**MFC Reference Software Manual**

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# General Information

1. General Information

## System Overview

This document contains a detailed description of the usage of the MFC (Multi-resolution Framce Compatible Stereo Coding) software built upon version 18.3 of the H.264/14496-10 MPEG-4 AVC JM reference software. The document includes information about the encoder and decoder input parameters, syntax, compilation issues, and additional information with regards to the best usage and configuration of this software.

## Acronyms and Abbreviations

* + 1. **AVC**: Advanced Video Coding
    2. **FC**: Frame Compatible
    3. **FCFR**: Frame Compatible Full Resolution
    4. **FR**: Full Resolution
    5. **MFC:** Multi-resolution Frame Compatible Stereo Coding
    6. **MVC:** Multi-view Video Coding
    7. **OM**: Orthogonal Muxing
    8. **RPU**: Reference Processing Unit
    9. **SbS**: Side-by-Side
    10. **TaB**: Top-and-Bottom

# Installation and Compilation

2. Installation and Compilation.

## Windows using MS Visual Studio .NET

The software package contains a Visual Studio .NET workspace named “jm\_vc10.sln” for .NET 2010 (v10). The workspace includes the following projects:

*lencod* the H.264/AVC reference encoder

*ldecod* the H.264/AVC reference decoder

*rtpdump* a tool for analyzing contents of RTP packets

*rtp\_loss* a tool for simulating RTP packet losses

*rpu\_sdk* an SDK static library which contains functions related to the MFC. The SDK is split into encoder\_layer, rpu\_layer , decoder\_layer and utilities\_layer. The library can be compiled and generated under directory rpu\_sdk.

Select the desired project and the appropriate compilation mode, i.e. “Debug” or “Release”, and platform, i.e. “Win32” or “x64”. Compilation will create the binaries “lencod\_[mode]\_[platform].exe” or “ldecod\_[mode]\_[platform].exe” in the “bin” directory. “rtpdump.exe” and “rtp\_loss.exe” will be created in the “bin” directory.

For compile time settings and options see section 5.

For faster execution it is recommended to compile and run the software in Release mode and on an x64 platform. For older, 32-bit only capable systems, only the Win32 platform can be used.

Note: The software has been primarily tested on an x64 environment.

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

For compiling the encoder, the decoder, the rpu\_sdk, rtpdump and rtp\_loss:

make

Binaries named “lencod.exe” ,“ldecod.exe”, “rtp\_loss.exe” and “rtpdump.exe” will be 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”, “ldecod.dbg.exe”, “rtp\_loss.dbg.exe” and “rtpdump.dbg.exe” in the “bin” directory.

By default, the binary executables will be created according to the architecture of the system, where the compilation is performed, i.e. a 32-bit executable will be created on a 32-bit system, while a 64-bit executable will be created on a 64-bit system. However, the compilation parameter M32, if set to 1, will enforce the generation of a 32-bit executable, even on a 64-bit architecture system. Additional options that can be used during compilation include OPT=N, which can control the compilations optimization level, and STC=1 for static linking of libraries.

For compile time settings and options see section 5.

Note: The software has been primarily tested on in linux with gcc version 4.5.1.

# Using The MFC Encoder Module

3. Using The MFC Encoder Module

This section provides a detailed description of the MFC related parameters in the H.264/MPEG-4 AVC JM encoder.

## Encoder Syntax

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

|  |  |
| --- | --- |
| ***Options:*** | |
| *-h* | Prints parameter usage. |
| *-d* | Use <encoder\_mfc.cfg> as the default file for encoder parameter initialization. If not used then by defaults the “encoder.cfg” in the current executation directory, if available, is processed. |
| *-f* | Read <curencM.cfg> for resetting selected encoder parameters. Multiple files could be used that set different parameters. |
| *-p* | 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 only supports MFC High Profile. Therefore, it has only been tested using planar 8-bit 4:2:0 raw YUV video data, with all frames packed in a single file.

Examples of usage:

lencod.exe

lencod.exe -h

lencod.exe -d encoder\_mfc.cfg**[[2]](#footnote-2)**

lencod.exe -f curenc1.cfg

lencod.exe -f curenc1.cfg –p InputFile="e:\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

## 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\_mfc.cfg.........................................

.......................................................................

Parsing Second View Configfile encoder\_mfc\_view1.cfg.......................

.................................

MFC HIGH PROFILE :DefaultGridPosition is set. Default values are being set for the view offsets.

