



© **Agilent Technologies, Inc. 2000-2011**

5301 Stevens Creek Blvd., Santa Clara, CA 95052 USA

No part of this documentation may be reproduced in any form or by any means (including electronic storage and retrieval or translation into a foreign language) without prior agreement and written consent from Agilent Technologies, Inc. as governed by United States and international copyright laws.

Acknowledgments

Mentor Graphics is a trademark of Mentor Graphics Corporation in the U.S. and other countries. Mentor products and processes are registered trademarks of Mentor Graphics Corporation. * Calibre is a trademark of Mentor Graphics Corporation in the US and other countries. "Microsoft®, Windows®, MS Windows®, Windows NT®, Windows 2000® and Windows Internet Explorer® are U.S. registered trademarks of Microsoft Corporation. Pentium® is a U.S. registered trademark of Intel Corporation. PostScript® and Acrobat® are trademarks of Adobe Systems Incorporated. UNIX® is a registered trademark of the Open Group. Oracle and Java and registered trademarks of Oracle and/or its affiliates. Other names may be trademarks of their respective owners. SystemC® is a registered trademark of Open SystemC Initiative, Inc. in the United States and other countries and is used with permission. MATLAB® is a U.S. registered trademark of The Math Works, Inc.. HiSIM2 source code, and all copyrights, trade secrets or other intellectual property rights in and to the source code in its entirety, is owned by Hiroshima University and STARC. FLEXIm is a trademark of Globetrotter Software, Incorporated. Layout Boolean Engine by Klaas Holwerda, v1.7 <http://www.xs4all.nl/~kholwerd/bool.html> . FreeType Project, Copyright (c) 1996-1999 by David Turner, Robert Wilhelm, and Werner Lemberg. QuestAgent search engine (c) 2000-2002, JObjects. Motif is a trademark of the Open Software Foundation. Netscape is a trademark of Netscape Communications Corporation. Netscape Portable Runtime (NSPR), Copyright (c) 1998-2003 The Mozilla Organization. A copy of the Mozilla Public License is at <http://www.mozilla.org/MPL/> . FFTW, The Fastest Fourier Transform in the West, Copyright (c) 1997-1999 Massachusetts Institute of Technology. All rights reserved.

The following third-party libraries are used by the NlogN Momentum solver:

"This program includes Metis 4.0, Copyright © 1998, Regents of the University of Minnesota", <http://www.cs.umn.edu/~metis> , METIS was written by George Karypis (karypis@cs.umn.edu).

Intel® Math Kernel Library, <http://www.intel.com/software/products/mkl>

SuperLU_MT version 2.0 - Copyright © 2003, The Regents of the University of California, through Lawrence Berkeley National Laboratory (subject to receipt of any required approvals from U.S. Dept. of Energy). All rights reserved. SuperLU Disclaimer: THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS "AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE COPYRIGHT OWNER OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE

POSSIBILITY OF SUCH DAMAGE.

7-zip - 7-Zip Copyright: Copyright (C) 1999-2009 Igor Pavlov. Licenses for files are: 7z.dll: GNU LGPL + unRAR restriction, All other files: GNU LGPL. 7-zip License: This library is free software; you can redistribute it and/or modify it under the terms of the GNU Lesser General Public License as published by the Free Software Foundation; either version 2.1 of the License, or (at your option) any later version. This library is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU Lesser General Public License for more details. You should have received a copy of the GNU Lesser General Public License along with this library; if not, write to the Free Software Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA 02111-1307 USA. unRAR copyright: The decompression engine for RAR archives was developed using source code of unRAR program. All copyrights to original unRAR code are owned by Alexander Roshal. unRAR License: The unRAR sources cannot be used to re-create the RAR compression algorithm, which is proprietary. Distribution of modified unRAR sources in separate form or as a part of other software is permitted, provided that it is clearly stated in the documentation and source comments that the code may not be used to develop a RAR (WinRAR) compatible archiver. 7-zip Availability: <http://www.7-zip.org/>

AMD Version 2.2 - AMD Notice: The AMD code was modified. Used by permission. AMD copyright: AMD Version 2.2, Copyright © 2007 by Timothy A. Davis, Patrick R. Amestoy, and Iain S. Duff. All Rights Reserved. AMD License: Your use or distribution of AMD or any modified version of AMD implies that you agree to this License. This library is free software; you can redistribute it and/or modify it under the terms of the GNU Lesser General Public License as published by the Free Software Foundation; either version 2.1 of the License, or (at your option) any later version. This library is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU Lesser General Public License for more details. You should have received a copy of the GNU Lesser General Public License along with this library; if not, write to the Free Software Foundation, Inc., 51 Franklin St, Fifth Floor, Boston, MA 02110-1301 USA Permission is hereby granted to use or copy this program under the terms of the GNU LGPL, provided that the Copyright, this License, and the Availability of the original version is retained on all copies. User documentation of any code that uses this code or any modified version of this code must cite the Copyright, this License, the Availability note, and "Used by permission." Permission to modify the code and to distribute modified code is granted, provided the Copyright, this License, and the Availability note are retained, and a notice that the code was modified is included. AMD Availability: <http://www.cise.ufl.edu/research/sparse/amd>

UMFPACK 5.0.2 - UMFPACK Notice: The UMFPACK code was modified. Used by permission. UMFPACK Copyright: UMFPACK Copyright © 1995-2006 by Timothy A. Davis. All Rights Reserved. UMFPACK License: Your use or distribution of UMFPACK or any modified version of UMFPACK implies that you agree to this License. This library is free software; you can redistribute it and/or modify it under the terms of the GNU Lesser General Public License as published by the Free Software Foundation; either version 2.1 of the License, or (at your option) any later version. This library is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU Lesser General Public License for more details. You should have received a copy of the GNU Lesser General Public License along with this library; if not, write to the Free Software Foundation, Inc., 51 Franklin St, Fifth Floor, Boston, MA 02110-1301 USA Permission is hereby granted to use or copy this

program under the terms of the GNU LGPL, provided that the Copyright, this License, and the Availability of the original version is retained on all copies. User documentation of any code that uses this code or any modified version of this code must cite the Copyright, this License, the Availability note, and "Used by permission." Permission to modify the code and to distribute modified code is granted, provided the Copyright, this License, and the Availability note are retained, and a notice that the code was modified is included. UMFPACK Availability: <http://www.cise.ufl.edu/research/sparse/umfpack> UMFPACK (including versions 2.2.1 and earlier, in FORTRAN) is available at <http://www.cise.ufl.edu/research/sparse> . MA38 is available in the Harwell Subroutine Library. This version of UMFPACK includes a modified form of COLAMD Version 2.0, originally released on Jan. 31, 2000, also available at <http://www.cise.ufl.edu/research/sparse> . COLAMD V2.0 is also incorporated as a built-in function in MATLAB version 6.1, by The MathWorks, Inc. <http://www.mathworks.com> . COLAMD V1.0 appears as a column-preordering in SuperLU (SuperLU is available at <http://www.netlib.org>). UMFPACK v4.0 is a built-in routine in MATLAB 6.5. UMFPACK v4.3 is a built-in routine in MATLAB 7.1.

