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# **H.264/14496-10 AVC REFERENCE SOFTWARE MANUAL**

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## Revision Sheet

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Rev. 3	02/15/05	TO	Various Document updates
Rev. 4	04/13/05	AT/KS/GS	Addition of new parameters supported in software such as Fast Mode parameters and Adaptive Offset Rounding
Rev. 5	10/12/05	AT	Parameter updates. Addition of new FME parameters
Rev. 6	04/02/06	AT/KS/GS	Parameter updates. Addition of new FME parameters. Addition of limitations section.
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## **1. GENERAL INFORMATION**

# 1. GENERAL INFORMATION

## 1.1 System Overview

This document contains a detailed description of the usage of the H.264/14496-10 AVC reference software, and more specifically version 18.0<sup>1</sup>. This includes information about the encoder and decoder input parameters, syntax, compilation issues, and additional information with regards to best usage and configuration of this software.

The JM software is the official reference software for the following H.264/14496-10 AVC profiles:

- Baseline profile
- Main profile
- Extended profile
- High profile
- High 10 profile
- High 4:2:2 profile
- High 4:4:4 Predictive profile
- High 10 Intra profile
- High 4:2:2 Intra profile
- High 4:4:4 Intra profile
- CAVLC 4:4:4 Intra profile

The reference software for Annex G (Scalable Video Coding) profiles is the JSVM software. The reference software for Annex H (Multi-View Video Coding) is the JMVC software.

In addition the JM software supports encoding and decoding of the following profiles:

## 1.2 Project References

It is recommended that the users of this software obtain a copy of the ITU H.264/ ISO MPEG-4 AVC recommendation for full understanding of the capabilities and specifics of the standard. For further info, users may access the ITU web site at [www.itu.int](http://www.itu.int) or the ISO web site at [www.iso.int](http://www.iso.int). The ITU document can be downloaded for free from <http://www.itu.int/rec/T-REC-H.264>, while the equivalent ISO one can be purchased at <http://tinyurl.com/pnyvo>. Some additional public references that could be useful in understanding this new standard and consequently the software are as follows:

- T. Wiegand, G.J. Sullivan, G. Bjontegaard, and A. Luthra, "Overview of the H.264/AVC Video Coding Standard," in *the IEEE Transactions on Circuits and Systems for Video Technology*, July 2003
- G. Sullivan and T. Wiegand, "Video Compression - From Concepts to the H.264/AVC Standard," in *Proceedings of the IEEE, Special Issue on Advances in Video Coding and Delivery*, December 2004

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<sup>1</sup> The software coordinators should point out that considerable effort was done to reorganize the reference software, remove almost all global variables, make various components reentrant and modular, while at the same time keeping or even extending the existing functionality of the software. Nevertheless, the interface of running the software has remained the same and there should be little impact to the end user.

- D. Marpe, H. Schwarz, and T. Wiegand, “Context-Based Adaptive Binary Arithmetic Coding in the H.264/AVC Video Compression Standard,” in *the IEEE Transactions on Circuits and Systems for Video Technology*, July 2003
- G.J. Sullivan and T. Wiegand, “Rate-Distortion Optimization for Video Compression,” in *the IEEE Signal Processing Magazine*, vol. 15, no. 6, pp. 74-90, Nov. 1998

The reference software described in these pages can be downloaded from the following link:

- <http://iphone.hhi.de/suehring/tml>

## 1.3 Authorized Use Permission

The software package contains a text file and source code header comments containing disclaimer text that describes the terms associated with the use of the software and clarifying its copyright and patent rights status.

## 1.4 Points of Contact

### 1.4.1 Information

For general inquiries with regards to the H.264/MPEG-4 AVC standard users may contact Dr. Gary Sullivan ([garysull@microsoft.com](mailto:garysull@microsoft.com)), Dr. Thomas Wiegand ([wiegand@hhi.fraunhofer.de](mailto:wiegand@hhi.fraunhofer.de)), and Dr. Ajay Luthra ([aluthra@motorola.com](mailto:aluthra@motorola.com)). Certain information can also be provided through the ITU ([www.itu.int](http://www.itu.int)) and ISO ([www.iso.int](http://www.iso.int)) websites. Information pertinent to the reference software should be directed to the reference software coordinators (see Section 1.4.2).

### 1.4.2 Coordination

Software coordination is performed by Mr. Karsten Sühring ([Karsten.Suehring@hhi.fraunhofer.de](mailto:Karsten.Suehring@hhi.fraunhofer.de)) and Dr. Alexis Michael Tourapis ([alexismt@ieee.org](mailto:alexismt@ieee.org)/atour@dolby.com). For further information on key contributors to the reference software implementation please check the files “contributors.h” within the reference software package.

### 1.4.3 Bug Reporting

Any bugs relating to the usage of this package can be reported directly to the software coordinators using the dedicated Mantis bug tracking system at <https://ipbt.hhi.de/>. Information of how to use this system can be found online. Nevertheless, it is suggested that the users consider the following simple rules before reporting any new bugs:

- a) The user should initially search the database for earlier reports that may relate to the same issue. If the problem has already been reported, however the user would like to report additional information that may help in the resolution of the software, this can be added to the original report.
- b) The user should specify if the problem relates to the encoder, decoder or both.
- c) The software version should be specified. Note however that it is recommended that the user first examines the latest version of the software and whether the problem to be reported has already been resolved.
- d) The bug encountered needs to be described as precisely as possible.
- e) The necessary steps to reproduce the problem should be described.
- f) The configuration files that were used or any other files that may be relevant to this bug and may help with its resolution should be provided.

- g) The users are strongly advised to use the language followed by the standard when referencing the text description.
- h) After a user files a report, he/she should frequently examine whether any additional information is requested relating to this issue.

## **1.5 Acronyms and Abbreviations**

1.5.1	<b>AUD:</b>	Access Unit Delimiter
1.5.2	<b>AVC:</b>	Advanced Video Codec
1.5.3	<b>CABAC:</b>	Context-based Adaptive Binary Arithmetic Coding
1.5.4	<b>CAVLC:</b>	Context-based Adaptive Variable Length Coding
1.5.5	<b>CBR:</b>	Constant Bit Rate
1.5.6	<b>DPB:</b>	Decoded Picture Buffer
1.5.7	<b>EPZS:</b>	Enhanced Predictive Zonal Search
1.5.8	<b>FFS:</b>	Fast Full Search
1.5.9	<b>FME:</b>	Fast Motion Estimation
1.5.10	<b>FRExt:</b>	Fidelity Range Extension
1.5.11	<b>FS:</b>	Full Search
1.5.12	<b>GOP:</b>	Group of Pictures
1.5.13	<b>HGOP:</b>	Hierarchical Group of Pictures
1.5.14	<b>HRD:</b>	Hypothetical Reference Decoder
1.5.15	<b>IDR:</b>	Instantaneous Decoding Refresh
1.5.16	<b>MB:</b>	Macroblock
1.5.17	<b>MBAFF:</b>	Macroblock-Adaptive Frame-Field Coding
1.5.18	<b>MVC:</b>	Multiview Video Coding
1.5.19	<b>NAL:</b>	Network Abstraction Layer
1.5.20	<b>Pel:</b>	Pixel
1.5.21	<b>PSNR:</b>	Peak Signal to Noise Ratio
1.5.22	<b>RTP:</b>	Rapid Transport Protocol
1.5.23	<b>SAD:</b>	Sum of Absolute Differences
1.5.24	<b>SATD:</b>	Sum of Absolute Transformed Differences
1.5.25	<b>SEI:</b>	Supplemental Enhancement Information
1.5.26	<b>SSE:</b>	Sum of Square Errors
1.5.27	<b>SSIM:</b>	Structural Similarity Index



- 1.5.28 **SVC:** Scalable Video Coding
- 1.5.29 **UMHex:** Uneven Multi-Hexagon search
- 1.5.30 **VBR:** Variable Bit Rate
- 1.5.31 **VDRD:** View Dependency and Representation Delimiter
- 1.5.32 **VUI:** Video Usability Information

## **2. INSTALLATION AND COMPILATION**

## 2. INSTALLATION AND COMPILATION.

### 2.1 Windows using MS Visual Studio .NET

The software package contains a Visual Studio .NET workspace named “jm\_vc7.sln” for .NET 2003 (v7), a workspace named “jm\_vc8.sln” for .NET 2005 (v8), and a workspace named “jm\_vc9.sln” for .NET 2008 (v9). The user should select the appropriate solution according to his/her .NET package. These workspaces include the following three projects:

lencod H.264/AVC reference encoder  
ldecod H.264/AVC reference decoder  
rtpdump a tool for analyzing contents of RTP packets  
rtp\_loss a tool for simulating RTP packet losses

Select the desired project and the appropriate compilation mode, i.e. “Debug” or “Release”. Compilation will create the binaries “lencod.exe” or “ldecod.exe” in the “bin” directory. “rtpdump.exe” and “rtp\_loss.exe” will be created in the rtpdump and rtp\_loss directories respectively.

For compile time settings and options see section 5.

Please note that the software package does not anymore provide support for Visual Studio 6.

### 2.2 UNIX and Windows using gcc (GNU Compiler Collection)

After unpacking the software package run the “unixprep.sh” shell script. This will remove Windows line break characters for compilation.

In most shell this should work with:

```
. unixprep.sh
```

or

```
chmod u+x unixprep.sh  
./unixprep.sh
```

For compiling the both encoder and decoder type:

```
make
```

For compiling only the encoder or only the decoder change to the “lencod” or “ldecod” directory and type:

```
make
```

within that directory

Binaries named “lencod.exe” and “ldecod.exe” are created in the “bin” directory. For debug mode binaries one can compile the software using the following syntax:

```
make DBG=1
```

The above would generate debug binary files named “lencod.dbg.exe” and “ldecod.dbg.exe” in the “bin” directory for the encoder and decoder respectively.

Additional options that can be used during compilation include M32=1 for enforcing generation of 32-bit binary executables on 64-bit architectures, OPT=N for controlling the optimization level, and STC=1 for static linking of libraries.

For compile time settings and options see section 5.

### **3. USING THE JM ENCODER MODULE**

### 3. USING THE JM ENCODER MODULE

This section provides a detailed description of the JM encoder's usage.

#### 3.1 Encoder Syntax

```
lencod [-h] [-d defenc.cfg] {[ -f curenc1.cfg]...[-f curencN.cfg]}
      {[-p EncParam1=EncValue1]...[-p EncParamM=EncValueM]}
```

##### *Options:*

<i>-h</i>	Prints parameter usage.
<i>-d</i>	Use <defenc.cfg> as default file for parameter initializations. If not used then file defaults to “encoder.cfg” in local directory.
<i>-f</i>	Read <curencM.cfg> for resetting selected encoder parameters. Multiple files could be used that set different parameters.
<i>-p</i>	Set parameter <EncParamM> to <EncValueM>. The entry for <EncParamM> is case insensitive.

See section 4 for a description of all parameters.

Supported video file formats:

The software supports both planar and interleaved/packed raw image data (8 to 14 bit sample inputs). Furthermore, support is provided for both concatenated (all video frames in a single file) and separate (all frames in distinct/separate) video data. See more information about different raw pixel formats at “<http://www.fourcc.org/>”.

```
RAW: .yuv.,rgb      :   P444 - Planar, 4:4:4
                        P422 - Planar, 4:2:2
                        P420 - Planar, 4:2:0
                        P400 - Planar, 4:0:0
                        I444 - Packed, 4:4:4
                        I422 - Packed, 4:2:2
                        I420 - Packed, 4:2:0
                        IYUV/YV12 - Planar, 4:2:0
                        IYU1 - Packed, 4:2:0 (UYYYVYY)
                        IYU2 - Packed, 4:4:4 (UYV)
                        YUY2 – Packed, 4:2:2 (YUYV)
                        YUV – Packed, 4:4:4 (YUV)
```

Examples of usage:

```
lencod.exe
lencod.exe -h
lencod.exe -d default.cfg
lencod.exe -f curenc1.cfg
```

```
lencod.exe -f curenc1.cfg -p InputFile="e:\data\container_qcif_30.yuv" \
           -p SourceWidth=176 -p SourceHeight=144

lencod.exe -f curenc1.cfg -p FramesToBeEncoded=30 \
           -p QPFirstFrame=28 -p QPRemainingFrame=28 -p QPBPicture=30
```

## 3.2 Encoder Output

When running the encoder, the encoder will display on screen rate/distortion statistics for every frame coded. Cumulative results will also be presented. The output information generated may look as follows depending on the setting of the Verbose input parameter:

```
Setting Default Parameters...
Parsing Configfile encoder.cfg
.....
.....
.....
.....
.....
.....
Parsing Quantization Offset Matrix file q_offset.cfg .....
----- JM 17.1 (FRExt) -----
Input YUV file           : /data/foreman_176x144_30p.yuv
Output H.264 bitstream   : test.264
Output YUV file          : test_rec.yuv
YUV Format                : YUV 4:2:0
Frames to be encoded     : 3
Freq. for encoded bitstream : 30.00
PicInterlace / MbInterlace : 0/0
Transform8x8Mode         : 1
ME Metric for Refinement Level 0 : SAD
ME Metric for Refinement Level 1 : SAD
ME Metric for Refinement Level 2 : Hadamard SAD
Mode Decision Metric      : Hadamard SAD
Motion Estimation for components : Y
Image format             : 176x144 (176x144)
Error robustness         : Off
Search range             : 32
Total number of references : 5
References for P slices   : 5
References for B slices (L0, L1) : 5, 1
Sequence type            : I-B-P-B-P (QP: I 28, P 28, B 30)
Entropy coding method     : CABAC
Profile/Level IDC         : (100,40)
Motion Estimation Scheme  : Fast Full Search
Search range restrictions : none
RD-optimized mode decision : used
Data Partitioning Mode    : 1 partition
Output File Format        : H.264/AVC Annex B Byte Stream Format
-----
```

Frame	Bit/pic	QP	SnrY	SnrU	SnrV	Time(ms)	MET(ms)	Frm/Fld	Ref
00000 (NVB)	176								
00000 (IDR)	24536	28	37.414	39.765	42.224	65	0	FRM	1
00002( P )	4664	28	36.714	39.563	41.932	376	281	FRM	1
00001( B )	992	30	36.275	39.467	41.829	1162	1011	FRM	0

```
-----
Total Frames: 3
Leaky BucketRateFile does not have valid entries.
Using rate calculated from avg. rate
Number Leaky Buckets: 8
      Rmin      Bmin      Fmin
301920    24536    24536
377400    24536    24536
```

```

452880    24536    24536
528360    24536    24536
603840    24536    24536
679320    24536    24536
754800    24536    24536
830280    24536    24536
----- Average data all frames -----

Total encoding time for the seq. : 1.603 sec (1.87 fps)
Total ME time for sequence      : 1.292 sec

Y { PSNR (dB), cSNR (dB), MSE } : { 36.80, 36.78, 13.66 }
U { PSNR (dB), cSNR (dB), MSE } : { 39.60, 39.60, 7.14 }
V { PSNR (dB), cSNR (dB), MSE } : { 41.99, 41.99, 4.11 }

Total bits                      : 30368 (I 24536, P 4664, B 992 NVB 176)
Bit rate (kbit/s) @ 30.00 Hz    : 303.68
Bits to avoid Startcode Emulation : 25
Bits for parameter sets         : 176
Bits for filler data            : 0
-----

Exit JM 17 (FRExt) encoder ver 17.1

```

The generated statistics in the above list represent the following information. Note that availability of the fields depends on the *Verbose Mode* currently used(see section 4.1.33):

<i>Name</i>	<i>Format</i>	<i>Purpose</i>	<i>Verbose Mode</i>
<i>Frame</i>	%04d(\$Type)	Frame Display Order and Type	All
<i>Bit/pic</i>	%8d	Allocated bits for current frame	All
<i>NVB</i>	%3d	Non Video Bits	Extended
<i>WP</i>	%1d	Weighted Prediction method	Detailed/Extended
<i>QP</i>	%2d	Frame Quantization value	All
<i>QL</i>	%2d	Frame Quantized Lagrangian value	Detailed/Extended
<i>SnrY</i>	%7.3f	Luma Y PSNR	All
<i>SnrU</i>	%7.3f	Chroma U PSNR	All
<i>SnrV</i>	%7.3f	Chroma V PSNR	All
<i>Time(ms)</i>	%7d	Total encoding time for frame	All
<i>MET(ms)</i>	%5d	Total motion estimation time for frame	All
<i>Frm/Fld</i>	FLD FRM	Picture coding mode	All
<i>I</i>	%3d	Intra Coded Macroblocks	Detailed/Extended
<i>D</i>	%1d	Direct mode (direct_spatial_mv_pred_flag)	Detailed/Extended
<i>L0</i>	%2d	List0 number of references	Detailed/Extended
<i>L1</i>	%2d	List1 number of references	Detailed/Extended
<i>RDP</i>	%d	Picture Level RD decision	Detailed/Extended
<i>Ref</i>	%d	Current Picture Reference Indicator (nal_reference_idc)	All



### 3.3 Encoder Limitations

At this point, the encoder is characterized by certain limitations which may limit its usage. In particular, some items that have been identified as being problematic or not properly supported in the software include:

- The encoder may not perform all level/profile checks as specified in Annex A of the standard which may result in incompatible/non-conforming bitstreams.
- The currently provided Rate Control is not a state of the art scheme and its slow adaptation speed can result in the encoder not properly achieving the target bit rate for short sequences.
- Picture Level RD Optimization does not currently fully support interlace coding modes and may require memory optimizations.
- Adaptive coding structures, i.e. creating Hierarchical groups of pictures of different length and with different coding/type arrangements, are not supported
- Redundant picture encoding works only with some settings

## **4. ENCODER PARAMETERS**

## 4. ENCODER PARAMETERS

### 4.1 File Input/Output Related Parameters

These parameters specify input/output control of the encoder, including input (source)/output (generated bitstreams or reconstructed sequence) file names, and file format.

#### 4.1.1 InputFile

*Class:* Text

*Description:* First input sequence file name. Name could include file path. Current software only supports concatenated input sources (i.e. all components and frames should be included in a single file)

*Note:* For Unix/Linux based systems directories should be separated using a forward slash “/”, while for DOS/Windows systems, directories should be separated using a backslash “\”. The parameter InputFile1 has exactly the same functionality as InputFile and can be used in it’s place.

