

Advanced Micro Devices

# Advanced Media Framework – AV1 Video Encoder

Programming Guide

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Contents

<b>1..... INTRODUCTION</b>	<b>4</b>
1.1 SCOPE.....	4
1.2 PRE-DEFINED ENCODER USAGES .....	5
<b>2..... AMF VIDEO ENCODER VCN-AV1 COMPONENT</b>	<b>6</b>
2.1 INPUT SUBMISSION AND OUTPUT RETRIEVAL.....	6
2.2 ENCODE PARAMETERS .....	6
2.2.1 Static Properties	6
2.2.2 Dynamic Properties	6
2.2.3 Frame Per-Submission Properties	6
2.2.4 ROI Feature	6
2.2.5 Encoder Statistics Feedback	6
2.2.1 Picture Transfer Mode	7
2.2.2 SVC Properties	7
2.2.3 LTR Properties	7
<b>3..... SAMPLE APPLICATIONS</b>	<b>9</b>
3.1 LIST OF PARAMETERS .....	9
3.2 COMMAND LINE EXAMPLE.....	10
3.2.1 Transcoding application (TranscodeHW.exe)	10
3.2.2 D3D application (VCEEncoderD3D.exe)	10
<b>ANNEX A: ENCODING &amp; FRAME PARAMETERS DESCRIPTION</b>	<b>11</b>
TABLE A-1. ENCODER PARAMETERS .....	11
TABLE A-2. INPUT FRAME AND ENCODED DATA PARAMETERS .....	16
TABLE A-3. DEFAULT VALUE OF PARAMETERS.....	18
TABLE A-4. ENCODER STATISTICS FEEDBACK.....	19
TABLE A-5. ENCODER PSNR/SSIM FEEDBACK.....	20
TABLE A-6. ENCODER CAPABILITIES EXPOSED IN AMFCAPS INTERFACE.....	20

# 1 Introduction

## 1.1 Scope

This document provides a complete description of the AMD Advanced Media Framework (AMF) Video Encoder Component. This component exposes the AMD Video Compression Engine, which provides hardware accelerated AV1 video encoding functionality.

Figure 1 provides a system overview of the AMF Video Encoder Component.

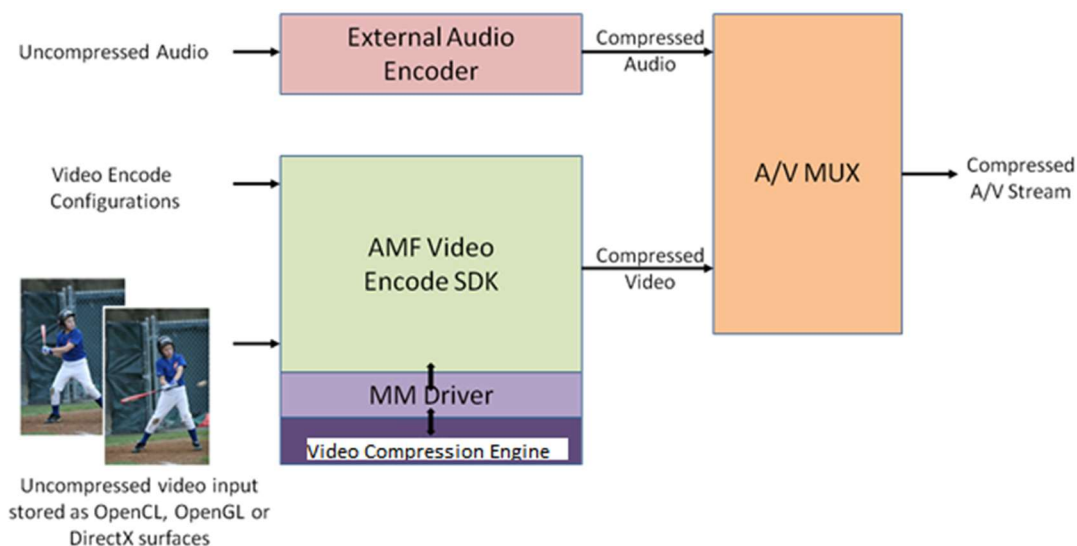


Figure 1 — System overview of the AMF Video Encode SDK

The AMF Video Encoder Component compresses RAW uncompressed video to an AV1 elementary bitstream.

The component does not provide a mechanism to handle audio compression, or stream multiplexing.

The component provides six different sets of pre-defined usages, which provide a convenient way for developers to configure the encoder to match the intended application use case. Advanced developers can also adjust encoding parameters to tailor the behavior to their specific application requirements.

## 1.2 Pre-defined Encoder Usages

The following table provides a brief overview of the encoding usage modes that have been defined:

Usage Mode	Intended use-cases	Comments
<b>Transcoding</b>	Transcoding, video editing	Favor compression efficiency and throughput over latency.
<b>Ultra-low latency</b>	Video game streaming	Optimize for extremely low latency use cases (e.g. cap the number of bits per frame), to enable high-interactivity applications.
<b>Low Latency</b>	Video collaboration, remote desktop	Optimize for low latency scenarios, but allow occasional bitrate overshoots to preserve quality.
<b>Webcam</b>	Video conferencing	Optimize for a low-latency video conferencing scenario.
<b>HQ</b>	High quality mode	Optimize for best subjective video quality with possible loss of performance
<b>HQLL</b>	High quality low latency mode	Optimize for good quality with low latency

Note: User can override the default settings for these pre-defined usages in Table A-3. Default value of parameters.

## 2 AMF Video Encoder VCN-AV1 Component

The AMF Video Encoder AV1 component provides hardware accelerated AV1 encoding using AMD's IP.