Qt Version 4.6.3 - Qt Notice: The Qt code was modified. Used by permission. Qt copyright: Qt Version 4.6.3, Copyright (c) 2010 by Nokia Corporation. All Rights Reserved. Qt License: Your use or distribution of Qt or any modified version of Qt implies that you agree to this License. This library is free software; you can redistribute it and/or modify it under the

terms of the GNU Lesser General Public License as published by the Free Software Foundation; either version 2.1 of the License, or (at your option) any later version. This library is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU Lesser General Public License for more details. You should have received a copy of the GNU Lesser General Public License along with this library; if not, write to the Free Software Foundation, Inc., 51 Franklin St, Fifth Floor, Boston, MA 02110-1301 USA Permission is hereby granted to use or copy this program under the terms of the GNU LGPL, provided that the Copyright, this License, and the Availability of the original version is retained on all copies. User documentation of any code that uses this code or any modified version of this code must cite the Copyright, this License, the Availability note, and "Used by permission." Permission to modify the code and to distribute modified code is granted, provided the Copyright, this License, and the Availability note are retained, and a notice that the code was modified is included. Qt Availability: <http://www.qtsoftware.com/downloads> Patches Applied to Qt can be found in the installation at: `$HPEESOF_DIR/prod/licenses/thirdparty/qt/patches`. You may also contact Brian Buchanan at Agilent Inc. at brian_buchanan@agilent.com for more information.

The HiSIM_HV source code, and all copyrights, trade secrets or other intellectual property rights in and to the source code, is owned by Hiroshima University and/or STARC.

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

Warranty The material contained in this document is provided "as is", and is subject to being changed, without notice, in future editions. Further, to the maximum extent permitted by applicable law, Agilent disclaims all warranties, either express or implied,

with regard to this documentation and any information contained herein, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. Agilent shall not be liable for errors or for incidental or consequential damages in connection with the furnishing, use, or performance of this document or of any information contained herein. Should Agilent and the user have a separate written agreement with warranty terms covering the material in this document that conflict with these terms, the warranty terms in the separate agreement shall control.

Technology Licenses The hardware and/or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license. Portions of this product include the SystemC software licensed under Open Source terms, which are available for download at <http://systemc.org/> . This software is redistributed by Agilent. The Contributors of the SystemC software provide this software "as is" and offer no warranty of any kind, express or implied, including without limitation warranties or conditions or title and non-infringement, and implied warranties or conditions merchantability and fitness for a particular purpose. Contributors shall not be liable for any damages of any kind including without limitation direct, indirect, special, incidental and consequential damages, such as lost profits. Any provisions that differ from this disclaimer are offered by Agilent only.

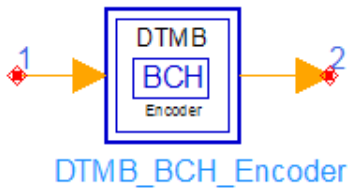
Restricted Rights Legend U.S. Government Restricted Rights. Software and technical data rights granted to the federal government include only those rights customarily provided to end user customers. Agilent provides this customary commercial license in Software and technical data pursuant to FAR 12.211 (Technical Data) and 12.212 (Computer Software) and, for the Department of Defense, DFARS 252.227-7015 (Technical Data - Commercial Items) and DFARS 227.7202-3 (Rights in Commercial Computer Software or Computer Software Documentation).

DTMB Source Component Palette	7
DTMB_BCH_Encoder	7
DTMB_ConvIntrlvCx	8
DTMB_DFT	9
DTMB_FrameHead	10
DTMB_FreqIntrlv	13
DTMB_LDPC_Encoder	14
DTMB_NR_Mapper	15
DTMB_Scrambler	16
DTMB_SystemInfo	18
DTMB Source Palette	21
DTMB_Source	21
DTMB_Source_RF	23

DTMB Source Component Palette

- DTMB BCH Encoder (dtmb)
- DTMB ConvIntrlvCx (dtmb)
- DTMB DFT (dtmb)
- DTMB FrameHead (dtmb)
- DTMB FreqIntrlv (dtmb)
- DTMB LDPC Encoder (dtmb)
- DTMB NR Mapper (dtmb)
- DTMB Scrambler (dtmb)
- DTMB SystemInfo (dtmb)

DTMB_BCH_Encoder



Description: DTMB BCH encoder

Library: DTMB, Source Component

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	uncoded bits, $x^{(752-1)}$ first	int

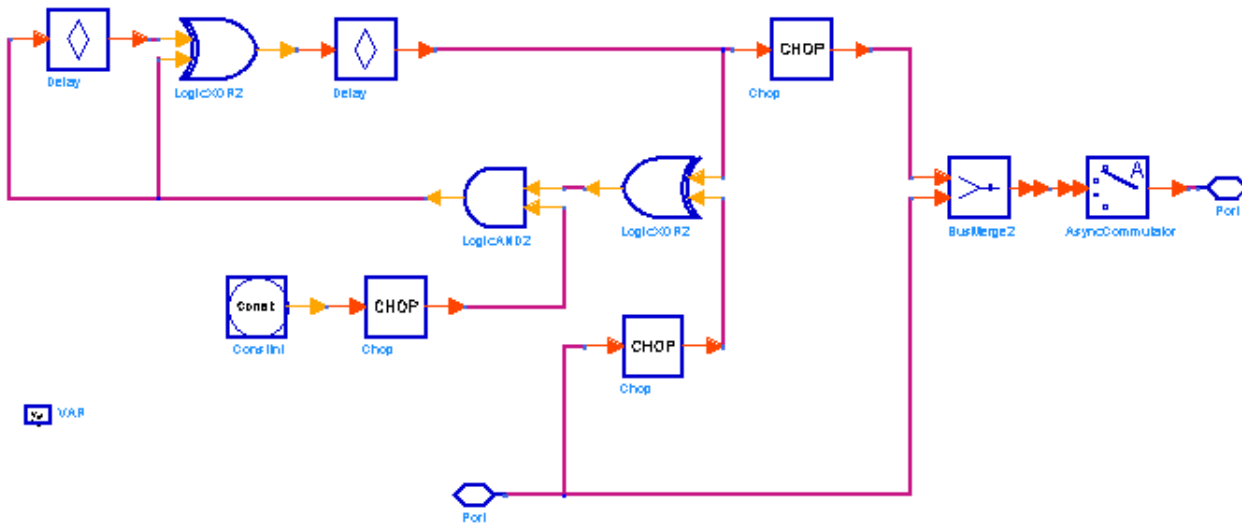
Pin Outputs

Pin	Name	Description	Signal Type
2	Output	coded bits, $x^{(762-1)}$ first	int

Notes/Equations

This model achieves DTMB BCH encoding.

This model is a sub-net model and the schematic is shown below



Each firing, the model takes 752 message bits and output 762 coded bits.

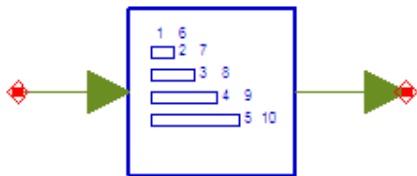
BCH(762, 752) is obtained by shortening BCH(1023, 1013) system code. 261 bits 0 are added in front of 752 scrambled information bits to form 1023 bits. After BCH encoding, the first 261 bits 0 are removed leaving 762 encoded bits.

The BCH polynomial is $G_{BCH}(x) = 1 + x^3 + x^{10}$

References

1. GB 20600-2006 Framing structure, channel coding and modulation for digital television terrestrial broadcasting system.