*Example 1 (DOS):*

```
lencod.exe -p InputFile="f:\seq\420\176x144\foreman_176x144_30.yuv"
```

*Example 2 (Unix/Linux):*

```
lencod.exe -p InputFile="/vol/seq/420/176x144/foreman_176x144_30.yuv"
```

#### 4.1.2 InputHeaderLength

*Class:* Numeric (Integer)

*Description:* Specifies inputfile header size in terms of bytes. For RAW data files (i.e. YUV) this is usually 0 (default).

#### 4.1.3 StartFrame

*Class:* Numeric (Integer)

*Description:* Specifies initial frame for encoding. Default value is 0.

#### 4.1.4 FramesToBeEncoded

*Class:* Numeric (Integer)

*Description:* Specifies number of frames to be encoded. Unlike earlier versions (14.2 and older) this parameter now considers all frames at all layers (primary and secondary)

*Example 1:*

Code 10 frames using an IPPPP... assignment and sequential ordering

```
lencod.exe -p FramesToBeEncoded=10
```

*Example 2:*

Code 10 frames using an IBBPBBPBBP assignment.

```
lencod.exe -p FramesToBeEncoded=10 -p NumberBFrames=2
```

#### 4.1.5 FrameRate

*Class:* Numeric (Double)

*Description:* Input File Frame rate. Supports values in the range [0.0, 100.0]. Default value is 30.0.

*Note:* For interlace material (i.e. 60 or 50 fields), value should be set equal to FieldRate/2 (i.e. 30.0 and 25.0 respectively).

#### 4.1.6 Enable32Pulldown

*Class:* Numeric (Integer)

*Description:* Alters the input sequence and converts it into a new interlace sequence using 3:2 pulldown methods.

<i>Options:</i>	
0	Do nothing (default)
1	A, B, Bt Cb, Ct Db, D
2	A, B, C, Ct Db, D

#### 4.1.7 SEIVUI32Pulldown

*Class:* Numeric (Integer)

*Description:* Enables 3:2 pulldown using pic\_struct signaling in Timing SEI messages.

<i>Options:</i>	
0	Do nothing (default)
1	A, Bt Bb, Bt Cb, Ct Cb, D
2	A, B, C, C, D
3	At Ab, Bt Bb, Bt Cb, Ct Cb, Dt Db
4	A, Bt Bb, Bt Cb, Ct Db, Dt Db
5	At Ab, Bt Bb, Bt Cb, Ct Db, Dt Db

#### 4.1.8 SourceWidth

*Class:* Numeric (Integer)

*Description:* Input image width in Luma Samples. If the value is not a multiple of 16 the image is automatically extended to the next number that is a multiple of 16 and cropping parameters to the original size are set in the Sequence Parameter Set. Default value is 176.

#### 4.1.9 SourceHeight

*Class:* Numeric (Integer)

*Description:* Input image height in Luma Samples. If no Interlace tools are used and if the value is not a multiple of 16 the image is automatically extended to the next number that is a multiple of 16. Otherwise if the value is not a multiple of 32 the image is automatically extended to the next number that is a multiple of 32. If the picture is extended, cropping parameters to the original size are set in the Sequence Parameter Set. Default value is 144.

#### 4.1.10 SourceResize

*Class:* Numeric (Boolean)

*Description:* If set to 1, then input sequence is resized according to the parameters OutputWidth and OutputHeight. Currently, resizing is considered through cropping or padding depending on the relationships of the source and output dimensions. The default value is 0 (disabled).

#### 4.1.11 OutputWidth

*Class:* Numeric (Integer)

*Description:* Output image width in Luma Samples. Value is ignored if SourceResize is 0. If the value is not a multiple of 16 the image is automatically extended to the next number that is a multiple of 16 and cropping parameters to the original size are set in the Sequence Parameter Set. Default value is 176.

#### 4.1.12 OutputHeight

*Class:* Numeric (Integer)

*Description:* Output image height in Luma Samples. Value is ignored if SourceResize is 0. If no Interlace tools are used and if the value is not a multiple of 16 the image is automatically extended to the next number that is a multiple of 16. Otherwise if the value is not a multiple of 32 the image is automatically extended to the next number that is a multiple of 32. If the picture is extended, cropping parameters to the original size are set in the Sequence Parameter Set. Default value is 144.

#### 4.1.13 ProcessInput

*Class:* Numeric (Integer)

*Description:* Perform optional preprocessing on the input sequence. Currently only supports YV12 to IYUV conversion, i.e. order inversion of chroma components, (ProcessInput=2), but will be extended in the future to provide further functionality such as simple pre-filtering.

#### 4.1.14 Interleaved

*Class:* Numeric (Integer)

*Description:* Enables support for Packed/Interleaved image formats. By default, if disabled (0), then a planar format is assumed. Note that currently this parameter only affects the input video sequence. Output video sequences are always generated using the planar format.

#### 4.1.15 RGBInput

*Class:* Numeric (Integer)

*Description:* Sets YUV or RGB Input

<i>Options:</i>	
0	GRB or YUV input (default)
1	RGB Input

#### 4.1.16 YUVFormat

*Class:* Numeric (Integer)

*Description:* YUV format

<i>Options:</i>	
0	4:0:0
1	4:2:0 (default)
2	4:2:2
3	4:4:4

**4.1.17 StandardRange***Class:* Numeric (Integer)*Description:* If RGB input, specifies if content uses standard (0) or full (1) range.**4.1.18 VideoCode***Class:* Numeric (Integer)*Description:* Specifies Video Codes for RGB => YUV conversions

<i>Options:</i>	
0	NULL
1	ITU_REC709
2	CCIR_601
3	FCC
4	ITU_REC624BG
5	SMPTE_170M
6	SMPTE_240M
7	SMPTE_260M
8	ITU_REC709_EXACT

**4.1.19 SourceBitDepthLuma***Class:* Numeric (Integer)*Description:* Specifies input source bit depth for Luma component. Allowable values are in the range of 8 (default) through 14.**4.1.20 SourceBitDepthChroma***Class:* Numeric (Integer)*Description:* Specifies input source bit depth for Chroma component. Allowable values are in the range of 8 (default) through 14.**4.1.21 SourceBitDepthRescale***Class:* Numeric (Boolean)*Description:* If enabled then the bitdepth of the original sequence is altered according to OutputBitDepthLuma and OutputBitDepthChroma. Default is 0 (disabled).**4.1.22 OutputBitDepthLuma***Class:* Numeric (Integer)*Description:* Specifies output source bit depth for Luma component. Allowable values are in the range of 8 (default) through 14.**4.1.23 OutputBitDepthChroma***Class:* Numeric (Integer)*Description:* Specifies input source bit depth for Chroma component. Allowable values are in the range of 8 (default) through 14.**4.1.24 OutputFile***Class:* Text*Description:* Output bitstream file name. Name could include file path.

*Note:* For Unix/Linux based systems directories should be separated using a forward slash “/”, while for DOS/Windows systems, directories should be separated using a backslash “\”.

*Example:*

```
lencod.exe -p InputFile="f:\seq\420\176x144\foreman_176x144_30.yuv" \
-p OutputFile="foreman.264"
```

#### 4.1.25 ReconFile

*Class:* Text

*Description:* First output reconstructed file name. Name could include file path. If empty, no output is generated.

#### 4.1.26 TraceFile

*Class:* Text

*Description:* Bitstream Trace file name. File is useful for debugging. To enable, code needs to be compiled by setting the define TRACE in defines.h to 1.

*Note:* Trace file generation may fail, if the size of the trace file exceeds 2GB.

*Warning:* Enabling this option may result in the generation of very large files, while it could also slow down encoding considerably. Enable with caution. Parameter recommended for debugging purposes.

#### 4.1.27 StatsFile

*Class:* Text

*Description:* Statistics output file. The file contains an overview of different coding statistics for the entire sequence such as number and types of intra and inter macroblocks used , motion vector and residual bit information, etc.

#### 4.1.28 ReportFrameStats

*Class:* Boolean

*Description:* Allows the generation of a file (*stat\_frame.dat*) containing statistical information such as number of intra/inter coded blocks, modes used etc. Default value is 0 (disabled).

#### 4.1.29 DisplayEncParams

*Class:* Boolean

*Description:* If enabled outputs all encoder parameters on screen, therefore capturing a snapshot of the encoder configuration. Default value is 0 (disabled).

#### 4.1.30 Verbose

*Class:* Numeric (Integer)

*Description:* Controls level of display verbosity.

<b>Options:</b>	
0	Short
1	Normal (default)
2	Full Detail
3	Full Detail with combined Frame/NVB bit statistics (Extended)

### 4.1.31 GrayScale

*Class:* Boolean

*Description:* Enforce GrayScale encoding of video data by resetting color components to the value  $(1 \ll (\text{bitdepth} - 1))$ . Default value is 0 (disabled). Requires that code is compiled with the #define flag `ALLOW_GRAYSCALE` set to 1.

## 4.2 Primary Control Parameters

This section described encoder parameters that are common for all profiles and essentially control encoder behavior, available test modes, Motion Estimation and Mode decision etc.

### 4.2.1 ProfileIDC

*Class:* Numeric (Integer)

*Description:* Value of the **profile\_idc** syntax element. For switching between predictive and intra only profiles, see the IntraProfile parameter. Default value is 88.

*Note:* Profiles restrict the usage of certain features and encoding modes. See Annex A of H.264/AVC for supported features for each profile. Reference software may perform tests for certain features for profile conformance, but it is possible that certain validations are missing.

<i>Options:</i>	
44	CAVLC 4:4:4 Intra
66	Baseline
77	Main
88	Extended
100	High
110	High 10 or High 10 Intra
122	High 4:2:2 Predictive or High 4:2:2 Intra
244	High 4:4:4 or High 4:4:4 Intra
118	Multiview High
128	Stereo High

### 4.2.2 IntraProfile

*Class:* Boolean

*Description:* Specifies usage of Intra only profiles for ProfileIDC equal to 110, 122 and 244. This results in setting **constraint\_set\_3\_flag** equal to 1 in the bitstream. Default value is 0 (disabled).

### 4.2.3 LevelIDC

*Class:* Numeric (Integer)

*Description:* Value of the **level\_idc** syntax element. Default value is 21.

*Note:* Similar with the ProfileIDC, LevelIDC specifies the capabilities a decoder must fulfill to decode a bitstream of a certain level. Most level restrictions are driven by memory restrictions and set restrictions such as resolution supported, maximum number of references, frame rate etc. See Annex A of H.264/AVC.

Note that the level setting does not prevent the encoder from breaking certain level restrictions.



<b>Options:</b>	
9	1b (Supports QCIF format and below with 380160 samples/sec)
10	1 (Supports QCIF format and below with 380160 samples/sec)
11	1.1 (Supports CIF and below. 768000 samples/sec)
12	1.2 (Supports CIF and below. 1536000 samples/sec)
13	1.3 (Supports CIF and below. 3041280 samples/sec)
20	2 (Supports CIF and below. 3041280 samples/sec)
21	2.1 (Supports HHR formats. Enables Interlace support. 5068800 samples/sec)
22	2.2 (Supports SD/4CIF formats. Enables Interlace support. 5184000 samples/sec)
30	3 (Supports SD/4CIF formats. Enables Interlace support. 10368000 samples/sec)
31	3.1 (Supports 720p HD format. Enables Interlace support. 27648000 samples/sec)
32	3.2 (Supports SXGA format. Enables Interlace support. 55296000 samples/sec)
40	4 (Supports 2Kx1K format. Enables Interlace support. 62914560 samples/sec)
41	4.1 (Supports 2Kx1K format. Enables Interlace support. 62914560 samples/sec)
42	4.2 (Supports 2Kx1K format. Frame coding only. 125829120 samples/sec)
50	5 (Supports 3672x1536 format. Frame coding only. 150994944 samples/sec)
51	5.1 (Supports 4096x2304 format. Frame coding only. 251658240 samples/sec)

#### 4.2.4 IntraPeriod

*Class:* Numeric (Integer)

*Description:* Max period of I-coded frames (non IDR) in the encoded sequence. Note that if the position corresponds to a non “primary” level, e.g. an intermediate picture belonging to a hierarchical structure, the nearest picture belonging to the primary level with a position smaller than IntraPeriod will be encoded as intra instead. A value of 0 (default) implies that only the first frame will be coded as intra.

*Note:* If field coding is enabled, depending on the value of parameter IntraBottom, only the top field will be coded as intra.

#### 4.2.5 IDRPeriod

*Class:* Numeric (Integer)

*Description:* Period of IDR frames in the encoded sequence. Behaviour is similar to Intra Period. A value of 0 (default) implies that only the first frame will be coded as IDR.

*Note:* If field coding is enabled, depending on the value of parameter IntraBottom, only the top field will be coded as IDR.

#### 4.2.6 EnableIDRGop

*Class:* Boolean

*Description:* Enables closed IDR GOPs, i.e.  $IDR_0-P_3-B_1-B_2-P_6-B_4-B_5-IDR_7-P_{10}-B_8-B_9-P_{13}-B_{11}-B_{12}$ . Can considerably improve coding efficiency when IDR pictures are desired. Default value is 0 (disabled).

#### 4.2.7 IntraDelay

*Class:* Numeric (Integer)

*Description:* Enable delayed (in display order) IDR pictures by IntraDelay pictures, e.g. if IntraDelay=2 then the resulting coding structure could look like this:

$IDR_2-P_1-P_0-P_3-P_4-P_5-P_6-IDR_9-P_8-P_7-P_{10}-P_{11}-P_{12}$ .

Can considerably improve coding efficiency. Default value is 0 (disabled).

#### **4.2.8 AdaptiveIntraPeriod**

*Class:* Boolean

*Description:* Currently ignored.

#### **4.2.9 AdaptiveIDRPeriod**

*Class:* Boolean

*Description:* Currently ignored.

#### **4.2.10 EnableOpenGOP**

*Class:* Boolean

*Description:* Enables support for Open GOP encoding. Default value is 0 (disabled). OpenGOP in this context restricts all pictures after an I coded picture in display order from referencing a picture prior to the I coded picture in display order. This is done through appropriate usage of reordering operations and setting of num\_ref\_idx\_lX\_active\_minus1 for each available reference list.

*Note:* Parameter currently does not support field coding, while it enforces reference reordering if hierarchical encoding is used.

#### **4.2.11 NumberBFrames**

*Class:* Numeric (Integer)

*Description:* Number of B slice coded frames used. Parameter is overwritten if the HierarchicalCoding (4.7.4) parameter is set to 3. Default value is 0.

#### **4.2.12 QPISlice**

*Class:* Numeric (Integer)

*Description:* Sets quantization parameter (QP) value for I slices. Allowable values are in the range of  $6 * (\text{BitDepthLuma} - 8)$  to 51. Default value is 24.

#### **4.2.13 QPPSlice**

*Class:* Numeric (Integer)

*Description:* Sets quantization parameter (QP) value for all P slices. Allowable values are in the range of  $6 * (\text{BitDepthLuma} - 8)$  to 51. Default value is 24.

#### **4.2.14 QPBSlice**

*Class:* Numeric (Integer)

*Description:* Quantization parameter used for non stored B slices. Should be in the range of  $6 * (\text{BitDepthLuma} - 8)$  to -51. Usually these quantizer can be set slightly higher than the quantizer for stored pictures. Default value is 24.

#### **4.2.15 ChangeQPFrame**

*Class:* Numeric (Integer)

*Description:* For fixed QP encodings, specifies a frame for which to start a new coding group while considering a different set of QP parameters (based on 4.2.16 through 4.2.20). Default value is 0 (no QP changes).

#### **4.2.16 ChangeQPI**

*Class:* Numeric (Integer)

*Description:* Sets quantization parameter (QP) value for all I slices in the second QP Group. Allowable values are in the range of  $6 * (\text{BitDepthLuma} - 8)$  to 51. Default value is 24.

#### **4.2.17 ChangeQPP**

*Class:* Numeric (Integer)

*Description:* Sets quantization parameter (QP) value for all P slices in the second QP Group. Allowable values are in the range of  $6 * (\text{BitDepthLuma} - 8)$  to 51. Default value is 24.

#### **4.2.18 ChangeQPB**

*Class:* Numeric (Integer)

*Description:* Sets quantization parameter (QP) value for all B slices in the second QP Group. Allowable values are in the range of  $6 * (\text{BitDepthLuma} - 8)$  to 51. Default value is 24.

#### **4.2.19 ChangeQPSP**

*Class:* Numeric (Integer)

*Description:* Sets quantization parameter (QP) value for all SP slices in the second QP Group. Allowable values are in the range of  $6 * (\text{BitDepthLuma} - 8)$  to 51. Default value is 24.

#### **4.2.20 ChangeQPSI**

*Class:* Numeric (Integer)

*Description:* Sets quantization parameter (QP) value for all SI slices in the second QP Group. Allowable values are in the range of  $6 * (\text{BitDepthLuma} - 8)$  to 51. Default value is 24.

#### **4.2.21 ChromaQPOffset**

*Class:* Numeric (Integer)

*Description:* Sets the quantization parameter (QP) offset that will be used for coding Chroma components. Value can be both negative and positive (-51..51). Default value is 0 (no offset).

*Note:* This option will be used only for Baseline, Main and Extended profiles. For FRExt profiles see CbQPOffset and CrQPOffset.

#### **4.2.22 CbQPOffset**

*Class:* Numeric (Integer)

*Description:* Sets the quantization parameter (QP) offset that will be used for coding Cb components. Value can be both negative and positive (-51..51). Default value is 0 (no offset).

*Note:* This is a FRExt profile only option. For other profiles see ChromaQPOffset.

#### **4.2.23 CrQPOffset**

*Class:* Numeric (Integer)

*Description:* Sets the quantization parameter (QP) offset that will be used for coding Cr components. Value can be both negative and positive (-51..51). Default value is 0 (no offset).

*Note:* This is a FRExt profile only option. For other profiles see ChromaQPOffset.

#### **4.2.24 FrameSkip**

*Class:* Numeric (Integer)

*Description:* Number of frames to be skipped when encoding the input sequence, essentially altering the frame rate of the output video sequence. This has no relationship to and is completely independent from the number of intermediate, e.g. B coded pictures, that can be used in the encoding. Default value is 0.

*Example 1:*

Reduce original framerate by half.

```
lencod.exe -p FrameSkip=1
```

**4.2.25 MEDistortionFPel***Class:* Numeric (Integer)*Description:* Error Metric for Full-Pel (first layer) motion estimation.

<i>Options:</i>	
0	Sum of Absolute Differences (SAD). (default)
1	Sum of Square Errors (SSE).
2	Sum of Absolute Transformed/Hadamard Differences (SATD).