To instantiate the AMF Video Encoder component, call the *AMFFactory::CreateComponent* method passing *AMFVideoEncoderHW\_AV1* component IDs defined in the */include/components/VideoEncoderAV1.h* header.

### 2.1 Input Submission and Output Retrieval

The AMF Video Encoder component accepts *AMFSurface* objects as input and produces *AMFBuffer* objects for output.

### 2.2 Encode Parameters

Annex A provides the detailed description of encoding parameters (i.e., encoder properties) exposed by the Video Encoder AV1 component.

All properties are accessed using the *AMFPropertyStorage* interface of the Encoder object.

#### 2.2.1 Static Properties

Static properties (e.g., profile, tier, level, usage) must be defined before the *Init()* function is called, and will apply until the end of the encoding session.

#### 2.2.2 Dynamic Properties

All dynamic properties have default values. Several properties can be changed subsequently and these changes will be flushed to encoder only before the next *Submit()* call.

#### 2.2.3 Frame Per-Submission Properties

Per submission properties are applied on a per frame basis. They can be set optionally to force a certain behavior (e.g., force frame type to IDR) by updating the properties of the *AMFSurface* object that is passed through the *AMFComponent::Submit()* call.

#### 2.2.4 ROI Feature

Region of importance (ROI) feature provides a way to specify the relative importance of the macroblocks in the video frame. Encoder will further adjust the bits allocation among code blocks based on the importance, on top of the base rate control decisions. More important blocks will be encoded with relatively better quality.

The ROI map can be attached to the input frame on a per frame basis. Currently, the ROI map can only use system memory. The ROI map includes the importance values of each 64x64 CTB, ranging from 0 to 10, stored in 32bit unsigned format. Refer to SimpleROI sample application for further implementation details.

#### 2.2.5 Encoder Statistics Feedback

If an application sets the *AMF\_VIDEO\_ENCODER\_AV1\_STATISTICS\_FEEDBACK* flag on for an input picture, the encoder will feedback to the application statistics for this specific picture. After the encoding ends, the application can retrieve by name the specific statistic(s) it is interested in. The supported encoder statistics are listed in Table A-4.

### 2.2.1 Picture Transfer Mode

If an application enables `AMF_VIDEO_ENCODER_AV1_PICTURE_TRANSFER_MODE` for a specific input picture, it can dump out the reconstructed picture after encoding. When `PSNR_FEEDBACK` or `SSIM_FEEDBACK` is enabled, this mode will be enabled automatically.

### 2.2.2 SVC Properties

Scalable Video Coding (SVC) is enabled by setting `AMF_VIDEO_ENCODER_AV1_NUM_TEMPORAL_LAYERS` to a value that is greater than 1. `AMF_VIDEO_ENCODER_AV1_NUM_TEMPORAL_LAYERS` is a dynamic property and can be changed at any time during an encoding session. To ensure proper support, `AMF_VIDEO_ENCODER_AV1_MAX_NUM_TEMPORAL_LAYERS` needs to be set before initializing the encoder to a value that is not smaller than the number of temporal layers. As an example, the maximum number of temporal layers shall be set to 4 if the number of temporal layers will be changed from 3 to 4 in an encoding session. The maximum number of temporal layers supported by the encoder can be queried from the encoder capabilities before initializing the encoder.

To define SVC parameters per layer, the following format must be used:

```
TL<Temporal_Layer_Number>.QL<Quality_Layer_Number>.<Parameter_name>
```

As an example, with two temporal layers, to configure “Target bitrate” for the base/first temporal layer and first quality layer, the following parameter should be used:

```
“TL0.QL0.AMF_VIDEO_ENCODER_AV1_TARGET_BITRATE”
```

To configure “Target bitrate” for the second temporal layer and first quality layer, the following parameter should be used:

```
“TL1.QL0.AMF_VIDEO_ENCODER_AV1_TARGET_BITRATE”
```

When setting per layer parameters, the equivalent non-SVC layer parameters should not be set for the encoder otherwise the per layer configuration will be overwritten.

Remark: quality layers are not supported. “QL0” must be used for quality layers.

The framerate for each layer should follow a fixed relationship as the table below:

Layer=2, framerate0:framerate1=1:1, here framerate0 means the framerate of layer0 and framerate1 means the framerate of layer1.

Layer=3, framerate0:framerate1:framerate2=1:1:2

Layer=4, framerate0:framerate1:framerate2:framerate3=1:1:2:4

### 2.2.3 LTR Properties

LTR (Long Term Reference) is to manually select a reference frame which can be far away to encode current frame. Normally, the encoder selects last frame as reference or a frame at lower layer in the SVC case.

In AV1, maximum of 8 reference frames are supported according to the spec. These 8 reference frames are shared by SVC and LTR.

To use LTR, you need to set these properties as Static Properties:

`AMF_VIDEO_ENCODER_AV1_MAX_LTR_FRAMES`, Max number of LTR frames. The maximum value can be queried from `AMF_VIDEO_ENCODER_AV1_CAP_MAX_NUM_LTR_FRAMES`.



```
AMF_VIDEO_ENCODER_AV1_LTR_MODE default = AMF_VIDEO_ENCODER_AV1_LTR_MODE_RESET_UNUSED;
remove/keep          unused          LTRs          (not          specified          in          property
AMF_VIDEO_ENCODER_AV1_FORCE_LTR_REFERENCE_BITFIELD)
```

The LTR\_MODE has two options:

```
enum AMF_VIDEO_ENCODER_AV1_LTR_MODE_ENUM
{
    AMF_VIDEO_ENCODER_AV1_LTR_MODE_RESET_UNUSED = 0,
    AMF_VIDEO_ENCODER_AV1_LTR_MODE_KEEP_UNUSED
};
```

Reset\_unused: encoder will discard all other LTR frames stored once a LTR frame is used as reference.