DTMB_ConvIntrlvCx



Description: Convolutional Interleaver

Library: DTMB, Source Component

Parameters

Name	Description	Default	Type	Range
RegNum	register number	3	int	(0, ∞)
RegStep	register length step	2	int	(0, ∞)
Direction	interleaving direction: Interleave, Deinterleave	Interleave	enum	
InitialType	initialization value type of registers: Const, RandomEnum, RandomRange	Const	enum	
InitialState	initialization state	(0,0)	complex array	

Pin Inputs

Pin	Name	Description	Signal Type
1	in	input	complex

Pin Outputs

Pin	Name	Description	Signal Type
2	out	output	complex

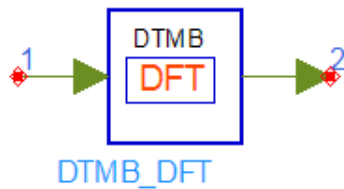
Notes/Equations

This is a convolutional interleaver and de-interleaver model.

References

1. GB 20600-2006 Framing structure, channel coding and modulation for digital television terrestrial broadcasting system.

DTMB_DFT



Description: DTMB Discrete Fourier Transformation

Library: DTMB, Source Component

Parameters

Name	Description	Default	Type
FFTSize	FFT size (if FrameBodyMode is set to C_1, it's forced to 1)	3780	int
FrameBodyMode	frame body mode (C=1, SingleCarrier; C=3780, MultiCarrier): C_1, C_3780	C_1	enum
Direction	FFT or Inversed FFT: Inverse, Forward	Forward	enum
DataReorder	if Yes, before IFFT (and after FFT), first half and second half of data shall be exchanged: NO, YES	NO	enum

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	uncoded bits, the first bit of BCH output first	complex

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	coded bits, parity bits first	complex

Notes/Equations

This model achieves DFT for framebody in C=3780 mode. For C=1 mode, This model pass input directly to output.

$$FBody(k) = \frac{1}{C} \sum_{n=0}^{C-1} X(n) e^{j2\pi n \frac{k}{C}}$$

When Direction is Inverse, IDFT equation is
 $k=0,1,\dots,3779$

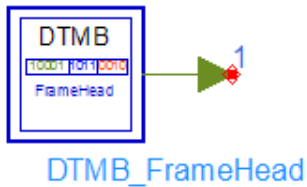
$$X(n) = \sum_{k=0}^{C-1} FBody(k) e^{-j2\pi k \frac{n}{C}}$$

When Direction is Forward, DFT equation is
 $k=0,1,\dots,3779$

References

1. GB 20600-2006 Framing structure, channel coding and modulation for digital television terrestrial broadcasting system.

DTMB_FrameHead



Description: DTMB Frame Head
Library: DTMB, Source Component

Parameters

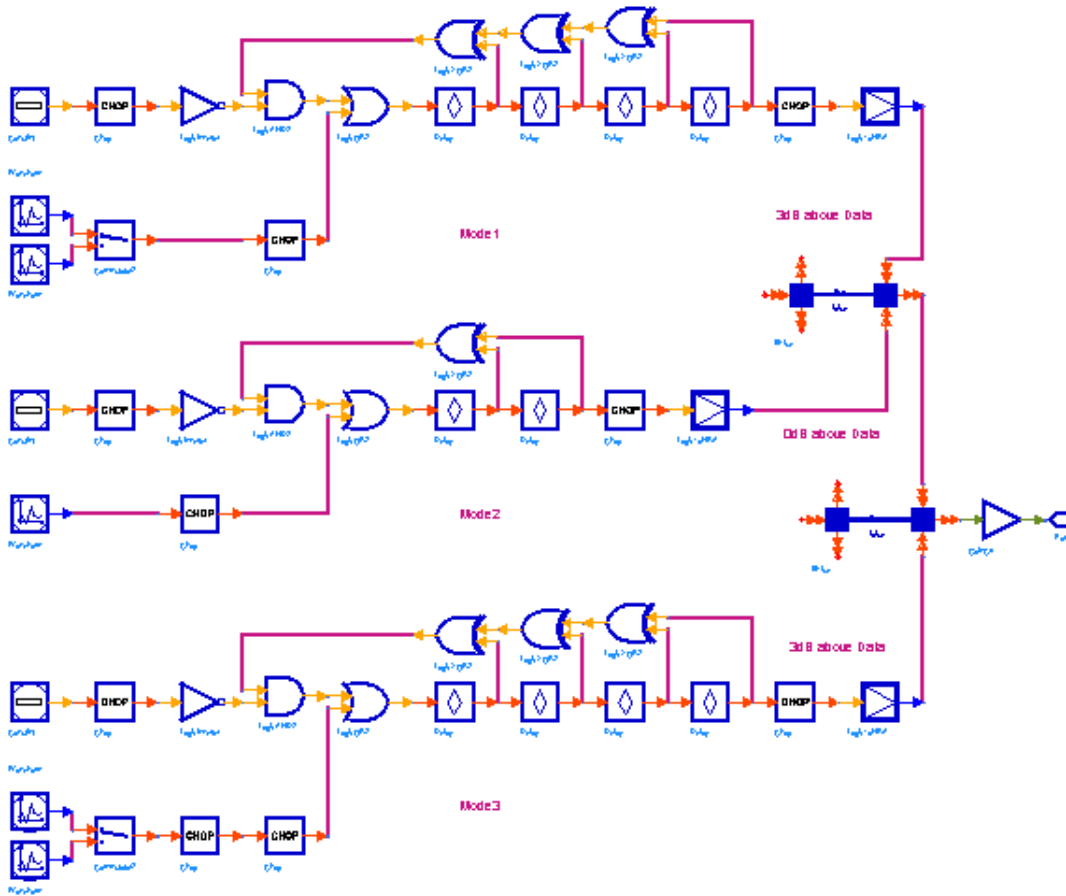
Name	Description	Default	Type
FrameHeadMode	frame head mode: Head_Mode1, Head_Mode2, Head_Mode3	Head_Mode1	enum
EnableFrameID	enable frame number indicator with different PN phases for PN420 and PN945: NO, YES	NO	enum

Pin Outputs

Pin	Name	Description	Signal Type
1	out	output	complex

Notes/Equations

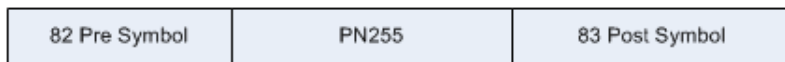
This model is used to generate frame head
 This is a sub-network model and the schematic is shown in the figure below.



DTMB_FrameHead Schematic

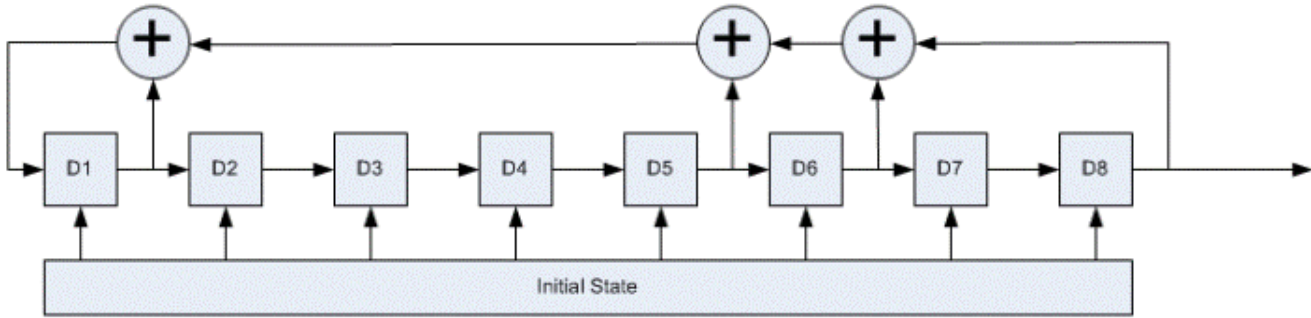
There are three frame head mode type. "0" is mapped to "+1" and "1" is mapped to "-1". The average power of frame head will be 2 time that of frame body for mode 1 (PN420) and mode 2 (PN945).

