



Bit Rate Control

Application Notes

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About This Document

Purpose

This document describes the parameter meanings and usage of the v1 and v2 bit rate algorithms. Some common issues of bit rate control are introduced, for example, the method for adjusting parameters in low bit rate scenarios.



NOTE

The document applies only to H.264 encoding.

Related Versions

The following table lists the product versions related to this document.

Product Name	Version
Hi3518A	V100
Hi3518C	V100
Hi3518E	V100
Hi3516C	V100
Hi3531	V100
Hi3532	V100
Hi3521	V100
Hi3520A	V100
Hi3520D	V100/V200
Hi3515A	V100
Hi3515C	V100
Hi3535	V100



Intended Audience

This document is intended for:

- Field application engineers
- Hardware engineers

Change History

Updates between document issues are cumulative. Therefore, the latest document issue contains all updates made in previous issues.

Issue 01 (2015-02-10)

This issue is the first official release.



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1 Description and Usage of Bit Rate Control Parameters

1.1 Parameter Description and Usage of CBRV1 and CBRV2

Table 1-1 Attributes of CBRV1 and CBRV2

Parameter	Description	Application Scenario	CBRV1	CBRV2
u32Gop	I frame interval Value range: [1, 65536]	This parameter is usually set to an integral multiple of the output frame rate.	-	-
u32StatTime	Statistics time Unit: second Value range: [1, 16]	In common scenarios, this parameter can be set to the GOP or output frame rate. This parameter affects long-term steadiness of the bit rate. It can be set to a large value when short-term fluctuation is acceptable, for example, during storage based on digital video recorders (DVRs).	-	As the value of this parameter increases, the re-encoding threshold increases, the re-encoding times decrease, and the bit rate fluctuation increases.
u32ViFrmRate	Input frame rate Value range: [1, 60]	Frame rate control	-	-
fr32TargetFrmRate	Output frame rate Value range: [1/16, 60]	Frame rate control	-	-
u32BitRate	Target bit rate	-	-	-



Parameter	Description	Application Scenario	CBRV1	CBRV2
u32FluctuateLevel	Fluctuation level, set to 0 by default	-	-	Invalid

Table 1-2 Advanced parameters of CBRV1 and CBRV2 (frame-level)

Parameter	Description	Application Scenario	CBRV1	CBRV2	Remarks
u32MinIprop	Minimum IP ratio The default value is 1 .	The default value can be used in all scenarios.	The I frame QP may be decreased by u32MaxIPDeltaQp at most.	The interface is ineffective at present.	-
u32MaxIprop	Maximum IP ratio The default value is 20 .	This parameter is used to control the I frame ratio and prevent the oversized I frame in still scenarios from causing the respiratory effect.	The I frame QP may be increased by u32MaxIPDeltaQp at most.	If the I frame size exceeds the P frame by u32MaxIprop times, the I frame QP will increase to restrict the I frame size.	-
u32MaxQp	Maximum QP The preferable value:40–51	This parameter is used to control the lowest image quality. The QP is not increased any longer after being adjusted to this value, which may cause bit rate rise.	The maximum value of this parameter is 45 .	This parameter is set to 51 when the bit rate must be controlled. This parameter is set based on the specific application scenarios when the image quality must be improved.	-
u32MaxStartQp	Equal to u32MaxQp	-	-	-	-
u32MinQp	Minimum QP The preferable value:10–20	This parameter is used to control the highest image quality. The QP is not decreased any longer after being adjusted to this value, which may cause bit rate insufficiency. This parameter is intended to reduce the bit rate in	-	-	-



Parameter	Description	Application Scenario	CBRV1	CBRV2	Remarks
		simple still scenarios.			
u32MinIQp	Minimum QP of the I frame The preferable value in still scenarios with complex texture ranges from 20 to 25. In common scenarios, this parameter is equal to u32MinQp .	This parameter is used to control the minimum QP of the I frame and the main purpose is to restrict the I frame ratio.	-	-	-
u32MaxPPDeltaQp	Maximum QP change of the PP frame The preferable value is 3.	This parameter is used to control the QP change amplitude of two adjacent P frames.	Suggestion: Retain the default value of this parameter.	None	-
u32MaxIPDeltaQp	Maximum QP change of the IP frame The preferable value ranges from 5 to 8.	This parameter is used to control the QP change amplitude of the adjacent I frame and P frame.	-	None	-
bLostFrmOpen	Frame loss policy for bit rate overshooting	N/A	-	-	-
u32LostFrmBpsThr		This parameter is used to set the bit rate threshold. When the threshold is crossed, frame loss may occur.	-	-	-
enSuperFrmMode	Jumbo frame policy	Three modes are available: recoding, discarding, and normally outputting.	-	-	-
u32SuperIFrmBitsThr		This parameter is used to set the bit number threshold for I frame encoding.	-	-	-
u32SuperPFrmBitsThr		This parameter is used to set the bit number threshold for P frame encoding.	-	-	-
s32IPQPDelt	QP difference of	N/A	-	-	-



