Bit Rate Control

Application Notes

Issue 03

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About This Document

Purpose

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

NOTE

- Unless otherwise stated, Hi3559C V100 and Hi3559A V100 contents are consistent.
- Unless otherwise stated, Hi3556A V100 and Hi3519A V100 contents are consistent.
- Unless otherwise stated, Hi3516D V300, Hi3516A V300, Hi3559 V200, Hi3556 V200, and Hi3516C V500 contents are consistent.
- Unless otherwise specified, Hi3516E V300, Hi3518E V300, Hi3516D V200, and Hi3516E V200 contents are consistent.

Related Versions

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

Product Name	Version
Hi3559A	V100ES
Hi3559A	V100
Hi3559C	V100
Hi3519A	V100
Hi3556A	V100
Hi3516C	V500
Hi3516D	V300
Hi3516A	V300
Hi3559	V200
Hi3556	V200
Hi3516E	V200
Hi3516E	V300

Product Name	Version
Hi3518E	V300
Hi3516D	V200

Intended Audience

This document is intended for:

- Technical support engineers
- Software development engineers

Change History

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

Issue 03 (2019-07-25)

This issue is the third official release, which incorporates the following changes:

Section 3.10 is modified.

Issue 02 (2019-01-30)

This issue is the second official release, which incorporates the following changes:

In section 1.3, Table 1-6 is modified.

In section 1.4, Table 1-8 is modified.

Issue 01 (2018-12-10)

This issue is the first official release, which incorporates the following changes:

Sections 1.5 and 3.8 are added.

Sections 1.4, 3.7 and 3.10 are modified.

Issue 00B04 (2018-11-15)

This issue is the fourth draft release, which incorporates the following changes:

The contents related to Hi3516E V300, Hi3516E V200, and Hi3518E V300 are added.

In section 1.3, Table 1-6 is modified.

Sections 1.4, 2.3, and 2.4 are updated.

Section 3.3 is updated.

Contents related to QVBR are added.

Issue 00B03 (2018-06-15)

This issue is the third draft release, which incorporates the following changes:

In section 1.1, Table 1-1 is modified.

In section 1.2, Table 1-3 is modified.

In section 1.3, Table 1-5 is modified.

Section 2.3 is modified.

Issue 00B02 (2018-01-15)

This issue is the second draft release, which incorporates the following changes:

Section 1.2 is added.

Sections 1.3 and 3.7 are modified.

Issue 00B01 (2017-04-28)

This issue is the first draft release.

Contents

Tables

1 Bit Rate Control Parameters

1.1 CBR Parameters

Table 1-1 and Table 1-2 describe the parameters of the constant bit rate (CBR).

Table 1-1 CBR attributes

Parameter	Description	Application Scenario	Remarks
u32Gop	I-frame interval	The parameter value is generally an integral multiple of the output frame rate.	-
u32StatTime	Statistical time Unit: second	In common scenarios, **u32StatTime** can be set to (GOP/Output frame rate). **u32StatTime** can be set to a larger value if the long-term bit rate stability is cared about but the short-term fluctuation is not cared about, such as the DVR scenario where data is stored in hard disks. If this parameter is set to a large value, the threshold for determining whether to re-encode frames is increased, the number of re-encoding times is decreased, but the bit rate fluctuation is increased.	-
u32SrcFrameRate	Input frame rate	Controls the frame rate.	-
fr32DstFrameRate	Output frame rate	Controls the frame rate.	-
u32BitRate	Target bit rate	-	-

Table 1-2 Advanced CBR parameters (frame level)

Parameter	Description	Application Scenario	Remarks
u32MinIprop	Minimum ratio of bits allocated to the I-frames and P-frames Default value: **1**	The API is invalid currently.	-

Parameter	Description	Application Scenario	Remarks
u32MaxIprop	Maximum ratio of bits allocated to the I-frames and P-frames Default value: **20**	This parameter is used to control the percentage of I-frames and limit the size of the I-frame in the static scenario. If the I-frame is too large, the respiratory effect may be caused. If the ratio of bits allocated to the I-frames and P-frames is greater than **u32MaxIprop**, the QP value of the I-frame is increased to limit the bit count of I-frames.	-
u32MaxQp	Maximum QP Recommended value range: [40, 51]	This parameter is used to limit the lowest image quality. The QP value will not be increased when it reaches **u32MaxQp**, which may cause bit rate overshoot. The parameter value is set to **51** in scenarios where the bit rate is cared about and set as required in scenarios where the quality is cared about.	-
u32MinQp	Minimum QP Recommended value range: [10, 20]	This parameter is used to limit the highest image quality. The QP value will not be decreased when it reaches **u32MinQp**, which may cause insufficient bit rate. This parameter is used to save the bit rate in the simple static scenario.	-
u32MaxIQp	Maximum QP value of an I-frame Recommended value range: [35, 45]	In the static scenario, the QP of an I-frame greatly affects the image quality. Limiting the maximum QP value of an I-frame can ensure the quality of the static parts of the image.	-
u32MinIQp	Minimum QP value of an I-frame The recommended value range is [20, 25] in the scenarios where static textures are complex. It is recommended that **u32MinIQp** be equal to **u32MinQp** in normal scenarios.	This parameter is used to control the percentage of I-frames.	-

