YES and EnableExpandedQPCH = YES
     This option is only allowed in Synchronous mode. The i^{th} modulation symbol at the output of the modulator of the k^{th} packet shall be mapped to the subcarrier with index 512*k + ReuseIndex*512/8 + (i mod (512/8)) of the OFDM symbol with index floor(8*i/512) + 1 in the superframe preamble, if this subcarrier is a usable subcarrier and is not a pilot subcarrier. The value of i ranges from 0 to ($N_{FFT,TDMPILOT}$)/2 - 1.
4. Meanwhile the Forward Preamble Pilot Channel (F-PPICH) will be present only on OFDM symbols with index 1 and 2 within the preamble. Furthermore, the Forward Preamble Pilot Channel shall only modulate subcarriers in the

PreamblePilotSubcarrierSet which is related to EnablePreambleFrequencyReuse, EnableExpandedQPCH and SuperframeIndex. For more information, please refer to 4.1.3.2.3 of Ref1.

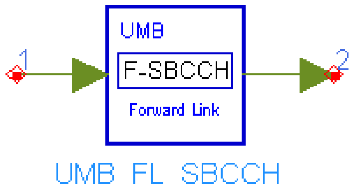
5. The output power of the Forward Quick Paging Channel is defined by the parameter PreambleUnitPower in dBm. Further, let n_{sc} denote the number of subcarriers which are mapped to F-QPCH and F-PPICH modulation symbols, then the power density at each modulation subcarrier is (PreambleUnitPower-10*log10(n_{sc}))dBm/Subcarrier.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_SBCCH

Symbol



Description: forward link SBCCH generator
Library: UMB, Signal Source

Parameters

Name	Description	Default	Type	Range
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
GuardSize	the size of guard subcarriers	32	int	
StartingSuperframe	the superframe index for the starting superframe	0	int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES	enum	
EnablePreambleFrequencyReuse	whether Preamble Frequency Reuse is enabled: NO, YES	NO	enum	
EnableExpandedQPCH	whether QPCH is expanded: NO, YES	NO	enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO	enum	
PilotPN	9-bit pilot PN for different sectors	10	int	[0,511]
SFNCellID	9-bit SFN cell ID	11	int	[0,511]
PreambleUnitPower	transmit unit power for these channels in the first five OFDM symbols in units of dBm	10.0	real	[-∞,∞]

Pin Inputs

Pin	Name	Description	Signal Type
1	ModulatedData	input modulated data	complex

Pin Outputs

Pin	Name	Description	Signal Type
2	SymbolOut	output data	complex

Notes/Equations

1. This model maps the QPSK modulation symbols of F-SBCCH onto the OFDM symbols with indices 1 through 4 in the superframe preamble in superframes with an odd value of SuperframeIndex.
   Each firing,
   - When EnablePreambleFrequencyReuse = NO, 4*$N_{FFT,TDMPilot}$ are consumed at pin ModulatedData where $N_{FFT,TDMPILOT}$ is defined as $N_{FFT,TDMPILOT}$ = min(N_{FFT}, 512); Otherwise $N_{FFT,TDMPilot}$/2 are consumed at pin ModulatedData.
   - 4*N_{FFT} tokens are output at pin SymbolOut.
2. The modulation of the Forward Secondary Broadcast Control Channel packet onto subcarriers depends on the value of EnablePreambleFrequencyReuse. If this

parameter is set to YES, the Forward Secondary Broadcast Control Channel transmission from different sectors occur different subcarrier sets (i.e., frequency reuse is enabled). Otherwise, the Forward Secondary Broadcast Control Channel from different sectors occupies the same set of subcarriers and hence interfere with each other.

- EnablePreambleFrequencyReuse = NO
  The i^{th} modulation symbol at the output of the modulator shall be mapped to the subcarrier with index $N_{FFT}/2 - N_{FFT,TDMPilot}/2 + (i \bmod N_{FFT,TDMPilot})$ of the OFDM symbol with index floor($i / N_{FFT,TDMPilot}$) + 1 in the superframe preamble, if this subcarrier is a usable subcarrier and is additionally not a pilot subcarrier. The value of i ranges from 0 to $4*N_{FFT,TDMPILOT} - 1$.
- EnablePreambleFrequencyReuse = YES
  This option is only allowed in Synchronous mode.
  In this case, each Forward Secondary Broadcast Control Channel packet is modulated only on a subset of subcarriers in the first OFDM symbol with indices 1 through 4 of the superframe preamble.
  The i^{th} modulation symbol at the output of the modulator shall be mapped to the subcarrier with index $N_{FFT}/2 - N_{FFT,TDMPilot}/2 + ReuseIndex* N_{FFT,TDMPilot}/8 + (i \bmod N_{FFT,TDMPilot}/8)$ of the OFDM symbol with index floor($8*i/N_{FFT,TDMPilot}$) + 1 in the superframe preamble, if this subcarrier is a usable subcarrier and is not a pilot subcarrier.The value of i ranges from 0 to $N_{FFT,TDMPILOT}/2 - 1$.

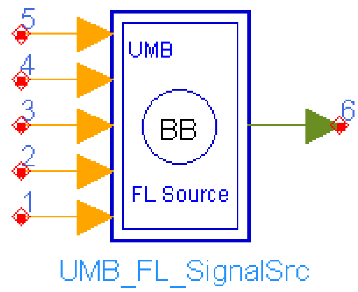
3. The Forward Preamble Pilot Channel (F-PPICH) will be present only on OFDM symbols with index 1 and 2 within the preamble. Furthermore, the Forward Preamble Pilot Channel shall only modulate subcarriers in the PreamblePilotSubcarrierSet which is related to EnablePreambleFrequencyReuse, EnableExpandedQPCH and SuperframeIndex. For more information, please refer to 4.1.3.2.3 of Ref1.
4. The ouput power of the Forward Secondary Broadcast Control Channel is defined by the parameter PreambleUnitPower in dBm. Further, let n_{sc} denote the number of subcarriers which are mapped to F-SBCCH and F-PPICH modulation symbols, then the power density at each modulation subcarrier is (PreambleUnitPower-10*log10(n_{sc})) dBm/Subcarrier.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_SignalSrc

Symbol



Description: 3GPP2 UMB Forward Link Signal Source
Library: UMB,Signal Source

Parameters

Name	Description	Default	Type	Range
OutputFrameFormat	output superframe format: Full Superframe, Compact Superframe	Full Superframe	enum	
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0	int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25	int	
OversamplingOption	Oversampling ratio option: Ratio 1, Ratio 2, Ratio 4, Ratio 8, Ratio 16, Ratio 32	Ratio 2	enum	
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
Ncp	the index for Cyclic Prefix (Tcp=Ncp*FFTSize*Tchip/16): Ncp 1, Ncp 2, Ncp 3, Ncp 4	Ncp 1	enum	
GuardSize	the size of guard subcarriers	32	int	
RsChMuxMode	The mux mode for resource channels: Mode 1, Mode 2	Mode 2	enum	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
NumDRCHSubzones	the number of DRCH subzones	0	int	[0,FFTSize/SubzoneSize-1]
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
EnableBRCHSubzoneCycling	whether the cycling for BRCH subzones is enabled: NO, YES	NO	enum	
EnableHalfDuplexOperation	whether the half duplex operation is enabled: NO, YES	NO	enum	
StartingSuperframe	the superframe index for the starting superframe	0	int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is	YES	enum	

	increased from superframe to superframe: NO, YES			
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO	enum	
PilotPN	9-bit pilot PN for different sectors	0	int	[0,511]
FDCH_NumPackets	number of data packets transmitted in F-DCH; At most four packets are supported	1	int	[1,4]
FDCH_1_PFIndex	the packet format index for the first data packet transmitted in F-DCH	1	int	[0,14]
FDCH_1_NodeID	the array of NodeID allocated to the first data packet transmitted in F-DCH	{31}	int array	
FDCH_1_MACID	the MAC ID of the first data packet (Access Terminal) transmitted in F-DCH	1	int	[0,511]
FDCH_1_NumHARQTrans	the number of HARQ transmissions for the first data packet transmitted in F-DCH	1	int	[1,25]
FDCH_1_HARQInterlace	the number of frames in HARQ interlace structure for the first data packet transmitted in F-DCH	6	int	[1,24]
FDCH_1_StartingFrame	the starting frame index from which the first data packet is allocated in F-DCH	0	int	[0,24]
FDCH_1_NumFrames	the number of frames on which the first data packet is allocated in F-DCH	25	int	[1,25]
FDCH_1_PowerDensity	the power density for the first data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}	real array	[-∞,∞]
FDCH_2_PFIndex	the packet format index for the second data packet transmitted in F-DCH	1	int	[0,14]
FDCH_2_NodeID	the array of NodeID allocated to the second data packet transmitted in F-DCH	{32}	int array	
FDCH_2_MACID	the MAC ID of the second data packet (Access Terminal) transmitted in F-DCH	2	int	[0,511]
FDCH_2_NumHARQTrans	the number of HARQ transmissions for the second data packet transmitted in F-DCH	1	int	[1,25]
FDCH_2_HARQInterlace	the number of frames in HARQ interlace structure for the second data packet transmitted in F-DCH	6	int	[1,24]
FDCH_2_StartingFrame	the starting frame index from which the second data packet is allocated in F-DCH	0	int	[0,24]
FDCH_2_NumFrames	the number of frames on which the second data packet is allocated in F-DCH	25	int	[1,25]
FDCH_2_PowerDensity	the power density for the	{-16.0}	real	[-∞,∞]

	second data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)		array	
FDCH_3_PFIndex	the packet format index for the third data packet transmitted in F-DCH	1	int	[0,14]
FDCH_3_NodeID	the array of NodeID allocated to the third data packet transmitted in F-DCH	{33}	int array	
FDCH_3_MACID	the MAC ID of the third data packet (Access Terminal) transmitted in F-DCH	3	int	[0,511]
FDCH_3_NumHARQTrans	the number of HARQ transmissions for the third data packet transmitted in F-DCH	1	int	[1,25]
FDCH_3_HARQInterlace	the number of frames in HARQ interlace structure for the third data packet transmitted in F-DCH	6	int	[1,24]
FDCH_3_StartingFrame	the starting frame index from which the third data packet is allocated in F-DCH	0	int	[0,24]
FDCH_3_NumFrames	the number of frames on which the third data packet is allocated in F-DCH	25	int	[1,25]
FDCH_3_PowerDensity	the power density for the third data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}	real array	[-∞,∞]
FDCH_4_PFIndex	the packet format index for the fourth data packet transmitted in F-DCH	1	int	[0,14]
FDCH_4_NodeID	the array of NodeID allocated to the fourth data packet transmitted in F-DCH	{34}	int array	
FDCH_4_MACID	the MAC ID of the fourth data packet (Access Terminal) transmitted in F-DCH	4	int	[0,511]
FDCH_4_NumHARQTrans	the number of HARQ transmissions for the fourth data packet transmitted in F-DCH	1	int	[1,25]
FDCH_4_HARQInterlace	the number of frames in HARQ interlace structure for the fourth data packet transmitted in F-DCH	6	int	[1,24]
FDCH_4_StartingFrame	the starting frame index from which the fourth data packet is allocated in F-DCH	0	int	[0,24]
FDCH_4_NumFrames	the number of frames on which the fourth data packet is allocated in F-DCH	25	int	[1,25]
FDCH_4_PowerDensity	the power density for the fourth data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}	real array	[-∞,∞]
FCPICH_HoppingMode	the hopping mode for F-CPICH: Random, Deterministic	Random	enum	
FCPICH_PilotSpacing	the subcarrier spacing for common pilots	16	int	[1,∞)

FCPICH_PowerDensity	the power density for F-CPICH (defined as power(dBm) per modulation symbol)	-16.0	real	[-∞,∞]
CodeOffset	code offset between 0 and 2 for Forward Dedicated Pilot Channel	0	int	[0,2]
DPICHFormat	the Forward Dedicated Pilot Channel format for Forward Data Channel: Format 0, Format 1, Format 2	Format 0	enum	[0,1]
EnableFLCS	whether the Forward Link Control Segment is enabled: NO, YES	NO	enum	
FLCS_NumBlocks	the number of blocks (tiles) allocated for FLCS, only valid when EnableFLCS is YES	3	int	[3,∞)
FLCS_UseDRCH	whether FLCS is on DRCH or on BRCH, only valid when EnableFLCS is YES: NO, YES	NO	enum	
FLCS_PowerDensity	the power density for FLCS (defined as power(dBm) per modulation symbol), only valid when EnableFLCS is YES	-16.0	real	[-∞,∞]
EnablePreamble	whether the Preamble is output: NO, YES	NO	enum	
EnablePreambleFrequencyReuse	whether Preamble Frequency Reuse is enabled: NO, YES	NO	enum	
EnableExpandedQPCH	whether QPCH is expanded: NO, YES	NO	enum	
SFNCellID	9-bit SFN cell ID	12	int	[0,511]
K_OSI	the OSIValue from the SFP MAC Protocol	0	int	[0,2]
K_SD	the 9-bit AcqInfo block provided by the SFP MAC Protocol	0	int	[0,511]
SBCCHScramblingSeed	F-SBCCH Scrambling Seed	1	int	[0,511]
QPCHScramblingSeed	F-QPCH Scrambling Seed	1	int	[0,511]
PreambleUnitPower	transmit unit power for these channels in the first five OFDM symbols in units of dBm	10.0	real	[-∞,∞]
FACQCH_Power	transmit unit power for F-ACQCH in units of dBm	10.0	real	[-∞,∞]
FOSICH_Power	transmit unit power for F-OSICH in units of dBm	10.0	real	[-∞,∞]

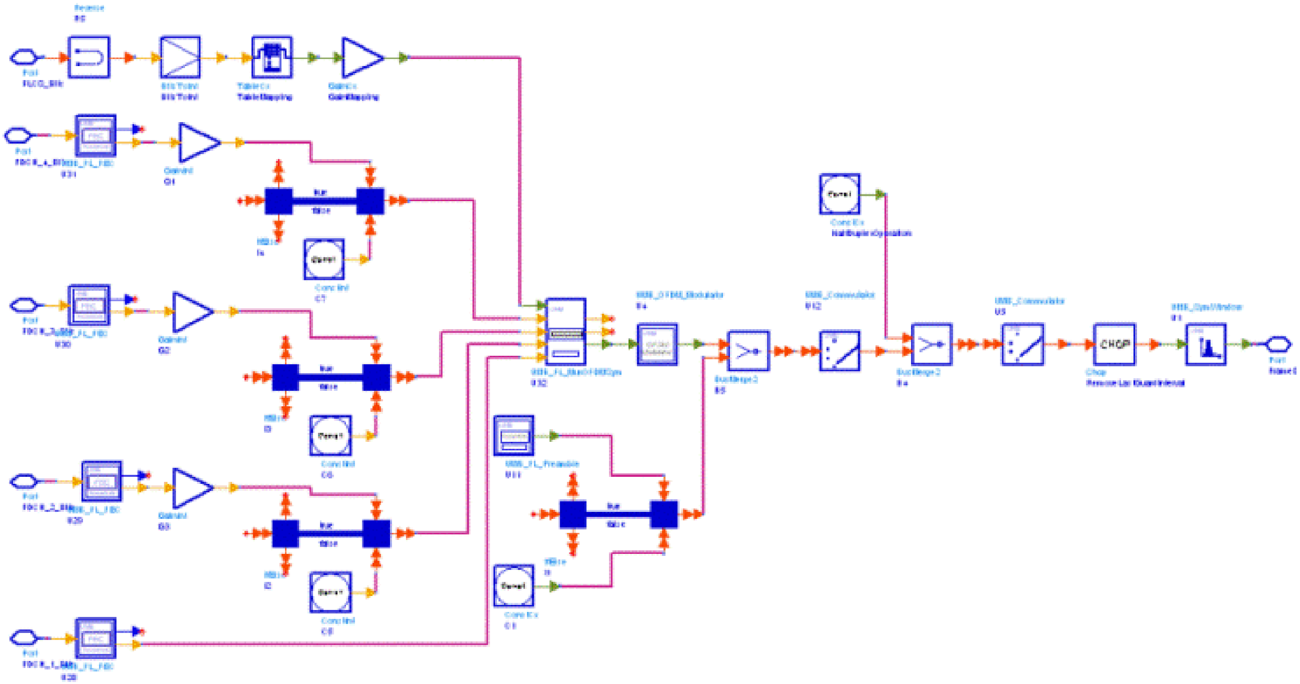
Pin Inputs

Pin	Name	Description	Signal Type
1	FDCH_1_Bits	input bits for the first data packet in F-DCH	int
2	FDCH_2_Bits	input bits for the second data packet in F-DCH	int
3	FDCH_3_Bits	input bits for the third data packet in F-DCH	int
4	FDCH_4_Bits	input bits for the fourth data packet in F-DCH	int
5	FLCS_Bits	input bits for FLCS	int

Pin Outputs

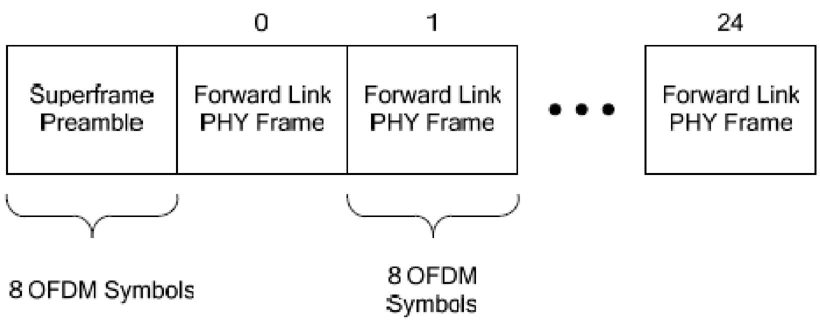
Pin	Name	Description	Signal Type
6	FrameData	output data	complex

1. This subnetwork is to implement 3GPP2 UMB Forward Link baseband source. The schematic for this subnetwork is shown in the following figure.

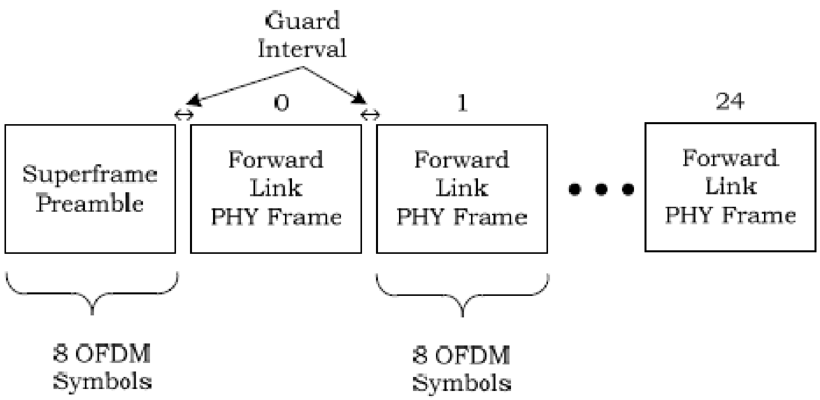


UMB_FL_SignalSrc Schematic

2. Transmission on the Forward Link is divided into units of superframes. Each Forward Link superframe consists of a superframe preamble followed by a sequence of $N_{PHYFrames}$ = 25 Forward Link PHY Frames. If EnableHalfDuplexOperation = 1, then each of the Forward Link PHY Frames is separated by a guard interval, whereas there is no separation when EnableHalfDuplexOperation = 0.
Each superframe has an associated SuperframeIndex that is incremented every superframe (SuperframeIndex may also be fixed when SuperframeIdxIncreased = NO). Both the superframe preamble and the Forward Link PHY Frames further consist of a sequence of OFDM symbols. The structure of a Forward Link superframe is shown in Superframe Structure when EnableHalfDuplexOperation=0 for EnableHalfDuplexOperation = 0 and in Superframe Structure when EnableHalfDuplexOperation=1 for EnableHalfDuplexOperation = 1.

