



## SDK Developer Reference for JPEG/Motion JPEG

API Version 1.25

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## Overview

The SDK (Software Development Kit) is a software development library that exposes the media acceleration capabilities of Intel platforms for decoding, encoding and video processing. The API library covers a wide range of Intel platforms.

This document describes the extension to the SDK for JPEG\* processing.

## Document Conventions

The SDK uses the Verdana typeface for normal prose. With the exception of section headings and the table of contents, all *code-related* items appear in the Courier New typeface.

## Acronyms and Abbreviations

<b>SDK</b>	Intel® Media Server Studio – SDK
<b>API</b>	Application Programming Interface
<b>DECODE</b>	Video decoding
<b>EXIF*</b>	A image file format used by digital cameras
<b>JFIF*</b>	A image file format used by digital cameras
<b>JPEG*</b>	A picture compression algorithm
<b>Motion JPEG</b>	A motion picture compression algorithm utilizing JPEG
<b>NV12</b>	A YCbCr 4:2:0 color format for raw video frames
<b>RGB4</b>	A RGB color format for raw photo pictures, or RGB32

## Architecture & Programming Guide

The SDK extension for JPEG\*/motion JPEG requires the application to use an additional include file, `mfxjpeg.h`, in addition to the regular SDK include files. No additional library is required at link time.

```
Include these files:
#include "mfxvideo.h"           /* SDK functions in C */
#include "mfxvideo++.h"        /* Optional for C++ development */
#include "mfxjpeg.h"           /* JPEG development */
Link this library:
libmfx.lib                     /* The SDK dispatcher library */
```

The SDK extends the codec identifier `MFX_CODEC_JPEG` for JPEG and motion JPEG processing.

## Decoding Procedure

The application can use the same decoding procedures for JPEG/motion JPEG decoding, as illustrated in Figure 1. See the *SDK Developer Reference* for the description of the decoding procedures.

**Figure 1: Pseudo Code of the JPEG Decoding Procedure**

```
// optional; retrieve initialization parameters
MFXVideoDECODE DecodeHeader (...);
// decoder initialization
MFXVideoDECODE Init (...);
// single frame/picture decoding
MFXVideoDECODE DecodeFrameAsync (...);
MFXVideoCORE SyncOperation (...);
// optional; retrieve meta-data
MFXVideoDECODE_GetUserData (...);
// close down
MFXVideoDECODE_Close (...);
```

**DECODE** supports JPEG baseline profile decoding as follows:

- DCT-based process
- Source image: 8-bit samples within each component
- Sequential
- Huffman coding: 2 AC and 2 DC tables
- 3 loadable quantization matrixes
- Interleaved and non-interleaved scans
- Single and multiple scans
- chroma subsampling ratios:
- Chroma 4:0:0 (grey image)
- Chroma 4:1:1
- Chroma 4:2:0
- Chroma horizontal 4:2:2
- Chroma vertical 4:2:2
- Chroma 4:4:4
- 3 channels images

The `MFXVideoDECODE_Query` function will return `MFX_ERR_UNSUPPORTED` if the input bitstream contains unsupported features.

For still picture JPEG decoding, the input can be any JPEG bitstreams that conform to the ITU-T\* Recommendation T.81, with an EXIF\* or JFIF\* header. For motion JPEG decoding, the input can be any JPEG bitstreams that conform to the ITU-T Recommendation T.81.

Unlike other SDK decoders, JPEG one supports three different output color formats - NV12, YUY2 and RGB32. This support sometimes requires internal color conversion and more complicated initialization. The color format of input bitstream is described by `JPEGChromaFormat` and `JPEGColorFormat` fields in `mfxInfoMFX` structure. The `MFXVideoDECODE_DecodeHeader` function usually fills

them in. But if JPEG bitstream does not contain color format information, application should provide it. Output color format is described by general SDK parameters - `FourCC` and `ChromaFormat` fields in `mfxFrameInfo` structure.