Parameter	Description	Application Scenario	Remarks
s32MaxReEncodeTimes	Maximum number of re-encoding times Value range: [0, 3] Default value: 2 You are advised to enable the re-encoding function because it is effective in ensuring bit rate stability.	The default value applies to common scenarios.	-
bQpMapEn	Relative QP mode for the QpMap, used for enabling the AdaptiveROI mode	This parameter applies to the scenario where intelligent analysis and encoding are combined. The CU-level bit rate control is adjusted based on the intelligent analysis result by using the relative QP of the QpMap. When this flag is valid, the encoder parses the QpMap in the MPI for transmitting images and configures it to the encoding logic.	-
enQpMapMode (Only for H.265 encoding)	Mode of selecting the encoding QP when the encoding CU block is greater than 16 x 16 and corresponds to multiple QPs **enQpMapMode** is valid when **bQpMapEn** is **HI_TRUE**.	When a CU corresponds to multiple QPs, the maximum, minimum, or average value can be selected as the QP used for the encoding CU.	-

1.2 VBR Parameters

Table 1-3 and Table 1-4 describe the parameters of the variable bit rate (VBR).

Table 1-3 VBR attributes

Parameter	Description	Application Scenario	Remarks
u32Gop	I-frame interval	This parameter is usually set to an integral multiple of the output frame rate.	-
u32StatTime	Statistical time Unit: second	Same as that of the CBR	-
u32SrcFrameRate	Input frame rate	Controls the frame rate.	-
fr32TargetFrmRate	Output frame rate	Controls the frame rate.	-

Parameter	Description	Application Scenario	Remarks
u32MaxBitRate	Maximum bit rate	-	-

Table 1-4 Advanced VBR parameters (frame level)

Parameter	Description	Application Scenario	Remarks
s32ChangePos	Bit rate for starting the adjustment The recommended value range is [80, 90]. If an excessive bit rate is unacceptable, set this parameter to **80**. If an excessive bit rate is acceptable, set this parameter to **90**.	-	-
u32MinIprop	Minimum ratio of bits allocated to the I-frames and P-frames Default value: **1**	Same as that of the CBR	-
u32MaxIprop	Maximum ratio of bits allocated to the I-frames and P-frames Default value: **20**	Same as that of the CBR	-
s32MaxReEncodeTimes	Maximum number of times that each frame is re-encoded Value range: [0, 3] Default value: **2**	Same as that of the CBR	-
bQpMapEn	Relative QP mode for the QpMap, used for enabling the AdaptiveROI mode	This parameter applies to the scenario where intelligent analysis and encoding are combined. The CU-level bit rate control is adjusted based on the intelligent analysis result by using the relative QP of the QpMap. When this flag is valid, the encoder parses the QpMap in the MPI for transmitting images and configures it to the encoding logic.	-
enQpMapMode (Only for H.265 encoding)	Mode of selecting the encoding QP when the encoding CU block is greater than 16 x 16 and corresponds to multiple QPs **enQpMapMode** is valid when **bQpMapEn** is **HI_TRUE**.	When a CU corresponds to multiple QPs, the maximum, minimum, or average value can be selected as the QP used for the encoding CU.	-

Parameter	Description	Application Scenario	Remarks
u32MaxQp u32MaxIQp u32MinQp u32MinIQp	QP configured based on the bit rate and scenario • u32MinIQp specifies the minimum QP value of the I-frames. • u32MaxIQp specifies the maximum QP value of the I-frames. • u32MinQp specifies the minimum QP value of other frames. • u32MaxQp specifies the maximum QP value of other frames. Recommended value range: • MinQP: [24, 32] • MaxQP: [40, 51]	The maximum QP value affects the image quality, and the minimum QP value affects the lowest VBR. The maximum QP value is configured to determine whether the image quality or the limit on the highest bit rate takes priority when the encoding pressure is increased. The minimum QP value is configured to determine whether the image quality or bit rate reduction takes priority when the encoding pressure is decreased.	-

1.3 AVBR Parameters

NOTE

This section is not supported by Hi3556A V100/Hi3559 V200/Hi3556 V200.

Table 1-5 and Table 1-6 describe the parameters of the adaptive variable bit rate (AVBR).

Table 1-5 AVBR attributes

Parameter	Description	Application Scenario	Remarks
u32Gop	I-frame interval	This parameter is usually set to an integral multiple of the output frame rate.	-
u32StatTime	Statistical time Unit: second	Same as that of the CBR	-
u32SrcFrameRate	Input frame rate	Controls the frame rate.	-
fr32DstFrameRate	Output frame rate	Controls the frame rate.	-
u32MaxBitRate	Maximum bit rate	-	-

Table 1-6 Advanced AVBR parameters (frame-level)

Parameter	Description	Application Scenario	Remarks
s32ChangePos	Bit rate for starting the adjustment Recommended value range: [80, 90] If an excessive bit rate is unacceptable, set this parameter to **80**. If an excessive bit rate is acceptable, set this parameter to **90**.	-	-
u32MinIprop	Minimum ratio of bits allocated to the I-frames and P-frames Default value: **1**	Same as that of the CBR	-
u32MaxIprop	Maximum ratio of bits allocated to the I-frames and P-frames Default value: **100**	Same as that of the CBR	-
s32MaxReEncodeTimes	Maximum number of times that each frame is re-encoded Value range: [0, 3] Default value: **2**	Same as that of the CBR	-
bQpMapEn	Relative QP mode for the QpMap, used for enabling the AdaptiveROI mode	This parameter applies to the scenario where intelligent analysis and encoding are combined. The CU-level bit rate control is adjusted based on the intelligent analysis result by using the relative QP of the QpMap. When this flag is valid, the encoder parses the QpMap in the MPI for transmitting images and configures it to the encoding logic.	-
enQpMapMode (Only for H.265 encoding)	Mode of selecting the encoding QP when the encoding CU block is greater than 16 x 16 and corresponds to multiple QPs **enQpMapMode** is valid when **bQpMapEn** is **HI_TRUE**.	When a CU corresponds to multiple QPs, the maximum, minimum, or average value can be selected as the QP used for the encoding CU.	-
s32MinStillPercent	Percentage of the minimum target bit rate in the static scenario Recommended value range: [5, 50]	A smaller value indicates more significant decrease of the bit rate in the static scenario. When this parameter is set to 100, the internal bit rate adjustment mechanism will not be started, and the bit rate control effect of the AVBR mode is the same as that of the VBR mode.	-
u32MaxStillQ	Maximum QP value of the	If the target bit rate is decreased too	-