**4.2.26 MEDistortionHPel***Class:* Numeric (Integer)*Description:* Error Metric for Half-Pel (second layer) motion estimation.

<i>Options:</i>	
0	Sum of Absolute Differences (SAD).
1	Sum of Square Errors (SSE).
2	Sum of Absolute Transformed/Hadamard Differences (SATD). (default)

**4.2.27 MEDistortionQPel***Class:* Numeric (Integer)*Description:* Error Metric for Quarter-Pel (third layer) motion estimation.

<i>Options:</i>	
0	Sum of Absolute Differences (SAD).
1	Sum of Square Errors (SSE).
2	Sum of Absolute Transformed/Hadamard Differences (SATD). (default)

**4.2.28 MDDistortion***Class:* Numeric (Integer)*Description:* Error Metric for Mode distortion operations.

*Note:* If RDOptimization is set to 0, this parameter should be set to exactly the same value as the last subpixel refinement performed. That is, if DisableSubpelME is 0 MDDistortion should be equal to MEDistortionQPel. Otherwise, if DisableSubpelME is 1, MDDistortion should be equal to MEDistortionFPel.

<i>Options:</i>	
0	Sum of Absolute Differences (SAD).
1	Sum of Square Errors (SSE).
2	Sum of Absolute Transformed/Hadamard Differences (SATD). (default)

**4.2.29 ChromaMCBuffer***Class:* Boolean

*Description:* Generates and stores sub pixel values for chroma components. Can improve performance somewhat if multiple references are used at the cost of increased memory usage. Default value is 0 (disabled).

#### 4.2.30 ChromaMEEEnable

*Class:* Boolean

*Description:* Considers Chroma components during motion estimation, potentially improving chroma and even overall quality. Requires *ChromaMCBuffer* to be enabled.

<i>Options:</i>	
0	Disabled (default)
1	Consider Chroma for Motion Compensation only for integer, first level, motion estimation
2	Consider Chroma for Motion Compensation for all motion estimation levels

#### 4.2.31 ChromaMEWeight

*Class:* Numeric (Integer)

*Description:* Specifies weighting factor of chroma component distortion during motion estimation. Default value is 1.

#### 4.2.32 DisableSubpelME

*Class:* Boolean

*Description:* Disables subpixel Motion Estimation. Default value is 0 (enabled).

#### 4.2.33 SearchRange

*Class:* Numeric (Integer)

*Description:* Sets allowable search range for Motion Estimation. Default value is 16.

*Note:* If Rate Distortion Optimization is enabled, the search window is centered around median predictor, not (0,0).

#### 4.2.34 UseMVLimits

*Class:* Boolean

*Description:* Constrain maximum absolute motion vector values according to SetMVXLimit and SetMVYLimit values. Default value is 0 (disabled).

#### 4.2.35 SetMVXLimit

*Class:* Numeric (Integer)

*Description:* Sets maximum absolute horizontal motion vector value in integer pixel units. Default value is 2048.

#### 4.2.36 SetMVYLimit

*Class:* Numeric (Integer)

*Description:* Sets maximum absolute vertical motion vector value in integer pixel units. Default value is 512. Value is further constrained according to LevelIDC limits.

#### 4.2.37 NumberReferenceFrames

*Class:* Numeric (Integer)

*Description:* Sets the maximum number of references stored in the Decoded Picture Buffer (DPB) for motion estimation and compensation. Essentially sets the syntax element **num\_ref\_frames** in the sequence parameter sets. Default value is 1.

*Note:* This parameter needs to conform to level constraints. See Annex A.

#### **4.2.38 PList0References**

*Class:* Numeric (Integer)

*Description:* Override of allowable references used for predicting P slices (basically sets the syntax element **num\_ref\_idx\_l0\_active\_minus1**). 0 (default) sets number to be equal to NumberReferenceFrames. Value needs to be smaller or equal to NumberReferenceFrames.

#### **4.2.39 DisposableP**

*Class:* Boolean

*Description:* Enable non-reference P slices in the primary layer. Default value is 0 (disabled).

*Note:* This parameter will enable the encoding of a sequence of the form: I0p1P2p3P4p5... where the numeric index corresponds to coding and display order, while uppercase and lowercase imply reference and non reference pictures respectively.

#### **4.2.40 DispPQPOffset**

*Class:* Numeric (Integer)

*Description:* Specifies quantization parameter (QP) offset used for non-reference P slices.

#### **4.2.41 PreferDispOrder**

*Class:* Boolean

*Description:* Prefer display order when building the prediction structure as opposed to coding order (affects intra and IDR periodic insertion, among others). Default is 0.

#### **4.2.42 PreferPowerOfTwo**

*Class:* Boolean

*Description:* Prefer prediction structures that have lengths expressed as powers of two. Default is 0.

#### **4.2.43 FrmStructBufferLength**

*Class:* Numeric (Integer)

*Description:* Length of the frame structure unit buffer; it can be overridden for certain cases. Default is 1.

#### **4.2.44 BList0References**

*Class:* Numeric (Integer)

*Description:* Override of allowable references used for predicting B slices using List0 (basically sets **num\_ref\_idx\_l0\_active\_minus1**). 0 (default) sets number to be equal to NumberReferenceFrames. Value needs to be smaller or equal to NumberReferenceFrames.

*Note:* Under most cases, setting this value to 2 should be sufficient (i.e. in terms of performance), while having a significant reduction in terms of complexity.

#### **4.2.45 BList1References**

*Class:* Numeric (Integer)

*Description:* Override of allowable references used for predicting B slices using List1 (basically sets **num\_ref\_idx\_l1\_active\_minus1**). 0 (default) sets number to be equal to NumberReferenceFrames. Value needs to be smaller or equal to NumberReferenceFrames.

*Note:* Under most cases, setting this value to 1 should lead to better performance (i.e. since no bits are spend for coding the reference index more bits can be allocated to code mv's or residual). If HierarchicalCoding is used nevertheless, a larger value might be better.

#### 4.2.46 BReferencePictures

*Class:* Numeric (Integer)

*Description:* Use B coded pictures as references (overwritten by HierarchicalCoding). Default is 0.

*Note:* Mainly available for testing purposes.

<i>Options:</i>	
0	Disabled (default).
1	Code B coded pictures in secondary layer as references.
2	Code primary layer reference pictures (normally coded as P) with B coded pictures.

#### 4.2.47 BListSingleDirRefFlag

*Class:* Boolean

*Description:* Remove references from list0 and list1 that come from a different direction. Default is 0 (disabled).

#### 4.2.48 LowDelay

*Class:* Boolean

*Description:* Enable Low Delay hierarchical coding structure generation. Default is 0 (disabled).

#### 4.2.49 Log2MaxFNumMinus4

*Class:* Numeric (Integer)

*Description:* This parameter sets the syntax element **log2\_max\_frame\_num\_minus4** which impacts the value of **frame\_num** in each slice. If the parameter is set to -1, the value of **log2\_max\_frame\_num\_minus4** is computed based on FramesToBeEncoded and the number of B coded frames. Otherwise **log2\_max\_frame\_num\_minus4** is set equal to Log2MaxFNumMinus4. Default value is 0.

*Note:* With sliding window DPB operation the combination of **log2\_max\_frame\_num\_minus4** equal to 0 and **num\_ref\_frames** equal to 16 could lead to inserting two reference frames with the same value of **frame\_num** into the DPB. To avoid this, the JM encoder prohibits this combination.

#### 4.2.50 Log2MaxPOCLsbMinus4

*Class:* Numeric (Integer)

*Description:* This parameter sets the syntax element **log2\_max\_pic\_order\_cnt\_lsb\_minus4** which impacts the value of **pic\_order\_cnt\_lsb**. If the parameter is set to -1, the value of **log2\_max\_pic\_order\_cnt\_lsb\_minus4** is computed based on FramesToBeEncoded and the number of B coded frames. Otherwise **log2\_max\_pic\_order\_cnt\_lsb\_minus4** is set equal to Log2MaxPOCLsbMinus4. Default value is 2.

*Note:* Parameter has to be properly set to avoid repetitions of **pic\_order\_cnt**.

#### 4.2.51 GenerateMultiplePPS

*Class:* Boolean

*Description:* When enabled, three different Picture Parameter Sets (PPS) are generated and included into the bitstream. These Picture Parameter Sets allow the combination of weighted and non weighted prediction for P and B slices. This option can be combined with the parameter RDPictureDecision to perform an RD optimal decision between picture coding modes. Value should be disabled when generating baseline profile bitstreams. Default value is 0 (disabled).

#### 4.2.52 SendAUD

*Class:* Boolean

*Description:* Transmit Access Delimiter Unit NALU for every Access Unit. Default value is 0 (disabled).

#### 4.2.53 ResendSPS

*Class:* Numeric (integer)

*Description:* Enables repetition of Sequence (SPS) and Picture Parameter Sets (PPS) at various intervals. This can be useful for random access/trick modes, error resilience, etc.

<i>Options:</i>	
0	Disabled (default)
1	Repeat for all Intra coded pictures
2	Repeat for all IDR pictures
3	Repeat for all IDR and Open GOP intra pictures

#### 4.2.54 ResendPPS

*Class:* Boolean

*Description:* Enables repetition of Picture Parameter Sets (PPS) before every primary coded picture. This could be useful for error resilience or if the encoder decides to update the PPS, i.e for use of a different WP method, different chroma offsets, different weighted matrices/transform, deblocking, etc. Default value is 0 (disabled).

#### 4.2.55 PicOrderCntType

*Class:* Numeric (Integer)

*Description:* Parameter sets the value of the syntax element **pic\_order\_cnt\_type** in SPS.

<i>Options:</i>	
0	POC mode 0. Recommended mode (default).
1	POC mode 1, Not fully supported in software.
2	POC mode 2. Not for use with out of order coding. i.e. all pictures need to be in sequential order.

#### 4.2.56 UseConstrainedIntraPred

*Class:* Boolean

*Description:* If set, disallows inter pixels from being used for intra prediction (sets the syntax element **constrained\_intra\_pred\_flag** in the PPS). Default value is 0.

#### 4.2.57 MbLineIntraUpdate

*Class:* Numeric (Integer)



*Description:* Enables error robustness by performing extra intra macro block updates. 0 (default) off, N: One GOB every N frames is intra coded.

#### **4.2.58 RandomIntraMBRefresh**

*Class:* Numeric (Integer)

*Description:* Number of macroblocks per picture that are forced to be intra coded. If non-zero, the intra macroblocks are selected randomly. Default value is 0.

### **4.3 Inter/Intra Mode Prediction Control**

The following parameters essentially control which inter or intra prediction modes could be used for encoding purposes.

#### **4.3.1 PSliceSkip**

*Class:* Boolean

*Description:* Enables Skip Inter modes in P Slices. Default value is 1 (enabled).

#### **4.3.2 PSliceSearch16x16**

*Class:* Boolean

*Description:* Enables 16x16 Inter Prediction & Motion Compensation in P Slices. Default value is 1 (enabled).

#### **4.3.3 PSliceSearch16x8**

*Class:* Boolean

*Description:* Enables 16x8 Inter Prediction & Motion Compensation in P Slices. Default value is 1 (enabled).

#### **4.3.4 PSliceSearch8x16**

*Class:* Boolean

*Description:* Enables 8x16 Inter Prediction & Motion Compensation in P Slices. Default value is 1 (enabled).

#### **4.3.5 PSliceSearch8x8**

*Class:* Boolean

*Description:* Enables 8x8 Inter Prediction & Motion Compensation in P Slices. Default value is 1 (enabled).

#### **4.3.6 PSliceSearch8x4**

*Class:* Boolean

*Description:* Enables 8x4 Inter Prediction & Motion Compensation in P Slices. Default value is 1 (enabled).

#### **4.3.7 PSliceSearch4x8**

*Class:* Boolean

*Description:* Enables 4x8 Inter Prediction & Motion Compensation in P Slices. Default value is 1 (enabled).

#### **4.3.8 PSliceSearch4x4**

*Class:* Boolean

*Description:* Enables 4x4 Inter Prediction & Motion Compensation in P Slices. Default value is 1 (enabled).

#### **4.3.9 BSliceDirect**

*Class:* Boolean

*Description:* Enables Direct Mode Inter Prediction & Motion Compensation in B Slices. Default value is 1 (enabled).

#### **4.3.10 BSliceSearch16x16**

*Class:* Boolean

*Description:* Enables 16x16 Inter Prediction & Motion Compensation in B Slices. Default value is 1 (enabled).

#### **4.3.11 BSliceSearch16x8**

*Class:* Boolean

*Description:* Enables 16x8 Inter Prediction & Motion Compensation in B Slices. Default value is 1 (enabled).

#### **4.3.12 BSliceSearch8x16**

*Class:* Boolean

*Description:* Enables 8x16 Inter Prediction & Motion Compensation in B Slices. Default value is 1 (enabled).

#### **4.3.13 BSliceSearch8x8**

*Class:* Boolean

*Description:* Enables 8x8 Inter Prediction & Motion Compensation in B Slices. Default value is 1 (enabled).

#### **4.3.14 BSliceSearch8x4**

*Class:* Boolean

*Description:* Enables 8x4 Inter Prediction & Motion Compensation in B Slices. Default value is 1 (enabled).

#### **4.3.15 BSliceSearch4x8**

*Class:* Boolean

*Description:* Enables 4x8 Inter Prediction & Motion Compensation in B Slices. Default value is 1 (enabled).

#### **4.3.16 BSliceSearch4x4**

*Class:* Boolean

*Description:* Enables 8x4 Inter Prediction & Motion Compensation in B Slices. Default value is 1 (enabled).

#### **4.3.17 BiPredMotionEstimation**

*Class:* Boolean

*Description:* Enables Multihypothesis based Motion Estimation for B slice coding. Option currently only supports 16x16 block sizes and the first list 0 and list 1 references. Option also considers weights if necessary. Default value is 0 (disabled).

For further information on such ME algorithms check the following papers.

- S.W. Wu and A. Gersho, "Joint estimation of forward and backward motion vectors for interpolative prediction of video," in *IEEE Transactions on Image Processing*, Vol.3, Iss.5 , pp.684=7, Sept.'94.

- Markus Flierl, Thomas Wiegand, and Bernd Girod, "A Locally Optimal Design Algorithm for Block-Based Multi-Hypothesis Motion-Compensated Prediction", *Proceedings of the Data Compression Conference*, Snowbird, USA, April 1998

#### 4.3.18 BiPredMERefinements

*Class:* Boolean

*Description:* Enables additional ME refinements for Multihypothesis based ME. Only considered if BiPredMotionEstimation is used. Possible values are [0-5]. Default value is 0 (only initial step is performed).

#### 4.3.19 BiPredMESearchRange

*Class:* Numeric (Integer)

*Description:* Specifies search range for BiPredMotionEstimation. However, if BiPredMERefinements are used then search range is decreased by half for every additional refinement. Default value is 8.

#### 4.3.20 BiPredMESubPel

*Class:* Numeric (Integer)

*Description:* Controls subpixel refinement for BiPredMotionEstimation.

<i>Options:</i>	
0	Disabled. No Subpel refinement is performed (default)
1	Subpel refinement is performed only for first list.
2	Subpel refinement is performed for both lists

#### 4.3.21 BiPredSearch16x16

*Class:* Boolean

*Description:* Enables bipredictive motion estimation for 16x16 partitions in B Slices. Default value is 1 (enabled).

#### 4.3.22 BiPredSearch16x8

*Class:* Boolean

*Description:* Enables bipredictive motion estimation for 16x8 partitions in B Slices. Default value is 0 (disabled).

#### 4.3.23 BiPredSearch8x16

*Class:* Boolean

*Description:* Enables bipredictive motion estimation for 8x16 partitions in B Slices. Default value is 0 (disabled).

#### 4.3.24 BiPredSearch8x8

*Class:* Boolean

*Description:* Enables bipredictive motion estimation for 8x8 partitions in B Slices. Default value is 0 (disabled).

#### 4.3.25 DisableIntraInInter

*Class:* Boolean

*Description:* Disable all intra prediction modes for Inter (P or B) slices. Default value is 0 (Intra prediction modes enabled in all slice types).

**4.3.26 IntraDisableInterOnly**

*Class:* Boolean

*Description:* Disable Intra prediction modes (in sections **Error! Reference source not found.** through **Error! Reference source not found.**) for Inter (P or B) slices. Default value is 0.

**4.3.27 DisableIntra4x4**

*Class:* Boolean

*Description:* Disables all intra 4x4 modes. Default value is 0 (enabled).

**4.3.28 DisableIntra16x16**

*Class:* Boolean

*Description:* Disables all intra 16x16 modes. Default value is 0 (enabled).

**4.3.29 DisableIntraInInter**

*Class:* Boolean

*Description:* Disable Intra prediction modes (in sections 4.3.10 through 4.3.34) for Inter (P or B) slices. Default value is 0 (Intra prediction modes enabled in all slice types).

**4.3.30 Intra4x4ParDisable**

*Class:* Boolean

*Description:* Disables I4x4 Vertical and Horizontal prediction modes. Default value is 0 (enabled).

**4.3.31 Intra4x4DiagDisable**

*Class:* Boolean

*Description:* Disables I4x4 Diagonal Down-Left and Diagonal Down-Right prediction modes. Default value is 0 (enabled).

**4.3.32 Intra4x4DirDisable**

*Class:* Boolean

*Description:* Disables I4x4 Vertical Right, Vertical Left, Horizontal Down, and Horizontal Up prediction modes . Default value is 0 (enabled).

**4.3.33 Intra16x16ParDisable**

*Class:* Boolean

*Description:* Disables I16x16 Vertical and Horizontal prediction modes. Default value is 0 (enabled).

**4.3.34 Intra16x16PlaneDisable**

*Class:* Boolean

*Description:* Disables I16x16 plane prediction mode. Default value is 0 (enabled).

**4.3.35 ChromaIntraDisable**

*Class:* Boolean

*Description:* Disable all Intra Chroma prediction modes except DC. Default value is 0 (enabled).

**4.3.36 FastCrIntraDecision**

*Class:* Boolean

*Description:* Perform a separate intra chroma mode decision prior to determining final coding mode. Can provide significant encoding speedup. Default value is 1 (enabled).

**4.3.37 EnableIPCM**

*Class:* Numeric (Integer)

*Description:* Enables usage of I\_PCM macroblock mode.

<b>Options:</b>	
0	Disabled (default)
1	Enabled
2	Enabled as needed, i.e. based on performance of other inter/intra modes (only available for RDOptimization = 9)

## 4.4 MVC coding parameters (main configuration file)

### 4.4.1 NumberOfViews

*Class:* Numeric (Integer)

*Description:* Set the number of views/layers to encoder for MVC, up to a maximum of 2. Default value is 1 (single view/layer).

