Rockchip Tunning Guide ISP32

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Foreword

Overview

This document is intended to guide users in image tuning.

Product Version

Chip Name	ISP version
RV1106	ISP3.2

Target Audience

This document (this guide) is intended for the following engineers:

ISP image effect debugging engineer

Revision History

Version number	Modify History	Date modified	Author
v0.1.0	First edition	2022-4-6	ALL
v0.1.1	Added AF chapter	2022-4-27	Hu Kejun
v0.1.2	1. AE Chapter Update	2022-10-27	Zhu Linjing
v0.1.3	1. AE chapter update: ISP Dgain related content 2. Added CAC chapter	2023-3-2	Zhu Linjing Xie Kedi

Contents

1 IQ debugging document relationship description

The use of this document is relevant to the following documents, which are summarized below:

- Rockchip_Development_Guide_ISP32_: describes the user interface and its structure accordingly
- Rockchip_IQ_Tools_Guide_ISP32_: Detailed instructions for using RK IQ Tools
- Rockchip_Color_Optimization_Guide_ISP32: A detailed description of color tuning

The first chapter of this document mainly explains the document relationship description involved in the ISP tuning process, and the second chapter provides a system overview of ISP, including the functional block diagram of ISP and the introduction of each module; Chapter 3 mainly introduces the operation steps and precautions of the entire image tuning process. After Chapter 4, the debugging methods of each submodule are introduced into modules.

2 ISP system overview

1. 2.1 Introduction to the feature

The ISP32 module supports standard sensor image data processing, including basic functions such as auto white balance, auto exposure, Demosaic, dead pixel correction and lens shadow correction, as well as HDR, dehazing, noise reduction and other advanced processing functions.

2. 2.2 ISP functional block diagram

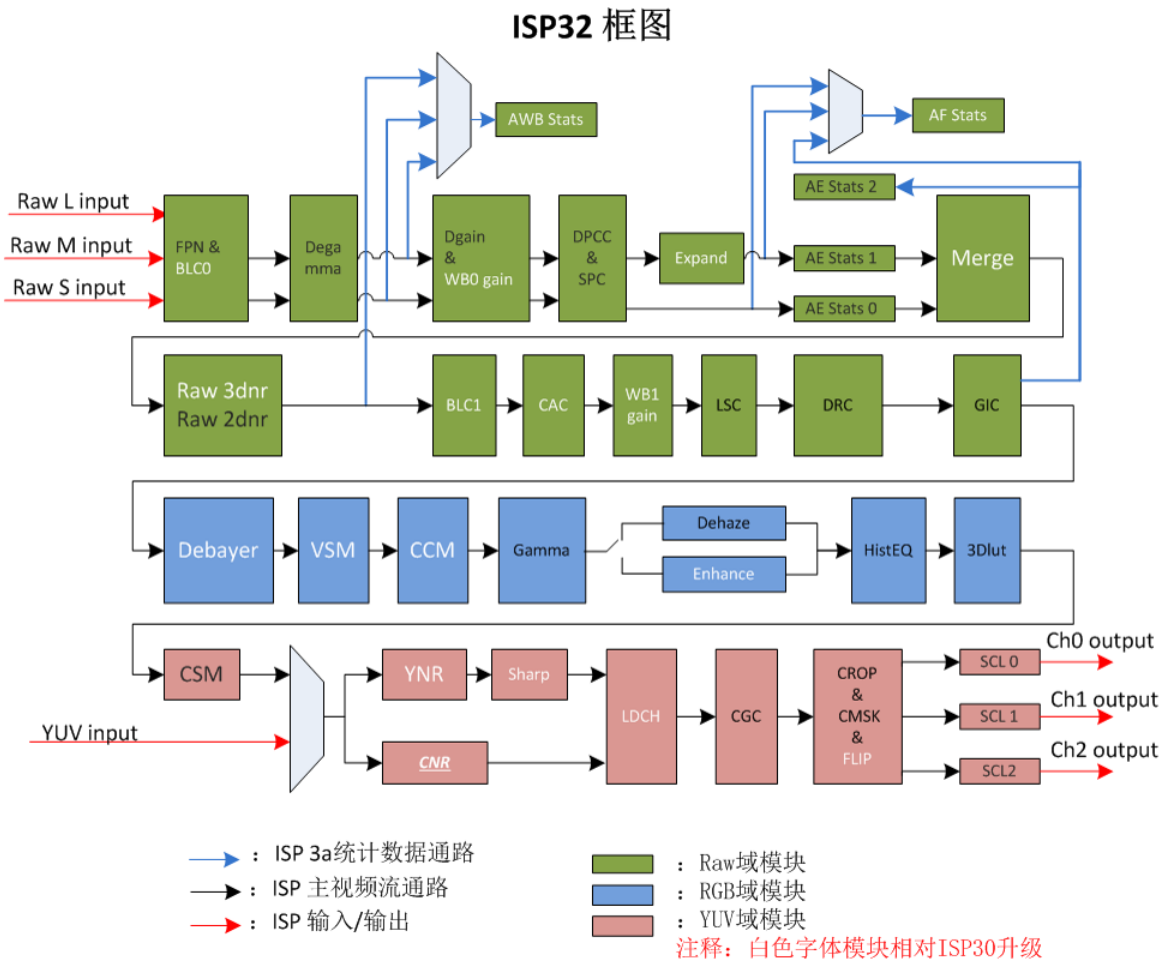


Figure 2-1 ISP32 functional block diagram

2.1 2.3 Introduction to each module

Module name	Description
FPN	The CIS input image is corrected by the black frame or black line of the phenotype to remove fixed mode noise.
BLC	Provides CIS-related black level correction.
Degamma	CIS nonlinearization correction
DPCC	Provides detection and correction of static and dynamic dead pixels.
SPC	Provides correction of occluded pixels (phase focus)
Expand	Decompress the compressed data inside the sensor
Dgain	Provides digital linear gain
WB Gain	White balance correction gain
MERGE	2-frame wide dynamic compositing.
Raw 3DNR & Raw 2DNR	RAW domain time domain, space domain combined with noise reduction module
DRC	Dynamic Range Compression
GIC	Correct the imbalance between the two channels of Gr and Gb, and improve the image quality of some scenes
LSC	Used for shadow correction of lenses.
CAC	Corrects the axial chromatic aberration introduced by the lens (purple fringing)
AE Stats	This module outputs the statistical information of automatic exposure, and the software adjusts CIS according to the statistical information to realize the function of automatic exposure.
AF	Support image sharpness evaluation information statistics, used to complete the support autofocus function.
AWB	The module outputs global statistics and regional statistics, and the software completes the automatic white balance function based on the statistics
Debayer	Convert a Raw image in Bayer format to an RGB image
CCM	Linear correction of the color space can be accomplished by standard 3X3 matrix and vector offsets
Gamma	The module adjusts the brightness according to the gamma curve in three channels: R\G\B
Dehaze & Enhance	Provides powerful dehaze capabilities to improve video contrast and clarity in haze scenes.
CSM	The input (R, G, B) is converted to (Y, U, V) through the standard 3X3 matrix and vector offset, and the chroma downsampling output YUV422 is provided to the post-stage module

Module name	Description
LDCH	Correct distortion in the vertical direction of the lens
3D-LUT	The 9x9x9 size 3Dlut implements complex color adjustment operations, such as brightness adjustment, saturation adjustment
Sharp	YUV domain realizes image sharpness and improves image clarity
YNR	Airspace denoising for brightness
UVNR	Separate color noise removal.
CGC	YUV Color Space Conversion
CMSK	Provide image mosaic, occlusion function
FBC	Data compression
SCL	Image scaling

3 Overall overview of image quality tuning

It is mainly oriented to two application scenarios, namely IPC security application scenarios and consumer application scenarios, among which IPC security application scenarios include linear mode and HDR mode; Consumer application scenarios mainly include sports DV, driving recorders, and capture products. Due to the special needs of the surveillance industry, IPC security application scenarios will focus on image quality differently from consumer application scenarios.

1. 3.1 Overview of IPC Application Image Tuning

For IPC application scenarios, it mainly includes two typical applications: linear mode and HDR mode. The image quality of linear mode mainly includes image brightness rationality, color reproduction accuracy, overall image clarity, overall sharpness and transparency. The image quality focus of HDR mode mainly includes the overall dynamic range of the image is reasonable (the bright areas are not exquisite, and the details in the dark areas can be seen), the color reproduction is as accurate as possible, and the overall clarity, sharpness, and transparency of the image. The following describes the debugging steps for image quality tuning for the two modes and the precautions for debugging the ISP single point algorithm.