Motion JPEG supports interlaced content by compressing each field (a half-height frame) individually. This behavior is incompatible with the rest SDK transcoding pipeline, where SDK requires that fields be in odd and even lines of the same frame surface.) The decoding procedure is modified as follows:

- The application calls the `MFXVideoDECODE_DecodeHeader` function, with the first field JPEG bitstream, to retrieve initialization parameters.
- The application initializes the SDK JPEG decoder with the following settings:
- Set the `PicStruct` field of the `mfxVideoParam` structure with proper interlaced type, `MFX_PICSTRUCT_TFF` or `MFX_PICSTRUCT_BFF`, from motion JPEG header.
- Double the `Height` field of the `mfxVideoParam` structure as the value returned by the `MFXVideoDECODE_DecodeHeader` function describes only the first field. The actual frame surface should contain both fields.
- During decoding, application sends both fields for decoding together in the same `mfxBitstream`. Application also should set `DataFlag` in `mfxBitstream` structure to `MFX_BITSTREAM_COMPLETE_FRAME`. The SDK decodes both fields and combines them into odd and even lines as in the SDK convention.

SDK supports JPEG picture rotation, in multiple of 90 degrees, as part of the decoding operation. By default, the `MFXVideoDECODE_DecodeHeader` function returns the `Rotation` parameter so that after rotation, the pixel at the first row and first column is at the top left. The application can overwrite the default rotation before calling `MFXVideoDECODE_Init`.

The application may specify Huffman and quantization tables during decoder initialization by attaching `mfxExtJPEGQuantTables` and `mfxExtJPEGHuffmanTables` buffers to `mfxVideoParam` structure. In this case, decoder ignores tables from bitstream and uses specified by application. The application can also retrieve these tables by attaching the same buffers to `mfxVideoParam` and calling `MFXVideoDECODE_GetVideoParam` or `MFXVideoDECODE_DecodeHeader` functions.

## Encoding Procedure

The application can use the same encoding procedures for JPEG/motion JPEG encoding, as illustrated in Figure 12. See the *SDK Developer Reference* for the description of the encoding procedures.

**Figure 2: Pseudo Code of the JPEG encoding Procedure**

```
// encoder initialization
MFXVideoENCODE Init (...);
// single frame/picture encoding
MFXVideoENCODE EncodeFrameAsync (...);
MFXVideoCORE SyncOperation (...);
// close down
MFXVideoENCODE_Close (...);
```

**ENCODE** supports JPEG baseline profile encoding as follows:

- DCT-based process
- Source image: 8-bit samples within each component
- Sequential
- Huffman coding: 2 AC and 2 DC tables
- 3 loadable quantization matrixes
- Interleaved and non-interleaved scans
- Single and multiple scans
- chroma subsampling ratios:
- Chroma 4:0:0 (grey image)
- Chroma 4:1:1
- Chroma 4:2:0
- Chroma horizontal 4:2:2
- Chroma vertical 4:2:2
- Chroma 4:4:4
- 3 channels images

The application may specify Huffman and quantization tables during encoder initialization by attaching `mfxExtJPEGQuantTables` and `mfxExtJPEGHuffmanTables` buffers to `mfxVideoParam` structure. If the application does not define tables then the SDK encoder uses tables recommended in ITU-T\* Recommendation T.81. If the application does not define quantization table it has to specify `Quality` parameter in `mfxInfoMFX` structure. In this case, the SDK encoder scales default quantization table according to specified `Quality` parameter.

The application should properly configure chroma sampling format and color format. `FourCC` and `ChromaFormat` fields in `mfxFrameInfo` structure are used for this. For example, to encode 4:2:2 vertically sampled YCbCr picture, the application should set `FourCC` to `MFX_FOURCC_YUY2` and `ChromaFormat` to `MFX_CHROMAFORMAT_YUV422V`. To encode 4:4:4 sampled RGB picture, the application should set `FourCC` to `MFX_FOURCC_RGB4` and `ChromaFormat` to `MFX_CHROMAFORMAT_YUV444`.

The SDK encoder supports different sets of chroma sampling and color formats on different platforms. The application has to call `MFXVideoENCODE_Query` function to check if required color format is supported on given platform and then initialize encoder with proper values of `FourCC` and `ChromaFormat` in `mfxFrameInfo` structure.

The application should not define number of scans and number of components. They are derived by the SDK encoder from `Interleaved` flag in `mfxInfoMFX` structure and from chroma type. If interleaved coding is specified then one scan is encoded that contains all image components. Otherwise, number of scans is equal to number of components. The SDK encoder uses next component IDs - "1" for luma (Y), "2" for chroma Cb (U) and "3" for chroma Cr (V).