Frame head mode 1 uses cyclic extended order 8 m sequence generator implemented by a LFSR. The 420 symbols head consists of a 82 symbols pre part, a 255 symbols PN255 sequence and a 83 symbols post part as shown in figure below



PN420

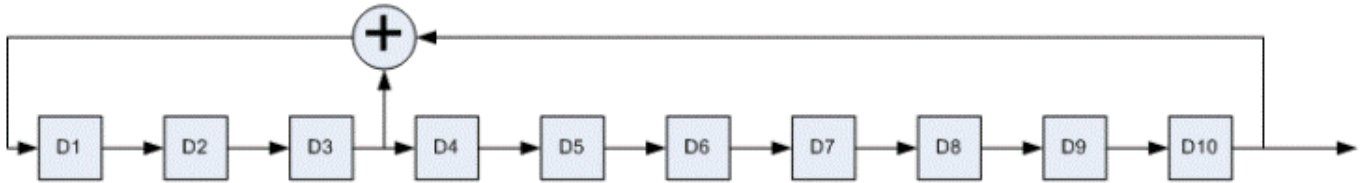
Both the pre part and the post part are cyclic extension of PN255 sequence. There are 225 signal frame in a supper frame. Each frame head uses different initial phase. The LFSR is shown in figure below



The polynomial is $G_{255}(x) = 1 + x + x^5 + x^6 + x^8$

When EnableFrameID is false which means frame ID indication is not needed, the initial phase of each frame head will not change.

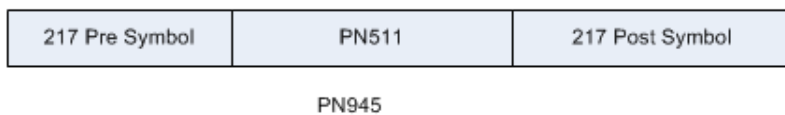
Frame head mode 2 uses the first 595 symbols of an order 10 pseudo random sequence. The LFSR used is shown in figure below. The initial phase is 0000000001 which will be reset in each signal frame.



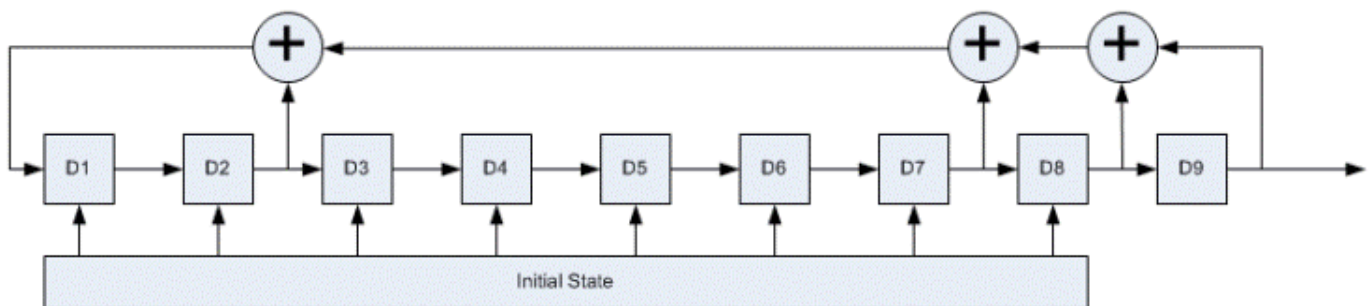
The polynomial is $G_{1023}(x) = 1 + x^3 + x^{10}$

There are 216 signal frame in a supper frame. Each frame head use same initial phase.

Frame head mode 3 uses cyclic extended order 9 m sequence generator implemented by a LFSR. The 945 symbols head consists of a 217 symbols pre part, a 511 symbols PN511 sequence and a 217 symbols post part as shown in figure below



Both the pre part and the post part are cyclic extension of PN511 sequence. There are 200 signal frame in a supper frame. Each frame head uses different initial phase. The LFSR is shown in figure below



The polynomial is $G_{511}(x) = 1 + x^2 + x^7 + x^8 + x^9$

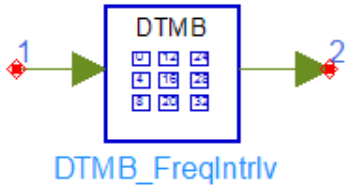
When EnableFrameID is false which means frame ID indication is not needed, the initial phase of each frame head will not change.

The NRZ (Non Return to Zero) PN sequence shall be multiplied with $(1+j)/\sqrt{2}$ before concatenating with frame body to form a signal frame.

References

1. GB 20600-2006 Framing structure, channel coding and modulation for digital television terrestrial broadcasting system.

DTMB_FreqIntrlv



Description: DTMB Freq Interleaver

Library: DTMB, Source Component

Parameters

Name	Description	Default	Type
FrameBodyMode	frame body mode (C=1, SingleCarrier; C=3780, MultiCarrier): C_1, C_3780	C_1	enum
Direction	interleaving direction: Interleave, Deinterleave	Interleave	enum

Pin Inputs

Pin	Name	Description	Signal Type
1	in	input	complex

Pin Outputs

Pin	Name	Description	Signal Type
2	out	output	complex

Notes/Equations

This model is used to achieve frequency interleave in C=3780 mode. For C=1 mode, data from input is fed to output directly without any permutation.

Each firing, 3780 subcarriers are consumed. After block interleaving, 3780 subcarriers are produced.

There are two steps. Firstly, the first 36 elements are inserted into the following positions,

{0,140,279,419,420,560,699,839,840,980,1119,1259, 1260, 1400, 1539, 1679, 1680, 1820, 1959, 2099, 2100, 2240, 2379, 2519, 2520, 2660, 2799, 2939, 2940, 3080, 3219, 3359, 3360, 3500, 3639, 3779}

and the 3744 data symbols are inserted to the remaining positions in sequence, i.e. 0th data symbol to position 1, 1th data symbol to position 2, ..., 3743th data to position 3778.

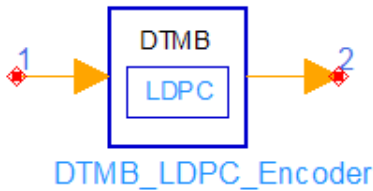
Secondly, The 3780 elements are interleaved following

```
for(int i=0;i<3;i++)
  for(int j=0;j<3;j++)
    for(int k=0;k<3;k++)
      for(int l=0;l<2;l++)
        for(int m=0;m<2;m++)
          for(int n=0;n<5;n++)
            for(int o=0;o<7;o++)
              Y[o*540+n*108+m*54+l*27+k*9+j*3+i] = Z[i*1260+j*420+k*140+l*70+m*35+n*7+o];
```

References

1. GB 20600-2006 Framing structure, channel coding and modulation for digital television terrestrial broadcasting system.