1.1 3.1.1 Linear mode image quality tuning

The entire frame diagram of linear mode image tuning for the IPC application scenario is shown below (Figure 3-1):

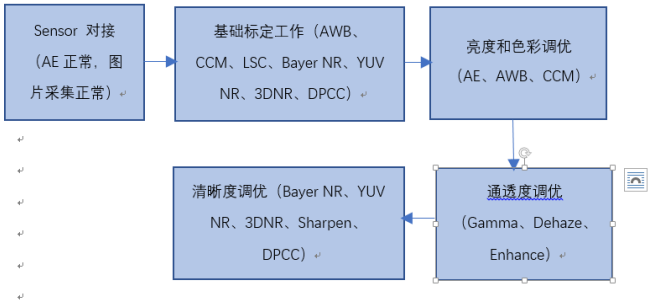


Figure 3-1 Linear mode image tuning flowchart for IPC application scenario

2. The main tasks that need to be done before image quality tuning are as follows:

    1. sensor docking: According to the definition of the product, the CSI of the sensor is set, including frame rate, resolution, HDR mode, AE mode, and the initialization register sequence in each mode is mined according to the sensor datasheet or FAE provided by the manufacturer, and the initialization sequence is adapted to the MIPI configuration of the RK platform.

    Completion standard: The docking mode path is normal, the AE basic working energy is normal, and RAW can be shot normally Rockchip_Driver_Guide_ISP2x.

    2. Module calibration work: The calibration work mainly involves black level calibration, RawNR/YUV NR/3DNR calibration, static dead pixel calibration, lens shading calibration, AWB calibration, CCM calibration, lens distortion parameter calibration, etc. This calibration step needs to be carried out in strict accordance with the process shown in Figure 3-2:

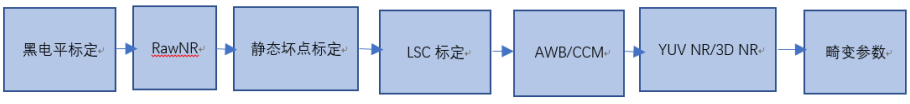


Figure 3-2 Module calibration flow chart

For the calibration details of each module, please refer to Chapter 4 for the details of the module introduction, and for AWB and CCM, please refer to Rockchip_Color_Optimization_Guide_ISP32

3. ISP module joint tuning: After completing the sensor docking and sensor lens calibration work, you can enter the ISP module joint tuning stage, linear image quality tuning includes multiple sets of ISO illuminance under the optimization of image quality, starlight level sensor generally needs to the highest ISO 204800, and ISO linkage BayerNR, Demosaic, sharpen, YUVNR, 3DNR, Dehaze, In addition to the open Mipi interface parameters of the enhanced and other algorithm modules, there are default parameters that will change according to the ISO linkage.

The scene of linear mode debugging mainly includes laboratory static scene and outdoor actual scene, generally using laboratory static scene to simulate each ISO scene, and then debugging the brightness, color, transparency, clarity, and noise under each illuminance. Then, on this basis, it is necessary to fine-tune according to the different application scenarios of IPC in the actual scene, covering the day and night scenes of traffic intersections, outdoor night low-light scenes, outdoor daytime scenes with rich texture details, including sunny and cloudy weather, outdoor evening sunset detailed texture scenes, etc. The specific tuning scenario sequence of the linear mode is shown in Figure 3-3.

Figure 3-3 Linear mode image tuning scene graph

The basic flow of linear mode ISP image quality attention dimension debugging is shown in Figure 3-4.

Figure 3-4 Image quality attention dimension debugging flowchart

Brightness dimension:

The main debugging module of the brightness dimension is AE, which mainly includes the tuning of the target value of AE, the tuning of AE Route, the tuning of the weight table of AE, and the tuning of convergence speed and smoothness of AE. The environment that needs to be prepared before adjusting AE: black level calibration is correct, Shading calibration is complete, AWB and CCM calibration are correct, a set of gamma parameters is preset for different modes, etc.

Step 1: The first step in AE tuning is to determine the weight table for AE. AE weight table determines the area of interest of AE exposure, different application requirements, AE weight table will also be different, generally for IPC application scenarios, the subject of the scene is the middle part of the picture, it is recommended to set the AE weight table in the middle part of the picture higher than the surrounding part. Figure 3-5 shows an example of an AE weight table:

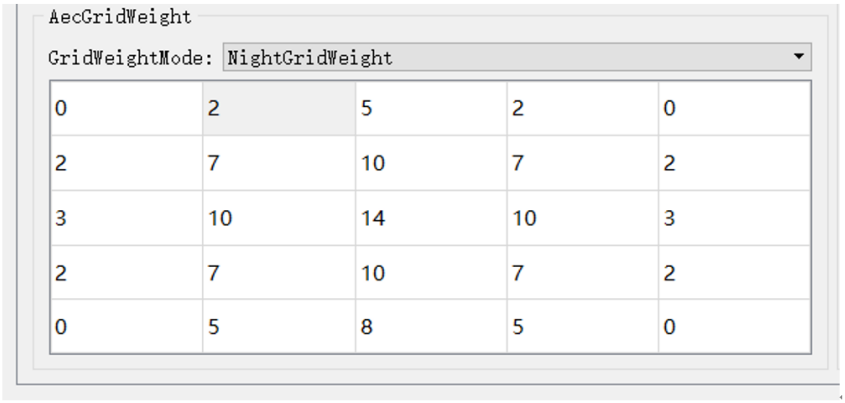


Figure 3-5 AE weight table

Step 2: On the basis of determining the AE weight table, the next step is to determine the route of AE, which mainly determines the distribution method of exposure, that is, the distribution of exposure time and gain. Different scenes need to set different AE routes, such as need to pay attention to fast-moving objects, need to give priority to the use of gain and limit exposure time, such as daytime scene capture license plate, generally need to limit the exposure time to 2~4ms, at this time the exposure is prioritized on the gain, such as night low-illumination scenes, at this time in order to balance the noise performance of the picture, the exposure needs to be appropriately prioritized on the exposure time.

Step 3: On the basis of determining the AE weight and AE route, the next step is to adjust the target value of AE according to different exposures, for laboratory static scenes, the debugging standard of AE target value is that the highest area in the center of the picture is no obvious overexposure, as shown in Figure 3-6 static scene schematic diagram, the texture card in the middle, ceramic coffee cup can not be overexposed, corner dead leaf map and rose brightness is reasonable. The AE target value mainly involves SetPoint, DynamicSetpoint adjustment, and the selection of AE backlight mode.

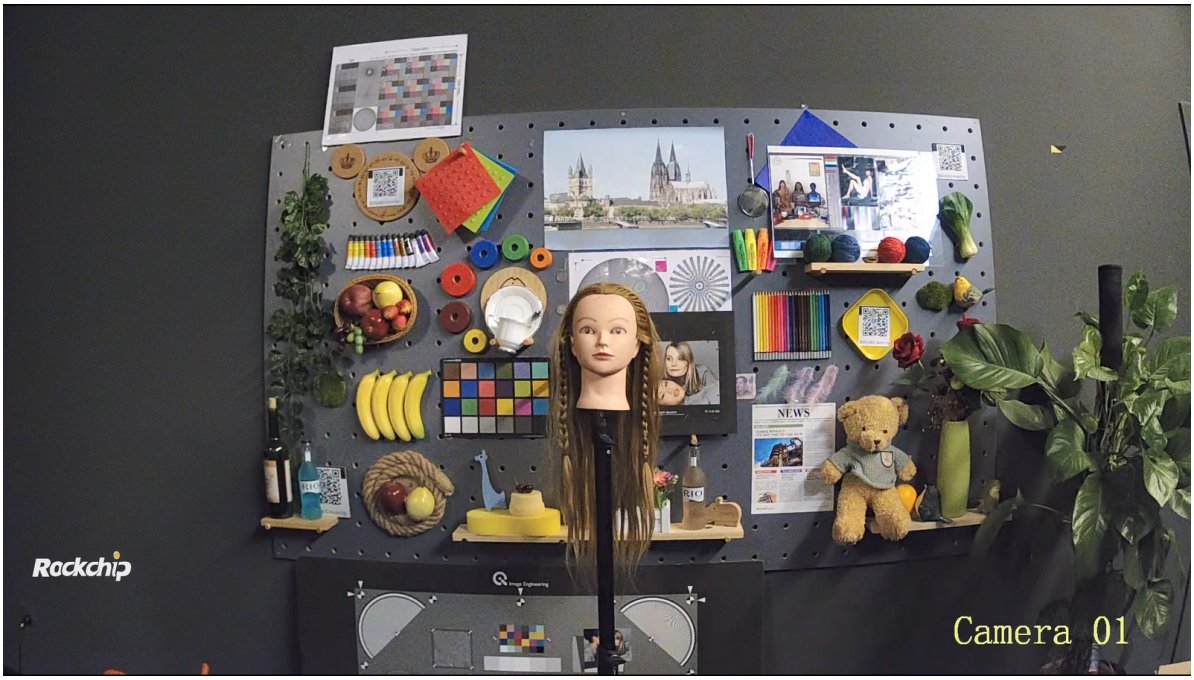


Figure 3-6 Schematic diagram of static scene

Step 4: Finally, you need to adjust the convergence speed and AE smoothness of AE, AE convergence speed and AE smoothness are a pair of balance points. Under the premise of preventing AE oscillation, it is possible to appropriately increase the convergence speed of AE, especially for driving recorders and sports DV application scenarios, and it is necessary to appropriately increase the AE convergence speed to adapt to the drastic changes of the scene. The convergence speed and convergence stability of AE can generally be tested by switching lights in laboratory still life scenes.