Keep\_unused: encoder will not change other LTR frames stored once any LTR frame is used as reference. When we enable auto LTR mode in PA, this mode will be automatically selected internally and AMF\_VIDEO\_ENCODER\_AV1\_MAX\_LTR\_FRAMES will be set to 4 no matter what users set. For details of “auto LTR mode”, please refer to AMF\_Video\_PreAnalysis\_API document.

There are two Frame Per-Submission Properties need be set to use LTR:

AMF\_VIDEO\_ENCODER\_AV1\_MARK\_CURRENT\_WITH\_LTR\_INDEX, Mark current frame with LTR index. -1 means don't save current frame into LTR slots. 0~N means save current frame into a LTR slot with index of 0~N. Here N should be <= AMF\_VIDEO\_ENCODER\_AV1\_MAX\_LTR\_FRAMES-1.

When we use SVC encoding, only next base frame can be stored as LTR frame (i.e. only temporal layer number = 0 frames are allowed to be saved into LTR slot.)

AMF\_VIDEO\_ENCODER\_AV1\_FORCE\_LTR\_REFERENCE\_BITFIELD, force LTR bit-field. This is a bit-field mask that indicate which LTR slot can be used as reference for current frame. 0b1 means only slot 0 can be used as reference. 0b10 means only slot 1 can be used as reference. 0b100 means only slot 2 can be used as reference.....

0b0 means no LTR frame will be used as reference for current frame hence current frame will select short term reference frame (usually last frame) as reference.

When there are multiple bits are enabled, for example: 0b1111 (=decimal 15), that means LTR slots 0,1,2 and 3 are all allowed to be selected as reference. In this case, the closest LTR frame to current frame will be selected.

When we encode a key frame or switch frame, all save LTR slots will be cleared.

Referring to a LTR frame not existing in LTR slot will generate an Intra only frame.

### 3 Sample Applications

The AMF Encoder Sample application show how to setup and use the AMF Video Encoder AV1 Component to encode video frames that are loaded from disk or rendered by the DirectX 3D engine.

#### 3.1 List of Parameters

Sample applications support almost all visible encoder parameters (except PictureStructure, EndOfSequence, EndOfStream) and few additional parameters.

Additional parameters of TranscodeHW application:

Category	Name	Values	Description
Miscellaneous parameters	Frames	Number of frames to be encoded	Number of frames to render
	Codec	AV1 or av1	Specify codec type
	Input	File name, relative or absolute path	Input file with frames (AVC or HEVC or YUV raw data)
	Output	File name, relative or absolute path	Output AV1 file for encoded data
	Engine	DX9, DX11	Specify Engine type
	AdapterID	Number	Index of GPU adapter

Additional parameters of VCEEncoderD3D application:

Category	Name	Values	Description
Miscellaneous parameters	Frames	Number of frames to be encoded	Number of frames to be encoded
	Codec	AV1 or av1	Specify codec type
	Output	File name, relative or absolute path	Output AV1 file for encoded data
	Render	DX9, DX9EX, DX11, OpenGL, OpenCL, etc.	Specify render type
	AdapterID	Number	Index of GPU adapter
	Windowmode	Flag ( without any values )	Shows rendering window for D3D sample application
	FullScreen	Flag ( without any values )	Enables full screen
	QueryInstanceCount	Flag ( without any values )	If the flag is set, the number of independent VCE instances will be queried and printed
	UseInstance	0 to (number of instances -1)	If there are more than one VCN instances, allow to force which instance to use.

## **3.2 Command line example**

### **3.2.1 Transcoding application (TranscodeHW.exe)**

```
TranscodeHW.exe -input input.h264 -output out.mp4 -codec AV1 -width 1280 -height 720 -AV1Usage transcoding -AV1RateControlMethod cbr -AV1TargetBitrate 100000
```

This command transcodes H264 elementary stream to AV1 video in .mp4 container. Encoder is created with “Transcoding” usage.

### **3.2.2 D3D application (VCEEncoderD3D.exe)**

```
VCEEncoderD3D.exe -output VideoSample_1024x768.mp4 -codec AV1 -width 1024 -height 768 -AV1Usage transcoding -AV1RateControlMethod cbr -AV1TargetBitrate 500000 -frames 400
```

This command encodes 400 frames through D3D renderer and creates an output file with the encoded data. Encoder is created with “Transcoding” usage. Initial configuration sets bitrate to a value of 500kbts/sec.

## Annex A: Encoding & frame parameters description

**Table A-1. Encoder parameters**

Category	Name (Prefix "AMF_VIDEO_ENCODER_AV1_")	Values	Description
Encoder static parameters	USAGE	0, 1, 2, 3, 4, 5 (Transcoding, UltraLowLatency, LowLatency, Webcam, HQ(high quality), HQLL(high quality low latency))	Selects the AMF usage (see 1.2)
	INSTANCE_INDEX	0,1	Selects the encoder engine used for encoding
	PROFILE	Main	Selects the AV1 profile
	LEVEL	1, 2, 2.1, 3, 3.1, 4, 4.1, 5, 5.1, 5.2, 6, 6.1, 6.2	Selects the AV1 Profile Level
	MAX_LTR_FRAMES	0 ... 8	The number of long-term references controlled by the user. Remarks: <ul style="list-style-type: none"> <li>When == 0, the encoder can not use LTRs during encoding.</li> <li>When &gt; 0, the user has control over all LTR.</li> <li>With user control of LTR, Intra-refresh features are not supported.</li> <li>The actual maximum number of LTRs allowed depends on SVC setting and AV1 Level limits, encoding resolution, and DPB size. The DPB size limit impacts the maximum number of LTR allowed.</li> </ul>
	TILES_PER_FRAME	>=1	Sets the number of tiles per frame
	LTR_MODE	0, 1 (Reset unused, keep unused) Default = 0	Remove/keep unused LTRs not specified inside the LTR reference bitfield.
	MAX_NUM_REFRAMES	0 ... 8	Maximum number of reference frames
	ENCODING_LATENCY_MODE	AMF_VIDEO_ENCODER_AV1_ENCODING_LATENCY_MODE_NONE = 0,  AMF_VIDEO_ENCODER_AV1_ENCODING_LATENCY_MODE_POWER_SAVING_REAL_TIME = 1,  AMF_VIDEO_ENCODER_AV1_ENCODING_LATENCY_MODE_REAL_TIME = 2,  AMF_VIDEO_ENCODER_AV1_ENCODING_LATENCY_MODE_LOWEST_LATENCY = 3	Choose different mode to balance encoder latency with power consumption