DTMB_LDPC_Encoder



Description: DTMB LDPC encoder
Library: DTMB, Source Component

Parameters

Name	Description	Default	Type
FEC_Rate	FEC code rate (BCH: 752/762, LDPC Erased: 3048/7488, 4572/7488 and 6096/7488): Rate 0.4, Rate 0.6, Rate 0.8	Rate 0.4	enum

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	uncoded bits, the first bit of BCH output first	int

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	coded bits, parity bits first	int

Notes/Equations

1. This model encodes the input bits with DTMB LDPC (Low Density Parity-Check) code generation matrix. The code generation matrix is in the form of:

$$G_{gc} = \begin{bmatrix} G_{0,0} & G_{0,1} & \cdots & G_{0,c-1} & I & O & \cdots & O \\ G_{1,0} & G_{1,1} & \cdots & G_{1,c-1} & O & I & \cdots & O \\ \vdots & \vdots & G_{i,j} & \vdots & \vdots & \vdots & \ddots & \vdots \\ G_{k-1,0} & G_{k-1,1} & \cdots & G_{k-1,c-1} & O & O & \cdots & I \end{bmatrix}$$

where $G_{i,j}$ is a bxb identity matrix, O is a bxb zero matrix, $G_{i,j}$ is a bxb cyclic matrix,

$0 \leq i \leq k-1, 0 \leq j \leq c-1$. See Reference 1 for the definition of $G_{i,j}$.

2. The code parameters are:

FEC Rate	k	c	b	Message length	Codeword length
0.4	24	35	127	3048	7488
0.6	36	23	127	4572	7488
0.8	48	11	127	6096	7488

Assuming message is $M = [m(0), m(1), \dots, m(k*b-1)]$, we get parity

$$P = M \times G_{qc} = [p(0), p(1), \dots, p(cxb-1)]$$

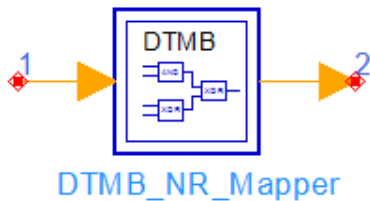
and the codeword generated is

$$C = [p(0), p(1), \dots, p(cxb-1), m(0), m(1), \dots, m(kxb-1)]$$

References

1. GB 20600-2006 Framing structure, channel coding and modulation for digital television terrestrial broadcasting system.

DTMB_NR Mapper



Description: DTMB NR (Nordstrom Robinson) mapper

Library: DTMB, Source Component

Parameters

Name	Description	Default	Type
ConstellationMode	Constellation mapping mode (type): _4QAM_NR, _4QAM, _16QAM, _64QAM	_4QAM_NR	enum

Pin Inputs

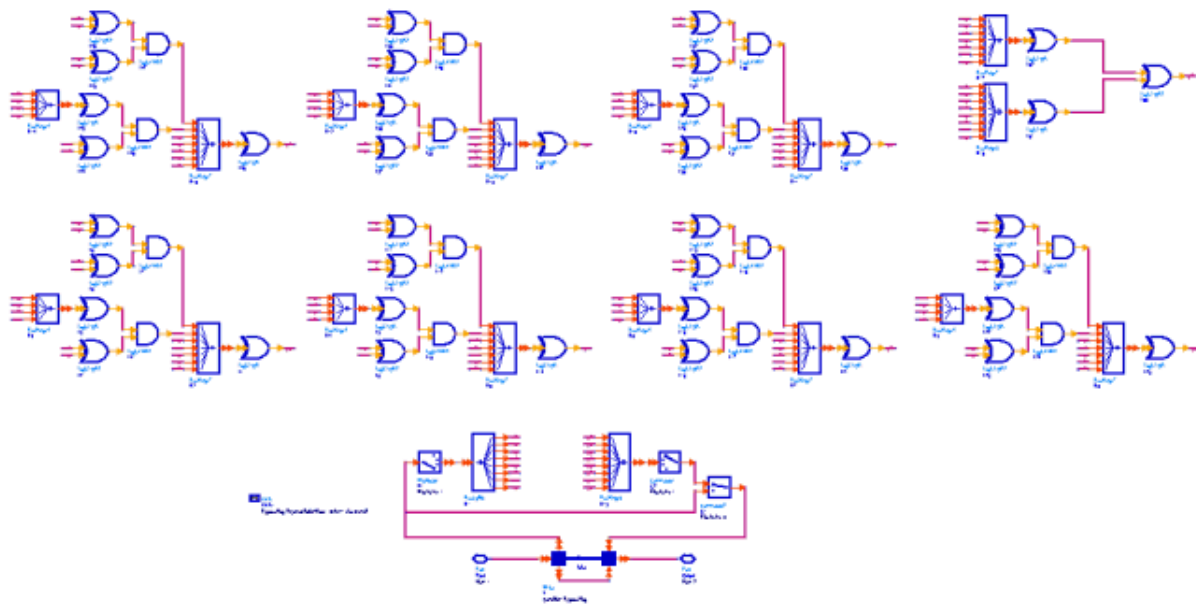
Pin	Name	Description	Signal Type
1	Input	unmapped bits	int

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	NR mapped bits	int

Notes/Equations

1. This model achieves NR mapping.
2. This model is a sub-network model and the schematic is shown below:



3. It maps 8 input bits (x_0 - x_7) into 16 output bits (x_0 - x_7 y_0 - y_7). y_0 - y_7 are bits generated by the following equations. The add and multiply are modulo 2.

$$y_0 = x_7 + x_6 + x_0 + x_1 + x_3 + (x_0 + x_4)(x_1 + x_2 + x_3 + x_5) + (x_1 + x_2)(x_3 + x_5)$$

$$y_1 = x_7 + x_0 + x_1 + x_2 + x_4 + (x_1 + x_5)(x_2 + x_3 + x_4 + x_6) + (x_2 + x_3)(x_4 + x_6)$$

$$y_2 = x_7 + x_1 + x_2 + x_3 + x_5 + (x_2 + x_6)(x_3 + x_4 + x_5 + x_0) + (x_3 + x_4)(x_5 + x_0)$$

$$y_3 = x_7 + x_2 + x_3 + x_4 + x_6 + (x_3 + x_0)(x_4 + x_5 + x_6 + x_1) + (x_4 + x_5)(x_6 + x_1)$$

$$y_4 = x_7 + x_3 + x_4 + x_5 + x_0 + (x_4 + x_1)(x_5 + x_6 + x_0 + x_2) + (x_5 + x_6)(x_0 + x_2)$$

$$y_5 = x_7 + x_4 + x_5 + x_6 + x_1 + (x_5 + x_2)(x_6 + x_0 + x_1 + x_3) + (x_6 + x_0)(x_1 + x_3)$$

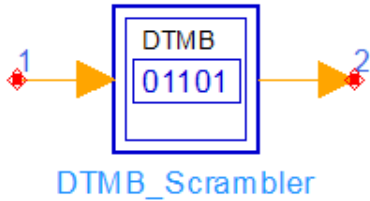
$$y_6 = x_7 + x_5 + x_6 + x_0 + x_2 + (x_6 + x_3)(x_0 + x_1 + x_2 + x_4) + (x_0 + x_1)(x_2 + x_4)$$

$$y_7 = x_0 + x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + y_0 + y_1 + y_2 + y_3 + y_4 + y_5 + y_6$$

References

1. GB 20600-2006 Framing structure, channel coding and modulation for digital television terrestrial broadcasting system.