Parameter	Description	Application Scenario	CBRV1	CBRV2	Remarks
a	the IP frame, to address the respiratory effect				
u32RQRatio[8]	-	-	Suggestion: Do not modify this parameter. It is used for internal debugging.	None	-
s32QualityLevel	Quality level The preferable value ranges from 1 to 5. The default value is 3 . It is used to regulate the QP adjustment amplitude during scenario switchover, for example, switchover between motion and still scenarios. The increasing bit rate becomes normal after QP adjustment.	This parameter is set to 5 when the bit rate must be controlled. This parameter is set to 1 when the image quality must be improved.	None	The default value is equalization adjustment. The difference between the maximum value and the minimum value is 1–2 in QP.	-
s32MaxReEncodeTimes	Maximum re-encoding times The preferable value ranges from 0 to 3. The default value is 2 . Suggestion: Enable re-encoding to ensure the steadiness of the bit rate.	-	None	The default value meets the requirements of common application scenarios.	-



1.2 Parameter Description and Usage of VBRV1 and VBRV2

Table 1-3 Attributes of VBRV1 and VBRV2

Parameter	Description	Application Scenario	VBRV1	VBRV2
u32Gop	I frame interval Value range: [1, 65536]	This parameter is usually set to an integral multiple of the output frame rate.	-	-
u32StatTime	Statistics time Unit: second Value range: [1, 16]	This parameter is consistent with the CBR.	-	As the value of this parameter increases, the re-encoding threshold increases, the re-encoding times decrease, and the bit rate fluctuation increases.
u32ViFrmRate	Input frame rate	Frame rate control	-	-
fr32TargetFrmRate	Output frame rate	Frame rate control	-	-
u32MaxBitRate	Maximum bit rate	-	-	-
u32MaxQp u32MinQp	QP set according to the bit rate and scenario: Preferable value: MinQP: 16–24 MaxQP: 40–51	The maximum QP restricts the image quality, while the minimum QP may affect the lowest bit rate of the VBR.	-	MaxQP is set to 51 . MinQP is used to adjust the image quality level.

Table 1-4 Advanced parameters of VBRV1 and VBRV2 (frame-level)

Parameter	Description	Application Scenario	VBRV1	VBRV2
s32DeltaQP	-	This parameter is used to address the respiratory effect.	-	The value of this parameter is consistent with that of s32IPQPDelta for the CBR.
s32ChangePos	Bit rate for starting the adjustment 80–90 If an excessive bit rate is unacceptable, set this parameter to 80 .	-	-	-



Parameter	Description	Application Scenario	VBRV1	VBRV2
	If an excessive bit rate is acceptable, set this parameter to 90 .			
u32MinIprop	-	See the parameter description of the CBR	-	-
u32MaxIprop	-	See the parameter description of the CBR	-	-
bLostFrmOpen	-	See the parameter description of the CBR	-	-
u32LostFrmBpsThr		See the parameter description of the CBR	-	-
enSuperFrmMode		See the parameter description of the CBR	-	-
u32SuperIFrmBitsThr		See the parameter description of the CBR	-	-
u32SuperPFrmBitsThr		See the parameter description of the CBR	-	-
u32MinIQP	-	-	-	-



1.3 Description and Usage of Macro Block-level Bit Rate Control Parameters

Table 1-5 Advanced parameters of CBRV1 and CBRV2 (macro block level)

Parameter	Description	Application Scenario	Remarks
u32ThrdI[12]	Texture-based macro block-level bit rate control for the I frame Default: [5, 5, 5, 10, 10, 10, 255, 255, 255, 255, 255, 255]	Texture-based bit rate control decreases the QP in the flat regions and increases the QP in the detail regions, allowing for a better subjective image quality.	If all values are set to 255, the texture-based macro block-level bit rate control is disabled.
u32ThrdP[12]	Texture-based macro block-level bit rate control for the P frame Default: [5, 5, 5, 255, 255, 255, 255, 255, 255, 255, 255, 255]	-	If all values are set to 255, the texture-based macro block-level bit rate control is disabled.
u32QpDelta	Row-based macro block-level bit rate control Default value: 2	Row-based bit rate control increases the bit rate stability.	If this parameter is set to 0, the row-based macro block-level bit rate control is disabled.