Category	Name (Prefix "AMF_VIDEO_ENCODER_AV1_")	Values	Description
	ALIGNMENT_MODE	<p>AMF_VIDEO_ENCODER_AV1_ALIGNMENT_MODE_64X16_ONLY = 1,</p> <p>AMF_VIDEO_ENCODER_AV1_ALIGNMENT_MODE_64X16_1080P_CODED_1082 = 2,</p> <p>AMF_VIDEO_ENCODER_AV1_ALIGNMENT_MODE_NO_RESTRICTIONS = 3</p>	default = AMF_VIDEO_ENCODER_AV1_ALIGNMENT_MODE_64X16_ONLY; AV1 alignment Mode.
	PRE_ANALYSIS	bool; default = false	Enables the pre-analysis module. Some features require this to be enabled. Refer to AMF Video PreAnalysis API reference for more details.
	MAX_NUM_TEMPORAL_LAYERS	Maximum number of temporal layers supported (<=4)	Sets the maximum number of temporal layers. It shall not be exceeded by the number of temporal layers. The maximum number of temporal layers supported is determined by the corresponding encoder capability.
	ENABLE_SMART_ACCESS_VIDEO	bool; default = false	true = enables smart access video feature, which allocate the encoding task smartly on different GPU
Encoder resolution parameters	FRAMESIZE	Width: 192 – 4096 Height: 128 – 2176	Frame width/Height in pixels, maximum value is hardware-specific, should be queried through <i>AMFCaps</i>
Encoder rate-control parameters	TARGET_BITRATE	>0	Sets the target bitrate, bit/s based on use case
	PEAK_BITRATE	>= TargetBitrate	Sets the peak bitrate, use for HRD model
	RATE_CONTROL_METHOD	0, 1, 2, 3, 4, 5, 6 (CQP, VBR_LAT, VBR, CBR, QVBR, HQVBR, HQCBR)	<p>Selects the rate control method:</p> <ul style="list-style-type: none"> <li>• CQP – Constrained QP,</li> <li>• VBR_LAT - Latency Constrained VBR</li> <li>• VBR - Peak Constrained VBR,</li> <li>• CBR - Constant Bitrate</li> <li>• QVBR – Quality VBR</li> <li>• HQVBR – High Quality VBR</li> <li>• HQCBR – High Quality CBR</li> </ul> <p>Remarks:</p> <ul style="list-style-type: none"> <li>• When SVC encoding is enabled, some rate-control parameters can be configured differently for a particular SVC-layer. An SVC-layer is denoted by an index pair [SVC-Temporal Layer index][SVC-Quality Layer index]. E.g. The bitrate may be configured differently for SVC-layers [0][0] and [1][0].</li> <li>• We restrict all SVC layers to have the same Rate Control method.</li> <li>• QVBR, HQVBR and HQCBR are only supported if PreAnalysis is enabled.</li> <li>• QVBR, HQVBR and HQCBR target improving subjective quality with the possible loss of objective quality (PSNR SSIM or VMAF).</li> </ul>

Category	Name (Prefix "AMF_VIDEO_ENCODER_AV1_")	Values	Description
	QVBR_QUALITY_LEVEL	1 – 51	Sets the quality level for QVBR rate control method.  Remarks: • Only available for QVBR rate control method.
	RATE_CONTROL_SKIP_FRAME	True/False	Enables skip frame for rate control
	MIN_Q_INDEX_INTRA	0 – 255	Sets the minimum Q for Intra frame
	MAX_Q_INDEX_INTRA	0 – 255	Sets the maximum Q for Intra frame
	MIN_Q_INDEX_INTER	0 – 255	Sets the minimum Q for inter frame
	MAX_Q_INDEX_INTER	0 – 255	Sets the maximum Q for inter frame
	Q_INDEX_INTRA	0 – 255	Sets the constant Q for Intra frames. Remarks: Only available for CQP rate control method.
	Q_INDEX_INTER	0 – 255	Sets the constant Q for Inter frames. Remarks: Only available for CQP rate control method.
	FRAMERATE	Input is : AMFRate for example, the code below will set the frame rate to 30000/1001=29.97 FPS: pEncoder->SetProperty(AMF_VIDEO_ENCODER_AV1_FRAMERATE, ::AMFConstructRate(30000, 1001));	Frame rate numerator/denominator
	VBV_BUFFER_SIZE	>0	Sets the VBV buffer size in bits based on use case, use for HRD model
	INITIAL_VBV_BUFFER_FULLNESS	0 – 64, 0=0%, 64=100%	Sets the initial VBV buffer fullness, use for HRD model
	ENFORCE_HRD	True/False	Disables/enables constraints on QP variation within a picture to meet HRD requirement(s)
	RATE_CONTROL_PREENCODE	True/False	Pre-analysis assisted rate control
	AQ_MODE	True/False	By default, disable Adaptive Quality Mode
	FILLER_DATA	True/False	Enable filler data for CBR usage
Encoder picture-control parameters	HIGH_MOTION_QUALITY_BOOST	Bool; default = false	Enable high motion quality boost mode to pre-analyze the motion of the video and use this information to improve encoding.
	MAX_COMPRESSED_FRAME_SIZE	0 – no limit	Maximum compressed frame size in bits that rate control algorithm will try to limit. May still larger than this number in some cases.
	HEADER_INSERTION_MODE	NONE, GOP aligned, Key frame aligned	Sets the headers insertion mode
	SWITCH_FRAME_INSERTION_MODE	MODE_NONE =0, FIXED_INTERVAL =1	switch frame insertion mode
	SWITCH_FRAME_INTERVAL	>0	the interval between two inserted switch frames. Valid only when AMF_VIDEO_ENCODER_AV1_SWITCH_FRAME_INSERTION_MODE is AMF_VIDEO_ENCODER_AV1_SWITCH_FRAME_INSERTION_MODE_FIXED_INTERVAL.
	GOP_SIZE	>0	The period to insert key frame in fixed size mode. 0 means only insert the first frame (infinite GOP size)
	CDEF_MODE	True/False	Disable/enable the CDEF filter