### 4.4.2 View1ConfigFile

*Class:* Text

*Description:* Specifies the configuration file name from which the options for the second view are read.

## 4.5 MVC coding parameters (View 1 configuration file)

### 4.5.1 MVCEnableInterViewFlag

*Class:* Boolean

*Description:* Enable inter layer/view prediction for MVC. Default is 1 (enabled)

### 4.5.2 MVCInterViewReorder

*Class:* Numeric (Integer)

*Description:* Enable reference reordering for interview prediction.

<b>Options:</b>	
0	Disabled (default)
1	Enabled (forced)

### 4.5.3 QPOffset

*Class:* Numeric (Integer)

*Description:* Sets the quantization parameter (QP) offset that will be used for coding the enhancement layer for MVC. Value can be either negative or positive (-51..51). Default value is 0 (no offset).

### 4.5.4 MVCInterViewForceB

*Class:* Boolean

*Description:* Force B coded pictures for the enhancement layer coding of MVC. Default is 0 (disabled).

### 4.5.5 MVCInterViewReorder

*Class:* Boolean

*Description:* Reorder References according to interview pictures. Default is 0 (disabled).

#### 4.5.6 SepViewInterSearch

*Class:* Boolean

*Description:* If set, allows different InterSearch modes to be set for each view. Default is 0 (disabled).

#### 4.5.7 NoResidueRDO

*Class:* Boolean

*Description:* Test no residue case for View 1 during RDO. Default is 1 (enabled).

#### 4.5.8 MVCFlipViews

*Class:* Boolean

*Description:* Reverses the order of the views in the bitstream (view 1 has VOIdx 0 and view 1 has VOIdx 0)

#### 4.5.9 Other View 1 parameters

In addition the following main configuration file parameters are available in the View 1 configuration file with the same meaning:

- InputFile
- ReconFile
- SearchRange
- DisableSubpelME
- DisableIntraInInter
- PList0Refs
- BList0Refs
- BList1Refs
- LambdaMultiplier
- MELambdaMultiplier
- PSliceSkip
- PSliceSearch16x16
- PSliceSearch16x8
- PSliceSearch8x16
- PSliceSearch8x8
- PSliceSearch8x4
- PSliceSearch4x8
- PSliceSearch4x4
- BSliceDirect
- BSliceSearch16x16
- BSliceSearch16x8
- BSliceSearch8x16
- BSliceSearch8x8
- BSliceSearch8x4
- BSliceSearch4x8
- BSliceSearch4x4
- BiPredMESearchRange
- MDReference
- DFDisableRefISlice
- DFDisableNRefISlice
- DFDisableRefPSlice
- DFDisableNRefPSlice

- DFDisableRefBSlice
- DFDisableNRefBSlice
- DFDisableRefSPSlice
- DFDisableNRefSPSlice
- DFDisableRefSISlice
- DFDisableNRefSISlice
- DFAlphaRefISlice
- DFAlphaNRefISlice
- DFAlphaRefPSlice
- DFAlphaNRefPSlice
- DFAlphaRefBSlice
- DFAlphaNRefBSlice
- DFAlphaRefSPSlice
- DFAlphaNRefSPSlice
- DFAlphaRefSISlice
- DFAlphaNRefSISlice
- DFBetaRefISlice
- DFBetaNRefISlice
- DFBetaRefPSlice
- DFBetaNRefPSlice
- DFBetaRefBSlice
- DFBetaNRefBSlice
- DFBetaRefSPSlice
- DFBetaNRefSPSlice
- DFBetaRefSISlice
- DFBetaNRefSISlice
- SearchMode
- EPZSTemporal
- EnableEPZSScalers
- EPZSMinThresScale
- EPZSMaxThresScale
- EPZSMedThresScale
- EPZSSubPelThresScale

## 4.6 Deblocking Filter Control

Parameters to control in-loop deblocking filter behavior.

### 4.6.1 DFParametersFlag

*Class:* Boolean

*Description:* Sets the value of the syntax element **deblocking\_filter\_control\_present\_flag**. Default value is 0 (disabled).

*Note:* Although currently the encoder supports multiple PPS this parameter still sets the same deblocking filter parameters for all coded pictures.

#### 4.6.2 DFDisableRefISlice

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **disable\_deblocking\_filter\_idc** for I slices belonging to a reference picture. Requires DFParametersFlag to be set.

<i>Options:</i>	
0	Default. Additional loopfilter offsets are also encoded and considered during deblocking
1	Disables deblocking for all edges.
2	Disables deblocking at slice boundaries only

#### 4.6.3 DFAlphaRefISlice

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **slice\_alpha\_c0\_offset\_div2** for I slices belonging to a reference picture. Requires DFParametersFlag to be set. Allowable values are in the range {-6, -5, ... 0, +1, .. +6}. Default value is 0.

#### 4.6.4 DFBetaRefISlice

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **slice\_beta\_offset\_div2** for I slices belonging to a reference picture. Requires DFParametersFlag to be set. Allowable values are in the range {-6, -5, ... 0, +1, .. +6}. Default value is 0.

#### 4.6.5 DFDisableNRefISlice

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **disable\_deblocking\_filter\_idc** for I slices belonging to a non reference picture. Requires DFParametersFlag to be set.

<i>Options:</i>	
0	Default. Additional loopfilter offsets are also encoded and considered during deblocking
1	Disables deblocking for all edges.
2	Disables deblocking at slice boundaries only

#### 4.6.6 DFAlphaNRefISlice

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **slice\_alpha\_c0\_offset\_div2** for I slices belonging to a non reference picture. Requires DFParametersFlag to be set. Allowable values are in the range {-6, -5, ... 0, +1, .. +6}. Default value is 0.

#### 4.6.7 DFDisableRefISlice

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **disable\_deblocking\_filter\_idc** for I slices belonging to a reference picture. Requires DFParametersFlag to be set.

<i>Options:</i>	
0	Default. Additional loopfilter offsets are also encoded and considered during



	deblocking
1	Disables deblocking for all edges.
2	Disables deblocking at slice boundaries only

#### 4.6.8 DFAAlphaRefPSlice

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **slice\_alpha\_c0\_offset\_div2** for P slices belonging to a reference picture. Requires DFParametersFlag to be set. Allowable values are in the range {-6, -5, ... 0, +1, .. +6}. Default value is 0.

#### 4.6.9 DFBetaRefPSlice

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **slice\_beta\_offset\_div2** for P slices belonging to a reference picture. Requires DFParametersFlag to be set. Allowable values are in the range {-6, -5, ... 0, +1, .. +6}. Default value is 0.

#### 4.6.10 DFDisableNRefPSlice

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **disable\_deblocking\_filter\_idc** for P slices belonging to a non reference picture. Requires DFParametersFlag to be set.

<i>Options:</i>	
0	Default. Additional loopfilter offsets are also encoded and considered during deblocking
1	Disables deblocking for all edges.
2	Disables deblocking at slice boundaries only

#### 4.6.11 DFAAlphaNRefPSlice

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **slice\_alpha\_c0\_offset\_div2** for P slices belonging to a non reference picture. Requires DFParametersFlag to be set. Allowable values are in the range {-6, -5, ... 0, +1, .. +6}. Default value is 0.

#### 4.6.12 DFDisableRefBSlice

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **disable\_deblocking\_filter\_idc** for B slices belonging to a reference picture. Requires DFParametersFlag to be set.

<i>Options:</i>	
0	Default. Additional loopfilter offsets are also encoded and considered during deblocking
1	Disables deblocking for all edges.
2	Disables deblocking at slice boundaries only

#### 4.6.13 DFAAlphaRefBSlice

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **slice\_alpha\_c0\_offset\_div2** for B slices belonging to a reference picture. Requires DFPParametersFlag to be set. Allowable values are in the range {-6, -5, ... 0, +1, .. +6}. Default value is 0.

#### 4.6.14 DFBetaRefBSlice

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **slice\_beta\_offset\_div2** for B slices belonging to a reference picture. Requires DFPParametersFlag to be set. Allowable values are in the range {-6, -5, ... 0, +1, .. +6}. Default value is 0.

#### 4.6.15 DFDisableNRefBSlice

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **disable\_deblocking\_filter\_idc** for B slices belonging to a non reference picture. Requires DFPParametersFlag to be set.

<i>Options:</i>	
0	Default. Additional loopfilter offsets are also encoded and considered during deblocking
1	Disables deblocking for all edges.
2	Disables deblocking at slice boundaries only

#### 4.6.16 DFAlphaNRefBSlice

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **slice\_alpha\_c0\_offset\_div2** for B slices belonging to a non reference picture. Requires DFPParametersFlag to be set. Allowable values are in the range {-6, -5, ... 0, +1, .. +6}. Default value is 0.

### 4.7 Weighted Prediction Parameters

The following parameters enable weighted prediction.

#### 4.7.1 WeightedPrediction

*Class:* Boolean

*Description:* Sets the value of the syntax element **weighted\_pred\_flag** and enables explicit weighted prediction for P slices. A simple model, based on picture DC values is used for estimating weights. Default value is 0 (disabled).

*Note:* This parameter is ignored when RDPictureDecision is used.

#### 4.7.2 WeightedBiprediction

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **weighted\_bipred\_idc** and enables weighted prediction for B slices.

<i>Options:</i>	
0	Disabled (default).
1	Explicit Weighted Prediction.
2	Implicit Weighted Prediction. Weights are based on POC distances.

*Note:* This parameter is ignored when RDPictureDecision is used.

#### 4.7.3 UseWeightedReferenceME

*Class:* Boolean

*Description:* Use weighted references for motion estimation. Default value is 0 (disabled).

#### 4.7.4 WPMMethod

*Class:* Boolean

*Description:* Use DC based (0: default) or Least Mean Square (LMS) method (1) for weighted prediction.

#### 4.7.5 WPIterMC

*Class:* Boolean

*Description:* Use DC Iterative Motion compensated based weighted prediction method. Default value is 0 (disabled)

#### 4.7.6 EnhancedBWeightSupport

*Class:* Boolean

*Description:* Use LMS method for B slice weighted prediction. Default value is 0 (disabled).

#### 4.7.7 WPMCPrecision

*Class:* Numeric (Integer)

*Description:* Improved Motion Compensation Precision using WP based methods. Clones WP references with slightly modified rounding offsets (Requires RDPictureDecision and GenerateMultiplePPS) :

<i>Options:</i>	
0	Disabled (default).
1	Up to one additional coding pass. Ref0 is 0, ref1 is 0 with a -1 offset
2	Up to two additional coding passes. (1) Ref0 is 0, ref1 is 0 with a -1 offset, (1) Ref0 is 0 with a -1 offset, ref1 is 0

#### 4.7.8 WPMCPrecFullRef

*Class:* Numeric (Integer)

*Description:* Increases the number of references in the reference picture lists to account for the lost reference slot when reordering is used during a coding pass in WPMCPrecision for reference replication. The number of references in non-reordered passes stays unchanged. Default value is 0 (keep the same number of references).

#### 4.7.9 WPMCPrecBSlice

*Class:* Numeric (Integer)

*Description:* Applies different methods when considering the improved motion compensation precision process in B slices.

<i>Options:</i>	
0	Disable rounding for B slices.
1	Disable rounding for non-reference B slices. Non-reference B slices are evaluated for alternative QPs during RDPictureDecision.(default)
2	Apply rounding on every B slice. This effectively disables the evaluation of

	alternative QPs during RDPictureDecision.
--	---

## 4.8 B Pictures and CodingStructure

### 4.8.1 BRefPicQPOffset

*Class:* Numeric (Integer)

*Description:* Quantization offset parameter used for stored B slices. Should be in the range [-51..51]. Default value is 0.

### 4.8.2 DirectModeType

*Class:* Boolean

*Description:* Sets the value of the syntax element **direct\_spatial\_mv\_pred\_flag** which controls the direct mode type to be used. 0 means temporal direct, while 1 means spatial direct. Default value is 0 (temporal).

### 4.8.3 DirectInferenceFlag

*Class:* Boolean

*Description:* Sets the value of the syntax element **direct\_8x8\_inference\_flag** in the SPS which affects semantics of Direct Mode. The value is constrained by level restriction in Annex A of H.264/AVC (i.e. for any level above or equal to 3 the parameter needs to be equal to 1), and should be set appropriately even if no B slices are to be used. Default value is 0.

### 4.8.4 HierarchicalCoding

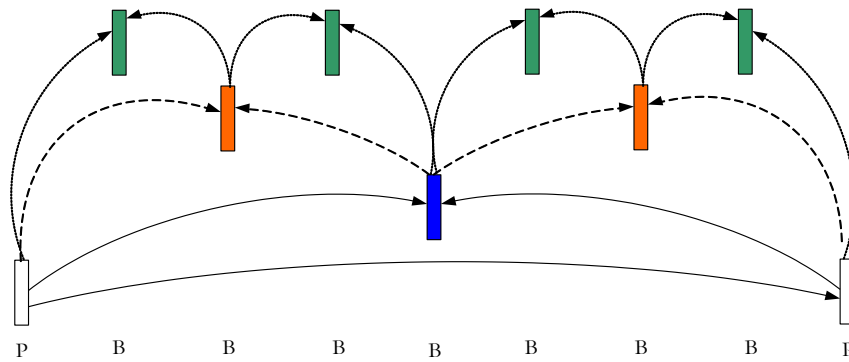
*Class:* Numeric (Integer)

*Description:* Enables the use of advanced coding picture structures for the secondary layer. This includes the use of a hierarchical type order, or explicit frame coding types/ordering.

<i>Options:</i>	
0	Disabled (default). Use default coding types.
1	Use double layer approach. More specifically, if N number of B coded frames are used, all B coded frames at odd positions (starting from 0) will be coded first and stored and used as references, while even ones will follow and be coded as non reference.
2	Use Hierarchical layer approach with multiple levels. Basically a power of two approach is used, where each level is assigned a different priority.
3	Explicit Coding type & order. Requires presence of ExplicitHierarchyFormat parameter.

*Example 1:*

We would like to encode video with the following coding order I0-P8-Bs4-Bs2-Bs6-B1-B3-B5-B7-P16... We would also like to assign QP values of 24 to referenced B coded frames, and 26 to non reference frames. Also, although we will like to have 5 total references, only one reference should be used for list0 and list1 for B slices. Note that the above structure looks as follows:



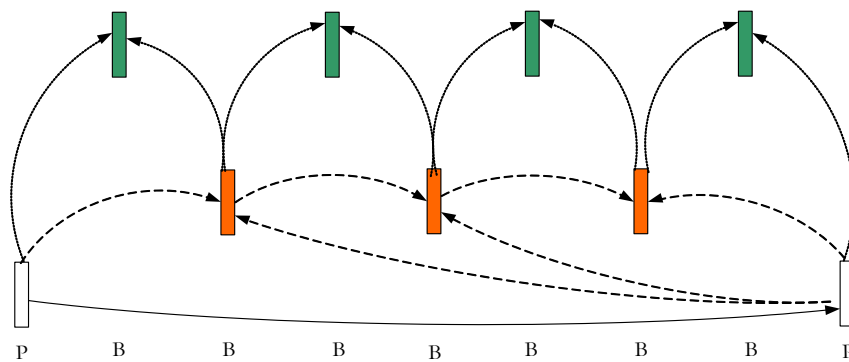
**Figure 1.4 Level Hierarchical structure.**

The above could be easily done using HierarchicalCoding mode 2 which automatically generates this hierarchy. An alternative way would be to use HierarchicalCoding mode 3, and to appropriately set the necessary params using the ExplicitHierarchyFormat parameter.

```
lencod.exe -p NumberReferenceFrames=5 -p NumberBFrames=7 \
-p HierarchicalCoding=2 -p QPBSlice=26 \
-p BRefPicQPOffset=-2 \
-p BList0References=1 -p BList1References=1
```

*Example 2:*

Lets assume that for the previous example we would prefer having only 3 levels, and that each level follows a sequential coding order. More specifically we would like the coding order to be as I0-P8-Bs2-Bs4-Bs6-B1-B3-B5-B7-P16... Note that this structure would now look as follows (i.e. we observe that now references are differently organized than in the previous case):



**Figure 2.3 Level Hierarchical structure.**

The above could be easily done using HierarchicalCoding mode 1 which automatically generates this hierarchy. HierarchicalCoding mode 3 could also be used.

```
lencod.exe -p NumberReferenceFrames=5 -p NumberBFrames=7 \
-p HierarchicalCoding=1 -p QPBSlice=26 \
-p BRefPicQPOffset=-2 \
-p BList0References=1 -p BList1References=1
```

#### 4.8.5 ExplicitHierarchyFormat

*Class:* Text

*Description:* Parameter used with HierarchicalCoding==3 and specifies coding method (i.e. type, quantizer, coding order etc) of a frame. Parameter also overwrites use of NumberBFrames

*Syntax:*

[TypeFrame0][OrderFrame0][ReferenceFrame0][QPFrame0][TypeFrame1][OrderFrame1][ReferenceFrame1][QPFrame1] ... [TypeFrameN][OrderFrameN][ReferenceFrameN][QPFrameN]

<b>Allowed entries:</b>	
[TypeFrameN]	I/i (Intra coded frame)
	P/p (P type coded frame)
	B/b (B type coded frame)
[OrderFrameN]	0-FrameSkip (specifies display order of coded frame. No duplicates are allowed)
[ReferenceFrameN]	R/r (Reference)
	E/e (Non Reference/Disposable)
[QPOffsetN]	Frame QP Offset.Final QP depends on slice type as defined by the QPNSlice parameters

*Example 1:*

We would like to encode video using 5 references and the following coding order I0-P8-Bs4-Bs2-B1-B3-Bs6-B5-B7-P16... We would also like to assign QP values of 24 to referenced B coded frames, and 26 to non reference frames.

```
lencod.exe -p NumberReferenceFrames=5 -p QPBSlice=24 \
-p HierarchicalCoding=3 \
-p ExplicitHierarchyFormat="B4r0B2r0B1e2B3e2B6r0B5e2B7e2"
```

*Example 2:*

In the previous example, we would like to replace Bs6 with a P coded frame, while B7 is coded in intra mode with a QP of 22. The original QP for I and P slices was 24. Regardless of the slice type used, note that frame 7 will still not be used as a reference.

```
lencod.exe -p NumberReferenceFrames=5 -p HierarchicalCoding=3 \
-p QPISlice=24 -p QPPSlice=24 -p QPBSlice=24 \
-p ExplicitHierarchyFormat="B4r0B2r0B1e2B3e2P6r0B5e2I7e-2"
```

*Example 3:*

We would like to encode a video sequence using a relatively similar coding structure as in example 1, with the difference that we would like to code all non reference frames last, i.e. I0-P8-Bs4-Bs2-Bs6-B1-B3-B5-B7-P16... In this case we may use HierarchicalCoding=2 also which would create this structure automatically.

```
lencod.exe -p NumberReferenceFrames=5 -p NumberBFrames=7 \  
-p HierarchicalCoding=2
```

#### 4.8.6 HierarchyLevelQPEnable

*Class:* Boolean

*Description:* Parameter, if enabled, adjusts QP values for hierarchical structures based on the current level in increments of 1. Ignores the BRefPicQPOffset parameter. Default value is 0 (disabled).