1.4 Description and Usage of Frame Discarding Parameters in Bit Rate Overshooting Scenarios

Table 1-6 Frame discarding parameters in bit rate overshooting scenarios

Parameter	Description	Application Scenario	Remarks
bLostFrmOpen	Frame discarding switch for the bit rate overshooting scenario	If the bit rate exceeds the threshold, frame discarding is enabled to ensure a stable bit rate.	The frame discarding switch and threshold are the same as those in advanced RC parameters. The latest settings prevail.
u32LostFrmBpsThr	Bit rate overshooting threshold	N/A	N/A



Parameter	Description	Application Scenario	Remarks
	It is recommended that this threshold is set to the maximum bit rate or 1.2 times of the target bit rate.		
enLostFrmMode	Frame discarding mode Normally discarding frames or encoding frames into PSkip frames.	If bit rate overshooting occurs, frames are discarded or encoded into PSkip frames.	-
u32LostFrmGaps	Number of consecutively discarded frames	This parameter is used to ensure smoothness when frames are consecutively discarded.	If this parameter is set to 0 , frames are consecutively discarded regardless of the frame count.



2 Bit Rate Control

2.1 Improving Bit Rate Stability

Table 2-1 lists the methods to improve bit rate stability.

Table 2-1 Methods to improve bit rate stability

Method	Parameter Configuration	Impact
Increase the adjustment amplitude of row-based bit rate control.	Change the default value 2 of VENC_RC_PARAM_S::u32QpDelta to 3.	If the value of u32QpDelta is overlarge, the bit rate is stable in still or slow-motion scenarios. However, in fast-motion scenarios, the response to QP adjustment becomes slow and fast-motion bit rate fluctuation grows. Therefore, do not set a value larger than 3.
Set a frame discarding threshold for the bit rate and the number of consecutively discarded frames.	VENC_PARAM_LOSTFRM_S::bLostFrmOpen = HI_TRUE; VENC_PARAM_LOSTFRM_S::u32LostFrmBpsThr = frame discarding threshold VENC_PARAM_LOSTFRM_S::enLostFrmMode = LOSTFRM_NORMAL or LOSTFRM_PSKIP; VENC_PARAM_LOSTFRM_S::u32EncFrmGaps = gap for consecutively discarding frames	If the bit rate is out of control, discard frames to decrease the bit rate, which may hinder smooth video display. It is recommended that the frame discarding threshold is 1.1 to 1.2 times of the target bit rate and the gap for consecutively discarding frames is 2 or 3.

2.2 Improving Image Quality

Table 2-2 lists the methods to improve image quality.



Table 2-2 Methods to improve image quality

Method	Parameter Configuration	Impact
Set the image quality level.	VENC_PARAM_H264_CBRV2_S::s32QualityLevel =1	When bit rate overshooting occurs, the RC algorithm keeps the bit rate at a relatively low level for a certain period to compensate bit rate overshooting and ensure long-term bit rate stability. If s32QualityLevel is set to a smaller value, the compensation amplitude is reduced, that is, the image quality loss is lowered. However, the compensation time is increased.
Set the maximum QP together with the maximum start QP.	VENC_PARAM_H264_CBRV2_S::u32MaxQp VENC_PARAM_H264_CBRV2_S:: u32MaxStartQp	Setting the maximum QP helps effectively protect the image quality, but bit rate overshooting is prone to occur.

2.3 Adjusting the Respiratory Effect

Table 2-3 lists the method to adjust the respiratory effect.

Table 2-3 Method to adjust the respiratory effect

Method	Parameter Configuration	Impact
Set the difference between I and P frames. If the difference is positive, the I frame QP is smaller than the P frame QP.	VENC_PARAM_H264_CBRV2_S::s32QualityLevel =1	The default value of s32IPQPDelta is associated with texture-based bit rate control. If texture-based bit rate control is enabled, the default value of s32IPQPDelta is 6 . If texture-based bit rate control is disabled, the default value of s32IPQPDelta is 2 . To adjust the respiratory effect, the default value of s32IPQPDelta needs to be increased or decreased accordingly.

2.4 Limiting the I Frame Amplitude

Table 2-4 lists the methods to limit the I frame amplitude.