Category	Name (Prefix "AMF_VIDEO_ENCODER_AV1_")	Values	Description
	INTRA_REFRESH_MODE	AMF_VIDEO_ENCODER_AV1_INTRA_REFRESH_MODE_DISABLED = 0,  AMF_VIDEO_ENCODER_AV1_INTRA_REFRESH_MODE_GOP_ALIGNED = 1,  AMF_VIDEO_ENCODER_AV1_INTRA_REFRESH_MODE_CONTINUOUS = 2	Default:AMF_VIDEO_ENCODER_AV1_INTRA_REFRESH_MODE_DISABLED
	INTRAREFRESH_STRIPE	>=1, how many stripes in a frame for intra refresh	Valid only when intra refresh is enabled.
Encoder miscellaneous parameters	QUALITY_PRESET	AMF_VIDEO_ENCODER_AV1_QUALITY_PRESET_HIGH_QUALITY, AMF_VIDEO_ENCODER_AV1_QUALITY_PRESET_QUALITY, AMF_VIDEO_ENCODER_AV1_QUALITY_PRESET_BALANCED, AMF_VIDEO_ENCODER_AV1_QUALITY_PRESET_SPEED	Selects the quality preset to balance between encoding speed and video quality
	QUERY_TIMEOUT	default = 0 (no wait);	Timeout for QueryOutput call in ms.
	PICTURE_TRANSFER_MODE	PICTURE_TRANSFER_MODE_ON, PICTURE_TRANSFER_MODE_OFF	The application can turn on this flag for a specific input picture to allow dumping the reconstructed picture.
	EXTRA_DATA	AMFInterface* -> AMFBuffer*;	buffer to retrieve coded sequence header
Encoder configuration	SCREEN_CONTENT_TOOLS	True/False	If true, allow enabling screen content tools by AMF_VIDEO_ENCODER_AV1_PALETTE_MODE_ENABLE and AMF_VIDEO_ENCODER_AV1_FORCE_INTEGER_MV; if false, all screen content tools are disabled.
	PALETTE_MODE	True/False	If true, enable palette mode; if false, disable palette mode. Valid only when AMF_VIDEO_ENCODER_AV1_SCREEN_CONTENT_TOOLS is true.
	FORCE_INTEGER_MV	True/False	If true, enable force integer MV; if false, disable force integer MV. Valid only when AMF_VIDEO_ENCODER_AV1_SCREEN_CONTENT_TOOLS is true.
	ORDER_HINT	True/False	code order hint; if false, don't code order hint
	FRAME_ID	True/False	If true, code frame id; if false, don't code frame id
	TILE_GROUP_OBU	True/False	If true, code FrameHeaderObu + TileGroupObu and each TileGroupObu contains one tile; if false, code FrameObu.
	ERROR_RESILIENT_MODE	True/False	If true, enable error resilient mode; if false, disable error resilient mode
	COLOR_BIT_DEPTH	8, 10	Sets the number of bits in each pixel's color component in the encoder's compressed output bitstream. Default is 8.
	CDF_UPDATE	True/False	if false, disable CDF update.