#### 4.8.7 ExplicitSeqCoding

*Class:* Boolean

*Description:* Encode video sequence using the Explicit Seq Coding metadata file provided by ExplicitSeqFile. Default value is 0 (disabled).

*Note:* This option is still experimental.

#### 4.8.8 ExplicitSeqFile

*Class:* Text

*Description:* Name of Explicit Seq Coding metadata file used when ExplicitSeqCoding is enabled.

#### 4.8.9 ReferenceReorder

*Class:* Boolean

*Description:* Performs reference picture list reordering for P coded frames based on POC values. This essentially places references according to temporal correlation instead of coding order. Default value is 0 (disabled).

*Note:* ReferenceReorder is not supported for interlace coding modes.

*Example:*

In example 1 of 4.7.5 the default coding order that will be used for coding frame 16 will be {Bs6, Bs2, Bs4, P8, I0}. Nevertheless, temporally frame 8 is much closer to frame 16 and therefore this coding mode may not be as efficient. Instead, we want to use reordering commands to consider references according to their display order.

```
lencod.exe -p NumberReferenceFrames=5 -p FrameSkip=7 \  
-p HierarchicalCoding=3 -p ReferenceReorder=1 \  
-p ExplicitHierarchyFormat="B4r24B2r24B1e26B3e26P6r24B5e26I7e40"
```

#### 4.8.10 PocMemoryManagement

*Class:* Boolean

*Description:* Performs memory management control based on POC values. Basically allows better memory management for “arbitrary” or hierarchical type coding methods if only a certain number of references are allowed due to level limitations. Parameter also recommended to be used with the EnableOpenGop parameter. Default value is 0 (disabled)

*Note:* PocMemoryManagement is not supported for interlace coding modes.

*Example:*

Lets assume that for the first example in 4.7.5, only a maximum of 4 references can be used. Unfortunately this would result, according to the default memory management behavior, in frame 8 being removed from the reference buffer immediately after adding frame 16, since this has the smallest frame\_num in the list. It would be preferable to remove frame 2 instead, since this frame would most likely not be very useful for predicting any future frames.

```
lencod.exe -p NumberReferenceFrames=5 -p NumberBFrames=7 \
-p HierarchicalCoding=3 -p ReferenceReorder=1 \
-p PocMemoryManagement=1 \
-p ExplicitHierarchyFormat="B4r24B2r24B1e26B3e26P6r24B5e26I7e40"
```

## 4.9 Error Resiliency and Slice control

### 4.9.1 SliceMode

*Class:* Numeric (Integer)

*Description:* Sets slice coding mode.

<i>Options:</i>	
0	Disabled (default)
1	Fixed number of MBs per slice
2	Fixed number of Bytes per slice
3	Use Callback

### 4.9.2 SliceArgument

*Class:* Numeric (Integer)

*Description:* For SliceMode equal to 1: number of macroblocks per slice. For SliceMode equal to two: number of bytes per slice. Default value is 0 (invalid).

### 4.9.3 num\_slice\_groups\_minus1

*Class:* Numeric (Integer)

*Description:* Number of slice groups decremented by 1 (i.e. 0 == one slice group, 1 == two slice groups, etc.). Default value is 0.

### 4.9.4 slice\_group\_map\_type

*Class:* Numeric (Integer)

*Description:* Specifies slice group map type if num\_slice\_groups\_minus1 is larger than 0 (sets the value of the syntax element **slice\_group\_map\_type**).

<i>Options:</i>	
0	Interleave mode (default)
1	Dispersed Mode
2	Foreground with left-over
3	Box-out



4	Raster Scan
5	Wipe
6	Explicit

*Note:* For slice\_group\_map\_type equal to 0, 2 or 6, additional parameters are read from a file specified in the SliceGroupConfigFileName parameter.

#### 4.9.5 slice\_group\_change\_direction\_flag

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **slice\_group\_change\_direction\_flag**.

<i>Options:</i>	
0	box-out clockwise, raster scan or wipe right (default)
1	box-out counter clockwise, reverse raster scan or wipe left

#### 4.9.6 slice\_group\_change\_rate\_minus1

*Class:* Numeric (Integer)

*Description:* Sets the value of the syntax element **slice\_group\_change\_rate\_minus1**. Default value is 0.

#### 4.9.7 SliceGroupConfigFileName

*Class:* Text

*Description:* Slice configuration file used for slice group map types 0, 2, and 6.

For slice\_group\_map\_type equal to 0 the file consist of one **run\_length\_minus1** syntax element value per line. For slice\_group\_map\_type equal to 2 the file contains in rows with odd line numbers the values for **top\_left** syntax elements and rows with even line numbers the values **bottom\_right** syntax elements. For slice\_group\_map\_type equal to 6, each line contains a value of a **slice\_group\_id** syntax element.

#### 4.9.8 UseRedundantPicture

*Class:* Boolean

*Description:* Enables the use of redundant pictures. Default value is 0 (disabled)

#### 4.9.9 NumRedundantHierarchy

*Class:* Numeric (Integer)

*Description:* Hierarchy mode of redundant pictures. Allowed values are in the range of 0 to 4.

#### 4.9.10 PrimaryGOPLength

*Class:* Numeric (Integer)

*Description:* GOP length for redundant allocation (1-16). NumberReferenceFrames must be no less than PrimaryGOPLength when redundant slice is enabled.

#### 4.9.11 NumRefPrimary

*Class:* Numeric (Integer)

*Description:* Actually used number of references for primary slices (1-16).

### 4.10 SP coding support

#### 4.10.1 SPPicturePeriodicity

*Class:* Numeric (Integer)

*Description:* Sets period of SP coded frames compared to FramesToBeEncoded. 0: no SP used (default), N>0: SP coded frames inserted every N frames.

*Note: SP coding might be broken in current implementation*

#### 4.10.2 QSPPicture

*Class:* Numeric (Integer)

*Description:* Quantization parameter of SP coded pictures for prediction Error (0-51). Default is 24.

#### 4.10.3 QSP2Picture

*Class:* Numeric (Integer)

*Description:* Quantization parameter of SP coded pictures for Predicted Blocks (0-51). Default is 24.

#### 4.10.4 SI\_Frames

*Class:* Boolean

*Description:* Eanbels SI frame encoding. Default value is 0 (disabled).

*Note: Currently this parameters needs to be enabled if SP slices are to be generated.*

#### 4.10.5 SP\_output

*Class:* Boolean

*Description:* Controls whether coefficients will be output to encode switching SP frames. Default value is 0 (disabled).

#### 4.10.6 SP\_output\_name

*Class:* Text

*Description:* Filename for SP coefficients output.

#### 4.10.7 SP2\_Frames

*Class:* Boolean

*Description:* Enables switching SP frame encoding. Default value is 0 (diabled).

#### 4.10.8 SP2\_input\_name1

*Class:* Text

*Description:* Filename for the first switched bitstream coefficients

#### 4.10.9 SP2\_input\_name2

*Class:* Text

*Description:* Filename for the second switched bitstream coefficients

### 4.11 Output Control/Entropy Coding, NALs

The following parameters control the entropy coding method that is to be used, and other output related control options.

#### 4.11.1 SymbolMode

*Class:* Numeric (Integer)

*Description:* Entropy Coding method.

<i>Options:</i>	
0	CAVLC (default)

1	CABAC
---	-------

#### 4.11.2 ContextInitMethod

*Class:* Numeric (Integer)

*Description:* CABAC context initialization method

<i>Options:</i>	
0	Fixed (default)
1	Adaptive

#### 4.11.3 FixedModelNumber

*Class:* Numeric (Integer)

*Description:* CABAC initialization model number for fixed initialization (ContextInitMethod equal to 0). Allowed model numbers are 0,1 and 2. Default value is 0.

#### 4.11.4 OutFileMode

*Class:* Numeric (Integer)

*Description:* Output File mode.

<i>Options:</i>	
0	Annex B Byte Stream format (default)
1	RTP packets

#### 4.11.5 PartitionMode

*Class:* Numeric (Integer)

*Description:* Enables Data Partitioning.

<i>Options:</i>	
0	No Data Partitioning (default)
1	Three partitions per slice

### 4.12 Interlace Format Handling

Options enable interlace coding modes such as field coding, Picture and Macroblock adaptive Field/Frame coding etc.

#### 4.12.1 PicInterlace

*Class:* Numeric (Integer)

*Description:* Enables adaptive field/frame coding support at the frame level.

<i>Options:</i>	
0	Use Frame picture coding mode only. Default.
1	Use field picture coding mode only
2	Use adaptive frame/field picture coding mode. Decision is based on lagrangian RDO of the form $J = Distortion + \lambda \times Rate$ where <i>Distortion</i> is the SSE distortion of the entire reconstructed frame (or both fields), $\lambda$ is the lagrangian parameter, and <i>Rate</i> is the allotted bits for coding the frame (or fields respectively).

*Note:* Decision is suboptimal, but works well under certain conditions.

#### 4.12.2 MBInterlace

*Class:* Numeric (Integer)

*Description:* Enables adaptive field/frame coding support at the macroblock level.

<i>Options:</i>	
0	Use Frame coding mode only ( <b>mb_adaptive_frame_field_flag=0</b> ). Default.
1	Set <b>mb_adaptive_frame_field_flag</b> =1 but code all macroblocks in frame in field mode. Mainly useful for testing purposes
2	Performs RD optimal decision between frame coded super macroblocks and field coded supermacroblocks.
3	Like option 1, but all macroblocks coded as frame macroblocks. Mainly useful for testing purposes

*Note:* Decision is suboptimal, but works well under certain conditions.

*Example 1:*

To encode a sequence using field/frame adaptive coding at both frame and macroblock level encoder should be set as follows:

```
lencod.exe -p PicInterlace=2 -p MBInterlace=2
```

*Example 2:*

Use only field/frame adaptive coding at the frame level:

```
lencod.exe -p PicInterlace=2 -p MBInterlace=0
```

#### 4.12.3 IntraBottom

*Class:* Boolean

*Description:* Forces both fields of a complementary field pair to be coded using I slices at intra periods. If disabled, the bottom field will be coded using P slices. Default value is 0 (disabled).

*Note:* Has only effect, if PicInterlace is not equal to zero.

### 4.13 Non Normative Encoder Decisions

#### 4.13.1 RDOptimization

*Class:* Numeric (Integer)

*Description:* Enable Lagrangian based Rate distortion optimized mode decision.

<i>Options:</i>	
0	Enable Low Complexity mode (default)
1	Enable High Complexity mode
2	Enable Fast High Complexity mode (does not support FRExt profiles)
3	RDO consideration with losses

*Note:* According to common condition, option should be set to 1 when evaluating algorithmic performance.

#### 4.13.2 I16RDOpt

*Class:* Boolean

*Description:* Enable high complexity rate distortion optimization for Intra 16x16 modes. Default value is 0 (disabled).

#### 4.13.3 SubMBCodingState

*Class:* Integer

*Description:* Parameter provides performance/speed tradeoffs for submacroblock mode decision when high complexity RDO is enabled. Essentially avoids storing/restoring state values resulting in somewhat suboptimal RD decision.

<i>Options:</i>	
0	Disable store/restore states for sub-macroblock mode decision (low complexity)
1	Reset coding state for every mode at the macroblock level (medium complexity)
2	Store/Reset coding state based on optimal decisions (high complexity/default)

#### 4.13.4 ForceTrueRateRDO

*Class:* Integer

*Description:* Mode bias for skip or intra modes during high complexity mode decision. Can provide benefits in some scenarios.

<i>Options:</i>	
0	Penalize skip modes by 1 bit if mode cost is 0 (default)
1	No penalty
2	Penalize intra modes by 1 bit.

#### 4.13.5 RDPictureDecision

*Class:* Boolean

*Description:* If parameter is enabled the same picture is coded in up to 3 different modes and the one yielding the best Lagrangian cost is selected as the final coding mode for this picture. Default value is 0 (disabled).

*Note:* If GenerateMultiplePPS is enabled, then coding mode considers all different WP methods supported by a slice. This includes normal, weights, offsets for P slices, and normal, implicit, and explicit modes for B slices. If RDPictureIntra intra slices are also coded multiple times by considering different Quantizers. If the GenerateMultiplePPS parameter is not set then all slice types are considered using 3 different Quantizers. Concept also can perform a “switch to I slice) decision for P slices if number of Intra MBs in a P slice is too high, or consideration of different QPs if Weighted Prediction is not recommended (i.e. weights are identical to default values). Currently tends to increase complexity significantly but will be improved through the consideration of Fast Motion Estimation and decision schemes.

**4.13.6 RDPSTliceBTest**

*Class:* Boolean

*Description:* Perform Slice level RD decision between P and B slices.

**4.13.7 RDPictureMaxPassISlice**

*Class:* Numeric (Integer)

*Description:* Set maximum number of coding passes for I slices. The valid range for this parameter is from 1 (default) through 3.

**4.13.8 RDPictureMaxPassPSlice**

*Class:* Numeric (Integer)

*Description:* Set the maximum number of coding passes for P slices. The valid range for this parameter is from 1 through 6. The default value is 2.

**4.13.9 RDPictureMaxPassBSlice**

*Class:* Numeric (Integer)

*Description:* Set the maximum number of coding passes for B slices. The valid range for this parameter is from 1 through 6. The default value is 3.

**4.13.10 RDPictureFrameQPPSlice**

*Class:* Boolean

*Description:* Perform an additional frame level QP check (QP+/-1) for P slices. The default value is 0 (disabled).

**4.13.11 RDPictureFrameQPBSlice**

*Class:* Boolean

*Description:* Perform an additional frame level QP check (QP+/-1) for B slices. , The default value is 0 (disabled).

**4.13.12 RDPictureDeblocking**

*Class:* Boolean

*Description:* Perform another coding pass to check deblocking performance, The default value is 0 (disabled).

**4.13.13 RDPictureDirectMode**

*Class:* Boolean

*Description:* Perform another coding pass for B slices that compares performance of the two direct modes. The default value is 0 (disabled).

**4.13.14 DistortionSSIM**

*Class:* Boolean

*Description:* Enable SSIM distortion computation for video analysis. Default value is 0 (disabled).

**4.13.15 DistortionSSIM**

*Class:* Boolean

*Description:* Enable SSIM distortion computation for video analysis. Default value is 0 (disabled).

**4.13.16 DistortionYUVtoRGB**

*Class:* Boolean

*Description:* Compute Distortion in both YUV and RGB color spaces. Default value is 0 (disabled).

**4.13.17 RDPictureIntra***Class:* Boolean*Description:* Enables RDPictureDecision for Intra slices based on different Quantizers. Default value is 0 (disabled).**4.13.18 RDPSliceWeightOnly***Class:* Numeric Boolean*Description:* Performs RD Picture Decision for P slices only if explicit weights are available, or if number of Intra macroblocks is high. Default value is 1 (enabled).**4.13.19 RDBSliceWeightOnly***Class:* Boolean*Description:* Skips RD Picture Decision for B slices for explicit weighted prediction if explicit weights are not available without testing an alternative QP. Otherwise (if flag 0 and explicit WP is not available) a  $QP + 1$  for non reference B, and  $QP - 1$  for reference B will be tested as well. Default value is 0 (disabled).**4.14 Lambda parameters for Lagrangian based optimization****4.14.1 CtxAdptLagrangeMult***Class:* Boolean*Description:* Flag enabled the Context Adaptive Lagrange Multiplier technique. Technique works best for RDOptimization set to 0. Default value is 0 (disabled).**4.14.2 UseExplicitLambdaParams***Class:* Numeric (Integer)*Description:* Enables the user to explicitly set the Lagrangian parameters, instead of using the equation based approach within the reference software. Default value is 0 (disabled).

<i>Options:</i>	
0	Default (disabled)
1	Use multiplier based lambda computation (i.e. $\lambda = \text{LambdaWeight} \times 2^{(QP-12)/3}$ )
2	Use constant lambda values (i.e. $\lambda = \text{FixedLambda}$ )

**4.14.3 UpdateLambdaChromaME***Class:* Boolean*Description:* Update Lambda for motion estimation to account for chroma consideration during this process. Default value is 0 (disabled).**4.14.4 FixedLambdaIslice***Class:* Numeric (Double)*Description:* Sets value of constant Lagrangian multiplier for I slices if UseExplicitLambdaParams is set to 2. Default value is 0.10.**4.14.5 FixedLambdaPslice***Class:* Numeric (Double)*Description:* Sets value of constant Lagrangian multiplier for P slices if UseExplicitLambdaParams is set to 2. Default value is 0.10.

**4.14.6 FixedLambdaBslice**

*Class:* Numeric (Double)

*Description:* Sets value of constant Lagrangian multiplier for B slices if UseExplicitLambdaParams is set to 2. Default value is 0.10.

**4.14.7 FixedLambdaRefBslice**

*Class:* Numeric (Double)

*Description:* Sets value of constant Lagrangian multiplier for reference B slices if UseExplicitLambdaParams is set to 2. Default value is 0.10.

**4.14.8 FixedLambdaSPslice**

*Class:* Numeric (Double)

*Description:* Sets value of constant Lagrangian multiplier for SP slices if UseExplicitLambdaParams is set to 2. Default value is 0.10.

**4.14.9 FixedLambdaSIslice**

*Class:* Numeric (Double)

*Description:* Sets value of constant Lagrangian multiplier for SI slices if UseExplicitLambdaParams is set to 2. Default value is 0.10.

**4.14.10 LambdaWeightIslice**

*Class:* Numeric (Double)

*Description:* Sets value of Lagrangian multiplier for I slices if UseExplicitLambdaParams is set to 1. Default value is 0.65

**4.14.11 LambdaWeightPslice**

*Class:* Numeric (Double)

*Description:* Sets value of Lagrangian multiplier for P slices if UseExplicitLambdaParams is set to 1. Default value is 0.68.