Parameter	Description	Application Scenario	Remarks
P	I-frame in the static scenario Recommended value range: [30, 40]	significantly, the QP value is increased and the image quality is lowered in the static scenario. In this case, **u32MaxStillQP** can be used to restrict the maximum QP value of the I-frame in the static scenario.	
u32MinStillPSNR	Reserved	-	-
u32MaxQp u32MinQp u32MaxIQp u32MinIQp	QP configured based on the bit rate and scenario • u32MinIQp specifies the minimum QP value of the I-frames. • u32MaxIQp specifies the maximum QP value of the I-frames. • u32MinQp specifies the minimum QP value of other frames. • u32MaxQp specifies the maximum QP value of other frames. Recommended value range: • MinQP: [24, 32] • MaxQP: [40, 51]	The maximum QP value affects the image quality, and the minimum QP value affects the lowest VBR. The maximum QP value is configured to determine whether the image quality or the limit on the highest bit rate takes priority when the encoding pressure is increased. The minimum QP value is configured to determine whether the image quality or bit rate reduction takes priority when the encoding pressure is decreased.	-
u32MinQpDelta	Difference between the minimum QP at the frame level and the minimum QP at the macroblock level For example, for P-frames, FrameLevelMinQp = u32MinQpDelta + u32MinQp. Value range: [0, 4] You are advised to adjust the parameter within the range of [1, 4].	When the image content is simple, the code control reduces the QP value. When the frame-level QP is adjusted to **FrameLevelMinQp**, the frame-level bit rate control stops reducing the QP value. However, the CU-level or macroblock-level bit rate control still takes effect. The QP value in the flat region can be reduced. **u32MinQpDelta** is **0** by default, indicating that the frame-level and CU-level or macroblock-level bit rate control use the same minimum QP.	-
u32MotionSensitivity	Motion sensitivity. A larger value indicates that bit rate control is more responsive to motion changes, as well as noises.	-	-

1.4 QVBR Parameters

Table 1-7 and Table 1-8 describe the QVBR parameters.

Table 1-7 QVBR attributes

Parameter	Description	Application Scenario	Remarks
u32Gop	I-frame interval	Generally, the value is an integral multiple of the output frame rate.	-
u32StatTime	Statistical time Unit: second	Same as that of the CBR	-
u32SrcFrameRate	Input frame rate	Controls the frame rate.	-
fr32DstFrameRate	Output frame rate	Controls the frame rate.	-
u32TargetBitRate	Target bit rate	-	-

Table 1-8 Advanced frame-level QVBR parameters

Parameter	Description	Application Scenario	Remarks
u32MinIprop	Minimum ratio of bits allocated to the I-frames and P-frames Default value: 1	Same as that of the CBR	-
u32MaxIprop	Maximum ratio of bits allocated to the I-frames and P-frames Default value: 100	Same as that of the CBR	-
s32MaxReEncodeTimes	Maximum re-encoding times Value range: [0, 3] Default value: 2	Same as that of the CBR	-
bQpMapEn	Relative QP mode for the QpMap, used for enabling the AdaptiveROI mode	This parameter applies to the scenario where intelligent analysis and encoding are combined. The CU-level bit rate control is adjusted based on the intelligent analysis result by the relative QP set by using the QpMap. When this flag is valid, the encoder parses the QpMap in the MPI for transmitting images and configures it to the encoding logic.	-
enQpMapMode (Only for H.265 encoding)	Mode of selecting the encoding QP when the encoding CU block is greater than 16 x 16 and corresponds to multiple QPs **enQpMapMode** is valid when **bQpMapEn** is	When a CU corresponds to multiple QP values, the maximum, minimum, or average value can be selected as the QP value used for the encoding CU.	-