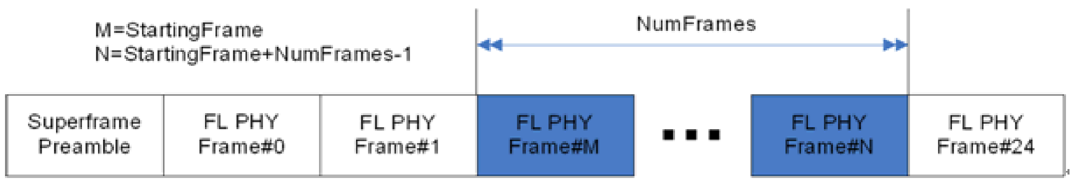


Forward Link Superframe Structure when EnableHalfDuplexOperation = 0



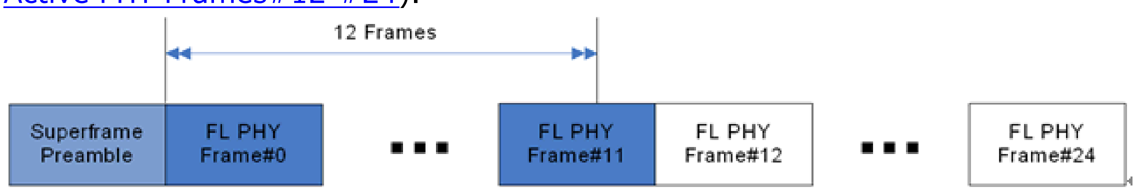
Forward Link Superframe Structure when EnableHalfDuplexOperation = 1

3. The supported 3GPP2 UMB Forward Link features in this source is described in *3GPP2 UMB Forward Link Features* (3gpp2umb).
4. Two Superframe Structure modes are supported in the library.
    - OutputFrameFormat = Full Superframe
    In this mode, the output PHY Frame structure is the standard-compatible complete Forward Link Superframe Structure which consists of a superframe preamble followed by a sequence of $N_{FLPHYFrames}$ = 25 Forward Link PHY Frames. Two parameters (StartingFrame and NumFrames) in this Forward Link source specify the active PHY Frames in each superframe as shown in the following figure:

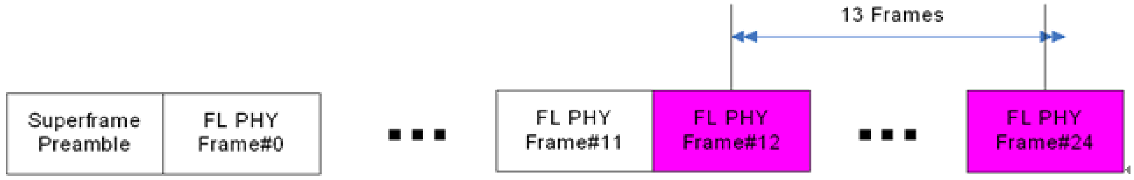


Active PHY Frames on FL Superframe Structure

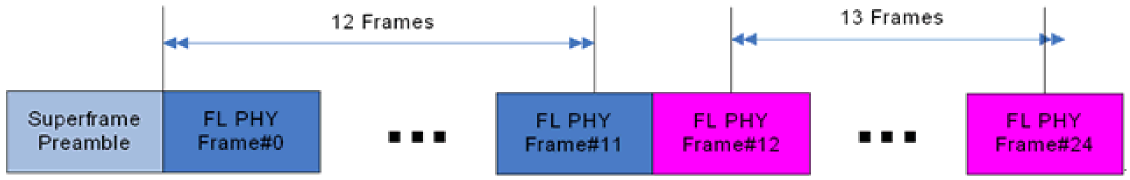
For each signal source, all the operations are performed only on these active PHY Frames whose range is from PHY Frame#(StartingFrame) to PHY Frame#(StartingFrame+NumFrames-1). Note that the time of the non-active PHY Frames is left blank which means the output signal source is still the complete superframe structure.
This mode is suitable for generating flexible Forward Link Superframe Sources with different configurations in different PHY Frames.
The example UMB_FL_Demo under the workspace UMB_Tx_wrk show an example in which the source RF_Frame0_11 has the active PHY Frames from Frame#0 to Frame#11 (see Active PHY Frame#0-#11), and the source RF_Frame12_24 has the active PHY Frames from Frame#12 to Frame#24 (see Active PHY Frames#12-#24).



An example with active PHY Frames from Frame#0 to Frame#11



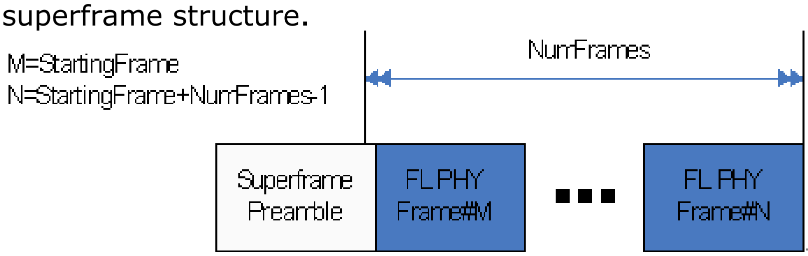
An example with active PHY Frames from Frame#12 to Frame#24



Combined FL PHY Superframe Structure

The configurations in PHY Frames#0~11 may be different from configurations in PHY Frames#12~24. Then these two sources are combined together to form a new source (see Combined PHY Frames).

- OutputFrameFormat = Compact Superframe
In this mode, the output PHY Frame structure is the compact Forward Link Superframe Structure which consists of a superframe preamble followed by a sequence of only $N_{FLPHYFrames}$ = NumFrames Forward Link PHY Frames. Two parameters (StartingFrame and NumFrames) in this Forward Link source specify the active PHY Frames which are included in each superframe as shown in Compact Superframe Structure. All the operations are only performed on these active PHY Frames whose range is from PHY Frame#(StartingFrame) to PHY Frame#(StartingFrame+NumFrames-1). Note that the time of the non-active PHY Frames is cut which means the output signal source is not the complete superframe structure.



Compact FL PHY Superframe Structure

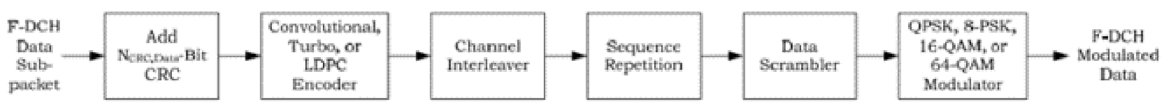
This mode is suitable for the reveiver measurement simulation in order to reduce the simulation time.

5. The OFDM symbol parameters for different FFT sizes shall be as specified in *PHY OFDM Symbol Numerology* (3gpp2umb); The OFDM superframe parameters for Forward Link shall be as specified in *PHY OFDM Superframe Numerology* (3gpp2umb); The channels for Forward Link supported is specified in *Forward Link Supported Features* (3gpp2umb).
6. **Superframe Preamble** is described in *Superframe Preamble* (3gpp2umb).
7. **Pilot Channels** is described in *Pilot Channels* (3gpp2umb).
8. **Forward Data Channel**
    1. The resources allocated to Forward Data Channel (F-DCH) are organized by base nodes on which a set of hop-ports are mapped. The mapping of hop-ports to base nodes in Forward Link is described in 6.5.6 of Ref2. when RsChMuxMode = Mode 2, each base node maps to MinHopPortsPerNode hop-ports, the first

MinHopPortsPerNode hop-ports (indices 0 to MinHopPortsPerNode-1) to the base node with the lowest NodeID, the second MinHopPortsPerNode hop-ports to the next base node, etc., until all hop-ports are mapped for all Q_{SDMA} sub-trees, where MinHopPortsPerNode=16 and Q_{SDMA} is fixed to be 1 in ADS UMB library.

In RsChMuxMode Mode 1, the first N_{DRCH} DRCH hop-ports are mapped to the first N_{DRCH}/MinHopPortsPerNode base nodes in the SDMA sub-tree 0 and the next N_{FFT} BRCH hop-ports are mapped to the next (N_{FFT}-N_{DRCH})/MinHopPortsPerNode base nodes in SDMA sub-tree 0. Note that The number of hop-ports in the BRCH base nodes may not be equally MinHopPortsPerNode.

2. For each data packet in F-DCH, it shall be converted into one or more subpackets for transmission (refer to *Packet Splitting* (3gpp2umb)). The input information bits shall use one or more sequences of CRC insertion, encoding, channel interleaving, sequence repetition, and data scrambling operations. Regarding coding schemes, only convolutional and turbo coders are supported. Note that in channel interleaving for Turbo Coder, the output sequence always consists of the permuted U sequence followed by the permuted V0/V'0 sequence followed by the permuted V1/V'1 sequence, and the data puncture depending on the packet size N_{PACKET_BITS} (see *Forward Link Packet Size Computation* (3gpp2umb)), and MaxRateOneFifthPacketSize, MaxRateOneThirdPacketSize and MaxRateOneHalfPacketSize for Forward Data Channel (F-DCH) is not supported. The coding and modulation structure is given in the following figure.



Channel Structure for Forward Data Channel (F-DCH)

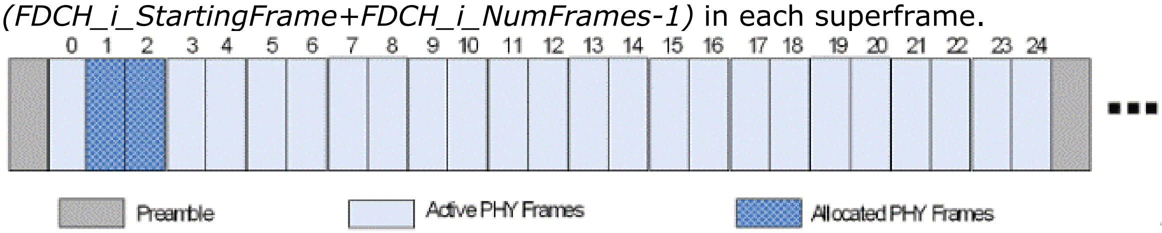
For each data packet in F-DCH, the CRC coding, channel coding (rate-1/3 convolutional coder or rate-1/5 turbo coder) and channel interleaving are performed in *UMB FL FEC* (3gpp2umb); Others are performed in *UMB FL MuxOFDMSym* (3gpp2umb).

3. The parameter FDCH_NumPackets determines the number of data packets allocated in the Forward Data Channel (F-DCH). At most four data packets are allowed (i.e. FDCH_NumPackets is an integer between 1 and 4). The i^{th} group of eight parameters (FDCH_i_PFIndex, FDCH_i_NodeID, FDCH_i_MACID, FDCH_i_NumHARQTrans, FDCH_i_HARQInterlace, FDCH_i_StartingFrame, FDCH_i_NumFrames and FDCH_i_PowerDensity) is defined for the i^{th} data packet, and only the first *FDCH_NumPackets* groups are active. For example, when FDCH_NumPackets =1, then only the eight parameters of the first group are valid.

Each data packet in F-DCH should belong to the same structure (DRCH or BRCH). The following is an example for how to set the NodeID:
- FFTSize = FFT 512
- RsChMuxMode = Mode 2
- SubzoneSize = Size 64
- NumDRCHSubzones = 1
- FDCH_1_NodeID = {31, 32, 33, 34}
  Then we can get:
- Base nodes: from 31 to 62
- N_{DRCH} = NumDRCHSubzones*SubzoneSize = 64
- Number of base nodes for DRCH subzones: N_{DRCH}/MinHopPortsPerNode = 4

- Base nodes for DRCH subzones: 31, 32, 33, 34
- The first data packet in F-DCH belongs to DRCH structure, and occupies all the hop-ports in DRCH subzones.

4. Note that the nodes allocated to the data packets should not be overlapped.
5. The power density for the ith data packet in F-DCH is defined in the parameter FDCH_i_PowerDensity. The allocation of power density has three different formats which the same as the allocation in Reverse Link:
    - Format 0: Each tile allocated to the data packet in F-DCH in each PHY Frame has the same power density.
    - Format 1: Different tiles allocated to the data packet in F-DCH in the same PHY Frame may have the different power density, but the same tiles in all the PHY Frames have the same power density.
    - Format 2: Each tile allocated to the data packet in F-DCH in each PHY Frame has the different power density.
6. The following messages are displayed on the window Status/Summary after the simulation finishes:
    - HARQ transmission status for each active data packet in F-DCH.
    - The usable hop-ports allocated for each active data packet in F-DCH.
    - The spectral efficiency allocated for each active data packet in F-DCH.
    - The number of information bits excluding CRC; Coding scheme (CC or TC); Subpacket splitting for each active data packet in F-DCH.
    - The base nodes allocated for each active data packet in F-DCH.
    - The usable base nodes allocated for each active data packet in F-DCH.
    - The Resource Channel Structure for each active data packet in F-DCH.
    - The power density Format employed for each active data packet in F-DCH.
7. For each data packet in F-DCH, two transmission modes are supported: non-HARQ transmission and HARQ transmission.
    1. Non-HARQ Transmission
       This mode is available when FDCH_i_NumHARQTrans is set to 1.
       In this mode, the parameter FDCH_i_HARQInterlace is useless.
       In this mode, the data packet transmits only one time on the PHY Frames from Frame#*FDCH_i_StartingFrame* to Frame#*(FDCH_i_StartingFrame+FDCH_i_NumFrames-1)* in each superframe.

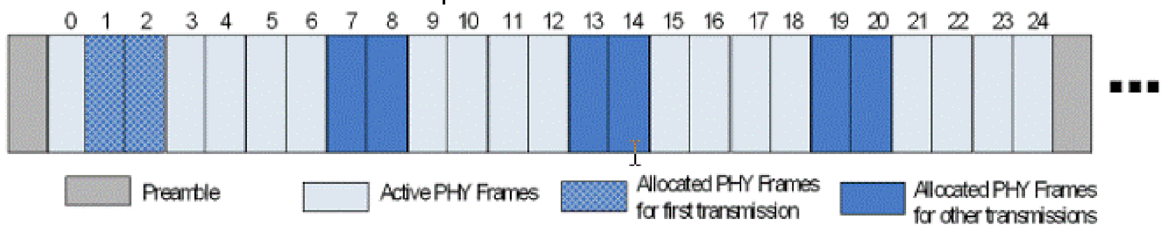


Non-HARQ Transmission for Forward Data Channel (F-DCH)

       The figure above gives an example where two PHY Frames are allocated to the first data packet in F-DCH in each superframe. The corresponding parameters are set as follows:

        - StartingFrame =0
        - NumFrames =25
        - FDCH_NumPackets =1
        - FDCH_1_NumHARQTrans =1
        - FDCH_1_StartingFrame =1
        - FDCH_1_NumFrames =2
    2. HARQ Transmission
       This mode is available when FDCH_i_NumHARQTrans is set to the value other than 1.
       Note that when HARQ transmission index is greater than six, the last

(sixth) modulation order given in table 6-4 of Ref2 will be adopted to modulate the scrambled bit sequence.



HARQ Transmission for Forward Data Channel (F-DCH)

The figure above gives an example where six interlace structure with two frame transmission is employed for the first data packet in F-DCH in each superframe. The corresponding parameters are set as follows:

- StartingFrame =0
- NumFrames =25
- FDCH_NumPackets =1
- FDCH_1_NumHARQTrans =4
- FDCH_1_HARQInterlace =6
- FDCH_1_StartingFrame =1
- FDCH_1_NumFrames =2

3. Note that there are some restrictions when HARQ transmissions are employed.
   - All the HARQ interlaces should be allocated in the active PHY Frames (i.e. Frames from Frame#StartingFrame to Frame#(StartingFrame+NumFrames-1).
   - The associated acknowledgement transmissions in RL PHY Frames are not supported. The number of HARQ transmission and retransmissions for the i^{th} data packet is defined by the parameter FDCH_i_NumHARQTrans.
     The HARQ transmission and retransmissions should not span upon two or more consecutive FL Superframes in ADS UMB library. In the example given in the figure above, FDCH_1_NumHARQTrans =5 is not allowed because the number of PHY Frames needed is 30 (=6*5) which will span on two consecutive superframes (since each superframe only has 25 PHY Frames).

9. **Forward Link Control Segment**
   1. In every PHY Frame starting from Frame#*StartingFrame* to Frame#(*StartingFrame+NumFrames-1*) in the Forward Link superframe, the Forward Link Control Segment, carrying the Forward Link control channels, may be allocated with a set of FLCS_NumBlocks hop-port blocks if the EnableFLCS = YES.
   2. The Forward Link Control Segment shall operate on all DRCH resources or all BRCH resources. The choice of DRCH or BRCH is specified by the parameter FLCS_UseDRCH.
   3. The Forward Link Control Segment employs third order diversity in which any three hop-port blocks with consecutive indices allocated to the Forward Link Control Segment are located in three different control hopping zones. Hence three subcarrier-symbols of each Forward Link Control Segment resource shall be placed in three hop-port blocks with consecutive hop-port block indices referred to as TileSegments.
   4. When the Forward Link Control Segment shall operate on all BRCH resources, since the total number of subcarrier-symbols available for control channels in every hop-port block is 110, there can be at most 110/3*FLCS_NumBlocks

Forward Link Control Segment resources in the Common Segment. Hence, the total number of Forward Link Control Segment resources consumed in each PHY frame is 36*FLCS_NumBlocks; The total number of Forward Link Control Segment resources consumed in each superframe is 36*FLCS_NumBlocks*NumFrames.

5. When the Forward Link Control Segment shall operate on all DRCH resources, since the total number of subcarrier-symbols available for control channels in every hop-port block is (128-NumPilots), where NumPilots is the number of common pilot subcarriers in this block, there can be at most (128-NumPilots)/3*FLCS_NumBlocks Forward Link Control Segment resources in the Common Segment. In this library, we assume that the total number of Forward Link Control Segment resources are consumed in each PHY frame is (128/3)*FLCS_NumBlocks, and only ((128-NumPilots)/3)*FLCS_NumBlocks resources may be modulated on the Forward Link Control Segment in each PHY frame.
6. In ADS UMB library, only the Common Segment is present in the Forward Link Control Segment, while the LAB Segment is not available. The encoding, channel interleaving and data scrambling for all the Common Forward Control Channels in the Common Segment are not implemented. Instead, the random QPSK data are generated with the same power density defined in the parameter FLCS_PowerDensity to represent the output of these channels. The Forward Dedicated Pilot Channel format 0 is always used for each Forward Link Control Segment block (tile), and the power density for the pilots is equal to the density for the data defined in the parameter FLCS_PowerDensity. The CodeOffset for Forward Dedicated Pilot Channel always takes value 0 in each Forward Link Control Segment block (tile).