Warning: Hierarchical coding or Referenced B slices used.

Make sure that you have allocated enough references

in reference buffer to achieve best performance.

AdaptiveRounding is disabled when RDO Quantization is used

Warning: Automatic cropping activated: Coded frame Size: 1920x1088

------------------------------------------ JM 18.2 (FRExt) ---------------------

---------------------

Input YUV file : K:\data\NewsRoomDolly\_L\_1920x1080\_24p.yuv Input YUV file 2 : K:\data\NewsRoomDolly\_R\_1920x1080\_24p.yuv

Output H.264 bitstream : test.264

Output YUV file : test\_rec.yuv

Output YUV file 2 : test\_rec2.yuv

YUV Format : YUV 4:2:0

Frames to be encoded : 2

Freq. for encoded bitstream : 24.00

PicInterlace / MbInterlace : 0/0

Transform8x8Mode : 1

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 : 1920x1080 (1920x1088)

Error robustness : Off

Search range : 256

Search range (view 1) : 256

Total number of references : 4

References for P slices : 4

References for B slices (L0, L1) : 3, 1

View 1 refs for P slices : 3

View 1 refs for B slices (L0, L1) : 2, 1

Sequence type : Hierarchy (QP: I 19, P 19, B 21)

Entropy coding method : CABAC

Profile/Level IDC : (134,41)

Motion Estimation Scheme : EPZS

EPZS Pattern : Extended Diamond

EPZS Dual Pattern : Extended Diamond

EPZS Fixed Predictors : All P + B

BL EPZS Temporal Predictors : Enabled

EL EPZS Temporal Predictors : Disabled

EPZS Spatial Predictors : Enabled

EPZS Threshold Multipliers : (1 0 2)

EPZS Subpel ME : Enhanced

EPZS Subpel ME BiPred : Enhanced

Motion Estimation Scheme : EPZS

EPZS Pattern : Extended Diamond

EPZS Dual Pattern : Extended Diamond

EPZS Fixed Predictors : All P + B

BL EPZS Temporal Predictors : Enabled

EL EPZS Temporal Predictors : Disabled

EPZS Spatial Predictors : Enabled

EPZS Threshold Multipliers : (1 0 2)

EPZS Subpel ME : Enhanced

EPZS Subpel ME BiPred : Enhanced

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 View Bit/pic NVB WP QP QL SnrY SnrU SnrV Time(ms) MET(ms

) Frm/Fld I D L0 L1 RDP Ref

--------------------------------------------------------------------------------

-------------------------------

00000(IDR) 0 2844960 576 0 19 1 45.137 45.759 45.848 7779 0

FRM 8160 0 0 0 0 3

00000( B ) 1 733248 0 0 20 2 44.734 47.072 46.771 27893 8956

FRM 31 1 1 1 0 2

00001( B ) 0 663112 0 0 19 2 44.199 45.576 45.642 32638 9125

FRM 565 1 1 1 0 2

00001( B ) 1 311040 0 0 20 2 44.560 47.052 46.715 32875 13911

FRM 4 1 2 1 0 2

--------------------------------------------------------------------------------

-----------------------

Total Frames: 4

LeakyBucketRate File does not exist. Using rate calculated from avg. rate

Number Leaky Buckets: 8

Rmin Bmin Fmin

27310704 2844384 2844384

34138368 2844384 2844384

40966032 2844384 2844384

47793696 2844384 2844384

54621360 2844384 2844384

61449024 2844384 2844384

68276688 2844384 2844384

75104352 2844384 2844384

--------------------------------------- Average data all frames --------------

-----------------------

Total encoding time for the seq. : 101.186 sec (0.04 fps)

Total ME time for sequence : 31.993 sec

Y { PSNR (dB), cSNR (dB), MSE } : { 44.658, 44.645, 2.23167 }

U { PSNR (dB), cSNR (dB), MSE } : { 46.365, 46.308, 1.52136 }

V { PSNR (dB), cSNR (dB), MSE } : { 46.244, 46.215, 1.55460 }

Base\_Y { PSNR (dB), cSNR (dB), MSE } : { 44.668, 44.643, 2.23260 }

Base\_U { PSNR (dB), cSNR (dB), MSE } : { 45.668, 45.667, 1.76369 }

Base\_V { PSNR (dB), cSNR (dB), MSE } : { 45.745, 45.744, 1.73264 }

Enh\_Y { PSNR (dB), cSNR (dB), MSE } : { 44.647, 44.646, 2.23074 }

Enh\_U { PSNR (dB), cSNR (dB), MSE } : { 47.062, 47.062, 1.27902 }

Enh\_V { PSNR (dB), cSNR (dB), MSE } : { 46.743, 46.743, 1.37657 }

Total bits : 4552360 (I 2844384, P 0, B 1707400 NVB 576)