Parameter	Description	Application Scenario	Remarks
	HI_TRUE.		
u32MaxQp u32MinQp u32MaxIQp u32MinIQp	QP configured based on the bit rate and scenario • **u32MinIQp** specifies the minimum QP value of the I-frames. • **u32MaxIQp** specifies the maximum QP value of the I-frames. • **u32MinQp** specifies the minimum QP value of other frames. • **u32MaxQp** specifies the maximum QP value of other frames. Recommended value range: • MinQP [24, 32] • MaxQP [40, 51]	The maximum QP value affects the image quality. The minimum QP affects the minimum VBR. The maximum QP is configured to determine whether the image quality or limiting the maximum bit rate takes priority when the encoding pressure is increased. The minimum QP is configured to determine whether the image quality or bit rate reduction takes priority when the encoding pressure is decreased.	-
s32BitPercentUL s32BitPercentLL	Dynamic range of the bit rate • Maximum bit rate =TargetBitRate x s32BitPercentUL/100 • Minimum bit rate = TargetBitRate x s32BitPercentLL/100 Recommended value range: • **s32BitPercentUL** [100, 125] • **s32BitPercentLL** [45, 100]	The QVBR control algorithm determines the image complexity in the current scenario in real time and proactively adjusts the target bit rate. This group of parameters defines the dynamic bit rate range. When the scenario is simple, the target bit rate is decreased. When the scenario is complex, the target bit rate is increased.	-
s32PsnrFluctuateUL s32PsnrFluctuateLL	Dynamic range of the PSNR (objective evaluation indicator for image quality) parameters Recommended value range: • **s32PsnrFluctuateUL** [30, 37] • **s32PsnrFluctuateLL** [21, 27]	When the PSNR value in real-time statistics is greater than or equal to **s32PsnrFluctuateUL**, the current image quality is good. The bit rate is decreased. When the PSNR value in real-time statistics is less than or equal to **s32PsnrFluctuateLL**, the current image quality is good. The bit rate is increased. If the PSNR value in real-time statistics is within the ranges of the two parameters, the bit rate remains unchanged.	When the PSNR value range exceeds [s32PsnrFluctuateLL-4, s32PsnrFluctuateUL+4]∩[20, 40], the PSNR does not take effect, and the bit rate is adjusted between the maximum and minimum bit rates.

1.5 CVBR Parameters

Table 1-9 and Table 1-10 describe CVBR parameters.

Table 1-9 CVBR attributes

Parameter	Description	Application Scenario	Remarks
u32Gop	I-frame interval	Generally, the value is usually set to an integral multiple of the output frame rate.	-
u32StatTime	Statistical time, in seconds	Same as that of the CBR	-
u32SrcFrameRate	Input frame rate	Frame rate control	-
fr32DstFrameRate	Output frame rate	Frame rate control	-
u32MaxBitRate	Maximum short-term bit rate, in kbit/s Recommended value: Maximum long-term bit rate x 1.5	You can increase the value of this parameter to improve the image quality of motion scenes.	-
u32ShortTermStatTime	Period of the short-term bit rate statistics, in seconds Recommended value: 3	A smaller value indicates quicker response of the image quality to the bit rate. Otherwise, the image quality changes more smoothly.	-
u32LongTermStatTime	Period of the long-term bit rate statistics: 1440 (max) The unit is determined by the advanced attribute **u32LongTermStatTimeUnit**. The default unit is minute (60 seconds). It is recommended that the average bit rate within the statistical period be less than or equal to **u32LongTermMaxBitrate**. Recommended value: 1440	To reduce the long-term statistical period to less than 1440 seconds, decrease the value.	-
• u32LongTermMaxBitrate • u32LongTermMinBitrate	Maximum bit rate and minimum bit rate in the long-term statistical period, in kbit/s The encoder makes the average bit rate stay within the long-term statistical period if possible.	To save the bit rate as much as possible, set **u32LongTermMinBitrate** to **0**. To have a fixed average bit rate, set **u32LongTermMaxBitrate** and **u32LongTermMinBitrate** to this fixed value.	-

Table 1-10 Advanced frame-level CVBR parameters

Parameter	Description	Application Scenario	Remarks
u32MinIprop	Minimum ratio of bits allocated to I-frames and P-frames Default value: 1	Same as that of the CBR	-
u32MaxIprop	Maximum ratio of bits allocated to I-frames and P-frames Default value: 100	Same as that of the CBR	-
s32MaxReEncodeTimes	Maximum number of re-encoding times Value range: [0, 3] Default value: 2	Same as that of the CBR	-
bQpMapEn	Relative QP mode for the QpMap, used for enabling the AdaptiveROI mode	This parameter applies to the scenario where intelligent analysis and encoding are combined. The CU-level bit rate control is adjusted based on the intelligent analysis result by using the relative QP of the QpMap. When this flag is valid, the encoder parses the QpMap in the MPI for transmitting images and configures it to the encoding logic.	-
enQpMapMode (supported only by H.265)	Mode of selecting the encoding QP when the encoding CU block is greater than 16x16 and corresponds to multiple QPs **enQpMapMode** is valid when **bQpMapEn** is **HI_TRUE**.	When a CU corresponds to multiple QP values, the maximum, minimum, or average value can be selected as the QP used for the encoding CU.	-
• u32MaxQp • u32MinQp • u32MaxIQp • u32MinIQp	QP configured based on the bit rate and scenario • **u32MinIQp** restricts the minimum QP value of the I-frame. • **u32MaxIQp** restricts the maximum QP value of the I-frame. • **u32MinQp** restricts the minimum QP value of other types of frames. • **u32MaxQp** restricts the maximum QP value of other types of frames. Recommended value range: • MinQP [24,32] • MaxQP [40,51]	The maximum QP value affects the image quality. The minimum QP affects the minimum VBR. The maximum QP value is configured to determine whether the picture quality or limiting the bit rate takes priority when the encoding pressure is increased. The minimum QP value is configured to determine whether the image quality or bit rate reduction takes priority when the encoding pressure is decreased.	-
• u32MinQp Delta	**u32MinQpDelta**: used to adjust the difference between the minimum QP value at the frame level and the minimum QP	When the image content is simple, the bit rate control decreases the QP value. When	-