10. Parameter Details
    - Basic Parameters
        - The parameters StartingFrame and NumFrames specify the active PHY Frames in each superframe as described above.
        - OversamplingOption specifies the oversampling ratio of transmission signal. There are six oversampling ratios (1x, 2x, 4x, 8x, 16x, 32x) to support in this source.
        - FFTSize specifies the size of FFT. Sizes 2048, 1024, 512, 256 and 128 are supported.
        - Ncp specifies a multiplicative factor that determines the cyclic prefix duration ($T_{CP}=N_{CP}N_{FFT}T_{CHIP}/16$) as shown in Table 2.7.2.2-1 in Ref1. Ncp 1, 2, 3 and 4 are supported.
        - GuardSize specifies the total number of guard subcarriers. In this source, GuardSize should be an integer multiple of 16.
        - RsChMuxMode specifies the multiplexing resource channel structure. If RsChMuxMode = 1, the DRCH structures are punctured onto the BRCH structures. If RsChMuxMode = 2, the DRCH and BRCH structures are only used on different subzones.
        - SubzoneSize specifies the size of a subzone on the Reverse Link. Size 64 and 128 are supported.
        - NumDRCHSubzones specifies the number of DRCH subzones in the Forward Link.
        - MaxPHYSubPacketSize specifies the maximum information bits in each subpacket. When the input packet size is larger than MaxPHYSubPacketSize, the packet shall be split into multiple subpackets. Size of 4096 bits and 8192 bits are supported according to the specification.
        - EnableBRCHSubzoneCycling specifies whether the mapping of BRCH subzones is cycled. This parameter is usable when RsChMuxMode = 2. Please refer to 2.14.5.1 of Ref1 for more information.

- EnableHalfDuplexOperation determines whether the sector supports half-duplex terminals.
- StartingSuperframe specifies the superframe index in the first superframe.
- SuperframeIdxIncreased specifies whether the superframe number for the superframe is increased. When FrameIncreased is set to YES, the superframe index in the first superframe is StartingSuperframe, and the index in the second superframe is StartingSuperframe+1, and so on. When FrameIncreased is set to NO, the superframe indices in al the superframes are StartingSuperframe.
- GloballySynchronous specifies whether the sector time-base reference is aligned to UTC.
- PilotPN specifies the integer identifier of the Sector in the range of [0, 511].

- Parameters for Forward Data Channel (F-DCH)
  - FDCH_NumPackets specifies the number of data packets transmitted in F-DCH. At most four data packets are allowed in F-DCH, where the allocation for the ith data packet is defined in the parameters with the prefix of FDCH_i_. Each data packet has the same parameters. In the following, the parameters for the first data packet are taken as the example to describe.
  - FDCH_1_PFIndex specifies the packet format (PF) index for the first data packet in F-DCH, which specifies the spectral efficiency, maximum number of transmissions, and the modulation format to be used for each transmission of a data packet. The indexing for the packed formats is described in Table 6-4 in Ref2.
  - FDCH_1_NodeID specifies the nodes allocated to the first data packet in F-DCH (see *Nodes and Hop-ports Allocation* (3gpp2umb)). This is an array parameter which means multiple nodes may be assigned to F-DCH. The nodes assigned to the first data packet in F-DCH can be the base nodes or parents (ancestors) nodes. For example, for N_{FFT}=512,

    MinHopPortsPerNode=16, and Q_{SDMA}=1, FDCH_1_NodeID = {15,16}

    (corresponding to the base-nodes {31, 32, 33, 34}) is allowed. Since the SDMA transmission is not supported, Q_{SDMA} is always equal to 1. The

    definition of FL nodes is described in 6.5.6 in Ref2.
  - FDCH_1_MACID specifies the MACID of the first data packet (Access Terminal). This parameter is used for the data scrambling operation.
  - FDCH_1_NumHARQTrans specifies the transmission mode for the first data packet. Non-HARQ transmission is employed when FDCH_1_NumHARQTrans=1; Otherwise HARQ transmission is employed.
  - FDCH_1_HARQInterlace specifies the number of PHY Frames for HARQ interlace structure when FDCH_1_NumHARQTrans is set to the value other than 1.
  - The parameters FDCH_1_StartingFrame and FDCH_1_NumFrames specify the active PHY Frames in which the first data packet is transmitted. Note that the range of the active PHY Frames for the first data packet (from Frame#(FDCH_1_StartingFrame) to Frame#(FDCH_1_StartingFrame + FDCH_1_NumFrames-1)) should be restricted in the range of the active PHY Frames for the this signal source (from Frame#(StartingFrame) to Frame#(StartingFrame + NumFrames-1)).
  - FDCH_1_PowerDensity specifies the power density for the first data packet in F-DCH which is defined as power (dBm) per modulation symbol. In 3GPP2 UMB system, the subcarrier spacing is 9.6KHz, so the power density can be described as FDCH_1_PowerDensity dBm/9.6KHz. Three input formats for FDCH_1_PowerDensity are allowed which is the same as the definition in the parameter RODCH_PowerDensity:
    Format 0: Each tile allocated to the first data packet in F-DCH in each PHY Frame has the same power density.

Format 1: Different tiles allocated to the first data packet in F-DCH in the same PHY Frame may have the different power density, but the same tiles in all the PHY Frames have the same power density.
Format 2: Each tile allocated to the first data packet in F-DCH in each PHY Frame has the different power density.
Please refer to the definition of RODCH_PowerDensity for more information.

- Parameters for Pilot Channels
  - FCPICH_HoppingMode specifies the hopping mode for the Forward Common Pilot Channel (F-CPICH) which could be Random or Deterministic. In Random mode, the CommonPilotFreqInterlace shall be set to output modulo CommonPilotSpacing of the hash function defined in 2.5.4, with a seed related to the OFDM Symbol within the Forward Link PHY Frame and SectorSeed. In Deterministic mode, the CommonPilotFreqInterlace shall be set to set to PilotPN mod CommonPilotSpacing, if 0 <= j < 4, and shall be set to (PilotPN + CommonPilotSpacing/4) mod FCPICH_PilotSpacing otherwise. Here j denotes the index of the OFDM symbol within the PHY Frame.
  - FCPICH_PilotSpacing specifies the subcarrier spacing between two consecutive pilots in the Forward Common Pilot Channel (F-CPICH).
  - FCPICH_PowerDensity specifies the power density for all subcarriers in the Forward Common Pilot Channel (F-CPICH).
  - CodeOffset specifies an value between 0 and 3 for the complex values of the Forward Dedicated Pilot Channel (F-DPICH) modulation symbol for Forward Data Channel (F-DCH)
  - DPICHFormat specifies the Forward Dedicated Pilot Channel format for Forward Data Channel (F-DCH) which could be Format 0, Format 1 or Format 2.
- Parameters for Forward link Control Segment (FLCS)
  - EnableFLCS specifies whether the Forward Link Control Segment is transmitted.
  - FLCS_NumBlocks specifies the number of blocks (tiles) allocated to Forward Link Control Segment. This value should not be greater than the maximum number of available blocks (tiles) for DRCH 0r BRCH structure in the PHY frames.
  - FLCS_UseDRCH specifies the structure (DRCH or BRCH) for the Forward Link Control Segment. BRCH is used when FLCS_UseDRCH=NO; DRCH is used otherwise.
  - FLCS_PowerDensity specify the power density for the Forward Link Control Segment. All the subcarriers (data and pilots) in the Forward Link Control Segment transmit with the same power density FLCS_PowerDensity.
- Parameters for Superframe Preamble
  - EnablePreamble specifies whether the Preamble is transmitted. When EnablePreamble=NO, the time corresponding to Preamble is left blank. This parameter can be useful when multiple sources are added together to form a complicated Forward Link superframe, in which EnablePreamble is set to YES in one of the sources while EnablePreamble is set to NO in the others. The setting above assures that only one Preamble exists in the Forward Link superframes.
  - EnablePreambleFrequencyReuse specifies whether frequency reuse on the superframe preamble is enabled. This parameter affects the modulation of the following channels: F-PBCCH, F-PPICH, F-SBCCH and F-QPCH.
  - EnableExpandedQPCH specifies the modulation of the Forward Quick Paging Channel (F-QPCH). This parameter should not be set to 1 unless $(N_{FFT} - N_{GUARD} + 128)/512 > 1$. EnableExpandedQPCH is set to 0, then a single Forward Quick Paging Channel packet shall be transmitted in each superframe preamble containing the Forward Quick Paging Channel. If

EnableExpandedQPCH is set to 1, then the number of Forward Quick Paging Channel packets transmitted in each superframe preamble shall be given by (N_{FFT} - N_{GUARD} + 128)/512.

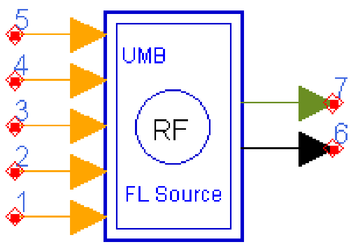
- SFNCellID is a nine-bit quantity which is used to get the SFNPhase in both Synchronous and Asynchronous modes.
- K_OSI is the OSI Value which is received from the SFP MAC Protocol (Ref2) for the modulation of TDM Pilots 2 and 3 (F-OSICH) of the superframe preamble.
- K_SD specifies the nine-bit information from the AcqInfo block which is provided by the SFP MAC Protocol (Ref2) for the modulation of TDM Pilots 3 (F-OSICH) of the superframe preamble.
- PreambleUnitPower specifies the transmit unit power in the first five OFDM symbols of the superframe preamble, defined in units of dBm.
- FACQCH_Power specifies the transmit power in the OFDM symbol TDM Pilots 1 (F-ACQCH) of the superframe preamble, defined in units of dBm.
- FOSICH_Power specifies the transmit power in the OFDM symbol TDM Pilots 2 and 3 (F-OSICH) of the superframe preamble, defined in units of dBm.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_FL_SignalSrc_RF

Symbol



UMB_FL_SignalSrc_RF

Description: 3GPP2 UMB Forward Link RF Signal Source
Library: UMB,Signal Source

Parameters

Name	Description	Default	Unit	Type	Range
RF_Parameters					
ROut	Output resistance	DefaultROut	Ohm	int	(0,∞)
RTemp	Temperature, in degrees C	DefaultRTemp	Celsius	real	[-273.15,∞]
FCarrier	Carrier frequency	2500 MHz	Hz	real	(0,∞)
MirrorSpectrum	Mirror spectrum about carrier?: NO, YES	NO		enum	
GainImbalance	Gain imbalance in dB, Q channel relative to I channel	0.0		real	(-∞,∞)
PhaseImbalance	Phase imbalance in degrees, Q channel relative to I channel	0.0		real	(-∞,∞)
I_OriginOffset	I origin offset in percent with repect to output rms voltage	0.0		real	(-∞,∞)
Q_OriginOffset	Q origin offset in percent with repect to output rms voltage	0.0		real	(-∞,∞)
IQ_Rotation	IQ rotation in degrees	0.0		real	(-∞,∞)
BasicParameters					
OutputFrameFormat	output superframe format: Full Superframe, Compact Superframe	Full Superframe		enum	
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0		int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25		int	
OversamplingOption	Oversampling ratio option: Ratio 1, Ratio 2, Ratio 4, Ratio 8, Ratio 16, Ratio 32	Ratio 2		enum	
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512		enum	[0,4]
Ncp	the index for Cyclic Prefix	Ncp 1		enum	

	(Tcp=Ncp*FFTSize*Tchip/16): Ncp 1, Ncp 2, Ncp 3, Ncp 4				
GuardSize	the size of guard subcarriers	32		int	
RsChMuxMode	The mux mode for resource channels: Mode 1, Mode 2	Mode 2		enum	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64		enum	
NumDRCHSubzones	the number of DRCH subzones	0		int	[0,FFTSize/SubzoneSize-1]
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192		enum	[0,1]
EnableBRCHSubzoneCycling	whether the cycling for BRCH subzones is enabled: NO, YES	NO		enum	
EnableHalfDuplexOperation	whether the half duplex operation is enabled: NO, YES	NO		enum	
StartingSuperframe	the superframe index for the starting superframe	0		int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES		enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO		enum	
PilotPN	9-bit pilot PN for different sectors	0		int	[0,511]
FDCH_Parameters					
FDCH_NumPackets	number of data packets transmitted in F-DCH; At most four packets are supported	1		int	[1,4]
FDCH_1_PFIndex	the packet format index for the first data packet transmitted in F-DCH	1		int	[0,14]
FDCH_1_NodeID	the array of NodeID allocated to the first data packet transmitted in F-DCH	{31}		int array	
FDCH_1_MACID	the MAC ID of the first data packet (Access Terminal) transmitted in F-DCH	1		int	[0,511]
FDCH_1_NumHARQTrans	the number of HARQ transmissions for the first data packet transmitted in F-DCH	1		int	[1,25]
FDCH_1_HARQInterlace	the number of frames in HARQ interlace structure for the first data packet transmitted in F-DCH	6		int	[1,24]
FDCH_1_StartingFrame	the starting frame index from which the first data packet is allocated in F-DCH	0		int	[0,24]
FDCH_1_NumFrames	the number of frames on which the first data packet is allocated in F-DCH	25		int	[1,25]
FDCH_1_PowerDensity	the power density for the first data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}		real array	[-∞,∞]

FDCH_2_PFIndex	the packet format index for the second data packet transmitted in F-DCH	1		int	[0,14]
FDCH_2_NodeID	the array of NodeID allocated to the second data packet transmitted in F-DCH	{32}		int array	
FDCH_2_MACID	the MAC ID of the second data packet (Access Terminal) transmitted in F-DCH	2		int	[0,511]
FDCH_2_NumHARQTrans	the number of HARQ transmissions for the second data packet transmitted in F-DCH	1		int	[1,25]
FDCH_2_HARQInterlace	the number of frames in HARQ interlace structure for the second data packet transmitted in F-DCH	6		int	[1,24]
FDCH_2_StartingFrame	the starting frame index from which the second data packet is allocated in F-DCH	0		int	[0,24]
FDCH_2_NumFrames	the number of frames on which the second data packet is allocated in F-DCH	25		int	[1,25]
FDCH_2_PowerDensity	the power density for the second data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}		real array	[-∞,∞]
FDCH_3_PFIndex	the packet format index for the third data packet transmitted in F-DCH	1		int	[0,14]
FDCH_3_NodeID	the array of NodeID allocated to the third data packet transmitted in F-DCH	{33}		int array	
FDCH_3_MACID	the MAC ID of the third data packet (Access Terminal) transmitted in F-DCH	3		int	[0,511]
FDCH_3_NumHARQTrans	the number of HARQ transmissions for the third data packet transmitted in F-DCH	1		int	[1,25]
FDCH_3_HARQInterlace	the number of frames in HARQ interlace structure for the third data packet transmitted in F-DCH	6		int	[1,24]
FDCH_3_StartingFrame	the starting frame index from which the third data packet is allocated in F-DCH	0		int	[0,24]
FDCH_3_NumFrames	the number of frames on which the third data packet is allocated in F-DCH	25		int	[1,25]
FDCH_3_PowerDensity	the power density for the third data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}		real array	[-∞,∞]
FDCH_4_PFIndex	the packet format index for the fourth data packet transmitted in F-DCH	1		int	[0,14]
FDCH_4_NodeID	the array of NodeID allocated to the fourth data packet	{34}		int array	

	transmitted in F-DCH				
FDCH_4_MACID	the MAC ID of the fourth data packet (Access Terminal) transmitted in F-DCH	4		int	[0,511]
FDCH_4_NumHARQTrans	the number of HARQ transmissions for the fourth data packet transmitted in F-DCH	1		int	[1,25]
FDCH_4_HARQInterlace	the number of frames in HARQ interlace structure for the fourth data packet transmitted in F-DCH	6		int	[1,24]
FDCH_4_StartingFrame	the starting frame index from which the fourth data packet is allocated in F-DCH	0		int	[0,24]
FDCH_4_NumFrames	the number of frames on which the fourth data packet is allocated in F-DCH	25		int	[1,25]
FDCH_4_PowerDensity	the power density for the fourth data packet transmitted in F-DCH (defined as power(dBm) per modulation symbol)	{-16.0}		real array	[-∞,∞]
FPICH_Parameters					
FCPICH_HoppingMode	the hopping mode for F-CPICH: Random, Deterministic	Random		enum	
FCPICH_PilotSpacing	the subcarrier spacing for common pilots	16		int	[1,∞)
FCPICH_PowerDensity	the power density for F-CPICH (defined as power(dBm) per modulation symbol)	-16.0		real	[-∞,∞]
CodeOffset	code offset between 0 and 2 for Forward Dedicated Pilot Channel	0		int	[0,2]
DPICHFormat	the Forward Dedicated Pilot Channel format for Forward Data Channel: Format 0, Format 1, Format 2	Format 0		enum	[0,1]
FLCS_Parameters					
EnableFLCS	whether the Forward Link Control Segment is enabled: NO, YES	NO		enum	
FLCS_NumBlocks	the number of blocks (tiles) allocated for FLCS, only valid when EnableFLCS is YES	3		int	[3,∞)
FLCS_UseDRCH	whether FLCS is on DRCH or on BRCH, only valid when EnableFLCS is YES: NO, YES	NO		enum	
FLCS_PowerDensity	the power density for FLCS (defined as power(dBm) per modulation symbol), only valid when EnableFLCS is YES	-16.0		real	[-∞,∞]
PreambleParameters					
EnablePreamble	whether the Preamble is output: NO, YES	NO		enum	
EnablePreambleFrequencyReuse	whether Preamble Frequency Reuse is enabled: NO, YES	NO		enum	
EnableExpandedQPCH	whether QPCH is expanded: NO, YES	NO		enum	

SFNCellID	9-bit SFN cell ID	12		int	[0,511]
K_OSI	the OSIValue from the SFP MAC Protocol	0		int	[0,2]
K_SD	the 9-bit AcqInfo block provided by the SFP MAC Protocol	0		int	[0,511]
SBCCHScramblingSeed	F-SBCCH Scrambling Seed	1		int	[0,511]
QPCHScramblingSeed	F-QPCH Scrambling Seed	1		int	[0,511]
PreambleUnitPower	transmit unit power for these channels in the first five OFDM symbols in units of dBm	10.0		real	[-∞,∞]
FACQCH_Power	transmit unit power for F-ACQCH in units of dBm	10.0		real	[-∞,∞]
FOSICH_Power	transmit unit power for F-OSICH in units of dBm	10.0		real	[-∞,∞]

Pin Inputs

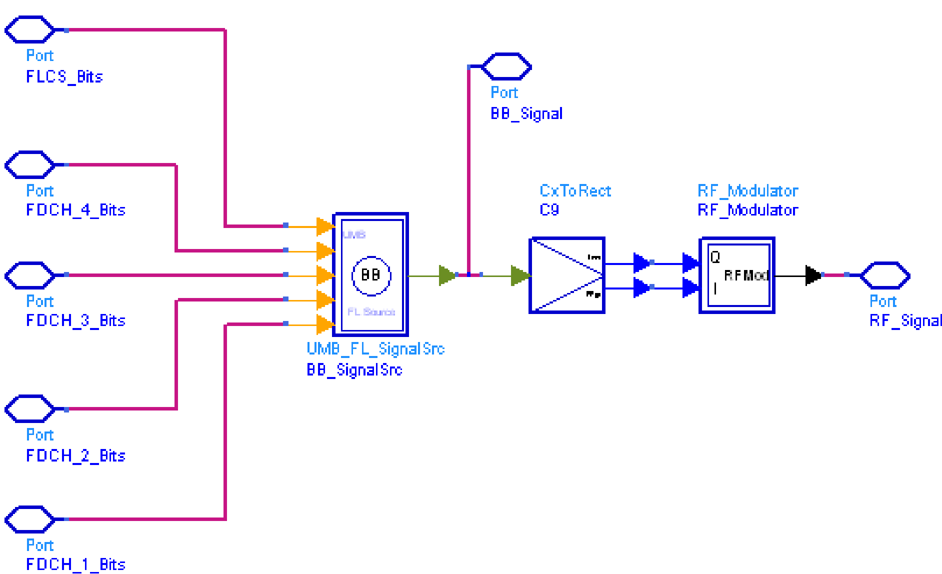
Pin	Name	Description	Signal Type
1	FDCH_1_Bits	input bits for the first data packet in F-DCH	int
2	FDCH_2_Bits	input bits for the second data packet in F-DCH	int
3	FDCH_3_Bits	input bits for the third data packet in F-DCH	int
4	FDCH_4_Bits	input bits for the fourth data packet in F-DCH	int
5	FLCS_Bits	input bitsforR-ODCCH	int

Pin Outputs

Pin	Name	Description	Signal Type
6	RF_Signal	RF signal	timed
7	BB_Signal	BB signal	complex

Notes/Equations

1. This subnetwork is to implement 3GPP2 UMB Forward Link RF source. The schematic for this subnetwork is shown in the following figure.