**4.14.12 LambdaWeightBslice**

*Class:* Numeric (Double)

*Description:* Sets value of Lagrangian multiplier for B slices if UseExplicitLambdaParams is set to 1. Default value is 2.00.

**4.14.13 LambdaWeightRefBslice**

*Class:* Numeric (Double)

*Description:* Sets value of Lagrangian multiplier for referenced B slices if UseExplicitLambdaParams is set to 1. Default value is 1.50.

**4.14.14 LambdaWeightSPslice**

*Class:* Numeric (Double)

*Description:* Sets value of Lagrangian multiplier for SP slices if UseExplicitLambdaParams is set to 1. Default value is 1.50.

**4.14.15 LambdaWeightSIslice**

*Class:* Numeric (Double)

*Description:* Sets value of Lagrangian multiplier for SI slices if UseExplicitLambdaParams is set to 1. Default value is 1.50.



**4.14.16 OffsetMatrixPresentFlag**

*Class:* Boolean

*Description:* Enable explicit Quantization offset support. Default value is 0 (disabled).

**4.14.17 QOffsetMatrixFile**

*Class:* Text

*Description:* File specifying the values of the explicit quantization offset matrices.

*Example:* Specify specific Q offset matrices for all blocks from file q\_offset\_matrix.cfg

```
lencod.exe -p OffsetMatrixPresentFlag=1 \
           -p QOffsetMatrixFile="q_offset_matrix.cfg"
```

**4.14.18 AdaptiveRounding**

*Class:* Boolean

*Description:* Enables adaptive rounding based on JVT\_N011. Default value is 0 (disabled).

**4.14.19 AdaptRoundingFixed**

*Class:* Numeric (Integer)

*Description:* Consider adaptive rounding separately for different quantization parameters.

<i>Options:</i>	
<i>0</i>	Separate QPs
<i>1</i>	Joint (default)

**4.14.20 AdaptRndPeriod**

*Class:* Numeric (Integer)

*Description:* Sets the macroblock period of when to use updated rounding parameters. Default value is 16. In JVT\_N011 a value of 1 was used.

**4.14.21 AdaptRndChroma**

*Class:* Numeric (Integer)

*Description:* Performs adaptive rounding for chroma. If disabled, only luma is considered. Default value is 0 (disabled).

**4.14.22 AdaptRndWFactorIRef**

*Class:* Numeric (Integer)

*Description:* Adaptive Rounding Weighting factor for luma in I and SI slices belonging to a reference picture (divided by 4096). Default value is 4.

**4.14.23 AdaptRndWFactorPRef**

*Class:* Numeric (Integer)

*Description:* Adaptive Rounding Weighting factor for luma in P and SP slices belonging to a reference picture (divided by 4096). Default value is 4.

**4.14.24 AdaptRndWFactorBRef**

*Class:* Numeric (Integer)

*Description:* Adaptive Rounding Weighting factor for luma in B slices belonging to a reference picture (divided by 4096). Default value is 4.

**4.14.25 AdaptRndWFactorINRef**

*Class:* Numeric (Integer)

*Description:* Adaptive Rounding Weighting factor for luma in I and SI slices belonging to a non-reference picture (divided by 4096). Default value is 4.

**4.14.26 AdaptRndWFactorPNRef**

*Class:* Numeric (Integer)

*Description:* Adaptive Rounding Weighting factor for luma in P and SP slices belonging to a non-reference picture (divided by 4096). Default value is 4.

**4.14.27 AdaptRndWFactorBNRef**

*Class:* Numeric (Integer)

*Description:* Adaptive Rounding Weighting factor for luma in B slices belonging to a non-reference picture (divided by 4096). Default value is 4.

**4.14.28 AdaptRndCrWFactorIRef**

*Class:* Numeric (Integer)

*Description:* Adaptive Rounding Weighting factor for chroma in I and SI slices belonging to a reference picture (divided by 4096). Default value is 4.

**4.14.29 AdaptRndCrWFactorPRef**

*Class:* Numeric (Integer)

*Description:* Adaptive Rounding Weighting factor for chroma in P and SP slices belonging to a reference picture (divided by 4096). Default value is 4.

**4.14.30 AdaptRndCrWFactorBRef**

*Class:* Numeric (Integer)

*Description:* Adaptive Rounding Weighting factor for chroma in B slices belonging to a reference picture (divided by 4096). Default value is 4.

**4.14.31 AdaptRndCrWFactorINRef**

*Class:* Numeric (Integer)

*Description:* Adaptive Rounding Weighting factor for chroma in I and SI slices belonging to a non-reference picture (divided by 4096). Default value is 4.

**4.14.32 AdaptRndCrWFactorPNRef**

*Class:* Numeric (Integer)

*Description:* Adaptive Rounding Weighting factor for chroma in P and SP slices belonging to a non-reference picture (divided by 4096). Default value is 4.

**4.14.33 AdaptRndCrWFactorBNRef**

*Class:* Numeric (Integer)

*Description:* Adaptive Rounding Weighting factor for chroma in B slices belonging to a non-reference picture (divided by 4096). Default value is 4.

**4.15 Error Resilient Optimized Rate Distortion Optimization****4.15.1 LossRateA**

*Class:* Numeric (Integer)

*Description:* Expected packet loss rate of the channel for the first partition. Only valid if RDOptimization is set equal to 3. Default value is 0.

#### 4.15.2 LossRateB

*Class:* Numeric (Integer)

*Description:* Expected packet loss rate of the channel for the second partition. Only valid if RDOptimization is set equal to 3. Default value is 0.

#### 4.15.3 LossRateC

*Class:* Numeric (Integer)

*Description:* Expected packet loss rate of the channel for the third partition. Only valid if RDOptimization is set equal to 3. Default value is 0.

#### 4.15.4 NumberOfDecoders

*Class:* Numeric (Integer)

*Description:* Numbers of decoders used to simulate the channel. Only valid if RDOptimization is set equal to 3. Default value is 0.

#### 4.15.5 RestrictRefFrames

*Class:* Boolean

*Description:* Does not allow reference to areas that have been intra updated in a later frame. Default value is 0 (disabled).

#### 4.15.6 RestrictSearchRange

*Class:* Numeric (Integer)

*Description:* Reduces Search range for motion estimation based on references and/or block types.

<i>Options:</i>	
0	Based on Block Type and Reference (default).
1	Based on reference (i.e. divide by (1<<reference_index))
2	No restrictions (should be used for common conditions)

#### 4.15.7 DisableThresholding

*Class:* Boolean

*Description:* Disable Thresholding of Transform Coefficients. Default value is 0 (enabled).

*Note:* Thresholding is usually more appropriate for low to medium bitrates, while this could result in loss of details under certain situations.

#### 4.15.8 BiasSkipRDO

*Class:* Boolean

*Description:* Force a negative bias for skip/direct modes during the mode decision process. Default value is 0 (disabled)

#### 4.15.9 ForceTrueRateRDO

*Class:* Numeric (Integer)

*Description:* Affects the consideration of the bitrate during the rate distortion optimized mode decision process.

<b>Options:</b>	
0	Bound rate to a minimum of ½ bit. Essentially affects skip/direct modes.
1	Consider true rate during the mode decision process (unbiased)
2	Negatively bias intra modes

#### 4.15.10 DisableBSkipRDO

*Class:* Boolean

*Description:* Disable B Skip Mode consideration from the RDO based mode decision. Default value is 0 (enabled)

#### 4.15.11 SkipIntraInInterSlices

*Class:* Numeric (Integer)

*Description:* Avoids testing Intra modes in Inter slices if best mode is P\_SKIP or B\_SKIP. Default value is 0 (disabled)

#### 4.15.12 SearchMode

*Class:* Numeric (Integer)

*Description:* Enables Usage of Fast Motion Estimation..

<b>Options:</b>	
-1	Full Search
0	Fast Full Search (default)
1	Uneven Multi-Hexagon Search (UMHex)
2	Simplified Hexagon Search
3	Enhanced Predictive Zonal Search (EPZS)

*Note:* Currently common conditions specify that Fast Full Search should be used. Options 1 and 2 are joint integer and fractional ME implementations. EPZS, on the other hand, can operate simultaneously on both integer and fractional positions if desired.

### 4.16 EPZS Options

EPZS is a very generic FME scheme which can achieve very high performance. For educational purposes but to also allow a user to refine the algorithm based on the target application additional parameters have been added to control the behavior of this scheme. The scheme could be further extended as is described in the original contribution as to support more patterns and additional adaptation. EPZS currently

#### 4.16.1 EPZSPattern

*Class:* Numeric (Integer)

*Description:* Specifies primary refinement pattern for EPZS (around best predictor)

<b>Options:</b>	
0	Diamond
1	Square
2	Extended Diamond (default)

3	Large Diamond
4	Subpixel Diamond
5	PMVFAST (switching large/small diamond)

#### 4.16.2 EPZSDualRefinement

*Class:* Numeric (Integer)

*Description:* Specifies usage of Dual Refinement around second best predictor

<i>Options:</i>	
0	Disabled
1	Diamond
2	Square
3	Extended Diamond (default)
4	Large Diamond
5	Subpixel Diamond
6	PMVFAST (switching large/small diamond)

#### 4.16.3 EPZSFxedPredictors

*Class:* Numeric (Integer)

*Description:* Specifies usage Window based predictors that can improve performance for encodings requiring large search windows.

<i>Options:</i>	
0	Disabled
1	P only
2	P and B (default)

#### 4.16.4 EPZSTemporal

*Class:* Boolean

*Description:* Enables usage of Temporal Predictors through the consideration of co-located partitions (i.e. similar to temporal direct). Default value is 1 (enabled).

#### 4.16.5 EPZSSpatialMem

*Class:* Boolean

*Description:* Enables usage of Spatial Predictors through the consideration of all block type MVs from surrounding MBs. Implementation is optimized as to require only a single row of MB Motion Vectors. Default value is 1 (enabled).

#### 4.16.6 EPZSMinThresScale

*Class:* Numeric (Integer)

*Description:* Lower limit for threshold used for early termination. Value depends on block type and is essentially multiplied with the base value MinBaseT in Table 1. Default value is 0.

#### 4.16.7 EPZSMedThresScale

*Class:* Numeric (Integer)

*Description:* Control multiplier parameter for the Median threshold. Value depends on block type and is essentially multiplied with the base value MedBaseT in Table 1. Default value is 1.

#### 4.16.8 EPZSMaxThresScale

*Class:* Numeric (Integer)

*Description:* Upper limit for threshold used for early termination. Value depends on block type and is essentially multiplied with the base value MaxBaseT in Table 1. Default value is 1.

<i>Blocktype</i>	<i>16x16</i>	<i>16x8</i>	<i>8x16</i>	<i>8x8</i>	<i>8x4</i>	<i>4x8</i>	<i>4x4</i>
<i>MinBaseT</i>	64	32	32	16	8	8	4
<i>MedBaseT</i>	256	128	128	64	32	32	16
<i>MaxBaseT</i>	768	384	384	192	96	96	48

**Table 1.** EPZS threshold control multipliers

#### 4.16.9 EPZSSubPelME

*Class:* Boolean

*Description:* EPZS Subpel ME consideration for single prediction motion estimation. Default value is 1 (enabled).

#### 4.16.10 EPZSSubPelMEBipred

*Class:* Boolean

*Description:* EPZS Subpel ME consideration for Bi-predictive motion estimation. Default value is 1 (enabled).

#### 4.16.11 EPZSSubPelThresScale

*Class:* Numeric (Integer)

*Description:* EPZS Subpel ME threshold scaler. Default value is 2.

#### 4.16.12 EPZSSubPelGrid

*Class:* Numeric (Integer)

*Description:* Perform EPZS Motion estimation using a combined integer/subpel grid. Default value is 0 (disabled).

### 4.17 UMHex Options

Recently, two new parameters were added to UMHex to improve its performance mainly in terms of speed. These options could probably be used with any other ME scheme as well.

#### 4.17.1 UMHexDSR

*Class:* Boolean

*Description:* Use an adaptive method to predict the maximum search range. Default value is 1 (enabled).

#### 4.17.2 UMHexScale

*Class:* Numeric (Integer)

*Description:* Distortion based Threshold Scaling factor relevant to picture size. Selecting a larger value should increase speed somewhat for larger resolutions. 0:Disabled. Default value is 3.

### 4.18 EarlySkipEnable

*Class:* Boolean

*Description:* Early skip mode detection when RDOptimization is set to 2. Default value is 0 disabled).

*Note:* Common conditions specify that High complexity RDO mode should be used

## 4.19 SelectiveIntraEnable

*Class:* Boolean

*Description:* Enables Selective Intra mode decision when RDOptimization is set to 2. Default value is 0 (disabled).

*Note:* Common conditions specify that High complexity RDO mode should be used

## 4.20 Rate Control & HRD support

Parameters for rate control support.

### 4.20.1 RateControlEnable

*Class:* Boolean

*Description:* Enable simple Rate Control support. Default value is 0 (disabled).

*Example:* Encode a sequence at 100kbps, with an initial QP of 32, while performing adaptation at the frame level.

```
lencod.exe -p RateControlEnable=1 -p Bitrate=100000 \
-p InitialQP=32 -p BasicUnit=99
```

*Note:* Existing algorithms should be used as a reference only.

### 4.20.2 RCUpdateMode

*Class:* Numeric (Integer)

*Description:* Specifies the Rate Control algorithm used, when RateControlEnable is enabled.

<i>Options:</i>	
0	Original quadratic rate control scheme based on JVT-G012r1 (default)
1	Extension of quadratic scheme for all Intra and IBsBsBs... coding.
2	Basic extension of quadratic scheme to better support hierarchical coding structures
3	Extension of quadratic scheme with slice type separation

### 4.20.3 Bitrate

*Class:* Numeric (Integer)

*Description:* Set target bitrate in bits per second for HRD conforming Rate Control. **Default value is 0.**

### 4.20.4 InitialQP

*Class:* Numeric (Integer)

*Description:* Set the initial quantization parameter for the HRD conforming Rate Control. Parameter should be selected based on bitrate goal, GOP length/type, and image spatiotemporal characteristics. If 0, the encoder tries to automatically select the best quantizer for the first picture. Default value is 0.

### 4.20.5 BasicUnit

*Class:* Numeric (Integer)

*Description:* Number of Macroblocks in rate control basic unit. Value needs to be a factor of the total number of MBs in a frame. If 0, then Basic Unit is equal to the number of macroblocks in a slice. Default value is 0.

#### 4.20.6 ChannelType

*Class:* Numeric (Integer)

*Description:* Type of Channel.

<i>Options:</i>	
0	Constant channel (default)
1	Time varying channel

#### 4.20.7 NumberofLeakyBuckets

*Class:* Numeric (Integer)

*Description:* Number of Leaky Bucket values. Default value is 2.

#### 4.20.8 LeakyBucketRateFile

*Class:* Text

*Description:* File from which encoder derives rate values.

#### 4.20.9 LeakyBucketParamFile

*Class:* Text

*Description:* File where encoder stores leakybucketparams.

#### 4.20.10 RCISliceBitRatio

*Class:* Numeric (Double)

*Description:* Sets the bitrate target ratio between I and P coded slices when RCUpdateMode is set to 3. Default value is 1.00.

#### 4.20.11 RCBSliceBitRatio0

*Class:* Numeric (Double)

*Description:* Sets the bitrate target ratio between B and P coded slices for hierarchical level 0 when RCUpdateMode is set to 3. Default value is 0.5.

#### 4.20.12 RCBSliceBitRatio1

*Class:* Numeric (Double)

*Description:* Sets the bitrate target ratio between B and P coded slices for hierarchical level 1 when RCUpdateMode is set to 3. Default value is 0.25.

#### 4.20.13 RCBSliceBitRatio2

*Class:* Numeric (Double)

*Description:* Sets the bitrate target ratio between B and P coded slices for hierarchical level 2 when RCUpdateMode is set to 3. Default value is 0.25.

#### 4.20.14 RCBSliceBitRatio3

*Class:* Numeric (Double)

*Description:* Sets the bitrate target ratio between B and P coded slices for hierarchical level 3 when RCUpdateMode is set to 3. Default value is 0.25.

#### 4.20.15 RCBSliceBitRatio4

*Class:* Numeric (Double)



*Description:* Sets the bitrate target ratio between B and P coded slices for hierarchical level 4 when RCUpdateMode is set to 3. Default value is 0.25.

#### **4.20.16 RCloverPRatio**

*Class:* Numeric (Double)

*Description:* Sets the “predicted” bit ratio relationship/complexity between I and P coded slices given the same QP. Used only when RCUpdateMode is set to 3. Default value is 3.8.

#### **4.20.17 RCBoverPRatio**

*Class:* Numeric (Double)

*Description:* Sets the “predicted” bit ratio relationship/complexity between I and P coded slices given the same QP. Used only when RCUpdateMode is set to 3. Default value is 0.45.

#### **4.20.18 RCMinQPPSlice**

*Class:* Numeric (Integer)

*Description:* Sets the minimum allowable P slice QP value for the rate control. Default value is 0.

#### **4.20.19 RCMaxQPPSlice**

*Class:* Numeric (Integer)

*Description:* Sets the maximum allowable P slice QP value for the rate control. Default value is 51.

#### **4.20.20 RCMinQPISlice**

*Class:* Numeric (Integer)

*Description:* Sets the minimum allowable I slice QP value for the rate control. Default value is 0.

#### **4.20.21 RCMaxQPISlice**

*Class:* Numeric (Integer)

*Description:* Sets the maximum allowable I slice QP value for the rate control. Default value is 51.

#### **4.20.22 RCMinQPBSlice**

*Class:* Numeric (Integer)

*Description:* Sets the minimum allowable B slice QP value for the rate control. Default value is 0.

#### **4.20.23 RCMaxQPBSlice**

*Class:* Numeric (Integer)

*Description:* Sets the maximum allowable B slice QP value for the rate control. Default value is 51.

#### **4.20.24 RCMinQPSPSlice**

*Class:* Numeric (Integer)

*Description:* Sets the minimum allowable SP slice QP value for the rate control. Default value is 0.

#### **4.20.25 RCMaxQPSPSlice**

*Class:* Numeric (Integer)

*Description:* Sets the maximum allowable SP slice QP value for the rate control. Default value is 51.

#### **4.20.26 RCMinQPSISlice**

*Class:* Numeric (Integer)

*Description:* Sets the minimum allowable SI slice QP value for the rate control. Default value is 0.