Parameter	Description	Application Scenario	Remarks
• u32MaxQp Delta	value at the macroblock level, for example, for the P-frame: FrameLevelMinQp = u32MinQp + u32MinQpDelta Value range: [0, 4] You are advised to adjust the parameter value within the range of [1, 4]. **u32MaxQpDelta**: used to adjust the difference between the maximum QP value at the frame level and the maximum QP value at the macroblock level, for example, for the P-frame: FrameLevelMaxQp = u32MaxQp – u32MaxQpDelta Value range: [0, 4] You are advised to adjust the parameter value within the range of [1, 4].	the frame-level QP value is adjusted to **FrameLevelMinQp**, the frame-level bit rate control does not decrease the QP value. However, the bit rate control at the CU/macroblock level still takes effect, and the QP value in the flat area of the image can be decreased to a smaller value.The default value of **u32MinQpDelta** is **0**, indicating that the bit rate control at the frame and CU/macroblock levels use the same minimum QP value. When the image content is complex, the bit rate control increases the QP value. When the frame-level QP value is adjusted to **FrameLevelMaxQp**, the frame-level bit rate control does not increase the QP value. However, the bit rate control at the CU/macroblock level still takes effect, and the QP value in the strong texture area of the image can be increased to a larger value.The default value of **u32MaxQpDelta** is **0**, indicating that the bit rate control at the frame and CU/macroblock levels use the same maximum QP value.	
u32ExtraBitPercent	Ratio of the maximum extra bits for the streams output from the encoder to the maximum long-term bit rate When the bit rate is insufficient, the encoder uses a certain number of extra bits to improve the image quality. The extra bit rate will be compensated when the encoding pressure is low. Value range: [0, 1000] Default value: 5	You can configure the ratio based on the actual storage device. ExtraBits = u32ExtraBitPercent x u32LongTermMaxBitrate x u32LongTermStatTime x u32LongTermStatTimeUnit	-
u32LongTermStatTimeUnit	Unit of the period of the long-term bit rate statistics (**u32LongTermStatTime**). The unit is second. For example, if the parameter is set to **60**, it indicates that the long-term statistical period is 60 seconds. If the parameter is set to **3**, it indicates that the long-term statistical period is 3 minutes.	The default value of **u32LongTermStatTimeUnit** is **60**, that is, the unit of **u32LongTermStatTime** configured by the customer is minute (60 seconds). If you need to use a long statistical period, you can set the unit to half an	-

Parameter	Description	Application Scenario	Remarks
	Value range: [1, 1800] Default value: 60	hour (1800 seconds).	

1.6 Macroblock-level Bit Rate Control Parameters

Table 1-11 describes the macroblock-level bit rate control parameters.

Table 1-11 Macroblock-level bit rate control parameters

Parameter	Description	Application Scenario	Remarks
u32ThrdI[16] u32ThrdP[16] u32ThrdB[16]	Texture-based macroblock-level bit rate control parameters: MADI thresholds of the I, P, and B-frames Default values in H.264 mode: I: [0, 0, 0, 0, 3, 3, 5, 5, 8, 8, 8, 15, 15, 20, 25, 25] P: [0, 0, 0, 0, 3, 3, 5, 5, 8, 8, 8, 15, 15, 20, 25, 25] B: [0, 0, 0, 0, 3, 3, 5, 5, 8, 8, 8, 15, 15, 20, 25, 25] Default values in H.265 mode: I: [0, 0, 0, 0, 3, 3, 5, 5, 8, 8, 8, 15, 15, 20, 25, 25] P: [0, 0, 0, 0, 3, 3, 5, 5, 8, 8, 8, 15, 15, 20, 25, 25] B: [0, 0, 0, 0, 3, 3, 5, 5, 8, 8, 8, 15, 15, 20, 25, 25]	The texture-based bit rate control decreases the QP of flat regions and increases the QP of detailed regions, which improves the subjective image quality. The first eight levels indicate the QP decrease direction, while the last eight levels indicate the QP increase direction. For the QP decrease direction, the value 0 indicates that the current level is disabled. For the QP increase direction, the value 255 indicates that the current level is disabled.	-
u32DirectionThrd	Controls the plus or minus direction during texture-based macroblock-level bit rate control Value range: [0, 16]	For example, **u32DirectionThrd** = **7** indicates that the first seven parameters of Thrd are used for QP minus direction and the last nine parameters are used for QP plus direction.	-

Parameter	Description	Application Scenario	Remarks
u32RowQpDelta	Row-based macroblock-level bit rate control Default value: 2 The row-based bit rate control increases bit rate stability. If **u32RowQpDelta** is set to **0**, the row-based macroblock-level bit rate control is disabled.	A larger parameter value indicates greater amplitude of QP adjustment within one frame and more stable bit rate.	-
s32FirstFrameStartQp	Start QP value of the first frame	The encoder will calculate an appropriate start QP value for the first frame based on empirical values. However, the customer can adjust the start QP based on actual scenario of the product.	-

1.7 Frame Discarding Parameters in Bit Rate Overshooting Scenarios

Table 1-12 Frame discarding parameters in bit rate overshooting scenarios

Parameter	Description	Application Scenario	Remarks
bFrmLostOpen	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.	-
u32FrmLostBpsThr	Bit rate overshooting threshold It is recommended that this threshold is set to the maximum bit rate or 1.2 times of the target bit rate.	-	-
enFrmLostMode	The non-zero value indicates the maximum number of discarded frames.	If bit rate overshooting occurs, frames are discarded or encoded into PskiP-frames.	-
u32EncFrmGaps	If **u32EncFrmGaps** is set to 0, frames are continuously discarded and the number of discarded frames is not counted.	This parameter is used to ensure smoothness when frames are consecutively discarded.	-

1.8 Advanced Parameters for the Jumbo Frame Policy

Table 1-13 Advanced parameters for the jumbo frame policy

Parameter	Description	Application Scenario	Remarks
enSuperFrmMode	Jumbo frame policy	The jumbo frames can be re-encoded, discarded, or normally output.	-
u32SuperIFrmBitsThr	Threshold for the number of bits encoded in an I-frame	-	-
u32SuperPFrmBitsThr	Threshold for the number of bits encoded in a P-frame	-	-
u32SuperBFrmBitsThr	Threshold for the number of bits encoded in a B-frame	-	-
enRcPriority	Re-encoding priority for the jumbo frame 1: The number of bits to be re-encoded is allocated based on the target bit rate. 2: The number of bits to be re-encoded is allocated based on the jumbo frame threshold.	-	-

2 GOP Structure Parameters

2.1 GOP Structure Parameters in NormalP-frame Mode

Table 2-1 describes the GOP structure parameters during NormalP-frame encoding.