UMB_FL_SignalSrc_RF Schematic

2. The implementation of 3GPP2 UMB Forward Link baseband source is described in

Forward Link baseband source (3gpp2umb).

3. Parameter Details
   - RF Parameters
     - ROut is the RF output resistance.
     - RTemp is the RF output resistance temperature in Celsius and sets the noise density in the RF output signal to (k(RTemp+273.15)) Watts/Hz, where k is Boltzmann's constant.
     - FCarrier is the RF output signal frequency.
     - MirrorSpectrum is used to mirror the RF_out signal spectrum about the carrier. This is equivalent to conjugating the complex RF envelope voltage. Depending on the configuration and number of mixers in an RF transmitter, the RF output signal from hardware RF generators can be inverted. If such an RF signal is desired, set this parameter to YES.
       GainImbalance, PhaseImbalance, I_OriginOffset, Q_OriginOffset, and IQ_Rotation are used to add certain impairments to the ideal output RF signal. Impairments are added in the order described here.
     - The unimpaired RF I and Q envelope voltages have gain and phase imbalance applied. The RF is given by:

$$V_{RF}(t) = A\left(V_I(t)\cos(\omega_c t) - gV_Q(t)\sin\left(\omega_c t + \frac{\Phi\pi}{180}\right)\right)$$

       where A is a scaling factor based on the Power and ROut parameters specified by the user, $V_I(t)$ is the in-phase RF envelope, $V_Q(t)$ is the quadrature phase RF envelope, g is the gain imbalance

$$g = 10^{\frac{GainImbalance}{20}}$$

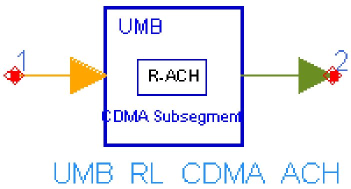
       and Φ (in degrees) is the phase imbalance.
       Next, the signal $V_{RF}(t)$ is rotated by IQ_Rotation degrees. The I_OriginOffset and Q_OriginOffset are then applied to the rotated signal. Note that the amounts specified are percentages with respect to the output rms voltage.
   - The basic parameters are described in *Basic Parameters* (3gpp2umb).
   - The parameters for Forward Data Channel (F-DCH) are described in *F-DCH Parameters* (3gpp2umb).
   - The parameters for pilot channels are described in *Pilot Parameters* (3gpp2umb).
   - The parameters for Forward link Control Segment (FLCS) are described in *FLCS Parameters* (3gpp2umb).
   - The parameters for Superframe Preamble are described in *Superframe Preamble Parameters* (3gpp2umb).

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_RL_CDMA_ACH

Symbol



Description: reverse link CDMA access channel generator
Library: UMB, Signal Source

Parameters

Name	Description	Default	Type	Range
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0	int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25	int	
StartingSuperframe	the superframe index for the starting superframe	0	int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES	enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO	enum	
PilotPN	9-bit pilot PN for different sectors	0	int	[0,511]
AccessScramblingID	the AccessScrambling ID	10	int	[0,∞]
RACH_PowerDensity	the power density for R-PICH (defined as power(dBm) per modulation symbol)	-16.0	real	[-∞,∞]

Pin Inputs

Pin	Name	Description	Signal Type
1	WalshSequenceID	the 10-bit WalshSequence ID	int

Pin Outputs

Pin	Name	Description	Signal Type
2	ModulatedData	output data	complex

Notes/Equations

1. This model generates the time-domain sequence of the Reverse Access Channel (R-ACH) which is used by the Access Terminal for initial access, for transition out of semi-connected state, or to hand off between sectors at the same or at different frequencies.
   Each firing,
   - NumFrames tokens are consumed at pin WalshSequenceID;
   - NumFrames*N_{FRAME}*$N_{CDMA\text{-}SUBSEGMENT}$ tokens are output at pin ModulatedData, where N_{FRAME} is the number of OFDM symbols in one PHY Frame (8 OFDM symbols); $N_{CDMA\text{-}SUBSEGMENT}$ is the number of subcarriers in one CDMA subsegment (128 subcarriers).
2. The Reverse Access Channel time-domain sequence shall be the Walsh sequence $W_{WalshSequenceID}^{1024}$. In each firing, the first value at pin WalshSequenceID is used to generate the Walsh sequence for R-ACH in the first active PHY Frame (i.e.

Frame#StartingFrame); The second value at pin WalshSequenceID is for R-ACH in the second active PHY Frame (i.e. Frame#StartingFrame+1), and so on.

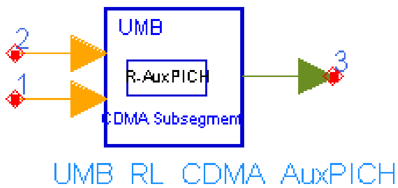
3. The Reverse Access Channel time-domain sequence shall be multiplied elementwise with a complex scrambling sequence of length 1024 and scaled by the quantity $sqrt(0.001*10^{RACH\_PowerDensity/10})$.
   The scrambling sequence is defined in 2.5.3 of Ref1 with the seed given by the output of the hash function defined in 2.5.4 of Ref1 with input equal to 32*p + (AccessScramblingID mod 16)*2 + 1, where p is the SectorSeed corresponding to the target sector.
4. The scrambled Reverse Access Channel sequence shall be time-interleaved according to the procedure described in 3.1.3.2.1 of Ref1; Then the last 128 entries of the time-interleaved Reverse Access Channel sequence, i.e., the elements with indices 896 through 1023, shall be set to zero.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_RL_CDMA_AuxPICH

Symbol



Description: reverse link CDMA auxiliary pilot channel generator
Library: UMB, Signal Source

Parameters

Name	Description	Default	Type	Range
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0	int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25	int	
StartingSuperframe	the superframe index for the starting superframe	0	int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES	enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO	enum	
PilotPN	9-bit pilot PN for different sectors	0	int	[0,511]
MACID	the MACID of the terminal in the target sector	0	int	[0,511]
RAuxPICH_PowerDensity	the power density for R-AuxPICH (defined as power(dBm) per modulation symbol)	-16.0	real	[-∞,∞]

Pin Inputs

Pin	Name	Description	Signal Type
1	PFID	packet format index used for the transmission of the Reverse CDMA Data Channel	int
2	HARQTransmissionIndex	the HARQ transmission index for the Reverse CDMA Data Channel	int

Pin Outputs

Pin	Name	Description	Signal Type
3	ModulatedData	output data	complex

Notes/Equations

1. This model generates the time-domain sequence of the Reverse Auxiliary Pilot Channel (R-AuxPICH) which is used to assist the Access Network in decoding an Access Terminal transmission on the Reverse CDMA Data Channel. In addition, this channel also carries information about the rate and HARQ transmission index of the Reverse CDMA Data Channel transmission in the same subsegment.
   Each firing,
   - NumFrames tokens are consumed at pin PFID;
   - NumFrames tokens are consumed at pin HARQTransmissionIndex;
   - NumFrames*N_{FRAME}*$N_{CDMA-SUBSEGMENT}$ tokens are output at pin ModulatedData, where N_{FRAME} is the number of OFDM symbols in one PHY Frame (8 OFDM symbols); $N_{CDMA-SUBSEGMENT}$ is the number of subcarriers in

one CDMA subsegment (128 subcarriers).

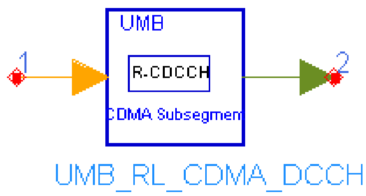
2. The Reverse Auxiliary Pilot Channel time-domain sequence shall be the Walsh sequence W_i^{1024}, where i = PFID*6 + HARQTransmissionIndex, where PFID denotes the packet format index used for the transmission of the Reverse CDMA Data Channel in the same subsegment, and HARQTransmissionIndex denotes the HARQ transmission index for the Reverse CDMA Data Channel in the same subsegment. In each firing, the first values at pin PFID and HARQTransmissionIndex are used for R-AuxPICH in the first active PHY Frame (i.e. Frame#StartingFrame); The second values at pin PFID and HARQTransmissionIndex are for R-AuxPICH in the second active PHY Frame (i.e. Frame#StartingFrame+1), and so on.
3. The Reverse Auxiliary Pilot Channel time-domain sequence shall be multiplied elementwise with a complex scrambling sequence of length 1024 and scaled by the quantity $sqrt(0.001*10^{RAuxPICH\_PowerDensity/10})$, where RAuxPICH_PowerDensity is the power density per modulation symbol which is the same across all the PHY Frames. The scrambling sequence is defined in 2.5.3 of Ref1 with the seed given by the output of the hash function defined in 2.5.4 of Ref1 with input equal to (32 *2048*p + 32*m + 6), where p is the SectorSeed corresponding to the target sector and is defined in 2.3.2.3 of Ref1, and m is the MACID of the terminal in the target sector.
4. The scrambled Reverse Auxiliary Pilot Channel sequence shall be time-interleaved according to the procedure described in 3.1.3.2.1 of Ref1.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_RL_CDMA_DCCH

Symbol



Description: reverse link CDMA dedicated control channel generator
Library: UMB, Signal Source

Parameters

Name	Description	Default	Type	Range
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0	int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25	int	
StartingSuperframe	the superframe index for the starting superframe	0	int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES	enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO	enum	
PilotPN	9-bit pilot PN for different sectors	0	int	[0,511]
MACID	the MACID of the terminal in the target sector	0	int	[0,511]
SHOGID	the SHOG ID	0	int	[0,511]
RCDCCH_PowerDensity	the power density for R-CDCCH (defined as power(dBm) per modulation symbol)	-16.0	real	[-∞,∞]

Pin Inputs

Pin	Name	Description	Signal Type
1	WalshSequenceID	the 10-bit WalshSequence ID	int

Pin Outputs

Pin	Name	Description	Signal Type
2	ModulatedData	output data	complex

Notes/Equations

1. This model generates the time-domain sequence of the Reverse CDMA Dedicated Control Channel (R-CDCCH) which can carry one or more of logical channels. Each firing,
   - NumFrames tokens are consumed at pin WalshSequenceID;
   - NumFrames*N_{FRAME}*$N_{CDMA\text{-}SUBSEGMENT}$ tokens are output at pin ModulatedData, where N_{FRAME} is the number of OFDM symbols in one PHY Frame (8 OFDM symbols); $N_{CDMA\text{-}SUBSEGMENT}$ is the number of subcarriers in one CDMA subsegment (128 subcarriers).
2. The Reverse CDMA Dedicated Control Channel time-domain sequence shall be the Walsh sequence $W_{WalshSequenceID}^{1024}$. In each firing, the first value at pin WalshSequenceID is used to generate the Walsh sequence for R-CDCCH in the first active PHY Frame (i.e. Frame#StartingFrame); The second value at pin

WalshSequenceID is for R-CDCCH in the second active PHY Frame (i.e. Frame#StartingFrame+1), and so on.

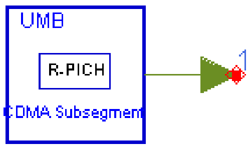
3. The Reverse CDMA Dedicated Control Channel time-domain sequence shall be multiplied elementwise with a complex scrambling sequence of length 1024 and scaled by the quantity sqrt(0.001*$10^{RCDCCH\_PowerDensity/10}$).
4. The scrambling sequence is defined in 2.5.2 of Ref1 with the seed given by $f_{PHY-HASH}$ (32*2048*p + 32*m + 4*(s mod 8) + 3), where p is the SectorSeed corresponding to the target sector defined in 2.3.2.3 of Ref1, m is the MACID of the terminal in the target sector, and s is the SHOGID.
5. The scrambled Reverse CDMA Dedicated Control Channel sequence shall be time-interleaved according to the procedure described in 3.1.3.2.1 of Ref1.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_RL_CDMA_PICH

Symbol



UMB_RL_CDMA_PICH

Description: reverse link CDMA pilot channel generator
Library: UMB, Signal Source

Parameters

Name	Description	Default	Type	Range
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0	int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25	int	
StartingSuperframe	the superframe index for the starting superframe	0	int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES	enum	
RPICHScramblingSeed_MSB	the 17-bit MSBs of 49-bit RPICHScramblingSeed	0	int	[0,2^17-1]
RPICHScramblingSeed_LSB	the 32-bit LSBs of 49-bit RPICHScramblingSeed	10	int	[0,2^32-1]
RPICH_PowerDensity	the power density for R-PICH (defined as power(dBm) per modulation symbol)	-16.0	real	[-∞,∞]

Pin Outputs

Pin	Name	Description	Signal Type
1	ModulatedData	output data	complex

Notes/Equations

1. This model generates the time-domain sequence of the Reverse Pilot Channel (R-PICH) which is an unmodulated DFT-precoded CDMA signal used to assist the Access Network for Reverse Link power control reference and Reverse Link quality measurement.
   Each firing, NumFrames*N_{FRAME}*$N_{CDMA-SUBSEGMENT}$ tokens are output at pin ModulatedData, where N_{FRAME} is the number of OFDM symbols in one PHY Frame (8 OFDM symbols); $N_{CDMA-SUBSEGMENT}$ is the number of subcarriers in one CDMA subsegment (128 subcarriers).
2. The Reverse Pilot Channel time-domain sequence shall be the Walsh sequence W_0^{1024}.
3. The Reverse Pilot Channel time-domain sequence shall be multiplied elementwise with a complex scrambling sequence of length 1024 and scaled by the quantity sqrt(0.001*$10^{RPICH\_PowerDensity/10}$). The scrambling sequence is defined in 2.5.3 of Ref1 with the seed determined by the parameters RPICHScramblingSeed (RPICHScramblingSeed_MSB and RPICHScramblingSeed_LSB), SuperframeIndex and Reverse Link PHY Frame Index.

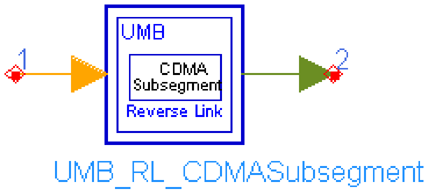
4. The scrambled Reverse Pilot Channel sequence shall be time-interleaved according to the procedure described in 3.1.3.2.1 of Ref1.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_RL_CDMASubsegment

Symbol



Description: reverse link CDMA subsegment generator
Library: UMB, Signal Source

Parameters

Name	Description	Default	Type	Range
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0	int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25	int	
EnableRPICH	whether R-PICH is enabled in this CDMA subsegment: NO, YES	NO	enum	
RPICH_PowerDensity	the power density for R-PICH (defined as power(dBm) per modulation symbol)	-16.0	real	[-∞,∞]
EnableRAuxPICH	whether R-AuxPICH is enabled in this CDMA subsegment: NO, YES	NO	enum	
RAuxPICH_PowerDensity	the power density for R-AuxPICH (defined as power(dBm) per modulation symbol)	-16.0	real	[-∞,∞]
EnableRACH	whether R-ACH is enabled in this CDMA subsegment: NO, YES	NO	enum	
RACH_PowerDensity	the power density for R-ACH (defined as power(dBm) per modulation symbol)	-16.0	real	[-∞,∞]
EnableRCDCCH	whether R-CDCCH is enabled in this CDMA subsegment: NO, YES	NO	enum	
RCDCCH_PowerDensity	the power density for R-CDCCH (defined as power(dBm) per modulation symbol)	-16.0	real	[-∞,∞]
EnableRCDCH	whether R-CDCH is enabled in this CDMA subsegment: NO, YES	YES	enum	
RCDCH_PacketSize	the number of packet bits in R-CDCH excluding CRC bits	136	int	[1,2048]
RCDCH_PowerDensity	the power density for R-CDCH (defined as power(dBm) per modulation symbol)	-16.0	real	[-∞,∞]
StartingSuperframe	the superframe index for the starting superframe	0	int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES	enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO	enum	
PilotPN	9-bit pilot PN for different sectors	0	int	[0,511]
MACID	the MAC ID of the terminal in the target sector	0	int	[0,511]
SHOGID	the SHOG ID for R-CDCCH	0	int	[0,511]
RPICHScramblingSeed_MSB	the 17-bit MSBs of 49-bit R-PICH Scrambling Seed	0	int	[0,2^17-1]
RPICHScramblingSeed_LSB	the 32-bit LSBs of 49-bit R-PICH Scrambling Seed	10	int	[0,2^32-1]
AccessScramblingID	the AccessScrambling ID for R-ACH	10	int	[0,∞]
RCDCH_PFID	the packet format index used for the transmission of the Reverse CDMA Data Channel	1	int	[0,??]
RCDCH_HARQIndex	the HARQ transmission index for the Reverse CDMA Data Channel	0	int	[0,5]
RACH_WalshSequenceID	the WalshSequence ID for R-ACH	3	int	[0,1023]
RCDCCH_WalshSequenceID	the WalshSequence ID for R-CDCCH	4	int	[0,1023]

Pin Inputs

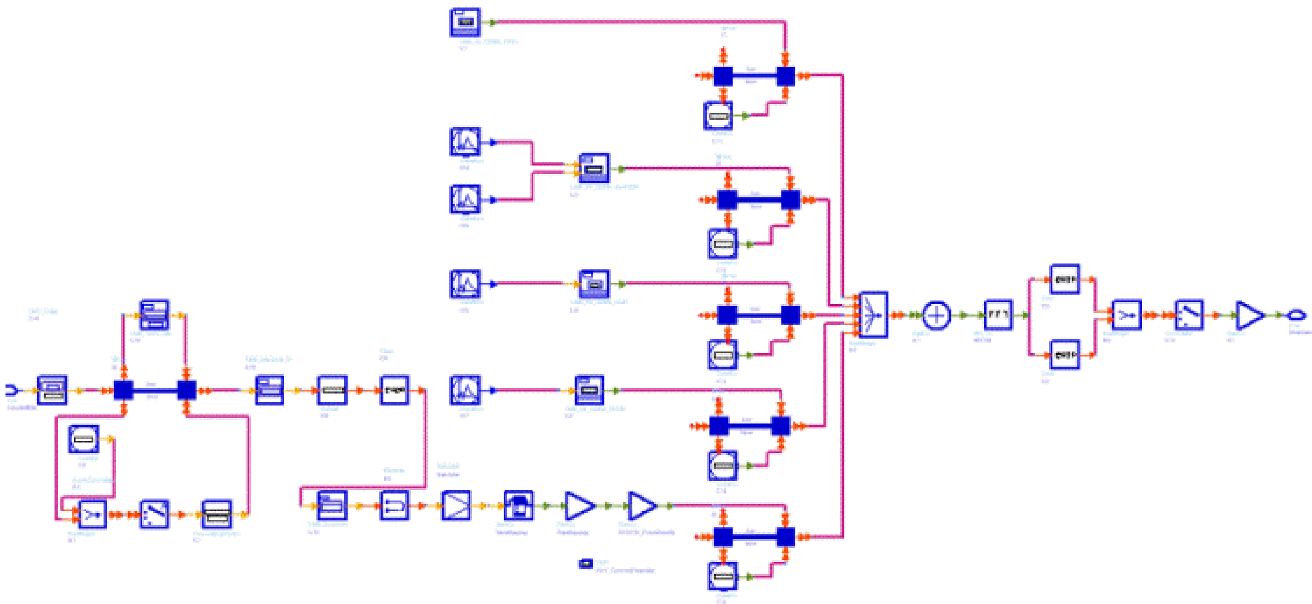
Pin	Name	Description	Signal Type
1	UncodedBits	input uncoded bits for R-CDCH	int

Pin Outputs

Pin	Name	Description	Signal Type
2	ModulatedData	output modulated data	complex

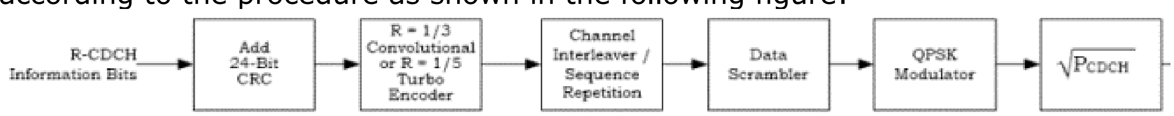
Notes/Equations

1. This subnetwork generates the frequency-domain sequence of one CDMA subsegment. The schematic for this subnetwork is shown in the following figure.