DTMB_Scrambler



Description: DTMB scrambler for TS bits

Library: DTMB, Source Component

Parameters

Name	Description	Default	Type
FEC_Rate	FEC code rate (BCH: 752/762, LDPC Erased: 3048/7488, 4572/7488 and 6096/7488): Rate 0.4, Rate 0.6, Rate 0.8	Rate 0.4	enum
ConstellationMode	Constellation mapping mode (type): _4QAM_NR, _4QAM, _16QAM, _64QAM	_4QAM_NR	enum

Pin Inputs

Pin	Name	Description	Signal Type
1	Input	TS bits (MSB of Byte first)	int

Pin Outputs

Pin	Name	Description	Signal Type
2	Output	Scrambled TS bits	int

Notes/Equations

1. This model achieves Scrambling.
2. This model is a sub-network model and the schematic is shown below:

Description: DTMB framebody mode, modulation type and code rate indicator

Library: DTMB, Source Component

Parameters

Name	Description	Default	Type
FEC_Rate	FEC code rate (BCH: 752/762, LDPC Erased: 3048/7488, 4572/7488 and 6096/7488): Rate 0.4, Rate 0.6, Rate 0.8	Rate 0.4	enum
ConstellationMode	Constellation mapping mode (type): _4QAM_NR, _4QAM, _16QAM, _64QAM	_4QAM_NR	enum
InterleaveMode	interleave mode of symbol interleaving (Mode1: B=52, M=240; Mode2: B=52, M=720): Intrlv_Mode1, Intrlv_Mode2	Intrlv_Mode1	enum
FrameHeadMode	frame head mode: Head_Mode1, Head_Mode2, Head_Mode3	Head_Mode1	enum
FrameBodyMode	frame body mode (C=1, SingleCarrier; C=3780, MultiCarrier): C_1, C_3780	C_1	enum

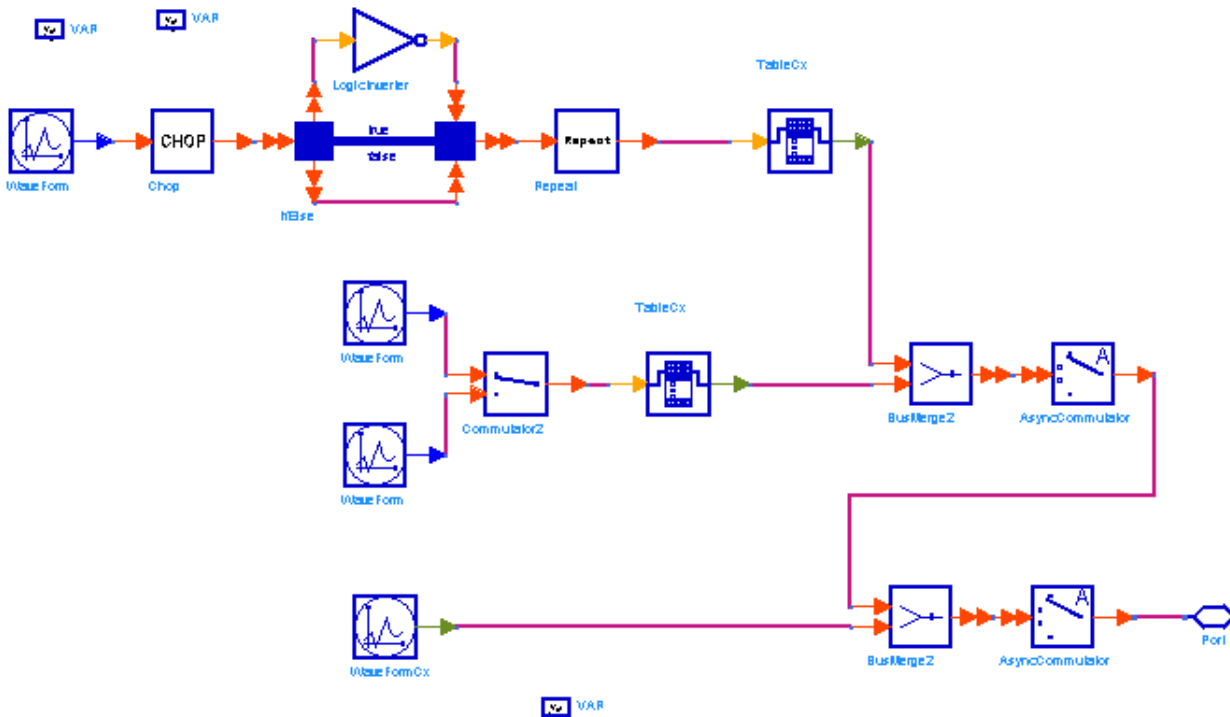
Pin Outputs

Pin	Name	Description	Signal Type
1	Output	System Info symbols	complex

Notes/Equations

This model is used to generate system information. System information has two parts. The first one contains 32 bits and the second one contains 4 bits. These 36 bits are mapped to 4QAM whose I is equal with Q.

This model is a sub-network model and the schematic is shown in figure below.



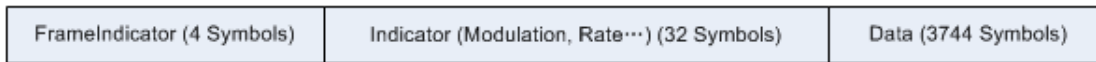
DTMB_SystemInfo Schematic

The 32 bits system information contains mapping mode, FEC coding rate, interleave mode etc which are necessary for modulation and decoding. Below is the table containing 12 system information vectors. The other 12 vectors are not listed here but they are easy to

get from these 12 vectors by changing "1" to "0" and "0" to "1". The vector got from index 1 vector means "first frame indication for even index supper frame". The vectors got from other 11 vectors have the same meaning with the original ones but interleave mode is 2.

index	system information vector	meaning
1	000111101010111100100100010110011	first frame indication for odd index supper frame
3	01111000110010000010111011010101	4 QAM-NR, FEC rate3, interleave mode1
5	01110111110001110010000111011010	4 QAM, FEC rate1, interleave mode1
7	00100010100100100111010010001111	4 QAM, FEC rate2, interleave mode1
9	01001011111110110001110111100110	4 QAM, FEC rate3, interleave mode1
11	00010001101000010100011110111100	16 QAM, FEC rate1, interleave mode1
13	01111000001101110010111000101010	16 QAM, FEC rate2, interleave mode1
15	00101101100111010111101110000000	16 QAM, FEC rate3, interleave mode1
17	01110111001110000010000100100101	32 QAM, FEC rate1, interleave mode1
19	00100010011011010111010001110000	64 QAM, FEC rate1, interleave mode1
21	01000100000010110001001000010110	64 QAM, FEC rate2, interleave mode1
23	00010001010111100100011101000011	64 QAM, FEC rate3, interleave mode1

The 4 bits system information is "0000" for C=1 mode and "1111" for C=3780 mode. The frame body structure is shown in figure below.



SystemInfo + Data

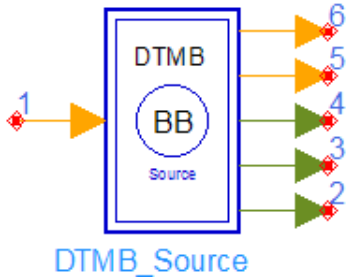
References

1. GB 20600-2006 Framing structure, channel coding and modulation for digital television terrestrial broadcasting system.