For specific parameter adjustment of AE module, please refer to the description chapter on AE in the AE module introduction of this document. It should be noted that the LSC module also affects the brightness of the image, so LSC recommends linkage attenuation according to ISO to avoid noise that will cause vignetting of the image to become larger in the case of slightly lower illumination.

----Come to an end

Color dimension:

On the basis of reasonable AE adjustment, the next main adjustment of color-related parameters, mainly involved modules are AWB and CCM. The environment that needs to be prepared before color: accurate black level correction, LSC calibration completed, and reasonable debugging of AE module parameters.

Step 1: In the laboratory lightbox scene, you need to capture the raw calibration of seven groups of 24 color cards at different color temperatures (D75, D65, D50, TL84, CWF, A, HZ) to obtain the AWB static white balance coefficient and generate a white balance white point condition box. For details, please refer to Subsection 4 of Chapter 4 of Rockchip_IQ_Tools_Guide_ISP32.

Step 2: Using the RAW diagram for AWB calibration, use the tool to generate the CCM matrix at the saturation of the corresponding light source.

Before that, you need to confirm the gamma curve used, generally default gamma 2.2, if you have special requirements for gamma, you need to fill in the gamma curve first. The operation interface reference is as follows:

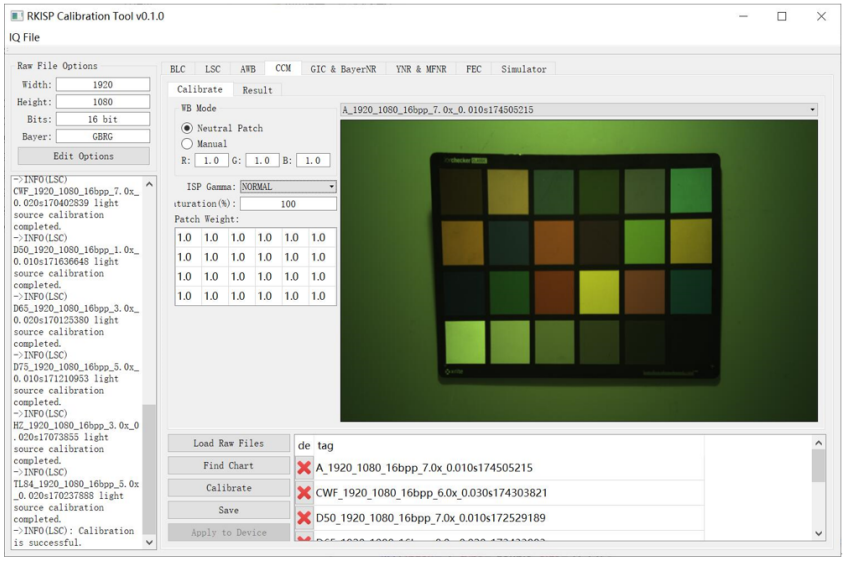


Figure 3-7 CCM calibration interface

Step 3: After completing steps 1 and 2, we can take 24-color card pictures of each light source in the standard light box, and test the color indicators of the 24-color card with imatest software. If the indicators meet the requirements, the AWB parameters and CCM matrix obtained by calibration can be preliminarily determined to meet the requirements.

Step 4: The parameter rationality of AWB and CCM modules also requires a lot of testing and debugging of practical application scenarios. Typical practical application scenarios include typical outdoor scenes, including front light, backlight, cloudy days, sunset, night, and mixed light sources. If there are gray blocks in the scene and the restoration is inaccurate, you need to adjust the AWB parameters, and some colors in the scene are color-cast, oversaturated or light, we recommend that you prioritize the parameters of CCM. For mixed light source application scenarios, you need to adjust the scene detection parameters in AWB, and if the skin tone of the characters in the actual scene is not accurately restored, you need to adjust the CCM parameters or 3Dlut parameters.

For specific tuning of AWB and CCM modules, refer to Rockchip_Color_Optimization_Guide_ISP32

----Come to an end

Contrast dimension

On the basis of the reasonable brightness dimension and color dimension, the next step is to optimize the contrast dimension. The modules that affect the contrast mainly include Gamma, Dehaze, Enhance, etc., and the general focus is on Gamma parameter adjustment in different scenarios, and Dehaze and Enhanced are auxiliary modules.

Prepare environment before adjusting contrast: black level correction is correct, LSC calibration is complete, AE exposure adjustment is reasonable, AWB and CCM parameters are reasonably calibrated.

Step 1: Adjust gamma parameters, which are the basic modules of image image contrast, taking static real scenes as an example, by adjusting Gamma parameters, the skin tone card in the middle of the picture and the light and dark textures of the edge three-dimensional plants are not lost, and the contrast visual experience of the picture is better. The following figure is shown.

Figure 3-8 Example of an area affected by a gamma curve in a static scene

Step 2: On the basis of adjusting the Gamma parameters, if you have higher requirements for the contrast of the image, you can adjust Dehaze or Enhanced to improve the contrast. For tuning instructions for Dehaze and Enhance, see sections 4.21 "Dehaze" and 4.22 "Enhance".

Step 3: On the basis of optimizing the contrast related parameters, it is necessary to objectively test the overall contrast effect, test the grayscale card in the D65 light source environment, observe whether the gray order can reach more than 18 steps, and test whether it can reach 14steps with imatest.

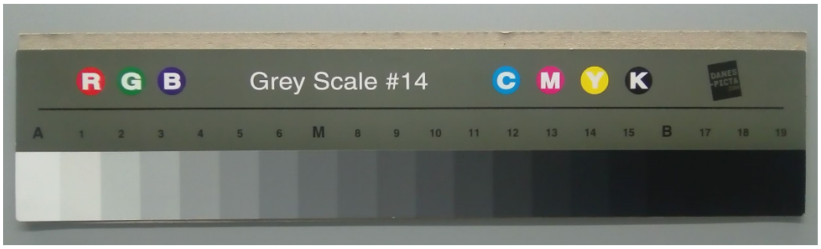


Figure 3-9 Example grayscale card in the environment of D65 light source in the laboratory lightbox and imatest analysis results

Step 4: In the actual static scene, you need to adjust Gamma, Dehaze, Enhance and other parameters according to different applications and different illuminance to achieve contrast balance in each scene. Of course, under normal illumination and low illumination, there will be certain differences in contrast debugging styles, such as night mode, Gamma will appropriately lower the dark area to reduce the burden of dark area noise.

----Come to an end

Clarity and noise dimension

Clarity and noise is a pair of balance points, due to different illuminance, the noise performance of the image is also different, normal low illumination, the noise of the picture will be more serious, very affect the visual experience, so we will appropriately sacrifice the requirements of clarity, so the parameters of clarity and noise need to be controlled according to different ISO scenes.

For the debugging of clarity and noise dimension, it is recommended to give priority to clarity first, and show the sharpened details before noise reduction, if debugging in the actual on-demand environment, you need to set the encoding bitrate high and the 3DNR level to the minimum, and observe whether the details of the still picture are sharpened. Under the premise that the clarity meets the requirements, the noise reduction module is debugged to finally achieve the balance between clarity and noise.

Adjust the sharpness and noise preparation environment: black level correction is correct, LSC calibration is completed, AE exposure adjustment is reasonable, AWB and CCM parameter calibration is reasonable, Gamma/Dehaze/Enhance and other adjustments are reasonable.