Table 2-1 GOP structure parameters during NormalP-frame encoding

Parameter	Description	Application Scenario	Remarks
s32IPQpDelta	QP variance of the I/P-frame, for adjusting the respiratory effect Recommended value range: [2, 6]	This parameter is used to adjust the respiratory effect and control the size of the I-frame.	-

2.2 GOP Structure Parameters in DualP-frame Mode

NOTE

This section does not apply to Hi3559A V100ES/Hi3556A V100/Hi3559 V200/Hi3556 V200.

Table 2-2 describes the GOP structure parameters during DualP-frame encoding.

Table 2-2 GOP structure parameters in DualP-frame encoding mode

Parameter	Description	Application Scenario	Remarks
u32SPInterval	Interval of the special P-frames Recommended value range: [4, 10]	In one GOP, some P-frames with higher quality are encoded based on a fixed interval, and they are called special P-frames. The overall quality of the encoded image is improved through time-domain relevance. When the dual reference P-frames mode is used, one	-

Parameter	Description	Application Scenario	Remarks
		frame buffer of DDR is added both at the encoding end and decoding end, but the system end-to-end latency is not increased.	
s32SPQpDelta	QP variance of the special P-frame relative to the common P-frame, for optimizing the image quality Recommended value range: [2, 4]	-	-
s32IPQpDelta	QP variance of the I-frame relative to the common P-frame, for adjusting the respiratory effect Recommended value range: [2, 6]	This parameter is used to adjust the respiratory effect and control the size of the I-frame.	-

2.3 GOP Structure Parameters in SmartP Mode

NOTE

This section does not apply to Hi3559AV100ES. Hi3519A V100/Hi3556A V100/Hi3516C V500/Hi3516D V300/Hi3559 V200/Hi3556 V200/Hi3516E V200 does not support AdvSmartP.

Table 2-3 describes the GOP structure parameters in SmartP/AdvSmartP encoding mode.

Table 2-3 GOP structure parameters in SmartP/AdvSmartP encoding mode

Parameter	Description	Application Scenario	Remarks
u32BgInterval	Interval of the long-term reference frame Recommended value: 10 to 30 times of the GOP	The long-term reference frames are inserted into streams periodically to improve the quality of the encoded image by using time-domain relevance. For the static scenarios where the camera is fixedly installed, the encoding performance can be improved. **u32BgInterval** is generally set to an integral multiple of the GOP, and matches the statistical time of the bit rate. When the SmartP-frame mode is used, one frame buffer of DDR is added both at the encoding end and decoding end, but the system end-to-end latency is not increased.	-

Parameter	Description	Application Scenario	Remarks
s32BgQpDelta	QP variance of the long-term reference frame relative to the common P-frame Recommended value range: [2, 10]	This parameter is used to adjust the quality and size of the long-term reference frame.	-
s32ViQpDelta	QP variance of the virtual I-frame relative to the common P-frame Recommended value range: [2, 4]	The virtual I-frame only refers to the long-term reference frame, can be independently decoded, and is used for error recovery or the seek operation of the player. In the SmartP-frame encoding mode, the interval of the virtual I-frame is **u32Gop**. **s32ViQpDelta** is used to adjust the quality and size of the virtual I-frame. A better image quality encoding mode can be used for the virtual I-frame to improve the encoding performance.	-

2.4 GOP Structure Parameters in BipredB-frame Mode

NOTE

This section does not apply to Hi3559A V100ES/Hi3556A V100/Hi3516C V500/Hi3516D V300/Hi3559 V200/Hi3556 V200/Hi3516E V200.

Table 2-4 describes the GOP structure parameters in BipredB-frame encoding mode.

Table 2-4 GOP structure parameters in BipredB-frame encoding mode

Parameter	Description	Application Scenario	Remarks
u32BFrmNum	Number of B-frames that are inserted between two P-frames Recommended value range: [1, 2]	The B-frame adopts the bidirectional reference mode and can use the relevance between the frames before and after it to the maximum. In this way, the encoding performance is improved and the bit rate is reduced. When the B-frame is used, one frame buffer of DDR and latency of **u32BFrmNum** frame intervals are added both at the encoding end and the decoding end.	-
s32BQpDelta	QP variance of the B-frame relative to the P-frame, for reducing the bit rate Recommended value range: [−4, −2]	As the B-frame is not referenced by other frames, it can be used to properly reduce the image quality. It is recommended that **s32BQpDelta** be set to a negative value to properly increase the QP of the B-frame and save the bit rate.	-

s32IPQpDelta	QP variance of the I-frame relative to the common P-frame, for adjusting the respiratory effect Recommended value range: [2, 6]	This parameter is used to adjust the respiratory effect and control the size of the I-frame.	-

3 Bit Rate Control

3.1 Improving Bit Rate Stability

Table 3-1 lists the methods to improve bit rate stability.