#### **4.20.27 RCMaxQPSISlice**

*Class:* Numeric (Integer)

*Description:* Sets the maximum allowable SI slice QP value for the rate control. Default value is 51.

## 4.21 Rate Distortion Optimized Quantization Parametetr

### 4.21.1 UseRDOQuant

*Class:* Boolean

*Description:* Enable Rate Distortion Optimized Quantization. Default value is 0 (disabled).

### 4.21.2 RDOQ\_DC

*Class:* Boolean

*Description:* Enable Rate Distortion Optimized Quantization for DC components. Default value is 0 (disabled).

### 4.21.3 RDOQ\_CR

*Class:* Boolean

*Description:* Enable Rate Distortion Optimized Quantization for Chroma components. Default value is 0 (disabled).

### 4.21.4 RDOQ\_DC\_CR

*Class:* Boolean

*Description:* Enable Rate Distortion Optimized Quantization for Chroma DC components Default value is 0 (disabled).

### 4.21.5 RDOQ\_QP\_Num

*Class:* Numeric (Integer)

*Description:* Number of QP values tested in RDO\_Q (I/P/B slice). Allowable values are from 1 (default) to 9.

### 4.21.6 RDOQ\_CP\_Mode

*Class:* Boolean

*Description:* Fast mode decision for RDOQ by copying the mode of the first QP tested for all other QP values. Default value is 0 (disabled).

### 4.21.7 RDOQ\_CP\_MV

*Class:* Boolean

*Description:* Fast motion estimation for RDOQ by copying the best motion vectors for each mode of the first QP tested for all other QP values. Default value is 0 (disabled).

### 4.21.8 RDOQ\_Fast

*Class:* Boolean

*Description:* Fast RDOQ decision method for multiple QPs based on CBP behavior.

## 4.22 SEI Parameters

### 4.22.1 GenerateSEIMessage

*Class:* Boolean

*Description:* Adds data unregistered SEI message (payload type 5) in the video. Default value is 0 (disabled).

### 4.22.2 SEIMessageText

*Class:* Text

*Description:* Text message added as unregistered SEI.

### 4.22.3 ToneMappingSEIPresentFlag

*Class:* Boolean

*Description:* Enable Tone mapping SEI. Default value is 0 (disabled).

### 4.22.4 ToneMappingFile

*Class:* Text

*Description:* Tone mapping parameter file.

## 4.23 VUI Parameters

VUI Parameters specify directly the values of the corresponding VUI syntax elements.

### 4.23.1 VUI\_aspect\_ratio\_info\_present\_flag

*Class:* Boolean

*Description:* If enabled specifies that aspect\_ratio\_idc is present. Default value is 0 (disabled).

### 4.23.2 VUI\_aspect\_ratio\_idc

*Class:* Numeric (Integer)

*Description:* Specifies the value of the sample aspect ratio of the luma samples. Default value is 0 (unspecified). See Annex E, Table E-1 of the AVC text for more info.

<i>Options:</i>	
0	Unspecified
1	1:1 (“square”)
2	12:11
3	10:11
4	16:11
5	40:33
6	24:11
7	20:11
8	32:11
9	80:33
10	18:11
11	15:11
12	64:33
13	160:99
14	4:3
15	3:2
16	2:1
17..254	Reserved
255	Extended_SAR

### 4.23.3 VUI\_sar\_width

*Class:* Numeric (Integer)

*Description:* indicates the horizontal size of the sample aspect ratio (in arbitrary units).

#### 4.23.4 VUI\_sar\_height

*Class:* Numeric (Integer)

*Description:* indicates the vertical size of the sample aspect ratio (in the same arbitrary units as VUI\_sar\_width).

#### 4.23.5 VUI\_overscan\_info\_present\_flag

*Class:* Numeric (Integer)

*Description:* If equal to 1, it specifies that the overscan\_appropriate\_flag is present. Default is 0 (not present).

#### 4.23.6 VUI\_overscan\_appropriate\_flag

*Class:* Numeric (Integer)

*Description:* If equal to 1, this flag indicates that the cropped decoded pictures output are suitable for display using overscan. If equal to 0, it indicates that the cropped decoded pictures output contain visually important information in the entire region out to the edges of the cropping rectangle of the picture, such that the cropped decoded pictures output should not be displayed using overscan. Instead, they should be displayed using either an exact match between the display area and the cropping rectangle, or using underscan.

#### 4.23.7 VUI\_video\_signal\_type\_present\_flag

*Class:* Numeric (Integer)

*Description:* If equal to 1, this flag specifies that the video\_format, video\_full\_range\_flag and colour\_description\_present\_flag flags are present. Default is 0 (not present).

#### 4.23.8 VUI\_video\_format

*Class:* Numeric (Integer)

*Description:* This parameter indicates the video format of the pictures. When this flag is not present then the format is inferred as 5 (unspecified). Default is 0.

<i>Options:</i>	
0	Component
1	PAL
2	NTSC
3	SECAM
4	MAC
5	Unspecified video format
6	Reserved
7	Reserved

#### 4.23.9 VUI\_video\_full\_range\_flag

*Class:* Numeric (Integer)

*Description:* This parameter indicates the black level and range of the luma and chroma signals. When not present, the value shall be inferred to be equal to 0 (default).

#### 4.23.10 VUI\_colour\_description\_present\_flag

*Class:* Numeric (Integer)

*Description:* When equal to 1, it specifies that colour\_primaries, transfer\_characteristics and matrix\_coefficients are present. When, equal to 0 (default), it specifies that colour\_primaries, transfer\_characteristics and matrix\_coefficients are not present.

#### **4.23.11 VUI\_colour\_primaries**

*Class:* Numeric (Integer)

*Description:* This parameter indicates the chromaticity coordinates of the source primaries.

When this flag is not present, its value shall be inferred to be equal to 2 (the chromaticity is unspecified or is determined by the application). Default is 2.

#### **4.23.12 VUI\_transfer\_characteristics**

*Class:* Numeric (Integer)

*Description:* This parameter indicates the opto-electronic transfer characteristic of the source picture. When this syntax element is not present, its the value shall be inferred to be equal to 2 (the transfer characteristics are unspecified or are determined by the application). Default is 2.

#### **4.23.13 VUI\_matrix\_coefficients**

*Class:* Numeric (Integer)

*Description:* This parameter describes the matrix coefficients used in deriving luma and chroma signals from the green, blue, and red primaries. When this syntax element is not present, its value shall be inferred to be equal to 2 (default).

#### **4.23.14 VUI\_chroma\_loc\_info\_present\_flag**

*Class:* Numeric (Integer)

*Description:* If flag is set to 1, it specifies that chroma\_sample\_loc\_type\_top\_field and chroma\_sample\_loc\_type\_bottom\_field are present. If set equal to 0 (default), it specifies that these parameters are not present.

#### **4.23.15 VUI\_chroma\_sample\_loc\_type\_top\_field**

*Class:* Numeric (Integer)

*Description:* This parameter specifies the location of chroma samples for the top field. If not present, the value is inferred to be equal to 0.

#### **4.23.16 VUI\_chroma\_sample\_loc\_type\_bottom\_field**

*Class:* Numeric (Integer)

*Description:* This parameter specifies the location of chroma samples for the bottom field. If not present, the value is inferred to be equal to 0.

#### **4.23.17 VUI\_timing\_info\_present\_flag**

*Class:* Numeric (Integer)

*Description:* If this flag is set equal to 1, it specifies that parameters num\_units\_in\_tick, time\_scale and fixed\_frame\_rate\_flag are present in the bitstream. If 0 (default) the above parameters are not present.

#### **4.23.18 VUI\_num\_units\_in\_tick**

*Class:* Numeric (Integer)

*Description:* This parameter is the number of time units of a clock operating at the frequency time\_scale Hz that corresponds to one increment of a clock tick counter. The default value is 1000.

#### **4.23.19 VUI\_time\_scale**

*Class:* Numeric (Integer)

*Description:* This parameter is the number of time units that pass in one second. The default value is 60000.

#### **4.23.20 VUI\_fixed\_frame\_rate\_flag**

*Class:* Numeric (Integer)

*Description:* If set to 1, this flag indicates that the temporal distance between the HRD output times of any two consecutive pictures in output order is constrained according to Annex E. Default is 0 (disabled).

*Note:* This flag has currently no real impact within the encoder and its presence may not indicate that the proper constraints are imposed.

#### **4.23.21 VUI\_nal\_hrd\_parameters\_present\_flag**

*Class:* Numeric (Integer)

*Description:* If set to 1, this flag specifies that NAL HRD parameters (pertaining to Type II bitstream conformance) are present. Default is 0 (not present).

#### **4.23.22 VUI\_nal\_vcl\_parameters\_present\_flag**

*Class:* Numeric (Integer)

*Description:* If set to 1, this flag specifies that VCL HRD parameters (pertaining to all bitstream conformance) are present. Default is 0 (not present).

#### **4.23.23 VUI\_low\_delay\_hrd\_flag**

*Class:* Numeric (Integer)

*Description:* This flag specifies the HRD operational mode as specified in Annex C of the text. When VUI\_fixed\_frame\_rate\_flag is equal to 1, this flag shall be equal to 0.

#### **4.23.24 VUI\_pic\_struct\_present\_flag**

*Class:* Numeric (Integer)

*Description:* If this flag is equal to 1, it specifies that picture timing SEI messages are present that include the pic\_struct syntax element. Default is 0 (not present).

*Note:* This flag has currently no real impact within the encoder and its presence may not indicate that the proper constraints are imposed.

#### **4.23.25 VUI\_bitstream\_restriction\_flag**

*Class:* Numeric (Integer)

*Description:* If this flag is equal to 1, it specifies that several sequence bitstream restriction parameters are present within the bitstream. Default is 0 (not present).

*Note:* This flag has currently no real impact within the encoder and its presence may not indicate that the proper constraints are imposed.

#### **4.23.26 VUI\_motion\_vectors\_over\_pic\_boundaries\_flag**

*Class:* Numeric (Integer)

*Description:* If this flag is equal to 0, it indicates that no sample outside the picture boundaries and no sample at a fractional sample position whose value is derived using one or more samples outside the picture boundaries is used to inter predict any sample. If equal to 1, it then indicates that one or more samples outside picture boundaries may be used in inter prediction. When not present, its value is inferred to be equal to 1 (default).

#### **4.23.27 VUI\_max\_bytes\_per\_pic\_denom**

*Class:* Numeric (Integer)

*Description:* This parameter indicates a number of bytes not exceeded by the sum of the sizes of the VCL NAL units associated with any coded picture in the sequence. When not present, its value is inferred to be equal to 2 (default).

#### 4.23.28 VUI\_max\_bits\_per\_mb\_denom

*Class:* Numeric (Integer)

*Description:* This parameter indicates the maximum number of coded bits of macroblock\_layer() data for any macroblock in any picture of the sequence. The value of max\_bits\_per\_mb\_denom shall be in the range of 0 to 16, inclusive. When this parameter is not present, its value is inferred to be equal to 1.

#### 4.23.29 VUI\_log2\_max\_mv\_length\_horizontal

*Class:* Numeric (Integer)

*Description:* This parameter indicates the maximum absolute value of a decoded horizontal motion vector component, respectively, in  $\frac{1}{4}$  luma sample units, for all pictures in the sequence. When not present, its value is inferred to be equal to 16.

#### 4.23.30 VUI\_log2\_max\_mv\_length\_vertical

*Class:* Numeric (Integer)

*Description:* This parameter indicates the maximum absolute value of a decoded vertical motion vector component, respectively, in  $\frac{1}{4}$  luma sample units, for all pictures in the sequence. When not present, its value is inferred to be equal to 16.

#### 4.23.31 VUI\_num\_reorder\_frames

*Class:* Numeric (Integer)

*Description:* This parameter indicates the maximum number of frames, complementary field pairs, or non-paired fields that precede any frame, complementary field pair, or non-paired field in the sequence in decoding order and follow it in output order. When this flag is not present, its value is inferred to be equal to max\_dec\_frame\_buffering.

#### 4.23.32 VUI\_max\_dec\_frame\_buffering

*Class:* Numeric (Integer)

*Description:* This parameter specifies the required size of the HRD decoded picture buffer (DPB) in units of frame buffers. When this parameter is not present, its value is inferred to be equal to MaxDpbSize (see AVC text).

### 4.24 Other settings

#### 4.24.1 NumFramesInELayerSubSeq

*Class:* Numeric (Integer)

*Description:* Number of frames in the Enhanced Scalability Layer. 0 (default) means that no Enhancement Layer is used.

#### 4.24.2 SparePictureOption

*Class:* Numeric (Integer)

*Description:* Creation of spare reference pictures

<i>Options:</i>	
0	No spare picture info (default)
1	Spare picture available

### 4.24.3 SparePictureDetectionThr

*Class:* Numeric (Integer)

*Description:* Threshold for spare reference pictures detection. Default value is 0.

### 4.24.4 SparePicturePercentageThr

*Class:* Numeric (Integer)

*Description:* Threshold for the spare macroblock percentage. Default value is 0.

## 4.25 FRExt profile parameters

In this section all FRExt specific parameters are described, including scaling matrices, 8x8 transform usage, lossless coding etc.

### 4.25.1 Transform8x8Mode

*Class:* Numeric (Integer)

*Description:* Enables 8x8 Transforms

<i>Options:</i>	
0	Disabled. Only 4x4 transforms are used (default).
1	Allows the additional use of 8x8 transform. Results in <i>optimal</i> RD performance since it considers all possible modes
2	Consider only 8x8 transform modes (i.e. disables 4x4 transform)

### 4.25.2 SeparateColourPlane

*Class:* Boolean

*Description:* Enables use of separate colour plane coding. Default value is 0 (disabled)

### 4.25.3 ScalingMatrixPresentFlag

*Class:* Numeric (Integer)

*Description:* Enable Quantization matrix support.

<i>Options:</i>	
0	Not Present – Disabled (Default)
1	Present only in SPS
2	Present only in PPS
3	Present in both SPS and PPS

### 4.25.4 QmatrixFile

*Class:* Text

*Description:* File specifying the values of the quantization scaling matrices. Used only if values are explicitly transmitted either at the SPS or PPS level. Otherwise default values are used.

*Example:* Specify specific Qmatrix for intra4x4 luma blocks. Use default for all other modes.

```
lencod.exe -p ScalingMatrixPresentFlag=1-p QmatrixFile="q_matrix.cfg" \
-p ScalingListPresentFlag0=1
```



**4.25.5 ScalingListPresentFlag0***Class:* Numeric (Integer)*Description:* Select scaling matrix for Intra4x4 Luma Component

<i>Options:</i>	
0	Not Present - Use default values if ScalingMatrixPresentFlag is not 0
1	Present only in SPS
2	Present only in PPS
3	Present in both SPS and PPS

**4.25.6 ScalingListPresentFlag1***Class:* Numeric (Integer)*Description:* Select scaling matrix for Intra4x4 Chroma U component

<i>Options:</i>	
0	Not Present - Use default values if ScalingMatrixPresentFlag is not 0
1	Present only in SPS
2	Present only in PPS
3	Present in both SPS and PPS

**4.25.7 ScalingListPresentFlag2***Class:* Numeric (Integer)*Description:* Select scaling matrix for Intra4x4 Chroma V component

<i>Options:</i>	
0	Not Present - Use default values if ScalingMatrixPresentFlag is not 0
1	Present only in SPS
2	Present only in PPS
3	Present in both SPS and PPS

**4.25.8 ScalingListPresentFlag3***Class:* Numeric (Integer)*Description:* Select scaling matrix for Inter4x4 Luma component

<i>Options:</i>	
0	Not Present - Use default values if ScalingMatrixPresentFlag is not 0
1	Present only in SPS
2	Present only in PPS
3	Present in both SPS and PPS

**4.25.9 ScalingListPresentFlag4***Class:* Numeric (Integer)*Description:* Select scaling matrix for Inter4x4 Chroma U component

<b>Options:</b>	
0	Not Present - Use default values if ScalingMatrixPresentFlag is not 0
1	Present only in SPS
2	Present only in PPS
3	Present in both SPS and PPS

**4.25.10 ScalingListPresentFlag5**

*Class:* Numeric (Integer)

*Description:* Select scaling matrix for Intrer4x4 Chroma V component

<b>Options:</b>	
0	Not Present - Use default values if ScalingMatrixPresentFlag is not 0
1	Present only in SPS
2	Present only in PPS
3	Present in both SPS and PPS

**4.25.11 ScalingListPresentFlag6**

*Class:* Numeric (Integer)

*Description:* Select scaling matrix for Intra8x8 Luma component

<b>Options:</b>	
0	Not Present - Use default values if ScalingMatrixPresentFlag is not 0
1	Present only in SPS
2	Present only in PPS
3	Present in both SPS and PPS

**4.25.12 ScalingListPresentFlag7**

*Class:* Numeric (Integer)

*Description:* Select scaling matrix for Inter8x8 Luma component

<b>Options:</b>	
0	Not Present - Use default values if ScalingMatrixPresentFlag is not 0
1	Present only in SPS
2	Present only in PPS
3	Present in both SPS and PPS

**4.25.13 LosslessCoding**

*Class:* Boolean

*Description:* Enable lossless coding when qpprime\_y is zero. Default value is 0 (disabled).

*Note:* Better explanation is needed for this parameter

## **5. HARDCODED ENCODER PARAMETERS**

## 5. HARDCODED ENCODER PARAMETERS

Although encoder behavior is mainly controlled through the parameters provided in section 4, additional hardcoded parameters within the reference software could also modify its behavior. This includes the generation of tracing and output information, and algorithmic considerations.