Modules that affect clarity and noise mainly include Bayer NR, Demosaic, DPCC, YNR, UVNR, 3DNR, sharpen, Edgefilter, etc.

Step 1: The first threshold for basic texture detail in an image is Demosaic. Before debugging the module, we need to confirm that the black level calibration is accurate, the RawNR calibration is reasonable, and the AWB/CCM calibration is reasonable.

First of all, we need to debug the Demosaic parameter against the resolution card under the D65 light source in the laboratory lightbox environment under the ISO50 light source, so that the resolution of the resolution card meets the objective index requirements, and at the same time, we need to check whether the high-frequency texture of the star map in the static scene can be interpolated in the ISO50 environment, so as to iterate back and forth. The other ISOs then need to be debugged in the same way to balance the high-frequency noise with the noise from the interpolated values and whether the clarity is appropriate. Figure 3-10 shows a schematic diagram of a resolution card in the environment of the D50 light source. The red frame is for the 4:3 field of view, and the basket frame is the center area of interest. For specific debugging methods of Demosaic, please refer to section 4.4 "Demosaic".

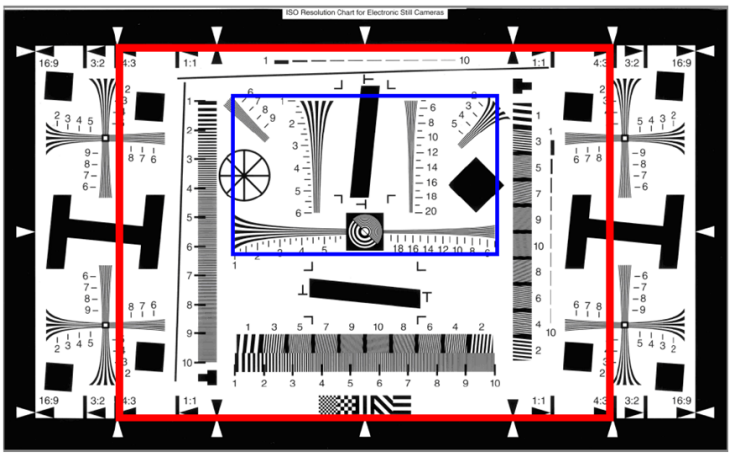


Figure 3-10 Schematic diagram of the clarity card in the environment of the laboratory light box D65 light source

Step 2: After the parameters of Demosaic are properly debugged, the next step is to focus on the BayerNR, YNR, UVNR, 3DNR and Sharpen and DPCC modules.

Before debugging the Bayer NR module, confirm that the black level calibration is accurate, the RawNR calibration is reasonable, and the AWB/CCM calibration is reasonable.

Bayer NR, as the front-stage noise processing module, should not open the intensity too large, otherwise the clarity of the picture will be lost. For specific tuning methods of Bayer NR, please refer to section 4.5 "Bayer NR".

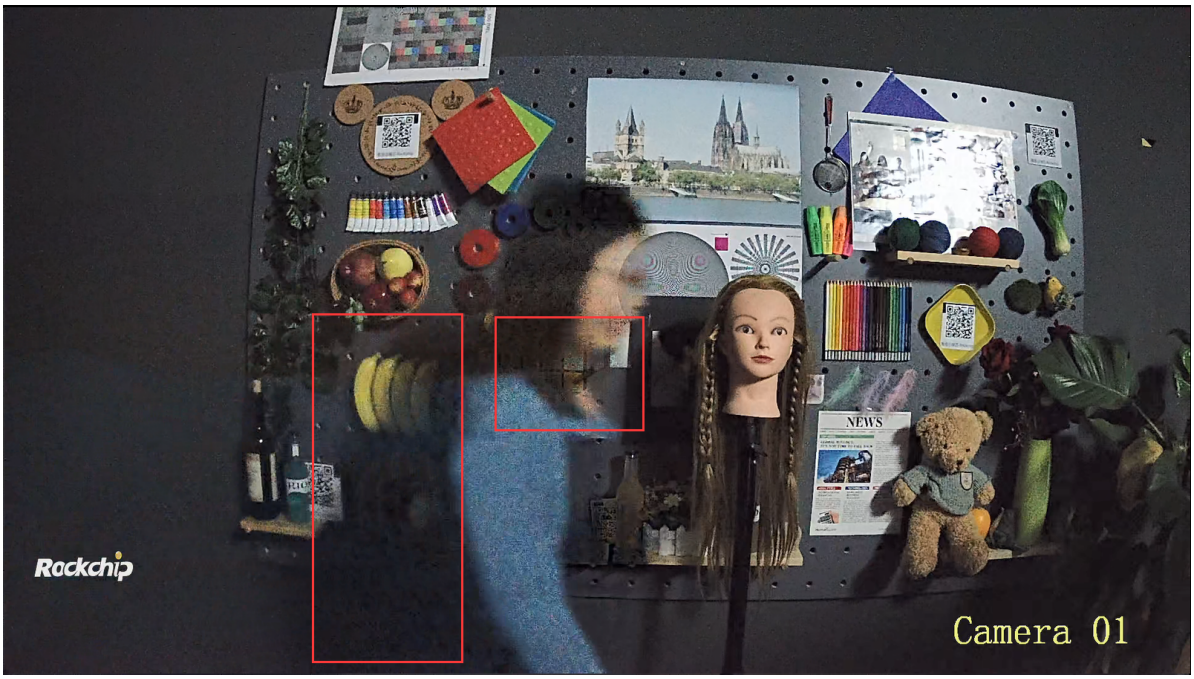
Step 3: YNNR and UVNR are the noise reduction modules that need to be debugged, for the high-frequency, low-frequency, and medium-frequency noise of the picture, YNR can independently control the intensity of the force, and UVNR is used to remove color noise, and its intensity does not affect the clarity, but excessive force will lead to color distortion. For specific tuning methods of YNNR and UVNR, please refer to Section 4.6 "YNNR and UVNR".

Step 4: The debugging criteria of sharpen and Edgefilter mainly adjust the texture details and edge sharpness of the image to the appropriate, taking the laboratory static scene as an example, sharpen and Edgefilter two modules need to sharpen the details of the still life scene such as green vine, green algae, bear and hemp rope before the image passes through 3DNR, and also sharpen the strong edges such as the circle star map in the center. The following figure is shown. For specific tuning methods of sharpen and edgefilter, please refer to section 4.7 "sharpen and edgefilter".

Figure 3-11 Static scene ISO50 needs to focus on sharpened texture schematic

Step 5: DPCC de-dynamic dead pixel intensity only needs to be confirmed clearly in scenes with slightly lower illumination. Scenes with good illumination suggest that the DPCC level is weak. For specific debugging methods of DPCC, please refer to Section 4.8 "DPCC".

Step 6: 3DNR is the key point in the overall balance between noise and sharpness, mainly including DEC, REC and NR adjustment. The module breaks down the noise into different frequency bands, removes them separately, and then fuses them. When optimizing 3DNR, we should pay attention to the edges of moving objects, the degree of smearing of moving objects, and the acceptability of overall noise. As shown in the red frame of the figure below, the motion blur state of the character and the overall noise need to be balanced. For specific debugging methods of 3DNR, please refer to Section 4.9 "3DNR".



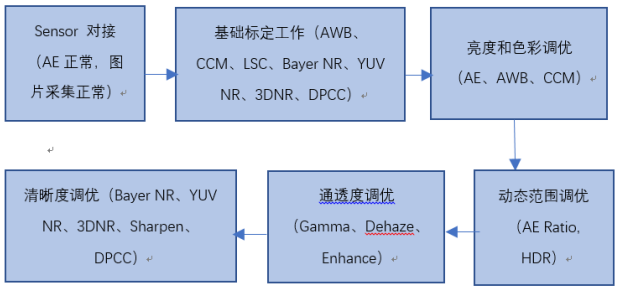
3-12 Schematic diagram of 3DNR test points

Step 7: After the above steps are completed, the final effect needs to be tested comprehensively under each ISO, and fine-tuning needs to be made when necessary to achieve the overall clarity and noise balance.