UMB_RL_CDMASubsegment Schematic

2. For each CDMA subsegment, one Reverse Pilot Channel (R-PICH), one Reverse Auxiliary Pilot Channel (R-AuxPICH), one Reverse Access Channel (R-ACH), one Reverse CDMA Dedicated Control Channel (R-CDCCH) and one Reverse CDMA Data Channel (R-CDCH) may be allocated. Each of them can be turned on or off independently.
3. The Reverse CDMA Data Channel (R-CDCH) may be used for the transmission of higher-level data to the Access Networks by the Access Terminals. The uncoded bits for R-CDCH are input at pin RCDCH_Bits. The size of the Reverse CDMA Data Channel packet is defined by the parameter RCDCH_PacketSize. The packet is appended with CRC, encoded, channel interleaved, repeated, data-scrambled and QPSK modulated according to the procedure as shown in the following figure:



The scrambling sequence shall be scaled by the quantity sqrt(0.001*10$^{RCDCH_PowerDensity/10}$). A CRC length of $N_{CRC,DATA}$ (24 bits) is used for this packet. A seed equal to $f_{PHY-HASH}$(7*2048*SectorSeed + m mod 2048) shall be used for the data scrambling operation.
4. The DFT operation on the combination of all the Reverse CDMA channels transmission shall be performed as described in 3.1.3.2.3 of Ref1.

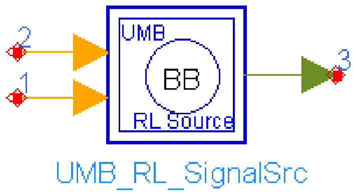
References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_RL_SignalSrc

Symbol



Description: 3GPP2 UMB Reverse Link Signal Source
Library: UMB,Signal Source

Parameters

Name	Description	Default	Type	Range
OutputFrameFormat	output superframe format: Full Superframe, Compact Superframe	Full Superframe	enum	
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0	int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25	int	
OversamplingOption	Oversampling ratio option: Ratio 1, Ratio 2, Ratio 4, Ratio 8, Ratio 16, Ratio 32	Ratio 2	enum	
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
Ncp	the index for Cyclic Prefix (Tcp=Ncp*FFTSize*Tchip/16): Ncp 1, Ncp 2, Ncp 3, Ncp 4	Ncp 1	enum	
GuardSize	the size of guard subcarriers	32	int	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64	enum	
MaxPHYSubPacketSize	the maximum subpacket size (4096 bits or 8192 bits): Size 4096, Size 8192	Size 8192	enum	[0,1]
EnableHalfDuplexOperation	whether the half duplex operation is enabled: NO, YES	NO	enum	
StartingSuperframe	the superframe index for the starting superframe	0	int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES	enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO	enum	
PilotPN	9-bit pilot PN for different sectors	0	int	[0,511]
FL_SubzoneSize	the number of hop-ports in a FL subzone for determining hopping structures in RL PHY Frames: FL Size 64, FL Size 128	FL Size 64	enum	
NumDRCHSubzones	the number of DRCH subzones in FL for determining hopping structures	4	int	[0,FFTSize/SubzoneSize-1]

	in RL PHY Frames			
RODCH_PFIndex	the packet format index for R-ODCH	1	int	[0,14]
RODCH_NodeID	the array of NodeID allocated to R-ODCH	{31}	int array	
RODCH_MACID	the MAC ID of the Access Terminal as associated with the RLSS	1	int	[0,511]
RODCH_NumHARQTrans	the number of HARQ transmissions for the R-ODCH	1	int	[1,25]
RODCH_HARQInterlace	the number of PHY frames in HARQ interlace structure for the R-ODCH	6	int	[1,24]
RODCH_StartingFrame	the starting frame index from which R-ODCH is allocated	0	int	[0,24]
RODCH_NumFrames	the number of frames on which R-ODCH is allocated starting from the RODCH_StartingFrame	25	int	[1,25]
RODCH_PowerDensity	the power density for R-ODCH (defined as power(dBm) per modulation symbol)	{-16.0}	real array	[-∞,∞]
CodeOffset	code offset between 0 and 2 for Reverse Dedicated Pilot Channel	0	int	[0,2]
DPICHFormat	the Reverse Dedicated Pilot Channel format for OFDMA Data Channels: Format 0, Format 1	Format 0	enum	[0,1]
EnableRODCCH	whether the allocation of R-ODCCH is enabled: NO, YES	NO	enum	
NumRODCIndices	the number of Indices for R-ODCCH (the number of tiles for R-ODCCH is max(2,system.NumRODCIndices/2	4	int	[0,∞]
RODCResourceIndex	the resource index for each R-ODCCH	{0}	int array	[0,2]
RODCCH_PowerDensity	the power density for R-ODCCH (defined as power(dBm) per modulation symbol)	-16	real	[-∞,∞]
EnableCDMASubsegments	whether the allocation of CDMA subsegments is enabled: NO, YES	NO	enum	
NumCDMASubsegments	number of allocated CDMA subsegments allocated, only valid when EnableCDMASubsegments is YES	1	int	[1,∞)
EnableRPICH	whether R-PICH is enabled in this CDMA subsegment: NO, YES	NO	enum	
RPICH_PowerDensity	the power density for R-PICH (defined as power(dBm) per modulation symbol)	-16	real	[-∞,∞]
EnableRAuxPICH	whether R-AuxPICH is enabled in this CDMA subsegment: NO, YES	NO	enum	
RAuxPICH_PowerDensity	the power density for R-AuxPICH (defined as power(dBm) per modulation symbol)	-16	real	[-∞,∞]
EnableRACH	whether R-ACH is enabled in this CDMA subsegment: NO, YES	NO	enum	
RACH_PowerDensity	the power density for R-ACH (defined as power(dBm) per modulation symbol)	-16	real	[-∞,∞]
EnableRCDCCH	whether R-CDCCH is enabled in this CDMA subsegment: NO, YES	NO	enum	
RCDCCH_PowerDensity	the power density for R-CDCCH (defined as power(dBm) per modulation symbol)	-16	real	[-∞,∞]

EnableRCDCH	whether R-CDCH is enabled in this CDMA subsegment: NO, YES	YES	enum	
RCDCH_PacketSize	the number of packet bits in R-CDCH excluding CRC bits	136	int	[1,2048]
RCDCH_PowerDensity	the power density for R-CDCH (defined as power(dBm) per modulation symbol)	-16	real	[-∞,∞]
MACID	the MAC ID of the terminal in the target sector	0	int	[0,511]
SHOGID	the SHOG ID for R-CDCCH	0	int	[0,511]
RPICHScramblingSeed_MSB	the 17-bit MSBs of 49-bit R-PICH Scrambling Seed	0	int	[0,2^17-1]
RPICHScramblingSeed_LSB	the 32-bit LSBs of 49-bit R-PICH Scrambling Seed	10	int	[0,2^32-1]
AccessScramblingID	the AccessScrambling ID for R-ACH	10	int	[0,∞]
RCDCH_PFID	the packet format index used for the transmission of the Reverse CDMA Data Channel	1	int	[0,16]
RCDCH_HARQIndex	the HARQ transmission index for the Reverse CDMA Data Channel	0	int	[0,5]
RACH_WalshSequenceID	the WalshSequence ID for R-ACH	3	int	[0,1023]
RCDCCH_WalshSequenceID	the WalshSequence ID for R-CDCCH	4	int	[0,1023]

Pin Inputs

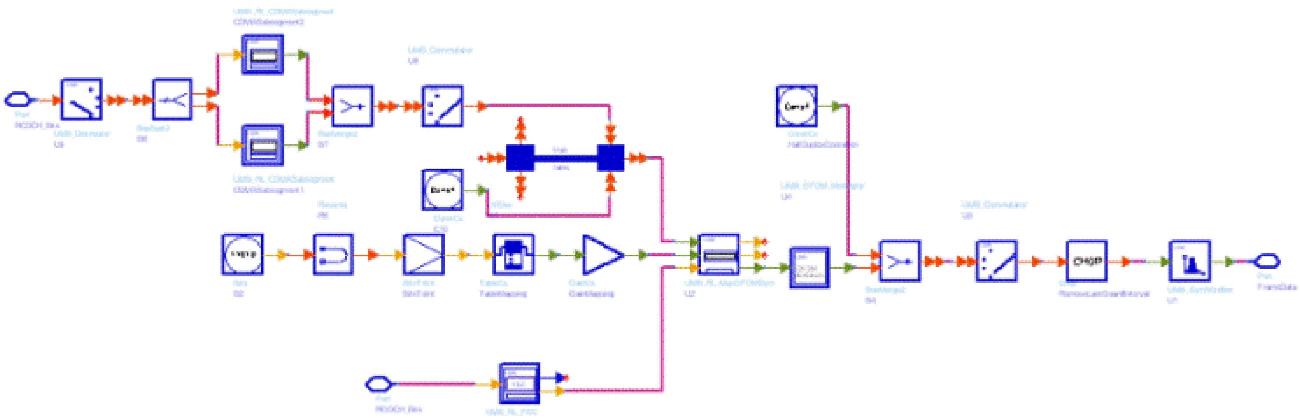
Pin	Name	Description	Signal Type
1	RODCH_Bits	input bits for R-ODCH	int
2	RODCCH_Bits	input bitsforR-ODCCH	int

Pin Outputs

Pin	Name	Description	Signal Type
3	FrameData	output data	complex

Notes/Equations

1. This subnetwork is to implement 3GPP2 UMB Reverse Link baseband source. The schematic for this subnetwork is shown in the following figure.



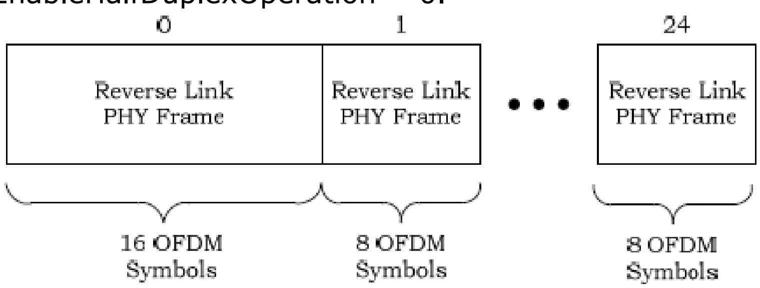
UMB_RL_SignalSrc Schematic

1. Transmission on the Reverse Link is divided into units of superframes. Each Reverse Link superframe consists of a sequence of $N_{PHYFrames}$ = 25 Reverse Link PHY Frames.

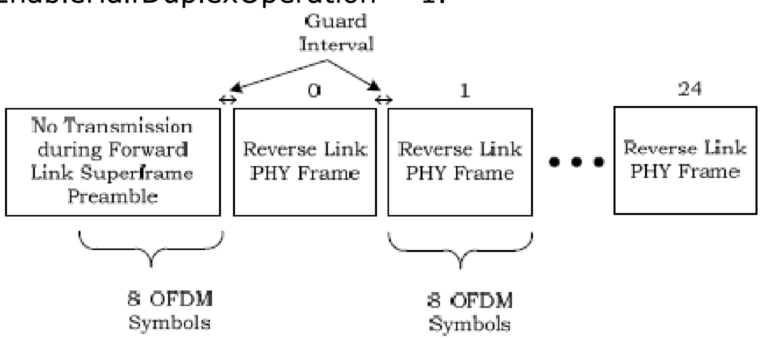
Consecutive Reverse Link PHY Frames are separated by a guard interval Tg when EnableHalfDuplexOperation equals 1, whereas there is no separation when EnableHalfDuplexOperation equals 0.

Each superframe has an associated SuperframeIndex that is incremented every superframe (SuperframeIndex may also be fixed when SuperframeIdxIncreased = NO). Each of the Reverse Link PHY Frames consists of a sequence of OFDM symbols. All Reverse Link PHY Frames consist of N_{FRAME} = 8 OFDM symbols except the Reverse Link PHY Frame with index 0. If EnableHalfDuplexOperation is equal to 0, the Reverse Link PHY Frame with index 0 consists of $2N_{FRAME}$ = 16 OFDM symbols, so as to cover the time occupied by the superframe preamble on the Forward Link. If EnableHalfDuplexOperation = 1, the Reverse Link PHY Frame with index 0 consists of only 8 OFDM symbols, which are aligned with the Forward Link PHY Frame with index 0. The time corresponding to the Forward Link superframe preamble is left blank on the Reverse Link.

The structure of a Reverse Link superframe is shown in the following figure for EnableHalfDuplexOperation = 0.

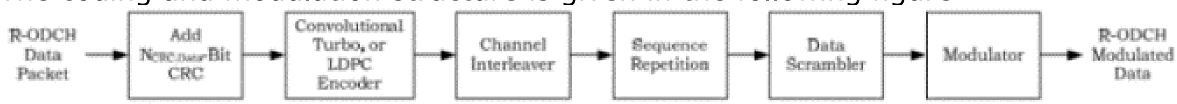


The structure of a Reverse Link superframe is shown in the following figure for EnableHalfDuplexOperation = 1.



2. The supported 3GPP2 UMB Reverse Link features in this source is described in *3GPP2 UMB Reverse Link Features* (3gpp2umb).
3. In UMB Reverse Link, two Superframe Structure modes are supported which is the same as Forward Link. Refer to *Superframe Structure Modes* (3gpp2umb) for more information. Note that, for Reverse Link, the time ocuupied by Superframe Preamble illustrated in *Superframe Structure Modes* (3gpp2umb) shall be blank or be part of Reverse Link PHY Frame with index 0 depending on EnableHalfDuplexOperation. Moreover, in Compact Superframe mode, the time ocuupied by Superframe Preamble doen't exsit when StartingFrame is other than 0; Otherwise it shall be blank or be part of Reverse Link PHY Frame with index 0.
4. **Reverse OFDMA Data Channel (R-ODCH)**
   1. The resources allocated to Reverse OFDMA Data Channel (R-ODCH) are organized by base nodes on which a set of hop-ports are mapped. The mapping of hop-ports to base nodes in Reverse Link is described in 8.5.9 of Ref2. Each base node maps to MinHopPortsPerNode hop-ports, the first MinHopPortsPerNode hop-ports (indices 0 to MinHopPortsPerNode-1) to the base node with the lowest NodeID, the second MinHopPortsPerNode hop-ports to the next base node, etc., until all hop-ports are mapped for all Q_{SDMA} sub-trees, where MinHopPortsPerNode=16 and Q is fixed to be 1 in ADS UMB library.

2. One Reverse OFDMA Data Channel (R-ODCH) is allocated in the Reverse Link PHY Frames from Frame#RODCH_StartingFrame to Frame #(RODCH_StartingFrame + RODCH_NumFrames-1). This Reverse OFDMA Data Channel (R-ODCH) includes only one data packet whose packet format index is defined by the parameter RODCH_PFIndex; The set of hop-ported in each PHY Frame is defined by the parameter RODCH_NodeID. Note that the PHY frames on which the R-ODCH is allocated (from Frame#RODCH_StartingFrame to Frame#(RODCH_StartingFrame + RODCH_NumFrames-1) should be in the range of Frame#StartingFrame to Frame#(StartingFrame+NumFrames-1). The input information bits shall use one or more sequences of CRC insertion, encoding, channel interleaving, sequence repetition, and data scrambling operations. The input packet shall be converted into one or more subpackets for transmission (see *Reverse Link Packet Size Computation* (3gpp2umb)). Regarding coding schemes, only convolutional and turbo coders are supported. The coding and modulation structure is given in the following figure.



1.
   1. The subpacket splitting, CRC insertion, encoding, channel interleaving are performed in *UMB RL FEC* (3gpp2umb); Others are performed in *UMB RL MuxOFDMSym* (3gpp2umb).
   2. Note that the nodes allocated to the data packet should not be overlapped.
   3. The power density for R-ODCH is defined in the parameter RODCH_PowerDensity. The allocation of power density has three different formats which the same as the allocation in Forward Link:
      - Format 0: Each tile allocated to the data packet in R-ODCH in each PHY Frame has the same power density.
      - Format 1: Different tiles allocated to the data packet in R-ODCH in the same PHY Frame may have the different power density, but the same tiles in all the PHY Frames have the same power density.
      - Format 2: Each tile allocated to the data packet in R-ODCH in each PHY Frame has the different power density.
   4. The following messages are displayed on the window Status/Summary after the simulation finishes:
      - HARQ transmission status for R-ODCH.
      - The usable hop-ports allocated for R-ODCH.
      - The spectral efficiency for R-ODCH.
      - The number of information bits excluding CRC; Coding scheme (CC or TC); Subpacket splitting for R-ODCH.
      - The base nodes allocated for R-ODCH.
      - The usable base nodes allocated for R-ODCH.
      - The power density Format employed for R-ODCH.
      - The Resource Channel Structure during each Superframe.
   5. For R-ODCH, two transmission modes are supported: HARQ transmission and non-HARQ transmission. Please refer to *Forward Link Data Channel HARQ transmission* (3gpp2umb).