Category	Name (Prefix "AMF_VIDEO_ENCODER_AV1_")	Values	Description
	CDF_FRAME_END_UPDATE_MODE	AMF_VIDEO_ENCODER_AV1_CDF_FRAME_END_UPDATE_MODE_DISABLE = 0,  AMF_VIDEO_ENCODER_AV1_CDF_FRAME_END_UPDATE_MODE_ENABLE_DEFAULT = 1	CDF frame end update mode
Encoder color conversion parameters	INPUT_COLOR_PROFILE	UNKNOWN, 601, 709, 2020, JPEG, FULL_601, FULL_709, FULL_2020	Color profile of the input surface. SDR - Setting this parameter (COLOR_PROFILE) can fully describe a surface for SDR use case. HDR – For HDR use case the TRANSFER_CHARACTERISTIC, COLOR_PRIMARIES, and NOMINAL_RANGE parameters describe the surface. See ColorSpace.h for enumeration.
	INPUT_TRANSFER_CHARACTERISTIC	UNDEFINED, BT709, UNSPECIFIED, RESERVED, GAMMA22, GAMMA28, SMPTE170M, SMPTE240M, LINEAR, LOG, LOG_SQRT, IEC61966_2_4, BT1361_ECG, IEC61966_2_1, BT2020_10, BT2020_12, SMPTE2084, SMPTE428, ARIB_STD_B67	Characteristic transfer function of the input surface used to perform the mapping between linear light components (tristimulus values) and a nonlinear RGB signal. Used (alongside COLOR_PRIMARIES and NOMINAL_RANGE parameters) to describe surface in HDR use case. See ColorSpace.h for enumeration.
	INPUT_COLOR_PRIMARIES	UNDEFINED, BT709, UNSPECIFIED, RESERVED, BT470M, BT470BG, SMPTE170M, SMPTE240M, FILM, BT2020, SMPTE428, SMPTE431, SMPTE432, JEDEC_P22	Color space primaries for the input surface which are the maximum red, green, and blue value permitted within the color space. Used (alongside TRANSFER_CHARACTERISTIC and NOMINAL_RANGE parameters) to describe surface in HDR use case. See ColorSpace.h for enumeration.
	OUTPUT_COLOR_PROFILE	UNKNOWN, 601, 709, 2020, JPEG, FULL_601, FULL_709, FULL_2020	Color profile of the compressed output stream. SDR - Setting this parameter (COLOR_PROFILE) can fully describe a surface for SDR use case. HDR – For HDR use case the TRANSFER_CHARACTERISTIC, COLOR_PRIMARIES, and NOMINAL_RANGE parameters describe the surface. See ColorSpace.h for enumeration. Determines the optional VUI parameter "matrix_coefficients".
	OUTPUT_TRANSFER_CHARACTERISTIC	UNDEFINED, BT709, UNSPECIFIED, RESERVED, GAMMA22, GAMMA28, SMPTE170M, SMPTE240M, LINEAR, LOG, LOG_SQRT, IEC61966_2_4, BT1361_ECG, IEC61966_2_1, BT2020_10, BT2020_12, SMPTE2084, SMPTE428, ARIB_STD_B67	Characteristic transfer function of the compressed output stream used to perform the mapping between linear light components (tristimulus values) and a nonlinear RGB signal. Used (alongside COLOR_PRIMARIES and NOMINAL_RANGE parameters) to describe surface in HDR use case. See ColorSpace.h for enumeration.



Category	Name (Prefix "AMF_VIDEO_ENCODER_AV1_")	Values	Description
	OUTPUT_COLOR_PRIMARIES	UNDEFINED, BT709, UNSPECIFIED, RESERVED, BT470M, BT470BG, SMPTE170M, SMPTE240M, FILM, BT2020, SMPTE428, SMPTE431, SMPTE432, JEDEC_P22	Color space primaries for the compressed output surface which are the maximum red, green, and blue value permitted within the color space. Used (alongside TRANSFER_CHARACTERISTIC and NOMINAL_RANGE parameters) to describe surface in HDR use case. See ColorSpace.h for enumeration.
	INPUT_HDR_METADATA	AMFInterface* -> AMFBuffer*;	buffer to retrieve coded sequence header
Encoder SVC parameters	NUM_TEMPORAL_LAYERS	Maximum number of temporal layers supported	Sets the number of temporal layers. SVC with temporal scalability is enabled when the number of layers is greater than 1. The maximum number of temporal layers supported is determined by the corresponding encoder capability.  Remarks: <ul style="list-style-type: none"> <li>Actual modification of the number of temporal layers will be delayed until the start of the next temporal GOP.</li> </ul> Intra-refresh feature is not supported with SVC.
Encoder SVC per-layer parameters	TL<TL_Num>. QL0. <Parameter_name>	Parameter-specific values	Configures rate-control parameter per SVC layer. <ul style="list-style-type: none"> <li>TL_Num — temporal layer number</li> <li>QL0 quality layer 0</li> <li>Parameter_name — rate-control parameter name (see below with AMF_VIDEO_ENCODER_AV1_ prefix)</li> <li>TARGET_BITRATE</li> <li>PEAK_BITRATE</li> <li>VBV_BUFFER_SIZE</li> <li>FRAMERATE</li> <li>Max_Q_INDEX_INTRA</li> <li>Max_Q_INDEX_INTER</li> <li>Min_Q_INDEX_INTRA</li> <li>Min_Q_INDEX_INTER</li> <li>Q_INDEX_INTRA</li> <li>Q_INDEX_INTER</li> <li>FILLER_DATA</li> <li>RATE_CONTROL_SKIP_FRAME</li> <li>ENFORCE_HRD</li> <li>MAX_COMPRESSED_FRAME_SIZE</li> </ul>

**Table A-2. Input frame and encoded data parameters**

Category	Name (prefix "AMF_VIDEO_ENCODER_AV1_")	Values	Description
Frame per-submission	FORCE_INSERT_SEQUENCE_HEADER	True/False	If true, force insert sequence header with current frame.