----Come to an end

1.2 3.1.2 HDR mode image quality tuning

For HDR mode, image quality mainly focuses on the following dimensions: dynamic range, brightness, clarity and noise, transparency, color reproduction, and sports tailing performance, among which the modules involved in brightness mainly include AE and LSC; The dynamic range mainly depends on the exposure ratio control, and the modules mainly involved in sharpness and noise are Bayer NR, Demosaic, DPCC, YNR, UVNR, 3DNR, sharpen, Edgefilter, etc.; Permeability mainly affects modules such as Gamma, Dehaze, Enhance, etc.; Color reproduction involves modules such as AWB, CCM, and 3DLUT; The severity of a sports tail depends on the control and exposure ratio of the HDR parameters. Most of the typical application scenarios of HDR include face acquisition under backlight or license plate acquisition under strong light. The entire architecture diagram of HDR mode image tuning is shown in Figure 3-13.



3-13 HDR mode image tuning architecture diagram

Before HDR mode image quality tuning, it is necessary to dock the sensor and calibrate the lens module, and the sensor docking steps can refer to the explanation of the sensor docking in summary 3.1.1. In the calibration of lens modules, AWB, Shading, Bayer NR and other modules can refer to the parameters of linear mode calibration, if the HDR mode of the sensor is HCG/LCG mode, it is necessary to follow up different modes to calibrate Bayer NR, YUV NR, 3DNR and other modules. Since CCM is after HDR TMO, the TMO module destroys the linear relationship of data, so CCM in HDR mode needs to make appropriate adjustments:

1. The saturation calibration value is about 80%~90%;
2. If individual colors appear abrupt, you can fine-tune them with 3D lut.
3. Appropriately reduce the TMO module's greatly improved brightness and reduce the impact on color reproduction. When the brightness is insufficient, you can consider using the Gamma module to co-debug with HDR TMO.

```
After completing the sensor docking and sensor lens calibration, the next step is to optimize the image mainly for the dimensions of image quality in HDR mode.
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HDR backlit scene to enhance face brightness application scenario debugging guide

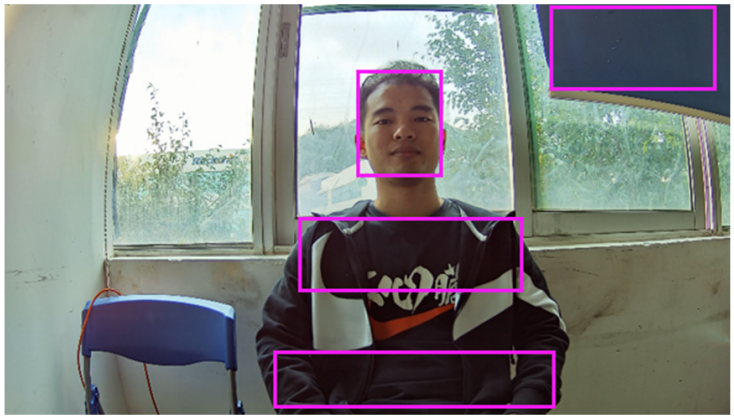
1. **Brightness dimension:**

   HDR brightness dimension, here mainly refers to the rationality of AE exposure, mainly through debugging the AE module, AE module has HDR AE and linear AE two sub-control modules. Part of the difference between HDR AE and linear AE is that it mainly adjusts the exposure ratio of AE to determine the exposure time of long and short frames. Other parameters of AE include AE weight table, AE route, AE target value, and AE convergence speed and smoothness, which can be referred to the brightness dimension subsection of 3.1.1 "Linear Mode Image Quality Tuning".

   The exposure ratio of HDR AE determines the dynamic range of HDR mode images, so HDR mode is used for different scene dynamic ranges, and the exposure ratio of HDR AE needs to be adjusted adaptively. The mode of HDR AE exposure ratio supports the automatic exposure ratio mode, the so-called automatic exposure ratio, that is, HDR AE will automatically calculate the dynamic range of the scene according to the histogram of the scene to get a reasonable exposure ratio, the rationality of the exposure ratio is reflected in the bright area details are not exposed and the long frame brightness is reasonable. HDR AE uses long frame exposure as a benchmark and determines short frame exposure by exposure ratio.

   In HDR mode, short-frame images are preferred for bright areas and long-frame images are used for dark areas. In a backlit scenario, the face is in the dark area of the scene, and the steps to improve the brightness of the face are as follows:

   1. Improve the brightness of long frame images by adjusting AE parameters including weight table, AE route, AE long frame target value, etc.
   2. Improve the brightness of dark areas by adjusting HDR TMO module parameters, including DetailsLowLight.
   3. By limiting the maximum exposure ratio, the dynamic range of the image is controlled, which will also slightly increase the brightness of the dark areas to some extent.



3-14 Schematic diagram of dark areas in long frames

1. **Motion smearing dimension of the composition area:**

   HDR mode affects images in the compositing area from long and short frames, respectively. In principle, motion smearing is caused by the time difference between the exposure time of long frames and short frames, and the movement of image content. The exposure ratio of the main HDR module and HDR AE is adjusted for this dimension, and the larger the exposure ratio, the greater the probability of motion smearing

in the composite area.

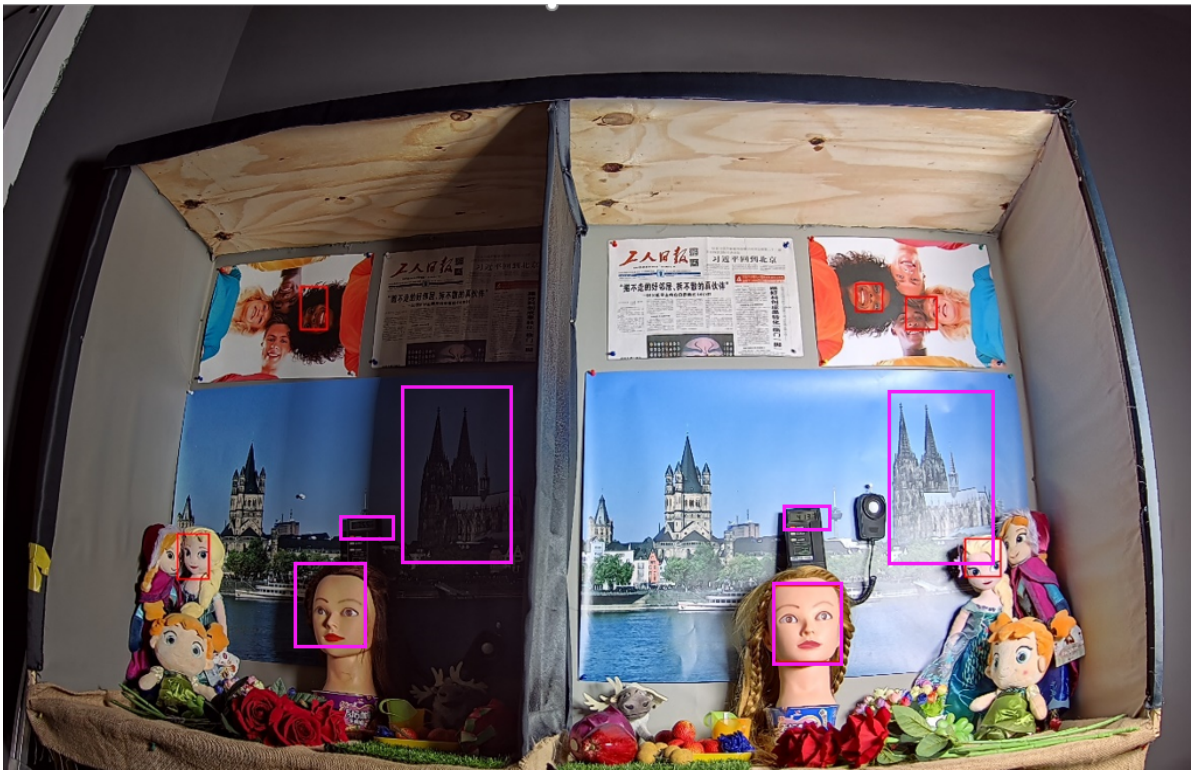
1. Take into account the dynamic range of the scene and motion smearing, and debug the HDR AE exposure ratio reasonably.
2. Under the same exposure ratio condition, reduce the exposure delay of long and short frame times by adjusting the exposure time of short frames, and then reduce the degree of smearing.
3. Reduce the probability of misusing short frames in the composition area due to motion by adjusting the OECurve_XXX and MDCurve_XXX parameters of the HDR MERGE module, thereby reducing the situation of motion tailing.

3-15 HDR composite area motion tailing diagram

Scene dynamic range dimension:

HDR mode affects image dynamic range including: AE's exposure ratio, HDR DRC module, and Gamma module. Debug the entry conditions of the DRC module: correct black level calibration, Shadimng calibration completed, reasonable debugging of AE module, complete AWB and CCM calibration, preset a set of Gamma parameters.

As shown in Figure 3-14, a similar scene is arranged in a separate box, a lux meter is put in, and dimmable LED fill lights are placed at 45 degrees on both sides of the box, so that scenes with different dynamic ranges can be simulated.



3-14 Dynamic range tuning scenario

Color dimension:

Please refer to the color debugging method in linear mode; Note that due to the Tonemap in HDR mode, the color performance is slightly different from linear, and it is recommended to reduce the saturation appropriately according to the situation after calibration.

Contrast dimension:

Please refer to the contrast debugging method in linear mode;

Clarity and noise dimensions:

Please refer to the sharpness and noise debugging method in linear mode;

4 Module introduction

This chapter mainly introduces the functions of each module and parameter description, in which the parameters are stored in firmware as XML files, and some parameters can be debugged with debugging tools. The parameter description format in this section is briefly described as follows:

" " : Indicates that the parameter is in string form

xxx/yyy: Represents the yyy element entity in the xml file is a xxx child element entity

1. 4.1 AEC

1.1 4.1.1 Feature description

The AE module is mainly composed of two parts: the metering statistics module and the AE control algorithm module. The metering statistics module enters the brightness statistics for the AE control algorithm module, and the luminance statistics include histogram statistics and block average brightness statistics. The statistics mainly include the following parts: 256-segment weighted histogram statistics based on RAW graph, R/G/B/Y mean statistics based on RAW plot; 32-segment weighted histogram statistics based on gamma pre-RGB plot, and chunked R/G/B/Y mean statistics based on gamma pre-RGB plot.

The AE control algorithm module compares the input luminance statistics value with the target brightness, calculates the new exposure, and finally automatically assigns the sensor exposure time, exposure gain and lens aperture value to obtain an image of suitable brightness.

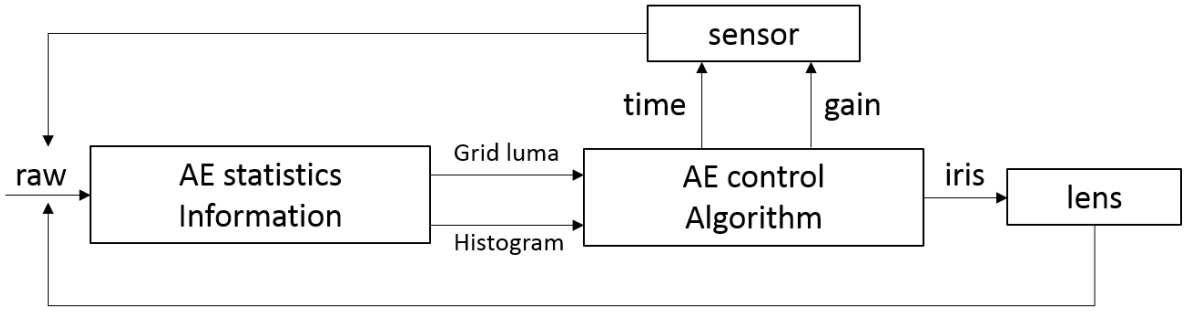


Figure 4-1 AEC module schematic

1.2 4.1.2 Key parameters

The parameters of the AEC module are roughly divided into public function control parameters, linear exposure debugging parameter modules, and HDR exposure debugging parameter modules according to functions. In addition, this section will also introduce the system parameters SensorInfo parameters and System parameters related to exposure, and their specific functions are detailed in the module description.

1.2.1 4.1.2.1 AEC module common function control parameters

Parameter name	Parameter type	Brief description
Enable	Debug parameters	User debugging parameters
AecRunInterval	Debug parameters	User debugging parameters
AecOpType	Debug parameters	User debugging parameters
HistStatsMode	Debug parameters	User debugging parameters generally use the default value
RawStatsMode	Debug parameters	User debugging parameters generally use the default value
YrangeMode	Debug parameters	User debugging parameters generally use the default value
AecSpeed	Debug parameters	User debugging parameters
AecDelayFrmNum	Debug parameters	User debugging parameters
AecFrameRateMode	Debug parameters	User debugging parameters
AecAntiFlicker	Debug parameters	User debugging parameters
AecGridWeight	Debug parameters	User debugging parameters
AecManualCtrl	Debug parameters	User debugging parameters

1.2.1.1 Enable

【Description】

AEC module switch function. 0: Close; 1: Open

【Notes】

- When the Enable value is 0, the AEC algorithm is turned off. The exposure remains at the value before it turned off.

1.2.1.2 AecRunInterval

【Description】

The AE algorithm runs at a value range of [0,255], and the default value is 0. If the value is 0, run AE every frame; If the value is 1, run AE every 1 frame; And so on.

It is recommended that this value should not be too large, otherwise it may cause slow and unsmooth AE response

1.2.1.3 AecOpType

【Description】

Exposure modes, divided into auto exposure (RK_AIQ_OP_MODE_AUTO) mode / manual (RK_AIQ_OP_MODE_MANUAL) exposure mode.

Manual exposure mode needs to be used in conjunction with AecManualCtrl to set the manual exposure value.

The AecManualCtrl parameters are detailed below.

1.2.1.4 HistStatsMode

【Description】

AEC module histogram statistical mode. There are five modes: CAM_HISTV2_MODE_Y/R/G/B/RGB, and the default is Y mode.

1.2.1.5 RawStatsMode

【Description】

AEC module luminance statistics mode. There are four modes: CAM_RAWSTATSV2_MODE_Y/R/G/B, and the default is Y mode.

1.2.1.6 YrangeMode

【Description】

Aec module Y-channel Range mode. The two modes are CAM_YRANGEV2_MODE_FULL/LIMITED, and the default is FULL mode.

This parameter is only valid when RawStatsMode is in Y mode.

1.2.1.7 AecGridWeight

【Description】

Count the weights of each subwindow of the main window, including 15x15 parameters

【Notes】

- The 1106 platform hardware can support the weight setting of 5X5 and 15X15 specifications, and the weight of 15X15 is uniformly set in the debugging file, and the weight is compressed or expanded according to the actual hardware configuration within the algorithm.

1.2.1.8 AecWinScale

【Description】

AE module hardware statistics window size ratio configuration parameters

【Member】

Member name	description
InputRaw	The AE hardware statistics window size ratio configuration parameter based on the raw graph contains a total of 4 parameters, corresponding to [h_off,v_off,h_size,v_size], and the range=[0,1] of each parameter
TmoRaw	The AE hardware statistics window size ratio configuration parameter based on the raw graph after the TMO module contains a total of 4 parameters, corresponding to [h_off, v_off, h_size, v_size], and the range=[0,1] of each parameter