Base layer Total-bits : 3507872 (I 2844384, P 0, B 663112 NVB 376)

Enh layer Total-bits : 1044488 (I 0, P 0, B 1044288 NVB 200)

Bit rate (kbit/s) @ 24.00 Hz : 54628.32

Base layer BR (kbit/s) @ 24.00 Hz: 42094.46

Enh layer BR (kbit/s) @ 24.00 Hz : 12533.86

Bits to avoid Startcode Emulation : 29

Bits for parameter sets : 576

Bits for filler data : 0

--------------------------------------------------------------------------------

-----------------------

Exit JM 18 (FRExt) encoder ver 18.3

Note: The above PSNR number is corresponding to the input of codec. In MFC case, Base layer is a frame compatible format, Enhancement layer is another frame compatible format. To compute the PSNR of the full resolution left view and right view, a reconstruction step at decoder is required. The full resolution reconstruction of the left and right views is not supported at the encoder.

## Encoder Limitations

At this point, the encoder is characterized by certain limitations which may impact its usage. In particular, some items that have been identified as being problematic or not properly supported in the JM18.3 software for MVC setting 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. Some of the conformance issues can be fixed by changing the encoder configuration. For example, the issue of mv limits can be avoided by disabling certain modes.
* Picture Level Rate Distortion (RD) Optimization does not currently fully support interlace coding modes and may also require memory optimizations to improve performance.

# MFC Encoder Parameters

4. MFC encoder Parameters

## MFC coding parameters (main configuration file)

The MFC coding parameters are primarily based on the MVC coding parameters that are supported in JM18.3. In this manual, only any newly introduced parameters as well as modified/extended parameters and parameters that have been restricted in terms of their usage are listed. For other parameters and their usage, please refer to the JM reference software manual **[[3]](#footnote-3)**.

### ProcessInput

*Class*: Numeric (Integer)

*Description*: Perform optional preprocessing on the input sequence. For MFC, the value is set to 14.

### ProfileIDC

*Class*: Numeric (Integer)

*Description*: Value of the **profile\_idc** syntax element. For MFC, the value is set to 134.

|  |  |
| --- | --- |
| ***Options:*** | |
| *44* | CAVLC 4:4:4 Intra |
| *66* | Baseline |
| *77* | Main |
| *88* | Extended |
| *100* | High |
| *110* | High 10 or High 10 Intra |
| *122* | High 4:2:2Predictive or High 4:2:2 Intra |
| *244* | High 4:4:4 or High 4:4:4 Intra |
| *118* | Multiview High |
| *128* | Stereo High |
| *134* | MFC High Profile |

### Rpu\_Filter\_Enabled\_Flag

*Class*: Numeric (Integer)

*Description*: Specifies whether the MFC RPU filter is enabled or disabled. Default value is 1.

|  |  |
| --- | --- |
| ***Options:*** | |
| *0* | RPU Filter Disabled. The output of the RPU is set to a constant value of 128. |
| *1* | RPU Filter Enabled. |

### MFC\_Format\_Idc

*Class*: Numeric (Integer)

*Description*: Specifies the FC base layer format for MFC.

|  |  |
| --- | --- |
| ***Options:*** | |
| *0* | SbS |
| *1* | TaB |

### DefaultGridPosition

*Class*: Numeric (Integer)

*Description*: Specifies whether the default grid position shall be used or not for the FC base layer. The default grid position depends on the value of MFC\_Format\_Idc as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***MFC\_Format\_Idc*** | ***View0\_Grid\_Position\_x*** | ***View0\_Grid\_Position\_y*** | ***View1\_Grid\_Position\_x*** | ***View1\_Grid\_Position\_y*** |
| *0* | 4 | 8 | 12 | 8 |
| *1* | 8 | 4 | 8 | 12 |

### View0\_Grid\_Position\_x

*Class*: Numeric (Integer)

*Description*: Specifies the explicit x component of the ( x, y ) coordinate pair for constituent frame 0 of the FC base layer, required only when DefaultGridPosition is set to 0. The allowed values are 4, 8 and 12.