DTMB Source Palette

- DTMB Source (dtmb)
- DTMB Source RF (dtmb)

DTMB_Source



Description: DTMB baseband signal source

Library: DTMB, Source

Parameters

Name	Description	Default	Type
FEC_Rate	FEC code rate (BCH: 752/762, LDPC Erased: 3048/7488, 4572/7488 and 6096/7488): Rate 0.4, Rate 0.6, Rate 0.8	Rate 0.4	enum
ConstellationMode	Constellation mapping mode (type): _4QAM_NR, _4QAM, _16QAM, _64QAM	_4QAM_NR	enum
InterleaveMode	interleave mode of symbol interleaving (Mode1: B=52, M=240; Mode2: B=52, M=720): Intrlv_Mode1, Intrlv_Mode2	Intrlv_Mode1	enum
FrameBodyMode	frame body mode (C=1, SingleCarrier; C=3780, MultiCarrier): C_1, C_3780	C_1	enum
FrameHeadMode	frame head mode: Head_Mode1, Head_Mode2, Head_Mode3	Head_Mode1	enum
EnableFrameID	enable frame number indicator with different PN phases for PN420 and PN945: NO, YES	NO	enum
DualPilot	insert dual pilot for C=1 mode, valid only when FrameBodyMode is C_1: NO, YES	NO	enum
OversamplingOption	over sampling ratio (x1 is meaningless): x1, x2, x4, x8, x16, x32	x2	enum

Pin Inputs

Pin	Name	Description	Signal Type
1	TS	Transport Stream in byte	int

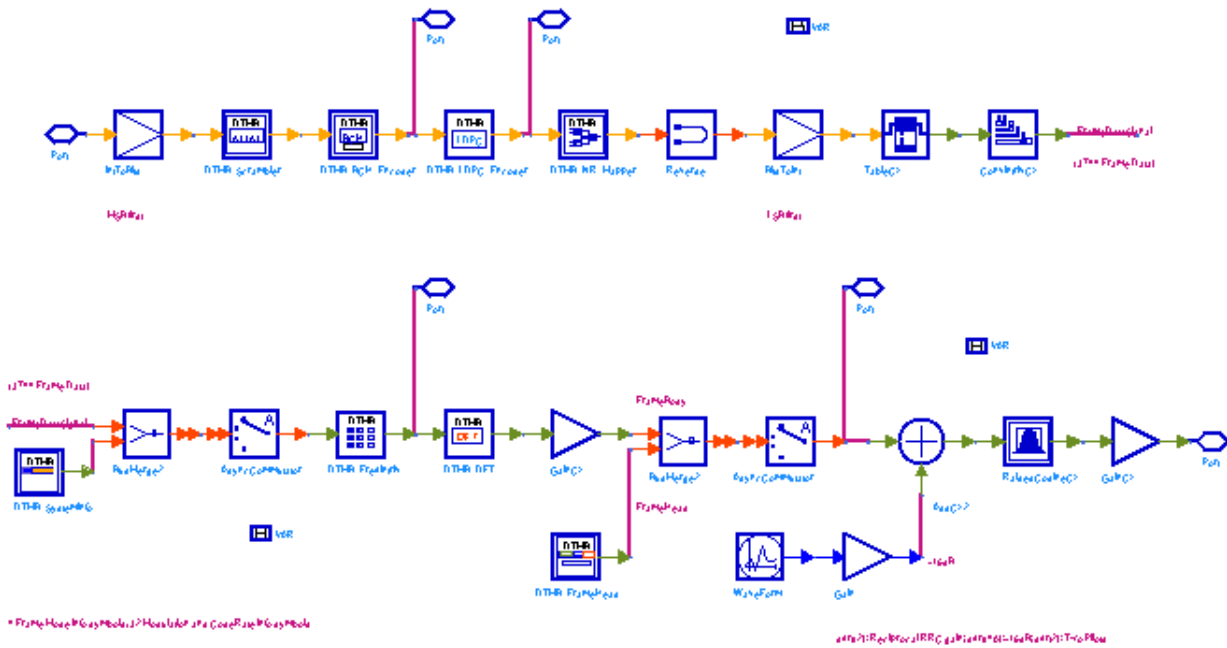
Pin Outputs

Pin	Name	Description	Signal Type
2	BaseBand	DTMB baseband signal	complex
3	FrmSig	signal after spatial mapping and before IFFT	complex
4	FrmBodySym	frame body symbols	complex
5	BitsAftLDPC	LDPC encoded bits	int
6	BitsAftBCH	BCH encoded bits	int

Notes/Equations

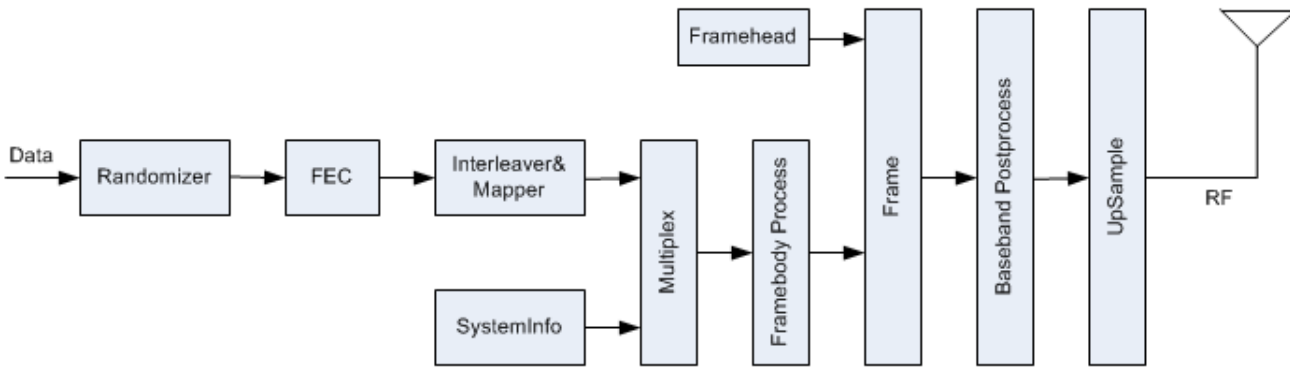
This model is DTMB baseband source.

This model is a sub-network model and the schematic is shown below.



DTMB_Source Schematic

The transmitter theorem consists several parts as shown below.



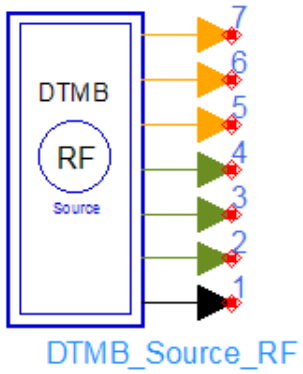
The input data in byte, such as MPEG-2 Transport Stream, are converted to bit sequence and scrambled before passing through channel encoder including BCH and LDPC. Then if ConstellationMode is 4QAM_NR, NR mapping is applied before constellation mapping. Otherwise, the bit sequence shall be mapped to complex constellations directly. Then the data will pass through a convolutional interleaver before merging with system information to form framebody. The framebody will pass a frequency domain interleaver. Then If FrameBodyMode is C=3780, a 3780-point IDFT is applied. Otherwise the framebody will concatenate directly with framehead to form a signal frame. Before passing an RRC (Root Raised Cosine) filter, if FrameBodyMode is C=1, DualPilot will be added onto signal frame.

Please refer to *Baseband Parameters* (dtmb) for parameter details.

References

1. GB 20600-2006 Framing structure, channel coding and modulation for digital television terrestrial broadcasting system.