Table 3-1 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: u32RowQpDelta to **3-5**.	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 5.
Set a frame discarding threshold for the bit rate and the number of consecutively discarded frames.	• VENC_FRAMELOST_S: bFrmLostOpen = HI_TRUE; • VENC_FRAMELOST_S: u32FrmLostBpsThr = frame discarding threshold • VENC_FRAMELOST_S: enFrmLostMode = FRMLOST_NORMAL or FRMLOST_PSKIP; • VENC_FRAMELOST_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.

3.2 Improving Image Quality

Table 3-2 lists the methods to improve image quality.

Table 3-2 Methods to improve image quality

Method	Parameter Configuration	Impact
Set the maximum QP	• VENC_PARAM_H264_CBR_S: u32MaxQp • VENC_PARAM_H265_CBR_S: u32MaxQp • VENC_PARAM_H264_VBR_S: u32MaxQp • VENC_PARAM_H265_VBR_S: u32MaxQp	Setting the maximum QP value helps effectively protect the image quality, but bit rate overshooting is prone to occur.

3.3 Adjusting the Respiratory Effect

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

Table 3-3 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_GOP_NORMALP_S: s32IPQPDelta • VENC_GOP_DUALP_S: s32IPQPDelta • VENC_GOP_BIPREDB_S: s32IPQPDelta	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.
Sets the parameters for removing the respiratory effect.	• VENC_DEBREATHEFFECT_S: s32Strength0 • VENC_DEBREATHEFFECT_S: s32Strength1	In principle, the respiratory effect should be removed as thoroughly as possible. Parameters **s32Strength0** and **s32Strength1** need to be adjusted together. Considering the adaptability across scenarios, you are advised to retain the default values.

NOTE
Hi3516E V200 does not support the respiratory removal parameters described in this section.

3.4 Limiting the I-Frame Amplitude

Table 3-4 lists the methods to limit the I-frame amplitude.

Table 3-4 Methods to limit the I-frame amplitude

Method	Parameter Configuration	Impact
Set the maximum ratio of bits allocated to the I-frames and P-frames. If the ratio exceeds the maximum value, an	• VENC_PARAM_H264_CBR_S: u32MaxIprop; • VENC_PARAM_H265_CBR_S: u32MaxIprop	In still scenarios, the image quality can be improved by allocating more bits to the I-frame. However, if the ratio of bits allocated to the I-frames and P-frames is overlarge, the image quality may be

Method	Parameter Configuration	Impact
internal algorithm will limit the bit count of I-frames.		decreased.
Set the minimum QP value of the I-frame.	• VENC_PARAM_H264_CBR_S: u32MinIQp; • VENC_PARAM_H265_CBR_S: u32MinIQp	This method has a strong constraint on the I-frame and may cause bit rate insufficiency. In addition, 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_SUPERFRAME_CFG_S: enSuperFrmMode = SUPERFRM_REENCODE; • VENC_SUPERFRAME_CFG_S: u32SuperIFrmBitsThr • VENC_SUPERFRAME_CFG_S: u32SuperPFrmBitsThr	Too much recoding wastes the chip performance and bandwidth.

3.5 Reducing Motion Smearing and Chrominance Smearing

Motion smearing mainly occurs in the regions where textures are flat. Motion smearing can be reduced by adjusting the parameters of texture-based macroblock-level bit rate control. Chrominance smearing can be reduced by adjusting the chrominance QP offset. Table 3-5 describes the methods of reducing motion smearing and chrominance smearing.

Table 3-5 Methods of reducing motion smearing and chrominance smearing

Method	Parameter Configuration	Side Effect
Adjusting the macroblock-level bit rate control parameters	VENC_RC_PARAM_S: u32ThrdP[16]	Generally, smearing easily occurs in the still regions with simple textures. Smearing can be reduced by decreasing the QP of the regions with simple textures through texture-based bit rate control. However, fewer bits are allocated to the regions with complex textures. As a result, the image quality is lowered.
Decreasing **chroma_qp_offset**, which reduces chrominance smearing	• VENC_H264_TRANS_S : chroma_qp_index_offset • VENC_H265_TRANS_S : cb_qp_offset • VENC_H265_TRANS_S : cr_qp_offset	The chrominance quality is better if the chrominance QP is decreased. However, fewer bits are allocated to the luminance because more bits are allocated to the chrominance.
Increasing the video	-	Fewer details are retained.

Method	Parameter Configuration	Side Effect
processing subsystem (3DNR) denoising strength		

3.6 Start QP for Bit Rate Control

The current bit rate control algorithm contains the experience algorithm of the start QP. The algorithm calculates an appropriate start QP based on the bit rate and resolution for a typical scenario. However, the calculated start QP may not be suitable for every scenario.

- If the start QP value is too large, the bit rate is insufficient for a period of time after the encoding starts and the image quality is slightly poor.
- If the start QP value is too small, the bit rate may exceed the threshold for a period of time after the encoding starts.
- If customers consider the experience value calculated by our algorithm is inappropriate, they can set a start QP value by using **VENC_RC_PARAM_S::s32FirstFrameStartQp**. This API is valid after a channel is created and before the first frame starts to be encoded.