Yuv	The AE hardware statistics window size ratio configuration parameter based on yuv diagram contains a total of 4 parameters, corresponding to [h_off,v_off,h_size,v_size], and the range=[0,1] of each parameter

【Notes】

- The window size ratio configuration parameter is based on the sensor resolution, set the corresponding scale value, where the scale configuration parameter range=[0,1]. The h_off and v_off represent the horizontal and vertical offset values of the upper left corner of the hardware statistics window relative to the sensor-sensitive area, respectively. The h_size and v_size represent the horizontal and vertical dimensions of the hardware statistics window, respectively.
- The resolution of the sensor is expressed in res, and the actual configured hardware window offset value is [res x h_off, res x v_off]; The actual configured hardware window size value is [res x h_size, res x v_size].
- The sum of the offset value and size value of the hardware window cannot exceed 1, that is, the requirement is h_off + h_size <=1, v_off + v_size <=1.

1.2.1.9 AecManualCtrl

【Description】

Manual exposure parameter setting, according to the exposure mode is divided into LinearAE and HdrAE two sets of parameters.

【Member】

Member name	Description
ManualTimeEn	Manual exposure time enabled, default value is 1
ManualGainEn	Manual exposure time enabled, default value is 1
ManualIspDgainEn	Manual ISP digital gain enabled, default value is 1
TimeValue	Manual exposure time values, in s, parameter values limited by sensor
GainValue	Manual sensor gain value, where the gain value is the actual value in units of 1x, and the parameter value is limited by the sensor
IspDGainValue	Manual ISP digital gain value, where the gain value is the actual value, the unit is 1x, and the parameter value is limited by the ISP

【Notes】

- This module only works when AeOptype = MANUAL. ManualTimeEn, ManualGainEn, ManualIspDgainEn are all 1, which is manual mode; As long as any of the above three is not enabled, it is semi-automatic mode; If all three of the above are 0, it is equivalent to automatic mode, and the system will **report an error reminder**.
- In manual/semi-manual mode, the manual exposure time and gain are limited by the maximum/minimum exposure time and gain in automatic mode. After the auto exposure limit is exceeded, the maximum/minimum value in auto mode is used instead.

1.2.1.10 AecSpeed

【Description】

Auto exposure adjusts the speed attribute.

【Member】

Member name	Description
SmoothEn	Smooth switch On: Enables exposure smoothing Off: Turns off exposure smoothing to increase exposure adjustment
DampOver	The ambient brightness is stable, and the corresponding exposure adjustment speed when the image brightness is higher than the target value, the value range [0,1]
DampUnder	The ambient brightness is stable, and the corresponding exposure adjustment speed when the image brightness is lower than the target value, the value range [0,1]
DampDark2Bright	Sudden change in ambient brightness, corresponding exposure adjustment speed from dark to light, value range [0,1]
DampBright2Dark	Sudden change in ambient brightness, corresponding exposure adjustment speed from light to dark, value range[0,1]
DyDamp	Dynamic exposure adjustment speed module

The members of DyDamp are as follows

Member name	Description
DyDampEn	Dynamic adjustment speed switch ON: the exposure adjustment speed is dynamically adjusted with the brightness of the scene; Off: The exposure adjustment speed is fixed at DampOver/DampUnder/DampDark2Bright/DampBright2Dark value
SlowOPType	Deceleration convergence mode: including manual mode (RK_AIQ_OP_MODE_MANUAL) and automatic mode (RK_AIQ_OP_MODE_AUTO)
SlowRange	The brightness range corresponding to deceleration convergence is only valid at SlowOPType=RK_AIQ_OP_MODE_MANUAL, and the value range is [0,100], unit percentage. Represents the current brightness when the target brightness ± SlowRange, using SlowDamp as the exposure adjustment speed.
SlowDamp	The exposure adjustment speed corresponding to deceleration convergence is only effective at SlowOPType=RK_AIQ_OP_MODE_MANUAL, and the value range is [0,1].

【Precautions】

- Automatic exposure adjustment damping coefficient, by adjusting the weight of the current exposure value and the current exposure value, to achieve the adjustment of the exposure speed. Final exposure value = current exposure value x DampCoef + new exposure value x (1 - DampCoef)
- The greater the damping factor of the AE adjustment, the slower the exposure adjustment and vice versa. In order to ensure a smooth adjustment process, it is recommended to set the adjustment speed within the range of [0.4, 0.7].
- Use DampDark2Bright/DampBright2Dark as the speed adjustment damping coefficient when the ambient brightness changes abruptly (dark becomes brighter/light becomes darker); When the ambient brightness is stable, DampOver/DampUnder is used as the speed adjustment damping coefficient during AE convergence. It is recommended that the DampDark2Bright/ DampBright2Dark value is less than DampOver/DampUnder, the DampDark2Bright value is less than DampBright2Dark, and the DampOver value is less than DampUnder.
- SmoothEn is enabled by default, which makes the auto exposure transition smooth; For applications that require fast convergence, such as dictionary pens, which have no requirements for smoothing, you can turn off.
- DyDamp Dynamic Exposure Adjustment Speed Module dynamically adjusts exposure speed based on the gap between the current brightness and the target brightness range. When SlowOPType = RK_AIQ_OP_MODE_AUTO, the dynamic exposure speed adjustment mechanism inside the algorithm is used by default (parameters are not adjustable); When SlowOPType = RK_AIQ_OP_MODE_MANUAL, you can manually set the brightness range (controlled by the SlowRange parameter) and the specific deceleration value (controlled by the SlowDamp parameter) to be decelerated.

1.2.1.11 AecDelay

【Description】

Auto exposure triggers the time-lapse property

【Members】

Member name	Description
DelayType	Delay modes, including frame delay mode DELAY_TYPE_FRAME and time delay mode DELAY_TYPE_TIME. DELAY_TYPE_FRAME: The delay unit is frames; DELAY_TYPE_TIME: The delay unit is fixed at 1/30 second
BlackDelay	Auto exposure triggers the delay property, which changes in units with DelayType. When the image brightness falls below the target value and exceeds BlackDelay, Ae starts to adjust
WhiteDelay	Auto exposure triggers the delay property, which changes in units with DelayType. When the brightness of the image exceeds the target value and exceeds WhiteDelay, Ae starts to adjust

【Precautions】

- BlackDelay/WhiteDelay should not be too large, otherwise it will cause the AE trigger response to be too slow and there will be a significant step brightness change.
- When DelayType=DELAY_TYPE_TIME, the time of delayed response = 1/30*BlackDelay(WhiteDelay), in seconds.

1.2.1.12 AecFrameRateMode

【Description】

Auto exposure frame rate mode, which can be divided into fixed frame rate mode and automatic frame reduction mode

【Members】

Member name	Description
isFpsFix	Frame rate mode selection, the default value is 0, that is, the automatic frame reduction mode is adopted; A value of 1 indicates a fixed frame rate mode.
FpsValue	isFpsFix=0 indicates the highest frame rate of the automatic frame reduction mode. When the default value is 0, the frame rate in the driver setting is used as the highest frame rate; If the value is not 0, the set frame rate is used as the maximum frame rate. isFpsFix=1 is used to represent a fixed frame rate value for fixed frame mode. When the default value is 0, the frame rate in the driver setting is used as the fixed frame rate; If the value is not 0, the set frame rate is used as the fixed frame rate.

【Precautions】

- Fixed frame rate mode: requires isFpsFix to be enabled. When FpsValue is 0, the default frame rate in the driver is used. If the value is not 0, the set frame rate value is used. When the set frame rate value is greater than the default frame rate in the driver setting, there will be a warning reminder and the frame rate setting is invalid. In fixed frame rate mode, the maximum exposure time will be determined by both the frame rate and the maximum exposure time set in AecRoute. When the maximum exposure time set in AecRoute exceeds the limit of the current fixed frame rate, the maximum exposure time is corrected internally by the algorithm.

- Automatic frame reduction mode: when isFpsFix is required to be set to 0 and FpsValue is 0, the frame rate in the driver setting is used as the highest frame rate; If the value is not 0, the set frame rate is used as the maximum frame rate. When the set frame rate value is greater than the default frame rate in the driver setting, there will be a warning reminder and the frame rate setting is invalid. The minimum frame rate for the auto-frame reduction mode is determined by the combination of the maximum exposure time in AecRoute and CISMinFPS in SensorInfo. When the maximum exposure time in AecRoute exceeds the maximum exposure time allowed by CISMinFps, this value is corrected internally by the algorithm. After the current exposure is decomposed, if the exposure time is greater than the exposure time allowed by driving the default frame rate, the exposure time will be improved by modifying the vblank value to reduce the frame rate; If the exposure time is less than or equal to the exposure time allowed by the drive's default frame rate, the current frame rate is set to the drive's default frame rate. The specific implementation of automatic frame reduction depends on the AecRoute parameter, sets the gain threshold in AecRoute, and triggers frame reduction when the gain is greater than the threshold.