DTMB_Source_RF



Description: DTMB RF signal source

Library: DTMB, Source

Parameters

Name	Description	Default	Unit	Type	Range
ROut	output resistance	DefaultROut	Ohm	real	(0,∞)
RTemp	temperature	-273.15	Celsius	real	[-273.15,∞)
FCarrier	carrier frequency	474 MHz	Hz	real	(0,∞)
Power	output power of modulator	0.01	W	real	[0,∞)
MirrorSpectrum	indication of 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 respect to output rms voltage	0.0		real	(-∞,∞)
Q_OriginOffset	Q origin offset in percent with respect to output rms voltage	0.0		real	(-∞,∞)
IQ_Rotation	IQ rotation in degrees	0.0		real	(-∞,∞)
DataPattern	data pattern: PN9, PN15, FIX4, _4_1_4_0, _8_1_8_0, _16_1_16_0, _32_1_32_0, _64_1_64_0	PN9		enum	
FEC_Rate	FEC code rate (BCH: 752/762, LDPC Erased: 3048/7488, 4572/7488 and 6096/7488): Rate 0.4, Rate 0.6, Rate 0.8	Rate 0.4		enum	
ConstellationMode	Constellation mapping mode (type): _4QAM_NR, _4QAM, _16QAM, _64QAM	_4QAM_NR		enum	
InterleaveMode	interleave mode of symbol interleaving (Mode1: B=52, M=240; Mode2: B=52, M=720): Intrlv_Mode1, Intrlv_Mode2	Intrlv_Mode1		enum	
FrameBodyMode	frame body mode (C=1, SingleCarrier; C=3780, MultiCarrier): C_1, C_3780	C_1		enum	
FrameHeadMode	frame head mode: Head_Mode1, Head_Mode2, Head_Mode3	Head_Mode1		enum	
EnableFrameID	enable frame number indicator with different PN phases for PN420 and PN945: NO, YES	NO		enum	
DualPilot	insert dual pilot for C=1 mode, valid only when FrameBodyMode is C_1: NO, YES	NO		enum	
SymbolRate	symbol rate (before applying RRC filtering)	7.56 MHz	Hz	real	(0,∞)
OversamplingOption	over sampling ratio (x1 is meaningless): x1, x2, x4, x8, x16, x32	x2		enum	

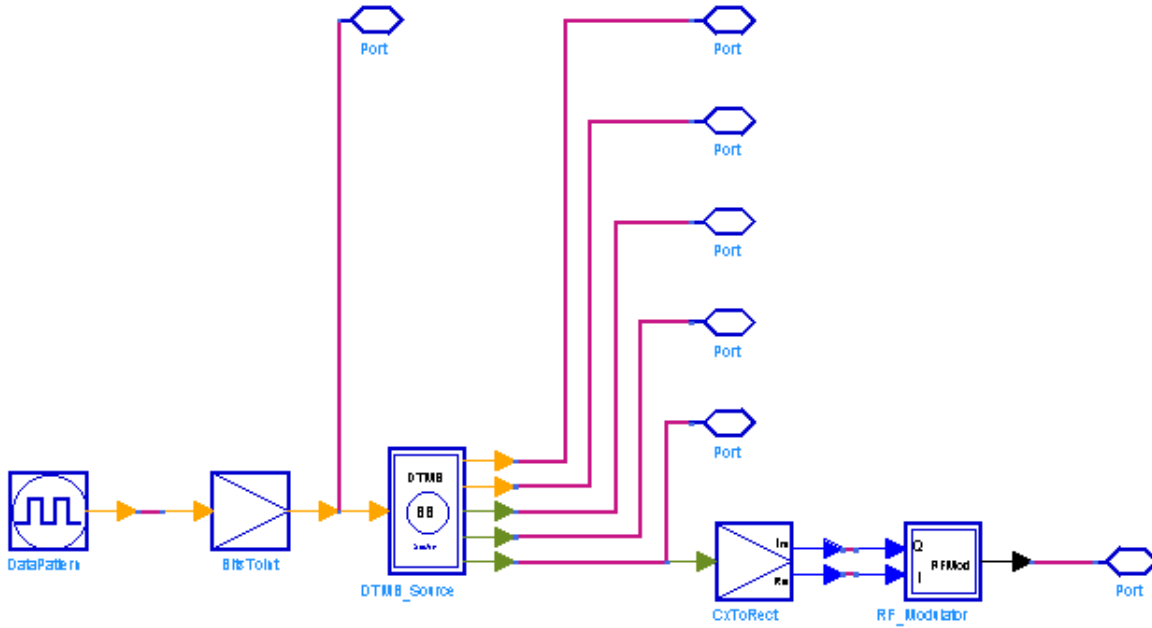
Pin Outputs

Pin	Name	Description	Signal Type
1	RF	DTMB RF signal	timed
2	BaseBand	DTMB baseband signal	complex
3	FrmSig	signal after spatial mapping and before IFFT	complex
4	FrmBodySym	frame body symbols	complex
5	BitsAftLDPC	LDPC encoded bits	int
6	BitsAftBCH	BCH encoded bits	int
7	TSBytes	original Transport Stream bytes	int

Notes/Equations

This model is used to generate DTMB (see [DTMB Spec](#)) RF signal source .

This model is a sub-network model and the schematic is shown below.



DTMB_RF_Source Schematic

Parameter details:

(RF parameters)

R_{Out}: source resistance. To get expected output power as parameter [Power](#), one should set R_{out} the same as the input resistance of connected payload.

R_{Temp}: resistance temperature.

F_{Carrier}: the centre frequency of output signal.

Power : expected output power on payload.

MirrorSpectrum: indication of mirror spectrum about carrier. If YES, quadrature component of output signal shall be mirrored (by multiplying -1).

GainImbalance: gain imbalance in dB Q channel relative to I channel. If not zero, the output power shall not be the expected value.

PhaseImbalance: Phase imbalance in degrees, Q channel relative to I channel.

I_OriginOffset: I origin offset in percent with respect to output rms voltage.

Q_OriginOffset: Q origin offset in percent with respect to output rms voltage.

IQ_Rotation: IQ rotation, in degrees.

(Baseband parameters)

DataPattern: data pattern.

FEC_Rate: FEC code rate. BCH rate is: 752/762. (Erased) LDPC rate is: 3048/7488, 4572/7488 and 6096/7488. The overall code rate is about: 0.4, 0.6 and 0.8.

ConstellationMode: Constellation mapping mode. There are 4 mapping mode: 4QAM NR, 4QAM, 16QAM and 64QAM.

InterleaveMode: interleave mode of symbol interleaving. For Mode1, B=52, M=240; For Mode2, B=52, M=720.

FrameBodyMode: frame body mode. C=1, SingleCarrier; C=3780, MultiCarrier.

FrameHeadMode: frame head mode. For mode 1, frame head length is 420 modulated symbols. For mode 2, 595 symbols. For mode 3, 945 symbols.

EnableFrameID: enable frame number indicator with different PN phases for PN420 and PN945. Invalid for PN595.

DualPilot: insert dual pilot for C=1 mode, valid only when FrameBodyMode is C_1. The dual pilot power is -16 dB of the frame body power, measured at output of the RRC filter.

SymbolRate: data symbol rate (before applying RRC filtering).

OversamplingOption: over sampling ratio (x1 result in non RRC filtered signal). x1, x2 and x4 means the signal has 1, 2 and 4 RRC samples per data symbol.

References

1. GB 20600-2006 Framing structure, channel coding and modulation for digital television terrestrial broadcasting system.