2. The **Reverse Dedicated Pilot Channel (R-DPICH)** is generated in *UMB RL MuxOFDMSym* (3gpp2umb).
3. **Reverse OFDMA Dedicated Control Channel (R-ODCCH)**
   The Reverse OFDMA Dedicated Control Channel exsits if EnableRODCCH = YES. The size of the array parameter RODCResourceIndex defines the number of Reverse OFDMA Dedicated Control Channel packets allocated. Each Reverse OFDMA Dedicated Control Channel packet shall be modulated on the two quarter-tiles which are determined as a function of RODCResourceIndex. In this source, the Reverse OFDMA Dedicated Control Channel (R-ODCCH) payload is modulated QPSK data generated

from a Bits source without channel coding. The mapping of R-ODCCH is performed in *UMB RL MuxOFDMSym* (3gpp2umb).

4. **Reverse CDMA Subsegments**
The CDMA Subsegments exsit if EnableCDMASubsegments = YES.
NumCDMASegments defines the number of CDMA subsegments in all PHY Frames. At most two CDMA Subsegments are supported.
CRC insertion, encoding, channel interleaving, sequence repetition, and data scrambling operations shall be performed on the input bits for R-ODCH. At last, the CDMA subsegments are mapped onto OFDM symbols. CRC insertion, encoding and channel interleaving for R-ODCH are performed in *UMB RL CDMASubsegment* (3gpp2umb); The other operations are performed in *UMB RL MuxOFDMSym* (3gpp2umb). The other CDMA channels are also generated in *UMB RL CDMASubsegment* (3gpp2umb).
5. **Parameter Details**
    - Basic Parameters
        - The parameters StartingFrame and NumFrames specify the active PHY Frames in each superframe as described above.
        - OversamplingOption specifies the oversampling ratio of transmission signal. There are six oversampling ratios (1x, 2x, 4x, 8x, 16x, 32x) to support in this source.
        - FFTSize specifies the size of FFT. Sizes 2048, 1024, 512, 256 and 128 are supported.
        - Ncp specifies a multiplicative factor that determines the cyclic prefix duration ($T_{CP}=N_{CP}N_{FFT}T_{CHIP}/16$) as shown in Table 2.7.2.2-1 in Ref1. Ncp 1, 2, 3 and 4 are supported.
        - GuardSize specifies the total number of guard subcarriers. In this source, GuardSize should be an integer multiple of 16.
        - SubzoneSize specifies the size of a subzone on the Reverse Link. Size 64 and 128 are supported.
        - MaxPHYSubPacketSize specifies the maximum information bits in each subpacket. When the input packet size is larger than MaxPHYSubPacketSize, the packet shall be split into multiple subpackets. Size of 4096 bits and 8192 bits are supported according to the specification.
        - EnableHalfDuplexOperation determines whether the sector supports half-duplex terminals.
        - StartingSuperframe specifies the superframe index in the first superframe.
        - SuperframeIdxIncreased specifies whether the superframe number for the superframe is increased. When FrameIncreased is set to YES, the superframe index in the first superframe is StartingSuperframe, and the index in the second superframe is StartingSuperframe+1, and so on. When FrameIncreased is set to NO, the superframe indices in al the superframes are StartingSuperframe.
        - GloballySynchronous specifies whether the sector time-base reference is aligned to UTC.
        - PilotPN specifies the integer identifier of the Sector, in the range of [0, 511].
        - FL_SubzoneSize specifies the size of a subzone on the Forward Link.
        - NumDRCHSubzones specifies the number of DRCH subzones the Forward Link. These two parameters (FL_SubzoneSize and NumDRCHSubzones) determine the Hopping structure used in each Reverse Link PHY Frame.
    - Parameters for Reverse Data Channel (R-ODCH)
        - RODCH_PFIndex specifies the packet format (PF) index for R-ODCH, which specifies the spectral efficiency, maximum number of transmissions, and the modulation format to be used for each transmission of a data packet. The indexing for the packed formats is described in Table 8-4 in Ref2.

- RODCH_NodeID specifies the nodes allocated to R-ODCH (see *Nodes and Hop-ports Allocation* (3gpp2umb)). This is an array parameter which means multiple nodes may be assigned to R-ODCH. The nodes assigned to R-ODCH can be the base nodes or parents (ancestors) nodes. For example, for NFFT=512, MinHopPortsPerNode=16, and QSDMA=1, RODCH_NodeID = {15,16} (corresponding the base-nodes {31, 32, 33, 34}) is allowed. Since the SDMA transmission is not supported, QSDMA is always equal to 1. The definition of RL nodes is described in 8.5.9 in Ref2.
- RODCH_MACID specifies the MACID of the data packet (Access Terminal). This parameter is used for the data scrambling operation.
- RODCH_NumHARQTrans specifies the transmission mode for R-ODCH. Non-HARQ transmission is employed when RODCH_NumHARQTrans=1; Otherwise HARQ transmission is employed.
- RODCH_HARQInterlace specifies the number of PHY Frames for HARQ interlace structure when RODCH_NumHARQTrans is set to the value other than 1.
- The parameters RODCH_NumFrames and RODCH_StartingFrame specify the active PHY Frames in which R-ODCH is transmitted. Note that the range of the active PHY Frames for R-ODCH (from Frame#(RODCH_StartingFrame) to Frame#(RODCH_StartingFrame + RODCH_NumFrames-1)) should be restricted in the range of the active PHY Frames for the this signal source (from Frame#(StartingFrame) to Frame#(StartingFrame + NumFrames-1)).
- RODCH_PowerDensity specifies the power density for R-ODCH which is defined as power (dBm) per modulation symbol. In 3GPP2 UMB system, the subcarrier spacing is 9.6KHz, so the power density for R-ODCH can be described as RODCH_PowerDensity dBm/9.6KHz. Three input formats for RODCH_PowerDensity are allowed:
  Format 0: Each tile allocated to R-ODCH in each PHY Frame has the same power density.
  Format 1: Different tiles allocated to R-ODCH in the same PHY Frame may have the different power density, but the same tiles in all the PHY Frames have the same power density.
  Format 2: Each tile allocated to R-ODCH in each PHY Frame has the different power density.
  For Format 1, the size of the array parameter RODCH_PowerDensity should be equal to the number of base-nodes allocated to R-ODCH, and the ith element in the array RODCH_PowerDensity is the power density for the ith base node, where i is from 0 to NumBaseNodes. For example, for NFFT=512, RODCH_NodeID={31, 32, 33, 34}, RODCH_PowerDensity can be {-15,-16,-17,-18}. Note that sometimes the base-node is an unusable node because this node is mapped to the unusable hop-pots. In this case, the corresponding power density will be ignored.
  For Format 2, the size of the array parameter RODCH_PowerDensity should be equal to the product of the number of base-nodes and RODCH_NumFrames. The (NumBaseNodes*j+i)th element in the array RODCH_PowerDensity is the power density for the ith base node in the jth PHY frame counting from PHY Frame#(RODCH_StartingFrame).
  When the requiremnts for both Format 1 and Format 2 are not met, Format 0 will be employed. In this format, the first element in the array parameter RODCH_PowerDensity will be selected as the unified power density for all the tiles across all the PHY Frames allocated to R-ODCH.
- CodeOffset specifies an integer between 0 and 2. This parameter is used for Reverse Dedicated Pilot Channel in the tiles belonging to the Reverse OFDMA Data Channel (R-ODCH).
- DPICHFormat could be Format 0 or Format 1. This parameter is used for Reverse Dedicated Pilot Channel in the tiles belonging to the Reverse

OFDMA Data Channel (R-ODCH).

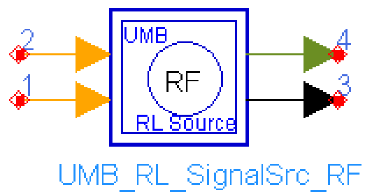
- Parameters for Reverse OFDMA Dedicated Control Channel (R-ODCCH)
  - EnableRODCCH specifies the existence of CDMA subsegments in the PHY Frames.
  - NumRODCIndices specifies the number of total tiles allocated for R-ODCCH which is equal to max(2,NumRODCIndices/2).
  - RODCResourceIndex is an array parameter whose size is the number of allocated R-ODCCHs. Each element in this array specifies two quarter-tiles for each R-ODCCH.
  - RODCCH_PowerDensity specifies the power density for all R-ODCCHs which is defined as power (dBm) per modulation symbol.
- Parameters for CDMA Subsegments.
  - EnableCDMASubsegments specifies the existence of CDMA subsegments in the PHY Frames. When EnableCDMASubsegments is NO, no CDMA subsegment is allocated. Otherwise the CDMA subsegments are allocated.
  - NumCDMASubsegments specifies the number of CDMA subsegments in the PHY Frames when hen EnableCDMASubsegments is YES.
  - The parameters EnableRPICH, EnableRAuxPICH, EnableRACH, EnableRCDCCH and EnableRCDCH specify the existence of R-PICH, R-AuxPICH, R-ACH, R-CDCCH and R-CDCH respectively.
  - The parameters RPICH_PowerDensity, RAuxPICH_PowerDensity, RACH_PowerDensity, RCDCCH_PowerDensity and RCDCH_PowerDensity specify the power density for R-PICH, R-AuxPICH, R-ACH, R-CDCCH and R-CDCH respectively.
  - RCDCH_PacketSize specifies the infomation bits transmitted in R-CDCH for each CDMA subsegments excluding CRC bits.
  - MACID specifies the MACID of the Access Terminal in the target sector which is used for getting the scrambling sequence in R-AuxPICH and R-CDCCH.
  - SHOGID specifies the SHOG ID which is used for getting the scrambling sequence in R-CDCCH.
  - The parameters RPICHScramblingSeed_MSB and RPICHScramblingSeed_LSB specify the 49-bit quantity value uniquely identifying the Access Terminal to all its active set members. RPICHScramblingSeed_MSB is the 17-bit MSBs of RPICHScramblingSeed and RPICHScramblingSeed_LSB is the 32-bit LSBs of RPICHScramblingSeed.
  - AccessScramblingID specifies the access scrambling ID which is used for getting the scrambling sequence in R-ACH.
  - RCDCH_PFID specifies the packet format index used for the transmission of the R-CDCH in the same subsegment.
  - RCDCH_HARQIndex specifies the HARQ transmission index for the R-CDCH in the same subsegment.
  - RACH_WalshSequenceID specifies the index of the Walsh sequence employed by R-ACH.
  - RCDCCH_WalshSequenceID specifies the index of the Walsh sequence employed by R-CDCCH.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_RL_SignalSrc_RF

Symbol



Description: 3GPP2 UMB Reverse Link RF Signal Source
Library: UMB,Signal Source

Parameters

Name	Description	Default	Unit	Type	Range
RF_Parameters					
ROut	Output resistance	DefaultROut	Ohm	int	(0,∞)
RTemp	Temperature, in degrees C	DefaultRTemp	Celsius	real	[-273.15,∞]
FCarrier	Carrier frequency	2500 MHz	Hz	real	(0,∞)
MirrorSpectrum	Mirror spectrum about carrier?: NO, YES	NO		enum	
GainImbalance	Gain imbalance in dB, Q channel relative to I channel	0.0		real	(-∞,∞)
PhaseImbalance	Phase imbalance in degrees, Q channel relative to I channel	0.0		real	(-∞,∞)
I_OriginOffset	I origin offset in percent with repect to output rms voltage	0.0		real	(-∞,∞)
Q_OriginOffset	Q origin offset in percent with repect to output rms voltage	0.0		real	(-∞,∞)
IQ_Rotation	IQ rotation in degrees	0.0		real	(-∞,∞)
BasicParameters					
OutputFrameFormat	output superframe format: Full Superframe, Compact Superframe	Full Superframe		enum	
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0		int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25		int	
OversamplingOption	Oversampling ratio option: Ratio 1, Ratio 2, Ratio 4, Ratio 8, Ratio 16, Ratio 32	Ratio 2		enum	
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512		enum	[0,4]
Ncp	the index for Cyclic Prefix (Tcp=Ncp*FFTSize*Tchip/16): Ncp 1, Ncp 2, Ncp 3, Ncp 4	Ncp 1		enum	
GuardSize	the size of guard subcarriers	32		int	
SubzoneSize	the number of hop-ports in each subzone (64 or 128): Size 64, Size 128	Size 64		enum	
MaxPHYSubPacketSize	the maximum subpacket size	Size 8192		enum	[0,1]

	(4096 bits or 8192 bits): Size 4096, Size 8192				
EnableHalfDuplexOperation	whether the half duplex operation is enabled: NO, YES	NO		enum	
StartingSuperframe	the superframe index for the starting superframe	0		int	[0,∞)
SuperframeIdxIncreased	whether the superframe index is increased from superframe to superframe: NO, YES	YES		enum	
GloballySynchronous	whether the sector is synchronized with GPS time: NO, YES	NO		enum	
PilotPN	9-bit pilot PN for different sectors	0		int	[0,511]
FL_SubzoneSize	the number of hop-ports in a FL subzone for determining hopping structures in RL PHY Frames: FL Size 64, FL Size 128	FL Size 64		enum	
NumDRCHSubzones	the number of DRCH subzones in FL for determining hopping structures in RL PHY Frames	4		int	[0,FFTSize/SubzoneSize-1]
RODCH_Parameters					
RODCH_PFIndex	the packet format index for R-ODCH	1		int	[0,14]
RODCH_NodeID	the array of NodeID allocated to R-ODCH	{31}		int array	
RODCH_MACID	the MAC ID of the Access Terminal as associated with the RLSS	1		int	[0,511]
RODCH_NumHARQTrans	the number of HARQ transmissions for the R-ODCH	1		int	[1,25]
RODCH_HARQInterlace	the number of PHY frames in HARQ interlace structure for the R-ODCH	6		int	[1,24]
RODCH_StartingFrame	the starting frame index from which R-ODCH is allocated	0		int	[0,24]
RODCH_NumFrames	the number of frames on which R-ODCH is allocated starting from the RODCH_StartingFrame	25		int	[1,25]
RODCH_PowerDensity	the power density for R-ODCH (defined as power(dBm) per modulation symbol)	{-16.0}		real array	[-∞,∞]
CodeOffset	code offset between 0 and 2 for Reverse Dedicated Pilot Channel	0		int	[0,2]
DPICHFormat	the Reverse Dedicated Pilot Channel format for OFDMA Data Channels: Format 0, Format 1	Format 0		enum	[0,1]
RODCCH_Parameters					
EnableRODCCH	whether the allocation of R-ODCCH is enabled: NO, YES	NO		enum	
NumRODCIndices	the number of Indices for R-ODCCH (the number of tiles for R-ODCCH is max(2,system.NumRODCIndices/2	4		int	[0,∞]
RODCResourceIndex	the resource index for each R-ODCCH	{0}		int array	[0,2]
RODCCH_PowerDensity	the power density for R-ODCCH (defined as power(dBm) per modulation symbol)	-16		real	[-∞,∞]
CDMASubsegmentParameters					
EnableCDMASubsegments	whether the allocation of CDMA	NO		enum	

	subsegments is enabled: NO, YES				
NumCDMASubsegments	number of allocated CDMA subsegments allocated, only valid when EnableCDMASubsegments is YES	1		int	[1,∞)
EnableRPICH	whether R-PICH is enabled in this CDMA subsegment: NO, YES	NO		enum	
RPICH_PowerDensity	the power density for R-PICH (defined as power(dBm) per modulation symbol)	-16		real	[-∞,∞]
EnableRAuxPICH	whether R-AuxPICH is enabled in this CDMA subsegment: NO, YES	NO		enum	
RAuxPICH_PowerDensity	the power density for R-AuxPICH (defined as power(dBm) per modulation symbol)	-16		real	[-∞,∞]
EnableRACH	whether R-ACH is enabled in this CDMA subsegment: NO, YES	NO		enum	
RACH_PowerDensity	the power density for R-ACH (defined as power(dBm) per modulation symbol)	-16		real	[-∞,∞]
EnableRCDCCH	whether R-CDCCH is enabled in this CDMA subsegment: NO, YES	NO		enum	
RCDCCH_PowerDensity	the power density for R-CDCCH (defined as power(dBm) per modulation symbol)	-16		real	[-∞,∞]
EnableRCDCH	whether R-CDCH is enabled in this CDMA subsegment: NO, YES	YES		enum	
RCDCH_PacketSize	the number of packet bits in R-CDCH excluding CRC bits	136		int	[1,2048]
RCDCH_PowerDensity	the power density for R-CDCH (defined as power(dBm) per modulation symbol)	-16		real	[-∞,∞]
MACID	the MAC ID of the terminal in the target sector	0		int	[0,511]
SHOGID	the SHOG ID for R-CDCCH	0		int	[0,511]
RPICHScramblingSeed_MSB	the 17-bit MSBs of 49-bit R-PICH Scrambling Seed	0		int	[0,2^17-1]
RPICHScramblingSeed_LSB	the 32-bit LSBs of 49-bit R-PICH Scrambling Seed	10		int	[0,2^32-1]
AccessScramblingID	the AccessScrambling ID for R-ACH	10		int	[0,∞]
RCDCH_PFID	the packet format index used for the transmission of the Reverse CDMA Data Channel	1		int	[0,16]
RCDCH_HARQIndex	the HARQ transmission index for the Reverse CDMA Data Channel	0		int	[0,5]
RACH_WalshSequenceID	the WalshSequence ID for R-ACH	3		int	[0,1023]
RCDCCH_WalshSequenceID	the WalshSequence ID for R-CDCCH	4		int	[0,1023]

Pin Inputs

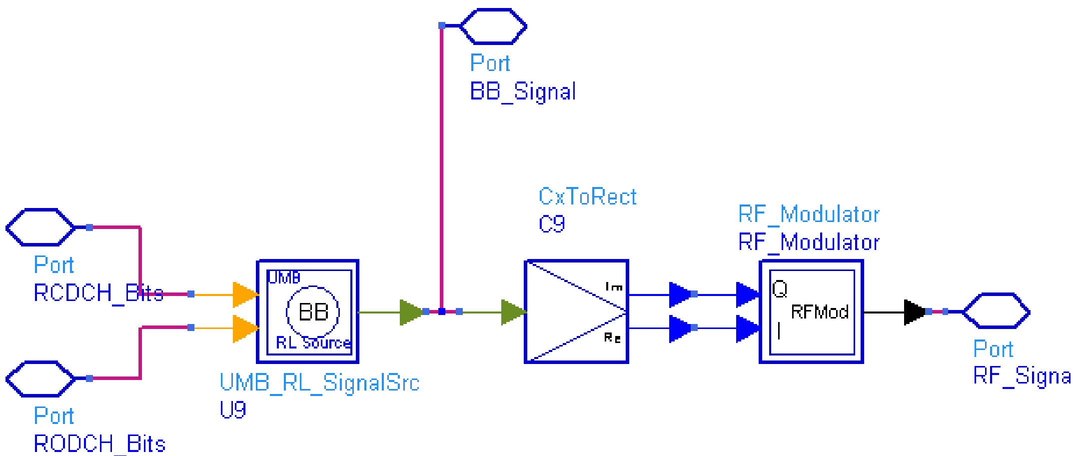
Pin	Name	Description	Signal Type
1	RODCH_Bits	input bits for R-ODCH	int
2	RODCCH_Bits	input bitsforR-ODCCH	int

Pin Outputs

Pin	Name	Description	Signal Type
3	RF_Signal	RF signal	timed
4	BB_Signal	BB signal	complex

Notes/Equations

1. This subnetwork is to implement 3GPP2 UMB Reverse Link RF source. The schematic for this subnetwork is shown in the following figure.