Category	Name (prefix "AMF_VIDEO_ENCODER_AV1_")	Values	Description
parameters	FORCE_FRAME_TYPE	AMF_VIDEO_ENCODER_A V1_FORCE_FRAME_TYPE_ NONE = 0,  AMF_VIDEO_ENCODER_A V1_FORCE_FRAME_TYPE_ KEY = 1,  AMF_VIDEO_ENCODER_A V1_FORCE_FRAME_TYPE_I NTRA_ONLY = 2,  AMF_VIDEO_ENCODER_A V1_FORCE_FRAME_TYPE_ SWITCH = 3,  AMF_VIDEO_ENCODER_A V1_FORCE_FRAME_TYPE_ SHOW_EXISTING = 4	Forces the frame type.
	MARK_CURRENT_WITH_LTR_INDEX	-1 ... (MaxOfLTRFrames - 1)	If != -1, the current picture is coded as a long-term reference with the given index. Remarks: <ul style="list-style-type: none"> <li>When the user controls N LTRs (using the corresponding Create parameter), then the LTR Index the user can assign to a reference picture varies from 0 to N-1. By default, the encoder will "use up" available LTR Indices (i.e. assign them to references) even if the user does not request them to be used.</li> <li>When LTR is used with SVC encoding, only base temporal layer pictures can be coded as LTR. In this case, the request to mark the current picture as LTR would be delayed to the next base temporal layer picture if the current picture is in an enhancement layer. If the user submits multiple requests to mark current as LTR between base temporal layer pictures, then only the last request is applied.</li> </ul>
	FORCE_LTR_REFERENCE_BITFIELD	Bitfield (MaxOfLTRFrames (max possible 8 bits))	Force LTR Reference allowed bitfield. If == 0, the current picture should predict from the default reference. If != 0, the current picture should predict from one of the LTRs allowed by the bitfield (bit# = LTR Index#). Remarks: <ul style="list-style-type: none"> <li>E.g. if Bit#0 = 1, then the existing LTR with LTR Index = 0 may be used for reference. The bitfield may allow more than one LTR for reference, in which case the encoder is free to choose which one to use. This bitfield also disallows existing LTRs not enabled by it from current/future reference.</li> <li>E.g. if Bit#1 = 0, and there is an existing reference with LTR Index = 1, then this LTR Index will not be used for reference until it is replaced with a newer reference with the same LTR Index.</li> </ul>
	ROI_DATA	Video surface in AMF_SURFACE_GRAY32 format	Important value for each 64x64 block ranges from 0 to 10, stored in 32bit unsigned format.
	STATISTICS_FEEDBACK	True/False (On/Off)	Instruct encoder to collect and feedback statistics.
	PSNR_FEEDBACK	True/False (On/Off)	Signal encoder to calculate PSNR score.

Category	Name (prefix "AMF_VIDEO_ENCODER_AV1_")	Values	Description
	SSIM_FEEDBACK	True/False (On/Off)	Signal encoder to calculate SSIM score.
	BLOCK_QP_FEEDBACK	True/False (On/Off)	Instruct encoder to collect and feedback block level QP values. Return data in BLOCK_QP_MAP.
	BLOCK_QP_MAP	AMFSurface	AMFSurface of format AMF_SURFACE_GRAY32 containing block level QP values. Get value from this property for the Block_QP_FEEDBACK data.
	RECONSTRUCTED_PICTURE	AMFSurface	returns reconstructed picture as an AMFSurface attached to the output buffer. Valid when PSNR_FEEDBACK or SSIM_FEEDBACK is on or PICTURE_TRANSFER_MODE = AMF_VIDEO_ENCODER_AV1_PICTURE_TRANSFER_MODE_ON.
Encoded data parameters	OUTPUT_FRAME_TYPE	AMF_VIDEO_ENCODER_AV1_OUTPUT_FRAME_TYPE_KEY = 0,  AMF_VIDEO_ENCODER_AV1_OUTPUT_FRAME_TYPE_INTRA_ONLY = 1,  AMF_VIDEO_ENCODER_AV1_OUTPUT_FRAME_TYPE_INTER = 2,  AMF_VIDEO_ENCODER_AV1_OUTPUT_FRAME_TYPE_SWITCH = 3,  AMF_VIDEO_ENCODER_AV1_OUTPUT_FRAME_TYPE_SHOW_EXISTING = 4	Type of encoded frame.
	OUTPUT_MARKED_LTR_INDEX	-1 ... (MaxOfLTRFrames -1)	Marked as LTR Index. If != -1, then this picture was coded as a long-term reference with this LTR Index.
	OUTPUT_REFERENCED_LTR_INDEX_BITFIELD	Bitfield (MaxOfLTRFrames (max possible 8 bits))	Referenced LTR Index bitfield. If != 0, this picture was coded to reference long-term references. The enabled bits identify the LTR Indices of the referenced pictures (e.g. if Bit #0 = 1, then LTR Index 0 was used as a reference when coding this picture).
	OUTPUT_TEMPORAL_LAYER	0 ... (Maximum number of temporal layers supported - 1)	Temporal layer of the encoded picture

**Table A-3. Default value of parameters**

Type	Name (prefix "AMF_VIDEO_ENCODER_AV1_")	Transcoding	Ultra low latency	Low latency	Webcam	HQ	HQLL
Static Parameters (Set at creation time)	PROFILE	Main	Main	Main	Main	Main	Main
	LEVEL	6.2	6.2	6.2	6.2	6.2	6.2
	MAX_LTR_FRAMES	0	0	0	0	0	0
	MAX_NUM_TEMPORAL_LAYERS	1	1	1	1	1	1
Rate control	RATE_CONTROL_METHOD	PEAK_CONSTRAINED_VBR	LATENCY_CONSTRAINED_VBR	PEAK_CONSTRAINED_VBR	PEAK_CONSTRAINED_VBR	PEAK_CONSTRAINED_VBR	PEAK_CONSTRAINED_VBR