### 5.1 defines.h

<i>DUMP_DPB</i>	:	Dumps DPB for debugging purposes
<i>GET_METIME</i>	:	Enabled ME Computation time
<i>IMGTYPE</i>	:	Defines data size type. 0 implies byte (i.e. best for profiles with 8 bit support), where as 1 implies unsigned short which is suitable for all types including 10-12 bit content. When set to 0, this option can provide considerable memory savings and some speed advantages when encoding 8 bit content.
<i>ENABLE_FIELD_CTX</i>	:	Enables field context types for CABAC. Required for interlaced coding. If coding only progressive content, disabling flag can provide some encoding speed up.
<i>ENABLE_HIGH444_CTX</i>	:	Enables High 444 context types for CABAC. If disabled, results in speedup of non High444 profile encodings.
<i>DEBUG_BITDEPTH</i>	:	Ensures that > 8 bit content have no values that would result in out of range results
<i>ALLOW_GRAYSCALE</i>	:	Allows encoding in grayscale of full colored image data
<i>LAMBDA_ACCURACY_BITS</i>	:	Accuracy bits for the motion estimation lambda value.
<i>TRACE</i>	:	Enables tracefile generation.
<i>ZEROSNR</i>	:	Definition avoids generation of infinite SNR by always forcing at least one difference sample
<i>_LUMA_COEFF_COST_</i>	:	8x8 block Luma coefficient threshold cost.
<i>_CHROMA_COEFF_COST_</i>	:	Chroma coefficient threshold cost.
<i>_LUMA_MB_COEFF_COST_</i>	:	Macroblock Luma coefficient threshold cost.
<i>_LUMA_8x8_COEFF_COST_</i>	:	Threshold for P8x8 sub-macroblocks.
<i>JM_INT_DIVIDE</i>	:	Perform integer divides (shifts) during ME
<i>JM_MEM_DISTORTION</i>	:	Use table lookup for distortion computations
<i>USE_RND_COST</i>	:	Use rounding for distortion computation instead of truncation
<i>JM_INT_DIVIDE</i>	:	Utilize integer divides for distortion computation
<i>JM_MEM_DISTORTION</i>	:	Use table lookup method for distortion computation
<i>JCOST_CALC_SCALEUP</i>	:	Compute RDcost as either $J = (D \ll \lambda\_bits) + \lambda * R$ or $J = D + ((\lambda * R + (1 \ll (\lambda\_bits - 1))) \gg \lambda\_bits)$
<i>INTRA_RDCOSTCALC_EARLY_TERMINATE</i>	:	Perform early rdcost termination for intra modes
<i>INTRA_RDCOSTCALC_NNZ</i>	:	Enable to recover block's non-zero coefficients after rd cost computation
<i>JCOST_OVERFLOWCHECK</i>	:	Enable check for distortion cost overflows
<i>JM_PARALLEL_DEBLOCK</i>	:	Enable parallel deblocking (OpenMP based)
<i>MVC_EXTENSION_ENABLE</i>	:	Enables MVC extension support (Stereo High Profile)

## **5.2 configfile.h**

DEFAULTCONFIGFILENAME : Sets default encoder configuration file.

# **6. EXPLICIT SEQUENCE INFORMATION FILE**

## 6. EXPLICIT SEQUENCE INFORMATION FILE

The explicit sequence information file (ExplicitSeqFile) enables the JM encoder to encode a video sequence using arbitrary coding orders and coding types. In this section we will describe how one may use this file for encoding a video sequence. It should be noted that this option is still experimental, will be further extended in the future, and should be used with care.

### 6.1 File Format

The explicit sequence information file needs to adhere to a strict file format. The file needs to start with the heading “Sequence”. Sequence information are then contained within curly brackets/braces. The first sequence level entry represents the number of frames that are present in the file (FrameCount). The number is separated from FrameCount using a colon “:” symbol.

FrameCount is followed by multiple “Frame” entries, each one again contained within curly brackets/braces. Variables can be present in any order and can be repeated within the Frame structure (only the last entry is considered). Frame entries include the following parameters:

Supported Parameter	Description
<i>SeqNumber</i>	: Sequence order of frame in input video file. Each frame is required to have a distinct number.
<i>SliceType</i>	: Slice type to be used when encoding this frame
<i>Reference</i>	: Set whether this frame will be used as a reference or not
<i>IDRPicture</i>	: Sets picture as IDR assuming picture is using I slices. Currently ignored.

Example:

```
Sequence
{
  FrameCount : 2
  Frame
  {
    SeqNumber : 0
    SliceType : I
    Reference : 1
  }
  Frame
  {
    SeqNumber : 1
    SliceType : I
    Reference : 1
  }
}
```

## **7. USING THE JM DECODER MODULE**

## 7. USING THE JM DECODER MODULE

### 7.1 Decoder Syntax

```
ldecod [-s] [-h] [-d] [defdec.cfg]
        {[-f curenc1.cfg]...[-f curencN.cfg]}
        [-i bitstream.264] [-o output.yuv] [-r reference.yuv]
        {[-p DecParam1=DecValue1]...[-p DecParamM=DecValueM]}
        [-n] Nframes [-mpr] LValue
```

#### Options:

<i>-s</i>	Silent decoding
<i>-h</i>	Prints parameter usage.
<i>[defdec.cfg]</i>	Optional decoder config file containing all decoder information.
<i>-f</i>	Read <curencM.cfg> for resetting selected decoder parameters. Multiple files could be used that set different parameters.
<i>-i</i>	Decode file <bitstream.264>. Default is set to test.264.
<i>-o</i>	Reconstructed file name is set to <output.yuv>. Default is test_dec.yuv
<i>-r</i>	Reference sequence file for PSNR computation is set to <reference.yuv>. Default is test_rec.yuv
<i>-p</i>	Set parameter <DecParamM> to <DecValueM>. The entry for <DecParamM> is case insensitive.
<i>-mpr</i>	Set Number of layers (LValue) to decode
<i>-n</i>	Number of frames to be decoded

Examples of usage:

```
ldecod.exe
ldecod.exe -h
ldecod.exe -d default.cfg
ldecod.exe -s -i bitstream.264
ldecod.exe -i bitstream.264 -o output.yuv -r reference.yuv
ldecod.exe -i bitstream420.264 -uv
```

### 7.2 Decoder Configuration File Format

The decoder format was recently modified to enable higher flexibility and to basically resemble the format of that of the encoder. The parameters allowed now are as follows:

#### 7.2.1 InputFile

*Class:* Text

*Description:* Input bitstream file name. Name could include file path.



*Note:* For Unix/Linux based systems directories should be separated using a backslash “\”, while for DOS/Windows systems, directories should be separated using a forward slash “/”.

*Example 1 (DOS):*

```
ldecod.exe -p InputFile="f:\seq\420\176x144\foreman_176x144_30.264"
```

*Example 2 (Unix/Linux):*

```
ldecod.exe -p InputFile="/vol/seq/420/176x144/foreman_176x144_30.264"
```

### 7.2.2 OutputFile

*Class:* Text

*Description:* Decoder output filename. The output will be a raw video file in either YUV or RGB format.

### 7.2.3 RefFile

*Class:* Text

*Description:* Reference input file for distortion (PSNR) computations.

### 7.2.4 WriteUV

*Class:* Boolean

*Description:* Write 4:2:0 chroma components for monochrome streams

### 7.2.5 FileFormat

*Class:* Boolean

*Description:* Input file format (0=Annex B, 1: RTP packets)

### 7.2.6 RefOffset

*Class:* Numeric (Integer)

*Description:* PSNR computation offset

### 7.2.7 POCScale

*Class:* Numeric (Integer)

*Description:* Poc Scale (1 or 2) to be utilized for PSNR computations

### 7.2.8 DisplayDecParams

*Class:* Boolean

*Description:* Display decoder configuration parameters.

### 7.2.9 ConcealMode

*Class:* Numeric (Integer)

*Description:* Perform Error Concealment

<i>Options:</i>	
0	Disabled (default)
1	Frame Copy method
2	Motion Copy method

**7.2.10 RefPOCGap***Class:* Numeric (Integer)*Description:* Reference POC gap (2: IPP (Default), 4: IbP / IpP)**7.2.11 POCGap***Class:* Numeric (Integer)*Description:* POC gap (2: IPP /IbP/IpP (Default), 4: IPP with frame skip = 1 etc.)**7.2.12 Silent***Class:* Boolean*Description:* Perform silent decoding**7.2.13 IntraProfileDeblocking***Class:* Boolean*Description:* Enable Deblocking filter in intra only profiles (0=disable, 1=filter according to SPS parameters). This method essentially works as a post-process.**7.2.14 DecFrmNum***Class:* Numeric (Integer)*Description:* Number of frames to be decoded (-n)**7.2.15 DecodeAllLayers***Class:* Boolean*Description:* Enables decoding of all layers for MVC. This is equivalent to -mpr.**7.3 Decoder Output**

When running the decoder, the decoder will display on screen rate/distortion statistics for every frame coded. Cumulative results will also be presented. The output information generated may look as follows:

```

----- JM 17.1 (FRExt) -----
Decoder config file           : decoder.cfg
-----
Input H.264 bitstream         : test.264
Output decoded YUV            : test_dec.yuv
Output status file            : log.dec
Input reference file          : test_rec.yuv
-----
POC must = frame# or field# for SNRs to be correct
-----
  Frame          POC  Pic#   QP   SnrY    SnrU    SnrV   Y:U:V   Time (ms)
-----
00000(IDR)       0    0    28  0.0000  0.0000  0.0000  4:2:0    16
00006( P )      12    1    28  0.0000  0.0000  0.0000  4:2:0     0
00004( b )       8    2    28  0.0000  0.0000  0.0000  4:2:0    15
00002( b )       4    3    28  0.0000  0.0000  0.0000  4:2:0    16
-----
Average SNR all frames -----
SNR Y(dB)        : 0.00
SNR U(dB)        : 0.00
SNR V(dB)        : 0.00
Total decoding time : 0.062 sec (64.516 fps)
-----
Exit JM 17 (FRExt) decoder, ver 17.1

```

The generated statistics in the above list represent the following information:

<i>Name</i>	<i>Format</i>	<i>Purpose</i>
<i>Frame</i>	%05d(\$Type)	Frame Display Order and Type
<i>POC</i>	%3d	Frame/Field POC number
<i>Pic#</i>	%3d	Frame_num associated with current frame
<i>QP</i>	%5d	Frame Quantization value
<i>SnrY</i>	%7.4f	Luma Y PSNR. If value is equal to 0.000 then reference is either not available or is identical to reconstructed.
<i>SnrU</i>	%7.4f	Chroma U PSNR. If value is equal to 0.000 then reference is either not available or is identical to reconstructed.
<i>SnrV</i>	%7.4f	Chroma V PSNR. If value is equal to 0.000 then reference is either not available or is identical to reconstructed.
<i>Y:U:V</i>	X:Y:Z	Color format
<i>Time(ms)</i>	%5d	Total decoding time for frame

1

## **8. HARDCODED DECODER PARAMETERS**

## 8. HARDCODED DECODER PARAMETERS

Although encoder behavior is mainly controlled through the parameters provided in section 4, additional hardcoded parameters within the reference software could also modify its behavior. This includes the generation of tracing and output information, and algorithmic considerations.

### 8.1 defines.h

<i>DUMP_DPB</i>	: Dump DPB for debugging purposes
<i>PRINTREFLIST</i>	: Print reference list information for debugging purposes
<i>IMGTYPE</i>	: Defines data size type. 0 implies byte (i.e. best for profiles with 8 bit support), where as 1 implies unsigned short which is suitable for all types including 10-12 bit content. When set to 0, this option can provide considerable memory savings and some speed advantages when encoding 8 bit content.
<i>ENABLE_FIELD_CTX</i>	: Enables field context types for CABAC. Required for interlaced coding.
<i>ENABLE_HIGH444_CTX</i>	: Enables High 444 context types for CABAC.
<i>ZEROSNR</i>	: Definition avoids generation of infinite SNR by always forcing at least one difference sample
<i>ENABLE_OUTPUT_TONEMAPPING</i>	: Enable tone mapping the output if the tone mapping SEI message is found in the bitstream
<i>DISABLE_ERC</i>	: Disable some error concealment code for speed purposes
<i>MAX_NUM_SLICES</i>	: Maximum number of slices supported per picture (increasing the value results in higher memory requirement)
<i>PAIR_FIELDS_IN_OUTPUT</i>	: always pair consecutive complementary fields in file output independent of their pairing in the DPB (e.g. if second decoded field is IDR)
<i>JM_PARALLEL_DEBLOCKING</i>	: Enable parallel deblocking implementation (OpenMP based)
<i>MVC_EXTENSION_ENABLE</i>	: Enable MVC decoding support
<i>MAX_NUM_DECSLICES</i>	: Maximum number of allocated decoded slices that can be decoded in parallel

## **9. SYSTEM GENERATED REPORTS/OUTPUT**

## 9. SYSTEM GENERATED REPORTS/OUTPUT

The Encoder and Decoder modules generate various reports that could be used for analysis purposes.

### 9.1 log.dat

File provides summary statistics for all simulations initiated within the current directory. This includes certain input parameters, PSNR values, bitrate, encoding duration etc. In more detail, the parameters shown in this file are:

<i>Name</i>	<i>Format</i>	<i>Purpose</i>
<i>Ver</i>	W.X/Y.Z	Encoder Version (W.X main branch, Y.Z FRExt)
<i>Date</i>	MM/DD	Simulation End Date
<i>Time</i>	HH:MM	Simulation End Time
<i>Sequence</i>	%30.30s	Sequence Name
<i>#Img</i>	%5d	Coded Primary Frames (excluding B or Hierarchical Structure)
<i>P/MbInt</i>	%d/%d	Picture level AFF/ Macroblock level AFF
<i>QPI</i>	%-3d	I slice Quantizer
<i>QPP</i>	%-3d	P slice Quantizer
<i>QPB</i>	%-3d	B slice Quantizer
<i>Format</i>	%4dx%4d	Width x Height
<i>Iperiod</i>	%3d	Intra Period
<i>#B</i>	%3d	Number of B coded frames
<i>FMES</i>	FS FFS HEX SHEX EPZS	Fast Motion Estimation usage
<i>Hdmd</i>	%1d%1d%1d	Distortion functions for Motion estimation
<i>S.R</i>	%3d	Maximum Search Range (around predictor for RDOPT ON)
<i>#Ref</i>	%2d	Maximum number of references (num_ref_frames)
<i>Freq</i>	%3d	Coded Video Frame Rate
<i>Coding</i>	CABAC CAVLC	Entropy Mode Used
<i>RD-opt</i>	%d	Rate Distortion Optimization Option
<i>Intra upd</i>	ON OFF	Use of MbLineIntraUpdate. Note that this incorrectly reports that this is off if MbLineIntraUpdate is larger than 1.
<i>8x8Tr</i>	%d	Mode usage of 8x8 transform
<i>SNRY I</i>	%-5.3f	Luma PSNR for first frame in sequence
<i>SNRU I</i>	%-5.3f	Chroma U PSNR for first frame in sequence
<i>SNRV I</i>	%-5.3f	Chroma V PSNR for first frame in sequence
<i>SNRY N</i>	%-5.3f	Luma PSNR for entire sequence
<i>SNRU N</i>	%-5.3f	Chroma U PSNR for entire sequence
<i>SNRV N</i>	%-5.3f	Chroma V PSNR for entire sequence
<i>#Bitr I</i>	%6.0f	Bitrate (not bits) assigned to I coded frames

<i>#Bitr P</i>	%6.0f	Bitrate (not bits) assigned to P coded frames
<i>#Bitr B</i>	%6.0f	Bitrate (not bits) assigned to B coded frames
<i>#Bitr IPB</i>	%6.0f	Sequence Bitrate including overheads
<i>Total Time</i>	%12d	Encoding Time in ms
<i>Me Time</i>	%12d	Motion Estimation only time in ms

## 9.2 StatsFile description (stats.dat)

This file contains information about the encoded sequence, such as statistics about the macroblock types used for each different slice type, distortion information, the last encoded sequence. An example stat.dat file could look as follows:

```
-----
This file contains statistics for the last encoded sequence
-----
Sequence                      : e:\data\foreman_176x144_30p.yuv
No.of coded pictures          : 19
Freq. for encoded bitstream   : 30
I Slice Bitrate(kb/s)         : 38.98
P Slice Bitrate(kb/s)         : 58.69
B Slice Bitrate(kb/s)         : 8.97
Total Bitrate(kb/s)           : 106.91
ME Metric for Refinement Level 0 : SAD
ME Metric for Refinement Level 1 : Hadamard SAD
ME Metric for Refinement Level 2 : Hadamard SAD
Mode Decision Metric           : Hadamard SAD
Motion Estimation for components : Y
Image format                   : 176x144
Error robustness               : Off
Search range                   : 32
Total number of references     : 10
References for P slices        : 2
List0 refs for B slices        : 2
List1 refs for B slices        : 2
Entropy coding method          : CABAC
Profile/Level IDC               : (100,40)
EPZS Pattern                   : Extended Diamond
EPZS Dual Pattern              : Extended Diamond
EPZS Fixed Predictors          : All P + B
EPZS Temporal Predictors       : Enabled
EPZS Spatial Predictors        : Enabled
EPZS Thresholds (16x16)       : (256 0 768)
EPZS Subpel ME                 : Enabled
Search range restrictions      : none
RD-optimized mode decision     : used
-----
```

Item	Intra	All frames
SNR Y(dB)	0.00	0.00
SNR U/V (dB)	0.00/ 0.00	0.00/ 0.00
Average quant	28	28.00

```
-----
```

SNR	I	P	B
SNR Y(dB)	0.000	0.000	0.000
SNR U(dB)	0.000	0.000	0.000
SNR V(dB)	0.000	0.000	0.000

```
-----
```

Intra	Mode used
-------	-----------



Mode 0	intra 4x4	91	
Mode 1	intra 8x8	0	
Mode 2+	intra 16x16	8	
Mode	intra IPCM	0	

Inter	Mode used	MotionInfo bits
Mode 0 (copy)	129	0.00
Mode 1 (16x16)	203	139.33
Mode 2 (16x8)	108	128.00
Mode 3 (8x16)	191	256.33
Mode 4 (8x8)	257	948.44
Mode 5 intra 4x4	0	
Mode 6 intra 8x8	0	
Mode 7+ intra 16x16	3	
Mode intra IPCM	0	

B frame	Mode used	MotionInfo bits
Mode 0 (copy)	561	0.00
Mode 1 (16x16)	295	210.67
Mode 2 (16x8)	9	10.44
Mode 3 (8x16)	20	21.56
Mode 4 (8x8)	6	22.89
Mode 5 intra 4x4	0	
Mode 6 intra 8x8	0	
Mode 7+ intra 16x16	0	
Mode intra IPCM	0	

Bit usage:	Intra	Inter	B frame
Header	32.00	32.00	40.00
Mode	71.00	416.44	186.00
Motion Info	./.	1472.11	265.56
CBP Y/C	284.00	240.44	27.44
Coeffs. Y	22094.00	1657.78	38.89
Coeffs. C	2141.00	250.89	16.33
Delta quant	7.00	5.22	0.67
Stuffing Bits	7.00	8.00	8.00
average bits/frame	24636.00	4082.89	582.89

**NOTE**

Statistics are not collected correctly when Picture or Macroblock Level Field/Frame coding is enabled.