UMB_RL_SignalSrc_RF Schematic

1. The implementation of 3GPP2 UMB Reverse Link baseband source is described in *Reverse Link baseband source* (3gpp2umb).
2. Parameter Details
   - RF Parameters
     - ROut is the RF output resistance.
     - RTemp is the RF output resistance temperature in Celsius and sets the noise density in the RF output signal to (k(RTemp+273.15)) Watts/Hz, where k is Boltzmann's constant.
     - FCarrier is the RF output signal frequency.
     - MirrorSpectrum is used to mirror the RF_out signal spectrum about the carrier. This is equivalent to conjugating the complex RF envelope voltage. Depending on the configuration and number of mixers in an RF transmitter, the RF output signal from hardware RF generators can be inverted. If such an RF signal is desired, set this parameter to YES.
       GainImbalance, PhaseImbalance, I_OriginOffset, Q_OriginOffset, and IQ_Rotation are used to add certain impairments to the ideal output RF signal. Impairments are added in the order described here.
     - The unimpaired RF I and Q envelope voltages have gain and phase imbalance applied. The RF is given by:

$$V_{RF}(t) = A\left(V_I(t)\cos(\omega_c t) - gV_Q(t)\sin\left(\omega_c t + \frac{\Phi\pi}{180}\right)\right)$$

       where A is a scaling factor based on the Power and ROut parameters specified by the user, $V_I(t)$ is the in-phase RF envelope, $V_Q(t)$ is the quadrature phase RF envelope, g is the gain imbalance

$$g = 10^{\frac{GainImbalance}{20}}$$

       and Φ (in degrees) is the phase imbalance.
       Next, the signal $V_{RF}(t)$ is rotated by IQ_Rotation degrees. The

I_OriginOffset and Q_OriginOffset are then applied to the rotated signal. Note that the amounts specified are percentages with respect to the output rms voltage. The output rms voltage is given by sqrt(2xROutxPower).

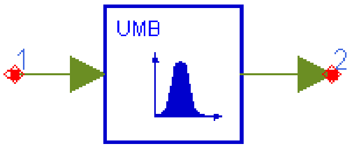
- The basic parameters are described in *Basic Parameters* (3gpp2umb).
- The parameters for Reverse Data Channel (R-ODCH) are described in *R-ODCH Parameters* (3gpp2umb).
- The parameters for Reverse OFDMA Dedicated Control Channel (R-ODCCH) are described in *R-ODCCH Parameters* (3gpp2umb).
- The parameters for CDMA Subsegments are described in *CDMA Subsegment Parameters* (3gpp2umb).

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

UMB_SymWindow

Symbol



UMB_SymWindow

Description: OFDM Symbol windowing operation
Library: UMB, Signal Source

Parameters

Name	Description	Default	Type	Range
OutputFrameFormat	output superframe format: Full Superframe, Compact Superframe	Full Superframe	enum	
StartingFrame	the starting frame index in each superframe from which this model will allocate the data	0	int	
NumFrames	the number of frames on which this model will allocate the data starting from the StartingFrame	25	int	
OversamplingOption	Oversampling ratio option: Ratio 1, Ratio 2, Ratio 4, Ratio 8, Ratio 16, Ratio 32	Ratio 1	enum	
FFTSize	the size of total subcarriers for FFT operation: FFT 2048, FFT 1024, FFT 512, FFT 256, FFT 128	FFT 512	enum	[0,4]
Ncp	the index for Cyclic Prefix (Tcp=Ncp*FFTSize*Tchip/16): Ncp 1, Ncp 2, Ncp 3, Ncp 4	Ncp 1	enum	
EnableHalfDuplexOperation	whether the half duplex operation is enabled: NO, YES	NO	enum	

Pin Inputs

Pin	Name	Description	Signal Type
1	DataIn	input data	complex

Pin Outputs

Pin	Name	Description	Signal Type
2	DataOut	output data	complex

Notes/Equations

1. This model applies the windowing operation on the output of IFFT operation.
   Each firing,
   When EnableHalfDuplexOperation = NO, $N_{FRAME}*N_{OFDM-SYMBOLS}$ tokens are consumed at pin DataIn; The number of tokens produced at pin DataOut is the same as that at pin DataIn, where N_{FRAME}=8, $N_{OFDM-SYMBOLS}$ is the number of samples in one OFDM symbols: $N_{OFDM-SYMBOLS} = N_{FFT} * 2^{OversamplingOption} * (1+Ncp/16+1/32)$.
   When EnableHalfDuplexOperation = YES, $(N_{FRAMES} + 1)*N_{FRAME}*N_{OFDM-SYMBOLS}+N_{FRAMES}*N_{TG}$ tokens are consumed at pin DataIn; The number of tokens produced at pin DataOut is the same as that at pin DataIn, where $N_{FRAMES} = N_{PHY-FRAMES}$ = 25 if

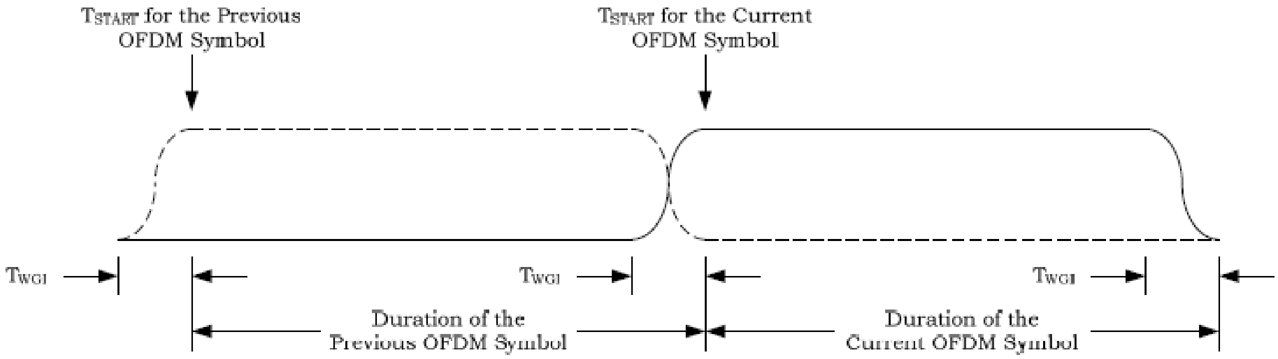
OutputFrameFormat = Full superframe; Otherwise N_{FRAMES} = NumFrames. N_{TG} is the number of samples in the guard time between PHY Frames: $N_{TG} = 3*N_{FFT}*2^{OversamplingOption}/4$.

2. The signal, x(t), at the output of the inverse Fourier transform operation shall be multiplied by a window function, w(t), giving a windowed signal of y(t) = x(t)w(t). The window function shall be given by

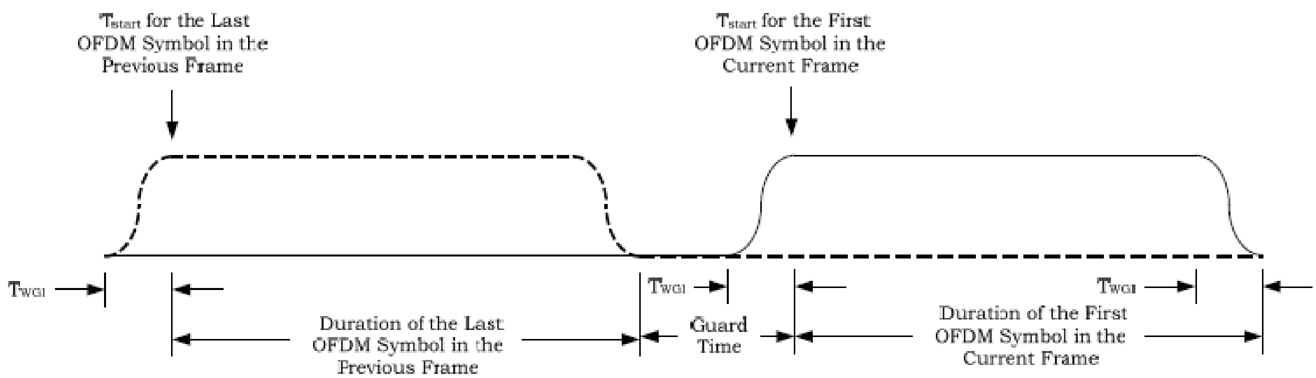
$$w(t) = \begin{cases} 0 & , (t - T_{START}) < -T_{WGI} \\ 0.5 - 0.5\cos\left(\dfrac{\pi(t + T_{WGI} - T_{START})}{T_{WGI}}\right) & , -T_{WGI} \le (t - T_{START}) < 0 \\ 1 & , 0 \le (t - T_{START}) < T_{CP} + T_{FFT} \\ 0.5 + 0.5\cos\left(\dfrac{\pi(t - T_{START} - T_{CP} - T_{FFT})}{T_{WGI}}\right) & , T_{CP} + T_{FFT} \le (t - T_{START}) < T_s \\ 0 & , (t - T_{START}) \ge T_s \end{cases}$$

where T_{START} denotes the start time of the OFDM symbol and Ts denotes the OFDM symbol duration: $Ts = N_{FFT}*(1+Ncp/16+1/32)*T_{CHIP}$; $T_{FFT} = N_{FFT}*T_{CHIP}$; T_{CHIP} is the chip time step, equal to 1/1.2288 usec, 1/2.4576 usec, 1/4.9152 usec, 1/9.8304 usec and 1/19.6608 usec for N_{FFT} = 128, 256, 512, 1024 and 2048 respectively.

3. All of the OFDM symbols shall be added together to create the final complex baseband waveform, z(t). If EnableHalfDuplexOperation = NO, the neighboring OFDM symbols shall overlap for a duration of T_{WGI} ($T_{WGI} = N_{FFT}/32*T_{CHIP}$), as illustrated as



If EnableHalfDuplexOperation = YES, the neighboring OFDM symbols or Guard Times shall overlap for a duration of T_{WGI}, as illustrated as



4. Note that a time delay of T_{WGI} (corresponding sampling number $N_{WGI}=N_{FFT}/32*2^{OversamplingOption}$) is introduced in this model.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.

About 3GPP2 UMB Design Library

The Agilent EEsof 3GPP2 UMB wireless library (WL) is for the 3GPP2 UMB market. This wireless design library follows 3GPP2 C.S0084-001-0 v2.0 (August 2007). This design library is intended to be a baseline system for designers to get an idea of what a 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.

3GPP2 UMB Systems

The Ultra Mobile Broadband (UMB) air interface specification, developed by the CDMA Development Group (CDG) and the Third Generation Partnership Project 2 (3GPP2), is the world's first IP-based mobile broadband standard to enable peak download data rates of 288 Mbps in a 20 MHz bandwidth, while preserving large economies of scope and scale. UMB represents a major break-through in next generation mobile broadband services by enabling the transfer of native IP, variable length, data packets at speeds that are orders of magnitude higher than what is commercially available today. It is the latest member of the family of CDMA2000(r) standards that was designed from the ground up to improve the overall end-user experience and strengthen an operator's earnings potential.
UMB is the leading Orthogonal Frequency Division Multiple Access (OFDMA) solution, using sophisticated control and signaling mechanisms, radio resource management (RRM), adaptive reverse link (RL) interference management, and advanced antenna techniques, such as Multiple Input Multiple Output (MIMO), Space Division Multiple Access (SDMA) and beamforming. UMB's use of OFDMA eliminates many of the disadvantages of the CDMA technology used by its predecessor, including the "breathing" phenomenon, the difficulty of adding capacity via microcells, and the fixed bandwidth sizes that limit the total bandwidth available to handsets. The UMB solution universally addresses a large cross-section of advanced mobile broadband services by economically delivering low-rate, low latency voice traffic at one end of the spectrum, just as efficiently as ultra-high-speed, latency insensitive, broadband data traffic at the other. To support ubiquitous and universal access, UMB supports inter-technology hand-offs and seamless operation with existing CDMA2000 1X and 1xEV-DO systems. The UMB solution delivers a compelling user experience based on the strongest performance and economic value proposition available within the wireless industry, including:

- High-Speed Data: Peak download and upload speeds of 288 Mbps and 75 Mbps, respectively, in a mobile environment with a 20 MHz bandwidth.
- Increased Data Capacity: Ability to deliver both high-capacity voice and broadband data in all environments; fixed, pedestrian and fully-mobile in excess of 300 km/hr.
- Low Latency: An average latency of 14.3 msec over-the-air to support VoIP, push-to-talk and other delay sensitive applications with minimal jitter.
- Increased VoIP Capacity: Up to 1000 simultaneous Voice over IP (VoIP) users within a single sector, 20 MHz of bandwidth in a mobile environment without degrading concurrent data throughput capacity.
- Large Coverage: Large wide area network (WAN) coverage areas equivalent to existing cellular networks; with either ubiquitous coverage for seamless roaming or non-contiguous coverage for hot zone applications.
- Full Mobility: Robust mobility support with seamless handoffs inherent in all aspects of the UMB design.
- Converged Access Network: Supports the deployment of a Converged Access Network (CAN), which is an advanced IP-based Radio Access Network (RAN) architecture being developed by 3GPP2 to support multiple access technologies and advanced network capabilities, such as enhanced QoS, with fewer network nodes and lower latencies.
- Multicasting: Support for high-speed multicast of rich multimedia content.

- Deployment Flexibility: Deployable in flexible bandwidth allocations between 1.25 MHz and 20 MHz, using incremental channel bandwidths allocations of around 150 kHz, within the 450 MHz, 700 MHz, 850 MHz, 1700 MHz, 1900 MHz, 1700/2100 MHz (AWS), 1900/2100 MHz (IMT) and 2500 MHz (3G extension) spectrum bands. The IP-based UMB radio access network is also designed to interoperate with legacy circuit-switched networks.
- Device Availability: Multi-mode, multi-band UMB devices will leverage the existing 3G CDMA device selection to preserve economies of scale.
- Strong Ecosystem: UMB leverages the existing ecosystem of 3G CDMA clients and experienced suppliers to achieve large economies of scope.

Major specifications for the 3GPP2 UMB PHY physical layer are listed in Physical Layer Major Specifications.

Specification	**Settings**
Information data rate	up to 280 Mbps at 20 MHz bandwidth
Modulation	QPSK, 8PSK, 16-QAM, 64-QAM, layered modulation
Error correcting code	CC, TC, LDPC
Coding rate	1/3, 1/5
N_{FFT}:FFT Size	2048, 1024, 512, 256, 128
Number of data subcarriers	variable
Number of pilot subcarriers	variable
Number of total subcarriers used	variable
Number of lower frequency guard subcarriers	variable
Number of higher frequency guard subcarriers	variable
G: Ratio of CP time to "useful" time	1/4, 1/8, 3/16, 1/16
WGI: Ratio of WinGuard time to "useful" time	1/32
BW: Nominal channel bandwidth	From 1.25 MHz to 20 MHz
Subcarrier frequency spacing	9.6 KHz
Tb: Useful symbol time	104.1667 us
Tg: CP time	6.51 us, 13.02 us, 19.53 us, 26.04 us
Ts: OFDM symbol time	113.93 us, 120.44 us, 126.95 us, 133.46 us

3GPP2 UMB PHY Physical Layer Major Specifications

The symbol parameters for different FFT sizes shall be as specified in the following table.

Parameter	FFT 128	FFT 256	FFT 512	FFT 1024	FFT 2048	Units
Chip Rate $1/T_{CHIP}$	1.2288	2.4576	4.9152	9.8304	19.6608	Mcps
Subcarrier Spacing $1/(T_{CHIP}N_{FFT})$	9.6	9.6	9.6	9.6	9.6	kHz
Bandwidth of Operation (B)	B <=1.25	1.25 < B <= 2.5	2.5 < B <= 5	5 < B <= 10	10 < B <= 20	MHz
Cyclic Prefix Duration $T_{CP} = N_{CP}N_{FFT}T_{CHIP}/16$, N_{CP} = 1, 2, 3, or 4	6.51, 13.02, 19.53, or 26.04	6.51, 13.02, 19.53, or 26.04	6.51, 13.02, 19.53, or 26.04	6.51, 13.02, 19.53, or 26.04	6.51, 13.02, 19.53, or 26.04	us
Windowing Guard Interval $T_{WGI} = N_{FFT}T_{CHIP}/32$	3.26	3.26	3.26	3.26	3.26	us
OFDM Symbol Duration $Ts = N_{FFT}T_{CHIP}(1 + N_{CP}/16 + 1/32)$, N_{CP} = 1, 2, 3, or 4	113.93, 120.44, 126.95, or 133.46	113.93, 120.44, 126.95, or 133.46	113.93, 120.44, 126.95, or 133.46	113.93, 120.44, 126.95, or 133.46	113.93, 120.44, 126.95, or 133.46	us

3GPP2 UMB PHY OFDM Symbol Numerology

The OFDM superframe parameters shall be as specified in the following table.

Parameter	Value	Units
N_{FRAME} = Number of OFDM Symbols in a Forward and Reverse Link PHY Frame (except the first Reverse Link PHY Frame)	8	
$N_{PREAMBLE}$ = Number of OFDM Symbols in the Superframe Preamble	8	
Number of PHY Frames in a Superframe	25	
Guard time between PHY Frames when EnableHalfDuplexOperation = 1 ($Tg = 3N_{FFT}T_{CHIP}/4$)	78.13	us
Superframe Duration ($T_{SUPERFRAME}$) when EnableHalfDuplexOperation = 0 for N_{CP} = 1, 2, 3, or 4	23.70, 25.05, 26.41, or 27.76	ms
Superframe Duration ($T_{SUPERFRAME}$) when EnableHalfDuplexOperation = 1 for N_{CP} = 1, 2, 3, or 4	25.65, 27, 28.4, or 29.7	ms

3GPP2 UMB PHY OFDM Superframe Numerology

In ADS 3GPP2 UMB wireless library, one Forward Link RF source and one Forward Link RF receiver are developed. The following table lists the channel features supported by ADS in this release.