3.7 Difference Between the VBR, AVBR, and QVBR

- VBR function: When the encoding pressure is high in the motion scenario, **StartQp** is adjusted to ensure that the bit rate does not exceed the maximum bit rate. When the encoding pressure is low in the static scenario, **StartQp** is clamped to **MinQp** and the bit rate will be lower than the maximum bit rate, which saves streams.
- AVBR function: The motion detection method is added to encoding. To be specific, the target bit rate is increased in the motion scenario and **StartQp** is controlled to ensure that the bit rate does not exceed the maximum bit rate; the target bit rate is decreased in the static scenario to save streams.
- QVBR function: As an objective evaluation indicator for image quality, the PSNR is used to dynamically adjust the bit rate. When the PSNR is small, QVBR proactively increases the target bit rate. When the PSNR is large, QVBR proactively decreases the target bit rate. In this way, the bit rate is saved and the image quality is ensured.
- CVBR function: The constraints on the instantaneous, short-term, and long-term bit rates are set. The bit rate is stored when the scenario is simple. The stored bit rate is used to improve the image quality in complex scenarios and ensure the long-term stability of the image quality.
- Difference between VBR and AVBR: The VBR passively saves the bit rate while the AVBR proactively saves the bit rate. In a static scenario, the QP value used by the AVBR can be greater than **MinQp**, therefore, the bit rate is further saved in the static scenario. The QVBR can dynamically increase or decrease the bit rate to ensure the quality stability of encoded images.

3.8 Difference Between the VBR, AVBR, CBR, and CVBR

- Difference between the CVBR and the VBR: The CVBR is similar to the VBR in the pursuit of stable image quality, but differs from the VBR by adding bit rate constraints for different statistical periods to meet the requirements of transmission bandwidth and storage space.
- Difference between the CVBR and the AVBR: The change of the output bit rate of the CVBR does not depend on motion detection. Instead, the output bit rate automatically changes based on the encoding pressure caused by the specific scenario. At the same time, the CVBR aims to provide stable image quality when the coding pressure changes, uses long-term bit rate statistics, and adjusts the target bit rate given that the long-term bit rate meets user requirements.
- Differences between the CVBR and the CBR: The CBR output does not vary according to different scenarios. That is, the bit rate decreases when the scenario is simple, and no extra bit rate can be used when the scenario is complex. However, the CVBR is automatically changed based on different scenarios. That is, the bit rate decreases when the scenario is simple, and an extra bit rate is used when the scenario is complex. In this way, the image quality is stable and the average bit rate does not exceed the target bit rate.

3.9 Low Bit Rate Scenarios

- Lower the AE sensitivity of the ISP module to increase the AE response delay and avoid frequent AE adjustment in the case of light/dark shifting.

  Recommended parameter configuration:

  Properly increase the AE adjustment (from dark to bright and from dark to bright) delay.

  Properly lower the sensitivity of AE changes.
- Increase the 3DNR denoising strength and TF/SF strength, and lower the sharpen strength and image detail.

  Recommended parameter configuration: Properly increase the TF strength and SF strength. During adjustment, note that the SF strength needs to be about four times the TF strength.
- Set a relatively large GOP and ensure that **u32StatTime** matches the GOP. When the **SmartP**/**AdvSmartP** mode is used, **u32BgInterval** should match **u32StatTime**.

  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.
- 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_FRAMELOST_S: **enFrmLostMode** = **FRMLOST_PSKIP**

  VENC_FRAMELOST_S: **u32EncFrmGaps** = **2**
- Enable texture-based macroblock-level bit rate control and set the recommended parameters.
- For the static scenarios (such as the scenario where the camera is fixedly installed), the SmartP/AdvSmartP mode is recommended for encoding. For the scenarios where the camera is motion and the requirement on latency is not high, the BipredB mode is

recommended for encoding. For other scenarios, the DualP mode is recommended for encoding.

3.10 Precautions

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**: **u32StatTime** is set 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. In the VOD scenario, if the I-frame request API is used, short-time bit rate overshoot occurs. Increasing the statistical time can reduce the QP change caused by the bit rate overshoot and stabilize the image quality.
- **u32SrcFrameRate**: **u32SrcFrameRate** is 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, **u32SrcFrameRate** must be consistent with the actual VI-frame rate. If not, the actual frame rate is inconsistent with the target frame rate.
- **u32MaxIprop**: **u32MaxIprop** is 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/u32MaxIQp**: **u32MaxQp** and **u32MaxIQp** are 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.
- **u32MinQp/u32MinIQp**: **u32MinQp/u32MinIQp** is used to limit the minimum QP. If bit rate reduction is required in still or slow-motion scenarios, the recommended value range is [10, 20] for the CBR mode and [24, 32] for the VBR mode.
- 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 image may deteriorate, and bit rate overshooting may be caused.
- In CVBR mode, the final bit rate may be lower than **u32LongTermMinBitrate** in simple scenarios.
- **MinIQp** and **MinPQp** of CVBR affect the bit rate control. If the values of **MinIQp** and **MinPQp** are too small, the bit rate in simple static scenarios cannot be saved, and no more bit rates can be used in complex motion scenarios. As a result, the effect of CVBR is close to that of CBR. Too large **MinIQp** and **MinPQp** values affect the image quality, because the bit rate is always lower than the upper limit **u32LongTermMaxBitrate**. Table 3-6 lists the recommended settings of **MinIQp** and **MinPQp**.

Table 3-6 Recommended values of **MinIQp** and **MinPQp** for CVBR

Protocol	Resolution	Bit Rate Range (Mbit/s)	MinIQp	MinPQp
H.264	1920 x 1080	[6, 7]	23	25
		[4, 6]	25	27
		[2, 4]	27	29
H.265	1920 x 1080	[4, 6]	23	25
		[2, 4]	25	27
		[1, 2]	27	29
	2560 x 1440	[9, 11]	23	25
		[6, 9]	25	27
		[3, 6]	27	29