Type	Name (prefix "AMF_VIDEO_ENCODER_AV1_")	Transcoding	Ultra low latency	Low latency	Webcam	HQ	HQLL
	FRAMERATE	30 fps	30 fps	30 fps	30 fps	30 fps	30 fps
	VBV_BUFFER_SIZE	20 mbits	735 kbits	4 mbits	2 mbits	40 mbits	10 mbits
	INITIAL_VBV_BUFFER_FULLNESS	64	64	64	64	64	64
	RATE_CONTROL_PREENCODE	false	false	false	false	false	false
	AQ_MODE	false	false	false	false	false	false
	TARGET_BITRATE	20 mbps	20 mbps	20 mbps	20 mbps	20 mbps	20 mbps
	PEAK_BITRATE	30 mbps	20 mbps	20 mbps	20 mbps	80 mbps	30 mbps
	MIN_Q_INDEX_INTRA	0	0	0	0	0	0
	MAX_Q_INDEX_INTRA	51	51	51	51	51	51
	MIN_Q_INDEX_INTER	0	0	0	0	0	0
	MAX_Q_INDEX_INTER	51	51	51	51	51	51
	Q_INDEX_INTRA	26	26	26	26	26	26
	Q_INDEX_INTER	26	26	26	26	26	26
	ENFORCE_HRD	false	true	false	false	false	false
	MAX_COMPRESSED_FRAME_SIZE	0	0	0	0	0	0
	FILLER_DATA	false	false	false	false	false	false
	RATE_CONTROL_SKIP_FRAME	false	true	true	true	false	false
Picture Control	HEADER_INSERTION_MODE	0	0	0	0	0	0
	GOP_SIZE	30	300	300	30	30	30
	CDEF_MODE	True	True	True	True	True	true
	TILES_PER_FRAME	1	1	1	1	1	1
	QUALITY_PRESET	Balanced	Speed	Speed	Speed	Quality	Quality
Intra refresh	INTRA_REFRESH_MODE	False	False	False	False	False	false
	INTRAREFRESH_STRIPES	0	0	0	0	0	0
Encode configuration SVC New parameters	SCREEN_CONTENT_TOOLS	False	False	False	False	False	False
	ORDER_HINT	False	False	False	False	False	False
	CDF_UPDATE	False	False	False	False	False	False
	CDF_FRAME_END_UPDATE_MODE	0	0	0	0	0	0
	NUM_TEMPORAL_LAYERS	1	1	1	1	1	1
	LOWLATENCY_MODE	off	on	off	off	off	on
	HIGH_MOTION_QUALITY_BOOST_ENABLE	off	off	off	off	on	on
	PRE_ANALYSIS	off	off	off	off	off	off
	MAX_NUM_REFRAMES	1	1	1	1	1	1
	QUERY_TIMEOUT	0	0	0	0	50	50

**Table A-4. Encoder statistics feedback**

Statistic Name (prefix "AMF_VIDEO_ENCODER_AV1_")	Description
STATISTIC_FRAME_QP	QP of the first encoded CTB in a picture
STATISTIC_AVERAGE_QP	Average QP of all encoded CTBs in a picture
STATISTIC_MAX_QP	Max QP among all encoded CTBs in a picture
STATISTIC_MIN_QP	Min QP among all encoded CTBs in a picture
STATISTIC_PIX_NUM_INTRA	Number of intra-coded pixels
STATISTIC_PIX_NUM_INTER	Number of inter-coded pixels
STATISTIC_PIX_NUM_SKIP	Number of skip-coded pixels
STATISTIC_BITCOUNT_RESIDUAL	Frame level bit count of residual data
STATISTIC_BITCOUNT_MOTION	Frame level bit count of motion vectors
STATISTIC_BITCOUNT_INTER	Frame level bit count of inter CTBs
STATISTIC_BITCOUNT_INTRA	Frame level bit count of intra CTBs
STATISTIC_BITCOUNT_ALL_MINUS_HEADER	Frame level bit count of the bitstream excluding header
STATISTIC_MV_X	Accumulated absolute values of MVX for full encoding
STATISTIC_MV_Y	Accumulated absolute values of MVY for full encoding
STATISTIC_RD_COST_FINAL	Frame level final RD cost

Statistic Name (prefix "AMF_VIDEO_ENCODER_AV1_")	Description
STATISTIC_RD_COST_INTRA	Frame level RD cost for intra mode
STATISTIC_RD_COST_INTER	Frame level RD cost for inter mode
STATISTIC_STD_FINAL	Frame level final SATD
STATISTIC_STD_INTRA	Frame level SATD for intra mode
STATISTIC_STD_INTER	Frame level SATD for inter mode

**Table A-5. Encoder PSNR/SSIM feedback**

Statistic Name(prefix "AMF_VIDEO_ENCODER_AV1_")	Description
STATISTIC_PSNR_Y	PSNR Y
STATISTIC_PSNR_U	PSNR U
STATISTIC_PSNR_V	PSNR V
STATISTIC_PSNR_ALL	PSNR YUV
STATISTIC_SSIM_Y	SSIM Y
STATISTIC_SSIM_U	SSIM U
STATISTIC_SSIM_V	SSIM V
STATISTIC_SSIM_ALL	SSIM YUV

**Table A-6. Encoder capabilities exposed in AMFCaps interface**

Name (prefix with AMF_VIDEO_ENCODER_AV1_CAP_)	Values	Description
NUM_OF_HW_INSTANCES	amf_int64	number of HW encoder instances
MAX_THROUGHPUT	amf_int64	MAX throughput for AV1 encoder in MB (16 x 16 pixel)
REQUESTED_THROUGHPUT	amf_int64	Currently total requested throughput for AV1 encode in MB (16 x 16 pixel)
COLOR_CONVERSION	amf_int64(AMF_ACCELERATION_TYPE)	type of supported color conversion. default AMF_ACCEL_GPU
PRE_ANALYSIS	amf_bool	pre analysis module is available
MAX_BITRATE	amf_int64	Maximum bit rate in bits
MAX_PROFILE	amf_int64(AMF_VIDEO_ENCODER_AV1_PROFILE_ENUM)	max value of code profile
MAX_LEVEL	amf_int64(AMF_VIDEO_ENCODER_AV1_LEVEL_ENUM)	max value of codec level
MAX_NUM_TEMPORAL_LAYERS	amf_int64	The cap of maximum number of temporal layers
MAX_NUM_LTR_FRAMES	amf_int64	The cap of maximum number of LTR frames. This value is calculated based on current value of AMF_VIDEO_ENCODER_AV1_MAX_NUM_TEMPORAL_LAYERS.