The application should allocate big enough buffer to hold encoded picture. Roughly, its upper limit may be calculated using next equation:

```
BufferSizeInKB = 4 + (Width * Height * BytesPerPx + 1023) / 1024;
```

where `Width` and `Height` are weight and height of the picture in pixel, `BytesPerPx` is number of byte for one pixel. It equals to 1 for monochrome picture, 1.5 for NV12 and YV12 color formats, 2 for YUY2 color format, and 3 for RGB32 color format (alpha channel is not encoded).

## Structure Reference Extension

### mfxInfoMFX

#### Definition

```
typedef struct {
    mfxU32   reserved[7];

    mfxU16   reserved4;
    mfxU16   BRCParmMultiplier;

    mfxFrameInfo   FrameInfo;
    mfxU32   CodecId;
    mfxU16   CodecProfile;
    mfxU16   CodecLevel;
    mfxU16   NumThread;

    union {
        struct { /* MPEG-2/H.264 Encoding Options */
            ...
        };
        struct { /* H.264, MPEG-2 and VC-1 Decoding Options */
            ...
        };
        struct { /* JPEG Decoding Options */
            mfxU16   JPEGChromaFormat;
            mfxU16   Rotation;
            mfxU16   JPEGColorFormat;
            mfxU16   InterleavedDec;
            mfxU8   SamplingFactorH[4];
            mfxU8   SamplingFactorV[4];
            mfxU16   reserved3[5];
        };
        struct { /* JPEG Encoding Options */
            mfxU16   Interleaved;
            mfxU16   Quality;
            mfxU16   RestartInterval;
            mfxU16   reserved5[10];
        };
    };
} mfxInfoMFX;
```

#### Description

The `mfxInfoMFX` structure is extended to include JPEG\* decoding options. Other fields remain unchanged. See the *SDK Developer Reference* for additional structure descriptions.

#### Members

JPEGChromaFormat	Specify the chroma sampling format that has been used to encode JPEG picture. See the <b>ChromaFormat</b> enumerator in <i>SDK Developer Reference</i> for details.
Rotation	Rotation option of the output JPEG picture; see the <a href="#">Rotation</a> enumerator for details.
JPEGColorFormat	Specify the color format that has been used to encode JPEG picture. See the <a href="#">JPEG Color Format</a> enumerator for details.
InterleavedDec	Specify JPEG scan type for decoder. See the <a href="#">JPEG Scan Type</a> enumerator for details.
Interleaved	Non-interleaved or interleaved scans. If it is equal to <code>MFX_SCANTYPE_INTERLEAVED</code> then the image is encoded as interleaved, all components are encoded in one scan. See the <a href="#">JPEG Scan Type</a> enumerator for details.
Quality	Specifies the image quality if the application does not specified quantization table. This is the value from 1 to 100 inclusive. "100" is the best quality.
RestartInterval	Specifies the number of MCU in the restart interval. "0" means no restart interval.
SamplingFactorH, SamplingFactorV	Sampling factor.

#### Remarks

The application must specify the JPEG initialization parameters before rotation.

#### Change History

The JPEG decoding options are available since SDK API 1.3. Encoding options since SDK API 1.5.

The SDK API 1.6 added `JPEGColorFormat` field.

The SDK API 1.7 added `InterleavedDec` field.

The SDK API 1.19 added `SamplingFactorH` and `SamplingFactorV` fields.

## mfExtJPEGQuantTables

### Definition

```
typedef struct {
    mfxExtBuffer    Header;

    mfxU16    reserved[7];
    mfxU16    NumTable;

    mfxU16    Qm[4][64];
} mfxExtJPEGQuantTables;
```

### Description

The structure specifies quantization tables. The application may specify up to 4 quantization tables. The SDK encoder assigns ID to each table. That ID is equal to table index in **Qm** array. Table “0” is used for encoding of Y component, table “1” for U component and table “2” for V component. The application may specify fewer tables than number of components in the image. If two tables are specified, then table “1” is used for both U and V components. If only one table is specified then it is used for all components in the image. Table below illustrate this behavior.

table ID>	0	1	2
number of tablesv			
1	Y, U, V		
2	Y	U, V	
3	Y	U	V

### Members

Header.BufferId	Must be MFX_EXTBUFF_JPEG_QT
NumTable	Number of quantization tables defined in <b>Qm</b> array.
Qm	Quantization table values.

### Change History

This structure is available since SDK API 1.5.