Channels	ADS Supported
Pilot Channels	
Forward Common Pilot Channel (F-CPICH)	YES
Forward Channel Quality Indicator Pilot Channel (F-CQIPICH)	NO
Forward Dedicated Pilot Channel (F-DPICH)	YES
Forward Preamble Pilot Channel (F-PPICH)	YES
Forward Beacon Pilot Channel (F-BPICH)	NO
Forward Cell Null Channel (F-CNCH)	NO
Control Channels Transmitted in the Superframe Preamble	
Forward Acquisition Channel (F-ACQCH)	YES
Forward Primary Broadcast Control Channel (F-PBCCH)	YES
Forward Secondary Broadcast Control Channel (F-SBCCH)	YES
Forward Quick Paging Channel (F-QPCH)	YES
Forward Other Sector Interference Channel (F-OSICH)	YES
Control Channels Transmitted in the Control Segment of PHY Frames	
Forward Shared Control Channel (F-SCCH)	NO
Forward Acknowledgment Channel (F-ACKCH)	NO
Forward Power Control Channel (F-PCCH)	NO
Forward Pilot Quality Indicator Channel (F-PQICH)	NO
Forward Fast Other Sector Interference Channel (F-FOSICH)	NO
Forward Start of Packet Channel (F-SPCH)	NO
Forward Reverse Activity Bit Channel (F-RABCH)	NO
Forward Interference over Thermal Channel (F-IOTCH)	NO
Traffic Channel	
Forward Data Channel (F-DCH)	YES, up to four data packets supported in F-DCH
Forward Superposed Data Channel	NO

ADS supported channels in Forward Link

In the Forward Link RF receiver, the following features are supported:

- Raw and fine timing synchronization
- Frequency synchronization
- Channel estimation
- Data de-scrambling for Forward Link Data channel
- Channel de-interleaving for Forward Link Data channel
- Rate-1/3 convolutional decoder or rate-1/5 turbo decoder for Forward Link Data channel
- CRC decoder for Forward Link Data channel

The following features for Forward Link are not included in this release:

- Channel Coding
  - Rate - 1/3 Tailbiting Convolutional encoder
  - Rate - 1/3 Concatenated encoder
  - LDPC encoder
- Inverted Sequence Repetition
- MIMO and STTD modes
- Rotational OFDM
- Reserved subzones

In ADS 3GPP2 UMB wireless library, one Reverse Link RF source is developed. The following table lists the channel features supported by ADS in this release.

Channels	**ADS Supported**
CDMA Subsegments	YES, up to two CDMA Subsegments are supported
Reverse Pilot Channel (R-PICH)	YES, one in each CDMA subsegment
Reverse Auxiliary Pilot Channel (R-AuxPICH)	YES, one in each CDMA subsegment
Reverse Access Channel (R-ACH)	YES, one in each CDMA subsegment
Reverse CDMA Dedicated Control Channel (R-CDCCH)	YES, one in each CDMA subsegment
Reverse CDMA Data Channel (R-CDCH)	YES, one in each CDMA subsegment
Reverse Dedicated Pilot Channel (R-DPICH)	YES, one in each CDMA subsegment
Reverse OFDMA Dedicated Control Channel (R-ODCCH)	YES, one in a given PHY Frame
Reverse Acknowledgment Channel (R-ACKCH)	NO
Reverse OFDMA Data Channel (R-ODCH)	YES, one data packet in R-ODCH

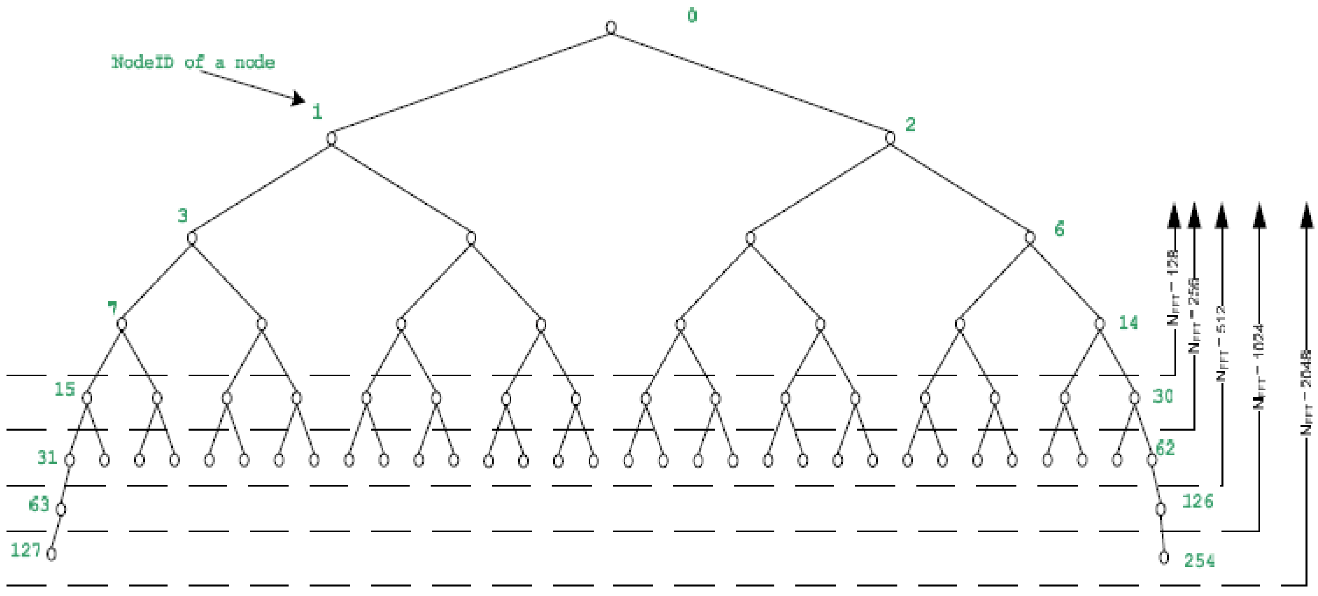
ADS supported channels in Reverse Link

The following features for Reverse Link are not included in this release:

- Channel Coding
    - Rate - 1/3 Tailbiting Convolutional encoder
    - Rate - 1/3 Concatenated encoder
    - LDPC encoder
- Erasure Sequence Transmission

Nodes and Hop-ports Allocation

For each Forward and Reverse Link data packet, a set of hop-ports is assigned. The set of hop-ports that are associated with each node identification number (NodeID) are specified by the channel tree (see Node Channel Tree). A set of hop-ports is said to be "mapped to a node" and a node "maps" a set of hop-ports.



Node Channel Tree

The channel tree is described as a function of the variable N_{FFT}. For each N_{FFT}, the nodes at the bottom in the figure are base nodes which have no children nodes. The NodeIDs for all the base nodes are list in the following table for N_{FFT} = 128, 256, 512, 1024 and 2048.

N_{FFT}	NodeIDs for base nodes
2048	127 ~ 254
1024	63 ~ 126
512	31 ~ 62
256	15 ~ 30
128	7 ~ 14

To be precise, the range of base node NodeIDs for N_{FFT} = 128, 256, 512, 1024 and 2048 is [N_{FFT}/16-1, N_{FFT}/8-2].

The mapping of hop-ports to each base node in Reverse Link and in Forward Link when ResourceChannelMuxMode =2 is described as follows. Each base node maps to MinHopPortsPerNode hop-ports, the first MinHopPortsPerNode hop-ports (indices 0 to MinHopPortsPerNode-1) to the base node with the lowest NodeID, the second MinHopPortsPerNode hop-ports to the next base node, etc., until all hop-ports are mapped for all SDMA sub-trees, where MinHopPortsPerNode = 16.
For Forward Link when ResourceChannelMuxMode 1, the first N_{DRCH} DRCH hop-ports are mapped to the first N_{DRCH}/MinHopPortsPerNode base nodes in the SDMA sub-tree 0 and the next N_{FFT} BRCH hop-ports are mapped to the next (N_{FFT}-N_{DRCH})/MinHopPortsPerNode base nodes in SDMA sub-tree 0. To be precise, the channel tree base node corresponding to hop-port index j shall be given by

$$\left\lfloor \left\lfloor \frac{j-N_{DRCH}}{MinHopportsPerNode} \right\rfloor \frac{N_{FFT}-N_{DRCH}}{N_{FFT}} \right\rfloor + \frac{N_{DRCH}}{MinHopportsPerNode} + \frac{N_{FFT}}{MinHopportsPerNode} - 1$$

The set of hop-ports specified by the NodeID of a parent node is the union of usable hop-ports mapped by all base nodes that are descendants of the node specified by NodeID. For each NodeID of a parent node, the descendant base nodes can be found from the figure Node Channel Tree. For example, for N_{FFT}=512 and NodeID=3, then the base nodes are [31,62], the descendants for NodeID=3 are {31,32,33,34,35,36,37,38}.
Note that since SDMA transmission is not supported in ADS UMB library, the SDMA order for transmissions, Q_{SDMA}, is equal to 0.

Packet Splitting

In ADS UMB library, the packet splitting applies to the Reverse OFDMA Data Channel and the Forward Data Channel only. The input packets shall be converted into one or more subpackets for transmission, and the sequence of CRC insertion, encoding, channel interleaving, sequence repetition, and data scrambling operations shall be performed independently for each subpacket.
If the input packet size N_{PACKET_BITS} is larger than MaxPHYSubPacketSize, the packet shall be split into $N_{SUBPACKETS}$ subpackets, indexed from 0 to $N_{SUBPACKETS}$ - 1, where $N_{SUBPACKETS}$ = ceil(N_{PACKET_BITS}/MaxPHYSubPacketSize), where MaxPHYSubPacketSize can be 8192 or 4096. When N_{PACKET_BITS} is less than MaxPHYSubPacketSize, there shall only be one subpacket.
Define

$$t_0 = \left(\frac{N_{PACKET\_BITS}}{8}\right) \bmod N_{SUBPACKETS}$$

$$t_1 = N_{SUBPACKETS} - t_0$$

$$b_0 = 8\left\lceil \frac{N_{PACKET\_BITS}}{8N_{SUBPACKETS}} \right\rceil$$

$$b_1 = \begin{cases} b_0, & \text{if } t_0 = 0 \\ b_0 - 8, & \text{otherwise} \end{cases}$$

Each of the first t0 subpackets shall have b0 bits, and each of the last t1 subpackets shall have b1 bits. The packet bits shall be distributed to the different subpackets in order, i.e., the first set of packet bits shall form the first subpacket, the next set of packet bits shall form the second subpacket, etc.

Forward Link Packet Size Computation

1. This section describes the computation of Forward Link packet size (N_{PACKET_BITS}).

   The input parameters are FFTSize, GuardSize, RsChMuxMode, SubzoneSize, NumDRCHSubzones, FDCH_PFIndex, FDCH_NodeID and FDCH_NumFrames.
2. N_{FFT} denotes the number of FFT size defined by the parameter FFTSize;

FFTSize	N_{FFT}
0	2048
1	1024
2	512
3	256
4	128

   N_{GUARD} denotes the number of gurad subcarriers: N_{GUARD}= GuardSize;

   $N_{SUBZONE\_MAX,FL}$ denotes the number of hop-ports in one subzone given by the parameter SubzoneSize which may be values of 64 or 128.

SubzoneSize	$N_{SUBZONE\_MAX,FL}$
0	64
1	128
3. FDCH_PFID indexes the Forward Link spectral efficiency, maximum number of transmissions, and the modulation format to be used for each transmission of a Forward Link data packet as shown in the following figure.

PF Index	**Spectral Efficiency on 1x**	**Mod on 1x**	**Mod on 2x**	**Mod on 3x**	**Mod on 4x**	**Mod on 5x**	**Mod on 6^{+} x**
0	0.33	2	2	2	2	2	2
1	0.67	2	2	2	2	2	2
2	0.94	2	2	2	2	2	2
3	1.5	4	3	3	3	3	3
4	2.0	4	3	3	3	3	3
5	2.5	6	4	4	3	3	3
6	3.0	6	4	4	4	4	4
7	3.5	6	4	4	4	4	4
8	4.0	6	6	4	4	4	4
9	4.5	6	6	4	4	4	4
10	5.0	6	6	4	4	4	4
11	6.0	6	6	4	4	4	4
12	7.0	6	6	6	4	4	4
13	8.0	6	6	6	4	4	4
14	9.5	6	6	6	6	4	4

4. FDCH_NodeID specifies the nodes allocated to the data packet (see Nodes and Hop-ports Allocation). This is an array parameter which means multiple nodes may be assigned to F-DCH. The nodes assigned to the data packet can be the base nodes or parents (ancestors). A set of hop-ports are mapped to each node. If we get the NodeIDs alloated to the data packet, we can get the set of hop-ports which are allocated to that packet. The hop-ports can be divided into Usable and Unusable hop-ports. We need to check all the hop-ports allocated to the data packet and can get the number of usable hop-ports. A hop-port is marked as usable only if it is not a reserved hop-port and it does not map to a guard subcarrier. A hop-port (DRCH, q, s, b, r) or (BRCH, q, s, b, r) shall be usable only if all of the following conditions are true:
   - $0 <= s < S - N_{RESERVED-SUBZONES}(k)$.
   - $b*N_{BLOCK} + r < N_{SUBZONE}(s)$.

     where hop-port (DRCH, q, s, b, r) or (BRCH, q, s, b, r) is an alternative indexing scheme described in 2.14.4.3 of Ref1; $N_{RESERVED-SUBZONES}(k)$ is fixed to 0 in ADS UMB library; S is the number of subzones defined as:
     $S = ceil((N_{FFT}-N_{GUARD})/N_{SUBZONE\_MAX,FL})$.

     $N_{SUBZONE}(s)$ defines the number of hop-port in Subzone s, defined as: Let $S_{SPLIT} = ((N_{FFT} - N_{GUARD}) / N_{BLOCK})mod S$. If $0<= s < S_{SPLIT}$, define $N_{SUBZONE}(s) = N_{BLOCK}*ceil((N_{FFT}-N_{GUARD})/(N_{BLOCK}*S))$. If $S_{SPLIT}<= s < S$, define $N_{SUBZONE}(s) = N_{BLOCK}*floor((N_{FFT}-N_{GUARD})/(N_{BLOCK}*S))$; N_{BLOCK} is the number of hop-ports in one block (fixed to 16);
5. The packet size for each assignment is computed based on the spectral efficiency listed in the table above and the assignment size. Let s denote the spectral efficiency of the packet format at the first HARQ transmission; let H denote the number of usable hop-ports in the assignment at the first HARQ transmission; let NumFrames denote the number of PHY frames allocated; let N_{PACKET_BITS} denote the number of information bits in the packet excluding CRC.
   - For all assignments except for the BRCH assignments in ResourceChannelMuxMode 1, the packet size is given by
     $N_{PACKET\_BITS} = 8*floor(NumFrames*s*H)-N_{CRC,Data}$

     where N is the number of CRC bits for the data packet (fixed to 24). For

$_{CRC,Data}$

regular assignments, NumFrames=1; For extended frame assignments, NumFrames=3.

- For all BRCH assignments in ResourceChannelMuxMode 1, the packet size is given by
  N_{PACKET_BITS} = 8*floor(NumFrames*s*H*(N_{FFT}-N_{DRCH})/N_{FFT})-$N_{CRC,Data}$
  where N_{DRCH} is the number of the hop-ports in DRCH: N_{DRCH}= NumDRCHSubzones*$N_{SUBZONE\_MAX,FL}$.

Reverse Link Packet Size Computation

1. This section describes the computation of Reverse Link OFDMA packet size (N_{PACKET_BITS}). The input parameters are FFTSize, GuardSize, SubzoneSize, EnableCDMASubsegments, NumCDMASubsegments, RODCH_PFIndex, RODCH_NodeID and RODCH_NumFrames.
2. N_{FFT} denotes the number of FFT size defined by the parameter FFTSize which is the same as FFTSize in Forward Link;
   N_{GUARD} denotes the number of gurad subcarriers: N_{GUARD}= GuardSize which is the same as GuardSize in Forward Link;
   $N_{SUBZONE\_MAX,RL}$ denotes the number of hop-ports in one subzone given by the parameter SubzoneSize which may be values of 64 or 128.
3. RODCH_PFIndex indexes the Reverse Link spectral efficiency, maximum number of transmissions, and the modulation format to be used for each transmission of a Reverse Link data packet as shown in the following figure.

PF Index	**Spectral Efficiency on 1x**	**Mod on 1x**	**Mod on 2x**	**Mod on 3x**	**Mod on 4x**	**Mod on 5x**	**Mod on 6^+ x**
0	0.44	2	2	2	2	2	2
1	0.71	2	2	2	2	2	2
2	1.07	2	2	2	2	2	2
3	1.4	3	2	2	2	2	2
4	1.8	4	3	3	3	3	3
5	2.13	6	4	4	4	4	4
6	2.5	6	4	4	4	4	4
7	3.0	6	4	4	4	4	4
8	3.5	6	4	4	4	4	4
9	4.0	6	6	4	4	4	4
10	4.5	6	6	4	4	4	4
11	5.0	6	6	4	4	4	4
12	6.0	6	6	4	4	4	4
13	7.0	6	6	6	4	4	4
14	8.0	6	6	6	4	4	4

4. RODCH_NodeID specifies the nodes allocated to the data packet (see Nodes and Hop-ports Allocation). This is an array parameter which means multiple nodes may be assigned to R-ODCH. The nodes assigned to the data packet can be the base nodes or parents (ancestors). A set of hop-ports are mapped to each node. If we get the NodeIDs alloated to the data packet, we can get the set of hop-ports which are allocated to that packet. The hop-ports can be divided into Usable and Unusable hop-ports. We need to check all the hop-ports allocated to the data packet and can get the number of usable hop-ports. A hop-port is marked as usable only if it is not a reserved hop-port and it does not map to a guard subcarrier. For hop-port p, define s = floor((p mod N)/N), and r = (p mod N). The hop-

FFT SUBZONE_MAX,RL p SUBZONE_MAX,RL

port p shall be usable only if all of the following conditions are true:

- s < S;
- $r_p < N_{SUBZONE}(s)$.

  where S is the number of subzones defined as: $S = ceil(N_{AVAILABLE}/N_{SUBZONE\_MAX,RL})$, where $N_{AVAILABLE}$ denotes the number of nominal available subcarriers defined as $N_{AVAILABLE} = max(0, N_{FFT} - N_{GUARD} - C \times N_{CDMA-SUBSEGMENT})$, where $N_{CDMA-SUBSEGMENT}$ is a constant of 128; C denotes the number of CDMA subsegments in each Reverse Link PHY Frame which is equal to NumCDMASubsegments when EnableCDMASubsegments is YES, and equal to 0 when EnableCDMASubsegments is NO. $N_{SUBZONE}(s)$ defines the number of hop-port in Subzone s, defined as: Let $S_{SPLIT} = (N_{AVAILABLE} / N_{BLOCK}) mod S$. If $0 <= s < S_{SPLIT}$, define $N_{SUBZONE}(s) = N_{BLOCK}*ceil(N_{AVAILABLE}/(N_{BLOCK}*S))$. If $S_{SPLIT} <= s < S$, define $N_{SUBZONE}(s) = N_{BLOCK}*floor(N_{AVAILABLE}/(N_{BLOCK}*S))$; N_{BLOCK} is the number of hop-ports in one block (fixed to 16);

5. The packet size for each assignment is computed based on the spectral efficiency listed in the table above and the assignment size. Let s denote the spectral efficiency of the packet format at the first HARQ transmission; let H denote the number of usable hop-ports in the assignment at the first HARQ transmission; let NumFrames denote the number of PHY frames allocated; let N_{PACKET_BITS} denote the number of information bits in the packet excluding CRC. The packet size is given by $N_{PACKET\_BITS} = 8*floor(NumFrames*s*H)-N_{CRC,Data}$, where $N_{CRC,Data}$ is the number of CRC bits for the data packet (fixed to 24). For regular assignments, NumFrames=1; For extended frame assignments, NumFrames=3.

References

1. 3GPP2 C.S0084-001-0 v2.0, Physical Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.
2. 3GPP2 C.S0084-002-0 v2.0, Medium Access Control Layer for Ultra Mobile Broadband (UMB) Air Interface Specification, August, 2007.