### View0\_Grid\_Position\_y

*Class*: Numeric (Integer)

*Description*: Specifies the explicit y component of the ( x, y ) coordinate pair for constituent frame 0 of the FC base layer, required only when DefaultGridPosition is set to 0. The allowed values are 4, 8 and 12.

### View1\_Grid\_Position\_x

*Class*: Numeric (Integer)

*Description*: Specifies the explicit x component of the ( x, y ) coordinate pair for constituent frame 1 of the FC base layer, required only when DefaultGridPosition is set to 0. The allowed values are 4, 8 and 12.

### View1\_Grid\_Position\_y

*Class*: Numeric (Integer)

*Description*: Specifies the explicit y component of the ( x, y ) coordinate pair for constituent frame 1 of the FC base layer, required only when DefaultGridPosition is set to 0. The allowed values are 4, 8 and 12.

### Mux3DBaseFilter

*Class*: Numeric (Integer)

*Description*: Specifies the low pass downsampling filter used for the creation of the MFC FC base layer. Default value is 0.

|  |  |
| --- | --- |
| ***Options:*** | |
| *0* | SVC3D (cutoff frequency = 0.40) |
| *1* | MFC\_MUX\_FC\_P44 (cutoff frequence = 0.44) |

### Mux3DEnhFilter

*Class*: Numeric (Integer)

*Description*: Specifies the downsampling filter used for the creation of the MFC enhancement layer. Default value is 1.

|  |  |
| --- | --- |
| ***Options:*** | |
| *0* | SVC3D (cutoff frequency = 0.40) |
| *1* | MFC\_MUX\_FC\_P44 (cutoff frequency = 0.44) |

### EnableDbgYUVFiles

*Class*: Numeric (Integer)

*Description*: Specifies if the generation of debug YUV files should be enabled. Default value is 0. The debug YUV files contain the base layer frame compatible source yuv, the enhancement layer frame compatible source yuv, the base layer frame compatible reconstructed yuv, the rpu processed base layer frame compatible reconstructed yuv. The size of the source yuv files were of the size of the input source’s horizontal and vertical ressolutions.The reconstructed yuv files were padded as to have the horizontal and vertical resolutions as multiple of 16.

### FPASEIPresentFlag

*Class*: Numeric (Integer)

*Description*: Specifies if the Frame Packing Arrangement (FPA) SEI message shall be created and be present in the FC base layer. Default value is 1 for MFC**[[4]](#footnote-4)**.

## MVC coding parameters (View 1/Enhancement layer configuration file)

No additional paramteres are added.

# MFC Hardcoded Encoder Parameters

5. MFC Hard coded Encoder Parameters

For MFC, several additional preprocessor directives, i.e. macro definitions, have been added that can control the behavior of the software.

## defines.h

|  |  |  |
| --- | --- | --- |
| *MFC\_ENC\_3D\_FCFR* |  | Enable MFC |
| *MFC\_PROCESS\_INPUT* |  | Set to 14 for MFC |
| *MFC\_INTERLACE\_POC\_MANAGEMENT* |  | allow PocMemeoryManagement for interlace in MVC profile |
| *MFC\_JMCODE\_FIX* |  | Fix JM code issue for interlaced coding |
| *DISPLAY\_LAYERLEVEL\_BITUSAGE* |  | Enable bit usage for each layer |
| *MFC\_ENC\_EL\_CONFIG* |  | Separate RDPictureDecision from Base layer |
| *MFC\_PROFILING* |  | Code for encoder run time profiling |
| *MFC\_FPA\_SEI* |  | Enable FPA SEI message |

# Using The MFC Decoder Module

6. Using The MFC Decoder Module

This section provides a detailed description of the MFC related parameters in the H.264/MPEG-4 AVC JM decoder.

Note that an additional reconstruction process is required after decoding MFC encoded bitstreams to reconstruct the enhanced resolution output images. To perform only decoding of both the base and enhancement layer video sequences, without reconstruction, ExportViews in decoder\_mfc.cfg should be set to 0. To perform a full reconstruction of both left and right views, ExportViews in decoder\_mfc.cfg should be set to 1.