## mfExtJPEGHuffmanTables

### Definition

```
typedef struct {
    mfxExtBuffer    Header;

    mfxU16    reserved[2];
    mfxU16    NumDCTable;
    mfxU16    NumACTable;

    struct {
        mfxU8    Bits[16];
        mfxU8    Values[12];
    } DCTables[4];

    struct {
        mfxU8    Bits[16];
        mfxU8    Values[162];
    } ACTables[4];
} mfxExtJPEGHuffmanTables;
```

### Description

The structure specifies Huffman tables. The application may specify up to 2 quantization table pairs for baseline process. The SDK encoder assigns ID to each table. That ID is equal to table index in **DCTables** and **ACTables** arrays. Table “0” is used for encoding of Y component, table “1” for U and V component. The application may specify only one table in this case it will be used for all components in the image. Table below illustrate this behavior.

table ID>	0	1
number of tablesv		
1	Y, U, V	
2	Y	U, V

### Members

Header.BufferId	Must be MFX_EXTBUFF_JPEG_HUFFMAN.
NumDCTable	Number of DC quantization table in <b>DCTable</b> array.
NumACTable	Number of AC quantization table in <b>ACTable</b> array.
Bits	Number of codes for each code length.
Values	List of the 8-bit symbol values.

### Change History

This structure is available since SDK API 1.5.

## Enumerator Reference Extension

## CodecFormatFourCC

### Description

Additional `CodecFormatFourCC` enumerator itemizes the JPEG\* codec. See the *SDK Developer Reference* for additional enumerator definitions.

### Name/Description

<code>MF_X_CODEC_JPEG</code>	JPEG codec
------------------------------	------------

## CodecProfile

### Description

Additional `CodecProfile` enumerator itemizes the supported JPEG profile. See the *SDK Developer Reference* for additional enumerator definitions.

### Name/Description

<code>MF_X_PROFILE_JPEG_BASELINE</code>	JPEG baseline profile
---	-----------------------

## ChromaFormatIdc

### Description

Additional `ChromaFormatIdc` enumerator itemizes the JPEG\* color-sampling formats. See the *SDK Developer Reference* for additional enumerator definitions.

### Name/Description

<code>MF_X_CHROMAFORMAT_JPEG_SAMPLING</code>	Color sampling specified via <code>mfxInfoMFX::SamplingFactorH</code> and <code>SamplingFactorV</code>
--	--

Available since SDK API 1.19.

## Rotation

### Description

The `Rotation` enumerator itemizes the JPEG rotation options.

### Name/Description

<code>MF_X_ROTATION_0</code>	No rotation
<code>MF_X_ROTATION_90</code>	90 degree rotation
<code>MF_X_ROTATION_180</code>	180 degree rotation
<code>MF_X_ROTATION_270</code>	270 degree rotation

## ExtendedBufferID

### Description

Additional `ExtendedBufferID` were added for JPEG support. See the *SDK Developer Reference* for additional enumerator definitions.

### Name/Description

<code>MF_X_EXTBUFF_JPEG_QT</code>	This extended buffer defines quantization tables for JPEG encoder.
<code>MF_X_EXTBUFF_JPEG_HUFFMAN</code>	This extended buffer defines Huffman tables for JPEG encoder.

## JPEG Color Format

### Description

This enumerator itemizes the JPEG color format options.

### Name/Description

<code>MF_X_JPEG_COLORFORMAT_UNKNOWN</code>	Unknown color format. The SDK decoder tries to determine color format from available in bitstream information. If such information is not present, then <code>MF_X_JPEG_COLORFORMAT_YCbCr</code> color format is assumed.
<code>MF_X_JPEG_COLORFORMAT_YCbCr</code>	Bitstream contains Y, Cb and Cr components.
<code>MF_X_JPEG_COLORFORMAT_RGB</code>	Bitstream contains R, G and B components.

This enumerator is available since SDK API 1.6.

## JPEG Scan Type

### Description

This enumerator itemizes the JPEG scan types.

### Name/Description

<code>MF_X_SCANTYPE_UNKNOWN</code>	Unknown scan type.
<code>MF_X_SCANTYPE_INTERLEAVED</code>	Interleaved scan.

`MFY_SCANTYPE_NONINTERLEAVED` Non-interleaved scan.

This enumerator is available since SDK API 1.7.