Table 2-4 Methods to limit the I frame amplitude

Method	Parameter Configuration	Impact
Set the maximum IP frame ratio. If the IP frame ratio exceeds the maximum value, an	VENC_PARAM_H264_CBRV2_S::u32MaxIprop	In still scenarios, the image quality can be improved by allocating more bits to the I frame. However, if the IP frame ratio is overlarge, the



Method	Parameter Configuration	Impact
internal algorithm will limit the I frame size.		image quality may be decreased.
Set the minimum QP of the I frame.	VENC_PARAM_H264_CBRV2_S::u32MinIQp	This method has a strong constraint on the I frame and may cause bit rate insufficiency. Meanwhile, the applicable I frame QP varies depending on scenarios, and the experience value of MinIQp is difficult to obtain.
Set recoding for oversized frames. Usually, set the I frame threshold to the permitted maximum value, and the P frame threshold to a half of the I frame threshold.	VENC_PARAM_H264_CBRV2_S::enSuperFrmMode = SUPERFRM_REENCODE; VENC_PARAM_H264_CBRV2_S::u32SuperIFrmBitsThr VENC_PARAM_H264_CBRV2_S::u32SuperPFrmBitsThr	Too much recoding wastes the chip performance and bandwidth.

2.5 Low-Bit Rate Scenario

1. Lower the AE sensitivity of the ISP module to increase the AE response delay and thus avoid frequent AE adjustment in the case of light/dark shifting.
Recommended parameter configuration:
u16BlackDelayFrame: 5->10
u16WhiteDelayFrame: 0->5. The AE is increased.
ExpTolerance; 2->4. The AE sensitivity is slightly lowered.
2. Increase the VPSS denoising strength and TF/SF strength, and lower the sharpen strength and image detail.
Recommended parameter configuration: Properly increase the TF/SF strength and ensure that SF is about 4 times of TF.
3. Set a relatively large GOP and ensure that u32StatTime matches the GOP.
Recommended parameter configuration:
Set the GOP to 4–10 times of the frame rate. For example, if the frame rate is 30 fps, set the GOP to 120–300. Set u32StatTime to 4–10s.
4. Properly lower the frame rate or use the PSkip encoding mode to decrease the frame rate.
Recommended parameter configuration:
Set the target frame rate to 15 fps.
VENC_PARAM_LOSTFRM_S::enLostFrmMode = LOSTFRM_PSKIP;
VENC_PARAM_LOSTFRM_S::u32EncFrmGaps = 2;
5. Enable texture-based macro block-level bit rate control and set the recommended parameters.



2.6 Notes

Note the following issues:

- **u32Gop:** You are advised to set u32Gop to an integral multiple of the encoding frame rate. If not, I frame distribution may be uneven in terms of time, causing transient bit rate fluctuation. For a medium and high bit rate, the GOP can be equal to the encoding frame rate. For a low bit rate, the GOP needs to be increased.
- **u32StatTime:** You are advised to set u32StatTime to an integral multiple of the GOP or encoding frame rate. For example, if the frame rate is 25 fps and the GOP is 50, u32StatTime should be set to 2s or 4s. Inconsistency between u32StatTime and GOP may cause transient bit rate instability and image quality instability. In common scenarios, u32StatTime can be set to a double of the GOP. If long-term bit rate stability is concerned, and short-term fluctuation is not, u32StatTime can be set to a larger value, for DVR storage, for example.
- **u32ViFrmRate:** set to the VI frame rate. The internal frame rate control of the encoder may verify the timestamp to determine whether frame loss occurs. The timestamp is added during VI image capturing. Therefore, u32ViFrmRate must be consistent with the actual VI frame rate. If not, the actual frame rate is inconsistent with the target frame rate.
- **u32MaxIprop:** used to limit the I frame that is larger than the P frame by u32MaxIprop times, helping effectively limit the I frame size in still scenarios.
- **u32MaxQp/u32MaxStartQp:** used to limit the maximum QP. The recommended value is 51 if the bit rate rather than quality is concerned. The recommended value range is [40, 51] if quality rather than bit rate overshooting is concerned. You are advised to set the same value for u32MaxQp and u32MaxStartQp.
u32MinQp/u32MinIQp: used to limit the minimum QP. If bit rate reduction is required in still or slow-motion scenarios, the recommended value range is [16, 20]
- For oversized frame discarding, the current encoded frame is discarded. For frame discarding in the case of bit rate overshooting, the next frame is discarded. The two methods do not conflict and can work together.
- ROI and OSD protection may affect the bit rate control. If large areas of ROI and OSD protection with low QP values are configured in low bit rate scenarios, the entire quality of the picture may deteriorate, and bit rate overshooting may be caused.