## Decoder Syntax

ldecod [-s] [-h] [-d] [decoder\_mfc.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

Examples of usage:

ldecod.exe

ldecod.exe -h

ldecod.exe –d decoder.cfg

ldecod.exe –s –i bitstream.264

ldecod.exe –i bitstream.264 –o output.yuv –r reference.yuv

ldecod.exe –i bitstream420.264 –uv

MFC example:

Decoding only: ldecod.exe –d decoder\_mfc.cfg **-p ExportViews=0**

MFC Complete View Reconstruction: ldecod.exe –d decoder\_mfc.cfg **-p ExportViews=1**

## Decoder Configuration File Format

### ExportViews

*Class*: Numeric (Integer)

*Description*: Specifies if the left and right views should be reconstructed by applying the recommended reconstruction method specified in the MFC specification. Default value is set to 0 (output base and enhancement layers as is). To be more specific, to perform only decoding of both the base and enhancement layer video sequences, without reconstruction, ExportViews in decoder\_mfc.cfg should be set to 0. To perform a full reconstruction of both left and right views, ExportViews in decoder\_mfc.cfg should be set to 1.

### DeMuxMode

*Class*: Numeric (Integer)

*Description*: Specifies whether the material are reconstructed at full resolution from only the FC base layer, using a predefined interpolation process, or using the complete MFC process. Default value is set to 1. It only takes effect when ExportViews is set to 1.

|  |  |
| --- | --- |
| ***Options:*** | |
| *0* | FC base layer |
| *1* | MFC |

### EnableDbgYUVFiles

*Class*: Numeric (Integer)

*Description*: Specifies if the generation of debug YUV files should be enabled. Default value is 0. The debug YUV files contain the base layer frame compatible reconstructed yuv, the rpu processed base layer frame compatible reconstructed yuv.The reconstructed yuv files were padded as to have horizontal and vertical resolutions as multiple of 16.

## Decoder Output

When running the decoder, the decoder will display on screen a variety of statistics for every frame that is decoded. The output information generated may look as follows:

Setting Default Parameters...

Parsing Configfile decoder\_mfc.cfg

..................

----------------------------- JM 18.2 (FRExt) -----------------------------

--------------------------------------------------------------------------

Input H.264 bitstream : test.264

Output decoded YUV : test\_dec.yuv

Input reference file : test\_rec.yuv

--------------------------------------------------------------------------

Image Format : 1920x1080 (1920x1088)

Color Format : 4:2:0 (8:8:8)

--------------------------------------------------------------------------

--------------------------------------------------------------------------

Frame POC Pic# QP Y:U:V Time(ms)

--------------------------------------------------------------------------

00000(IDR) 0 0 19 4:2:0 183

00000( B ) 0 0 20 4:2:0 103

00001( B ) 2 1 19 4:2:0 116

00001( B ) 2 1 20 4:2:0 85

Total decoding time : 0.488 sec (8.197 fps)[4 frm/488 ms]

--------------------------------------------------------------------------

Exit JM 18 (FRExt) decoder, ver 18.3

Output status file : log.dec

4 frames are decoded.

Note: The decoder does not support the computation of PSNR. The external tools can be used to compute the PSNR after the decoding or the reconstruction of the left and right view.

# MFC Hardcoded Decoder Parameters

7. MFC Hardcoded Decoder Parameters

For MFC, several additional preprocessor directives, i.e. macro definitions, have been added that can control the behavior of the software.

## defines.h

|  |  |  |
| --- | --- | --- |
| *MFC\_DEC\_3D\_FCFR* | : | Enable MFC decoder |
| *MFC\_DEC\_3D\_FCFR\_STAT* | : | Print inter-layer stats for MFC |
| *IMGTYPE* | : | Hardcoded to 0. |
| *MFC\_JM\_CODE\_CHANGE* | : | Code changes, mostly bug fixes of JM code |
| *MFC\_PROFILING* | : | Code for decoder run time profiling |

1. Note: this software manual only contains additional information relating to the Multi-resolution Frame Compatible Stereo Coding (MFC) extension of MPEG-4 AVC and its reference software. Please refer to the JM Reference Software Manual for any details relating to the generic use of the MPEG-4 AVC JM reference software (based on version 18.3). [↑](#footnote-ref-1)
2. Note: In JM18.3, the second view configuration is placed in another configuration file, specified by the parameter View1ConfigFile. In our example, the second view configuration file is encoder\_mfc\_view1.cfg. [↑](#footnote-ref-2)
3. Note: The JM Reference software manual can be found in the doc directory of the JM reference software. [↑](#footnote-ref-3)
4. Note: The FPA SEI message is required to be sent for the base layer in MFC. [↑](#footnote-ref-4)