1.2.1.13 AecAntiFlicker

【Description】

Auto exposure anti-power frequency flicker property

【Members】

Member name	Description
enable	The anti-power frequency flicker function is enabled, when the value is 1, the anti-power frequency flicker function is turned on, and vice versa.
Frequency	Set the power frequency in two types: AECV2_FLICKER_FREQUENCY_50HZ and AECV2_FLICKER_FREQUENCY_60HZ
Mode	Anti-power frequency flicker working mode, a total of two modes: AECV2_ANTIFLICKER_NORMAL_MODE mode, AECV2_ANTIFLICKER_AUTO_MODE mode. Through different working modes, the exposure time is adjusted to achieve anti-power frequency flicker

【Precautions】

- When enable is 0, the anti-flash function is turned off.
- NORMAL anti-flash mode: Minimum exposure time and exposure time adjustment step fixed to 1/120 s (60Hz) or 1/100 s (50Hz). Therefore, in a high-brightness environment, overexposure may occur. In a lit environment, the exposure time can be matched to the frequency of the light source, which can prevent the image from flickering
- AUTO anti-flash mode: the exposure time is adjusted according to the brightness, the minimum exposure time can reach the sensor's minimum exposure time, and the difference from the normal anti-flash mode is the high brightness environment, which can suppress overexposure, but the anti-flash fails.
- Power frequency flicker cannot be completely eliminated, and it is necessary to select the appropriate working mode mode according to the current usage scenario and product application. The NOMRAL mode can completely suppress power frequency flicker, but overexposure will occur in the bright environment, and the image information will be lost; AUTO mode can avoid overexposure, but power frequency flicker will occur in bright environments, it is recommended to set the frame rate to 30fps (60HZ) or 25fps (50HZ).

1.2.1.14 AecEnvLvCalib

【Description】

Ambient brightness calibration parameters

【Members】

Member name	Description
Enable	Ambient brightness calculation module switch, 0: off; 1: Turn on
CalibFNumber	The relative aperture size of the reference for ambient brightness calibration, which is lens dependent
CurveCoeff	Ambient brightness calibration curve coefficient

【Precautions】

- This parameter is temporarily invalid, Enable defaults to 0, and the ambient brightness calibration function is temporarily unavailable

1.2.2 4.1.2.2 AEC Module Linear Exposure Debugging Parameters

Parameter name	Parameter type	Brief description
RawStatsEn	Debug parameters	The user debugging parameter is generally the default value
EvBias	Debug parameters	User debugging parameters
ToleranceIn/Out	Debug parameters	User debugging parameters
StrategyMode	Debug parameters	User debugging parameters
Route	Debug parameters	User debugging parameters
InitExp	Debug parameters	User debugging parameters
DySetpoint	Debug parameters	User debugging parameters
BackLightCtrl	Debug parameters	User debugging parameters
OverExpCtrl	Debug parameters	User debugging parameters

1.2.2.1 RawStatsEn

【Description】

Linear exposure supports exposure calculation using Raw domain statistical luminance or RGB domain statistical luminance, which can be switched according to specific application needs. By default, the RAW chart statistic value is used, that is, the position 1.

- RawStatsEn = 0, indicating that the exposure is calculated using the statistical values of the RGB plot (before gamma).
- RawStatsEn = 1, indicating that the exposure is calculated using the statistical value of the raw plot (blacked level reduced and multiplied by the white balance gain value).

【Precautions】

The 1106 stage linear exposure only supports RAW domain statistics, so this parameter can only be set to 1, and the 0 value is invalid.

1.2.2.2 ToleranceIn/Out

【Description】

The tolerance of the brightness of the picture when adjusting the auto exposure. The unit is % and the value range is [0,100]

When the AE converges, the screen brightness value B should be within the range of [True Effective Target Luminance X(1-tolerance/100), True Effective Target Luminance X(1+Tolerance/100)].

ToleranceIn represents tolerance when exposure does not converge, and ToleranceOut represents tolerance when exposure converges. ToleranceIn < ToleranceOut is recommended to avoid excessive sensitivity to exposure changes and stabilize exposure.

1.2.2.3 EvBias

【Description】

When adjusting the auto exposure, the percentage deviation of the exposure amount in % is in the range of [-200, +200]

It is used to adjust the (fixed/dynamic) target brightness value (SetPoint/NightSetPoint) in special scenarios. The true effective target brightness is (SetPoint/ NightSetPoint)*[1+abs(EvBias)/100]^[EvBias/abs(EvBias)].

If you set EvBias=100, the brightness is twice the default parameter; When EvBias=-100, the brightness is 1/2 of the default parameter.

【Precautions】

For example, the toleranceIn/Out setting above is large, which will affect the response speed of AE on the one hand, and the EvBias value on the other hand. When the interval value of EvBias adjustment is lower than toleranceIn/Out, it may cause the brightness adjustment to not take effect.

1.2.2.4 StrategyMode

【Description】

Auto exposure strategy mode, highlight priority or low light priority

【Precautions】

- Currently this parameter is **currently invalid**

1.2.2.5 Route

【Description】

Auto Exposure Decomposition strategy properties. Used to set the AE exposure decomposition route, the exposure calculated by the AE algorithm will be distributed according to the set route, and the user can set the route to exposure time priority (shutter priority), gain priority, and aperture priority according to the needs of the specific application.

【Members】

- LinearAE

Member name	**Description**
TimeDot	Exposure time node in seconds
GainDot	Sensor gain node, where the gain value is the actual value in units of 1x
IspgainDot	The ISO digital gain node, where the gain value is the actual value, in units of 1x
PIrisDot	The aperture is equivalent to the gain node, where the gain value is the actual value in units of 1x

【Precautions】

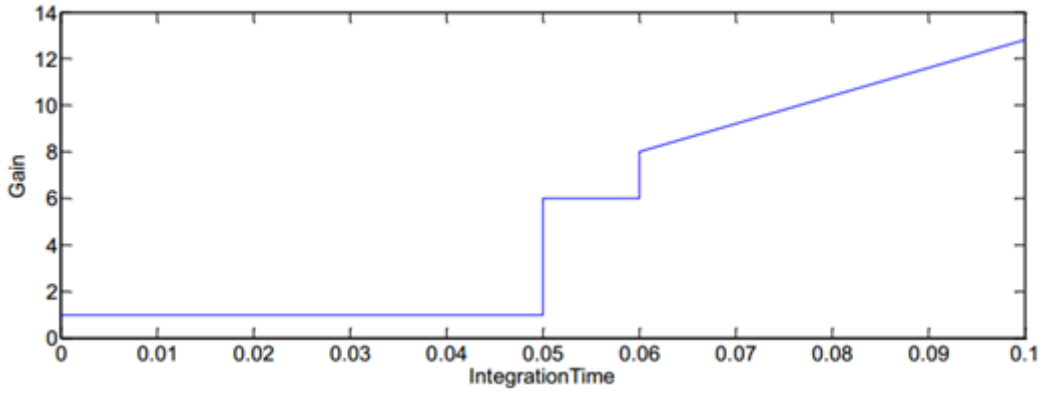


Figure 4-2 Schematic diagram of exposure decomposition

- There is no limit to the number of nodes per exposure component in the exposure decomposition route, **It is recommended to set at least 6 nodes** to prevent the exposure decomposition transition from being smooth, and the number of nodes for each exposure component needs to be consistent.
- The total exposure of the node is the product of each component such as exposure time, sensor gain, ISP digital gain, aperture equivalent gain, etc. The total exposure of the node must be monotonically increasing, that is, the total exposure of the latter node must be greater than the total exposure of the previous node. The first node has the smallest total exposure, and the last node has the largest total exposure.
- The unit of the exposure time component in the node is seconds, the minimum value is allowed to be 0, and the actual minimum exposure time code will be corrected internally according to the sensor limit; The exposure gain component in the node is measured in multiples, with a minimum value of 1x.
- ISP digital gain node settings have the following limitations: Currently, ISP dgain can only be used as a gain supplement to increase brightness after the maximum gain defined in the sensor gain node has been exhausted. Therefore, for ISP digital gain nodes, only the last node is valid, fill in the maximum value of ISP digital gain that needs to be used.

- Aperture component only supports P-Iris, DC-Iris is not supported. The P-iris equivalent gain component is only valid when the Airis auto iris function is enabled, otherwise the default aperture is fixed to the initial value size. The calculation of the equivalent gain of P-iris is detailed in the IrisCtrl module.
- Note: The exposure decomposition route set is not necessarily the exposure decomposition route that will take effect in the end. The algorithm will internally perform a range check on the values of each node in the decomposition route according to the maximum/minimum value limit of the exposure component by the sensor or ISP (which can be viewed in SensorInfo), and the nodes that do not meet the restriction conditions will be corrected. Therefore, before setting the exposure decomposition route node, it is recommended to understand the exposure component range supported by the sensor or ISP through the parameters in the sensorinfo module, and then set the node value according to the product application.
- If the exposure of adjacent nodes increases, only one exposure component should increase and the others fixed. The added component determines the allocation strategy for that segment of the route. For example, if the gain component increases and the other components are fixed, then the distribution strategy of this segment of the route is gain first.

1.2.2.6 InitExp

【Description】

Linear exposure mode initial value setting.

【Members】

Member name	Description
InitTimeValue	Initial exposure time value in seconds
InitGainValue	The initial sensor gain value, where the gain value is the actual value, in units of 1x
InitIspDGainValue	The initial ISP digital gain value, where the gain value is the actual value, in units of 1x
InitPIrisGainValue	The initial P-aperture is equivalent to the gain value, where the gain value is the actual value in units of 1x
InitDCIrisDutyValue	The initial DC aperture duty cycle value in the range of [0,100]

【Precautions】

- When the initial auto exposure value is not set (that is, when each value is 0), the system default value is used.
- The size of the initial AE value, limited by the maximum/small value of the AE decomposition curve. When the size of the initial value of the auto exposure exceeds or falls below the maximum/small value of the auto exposure decomposition curve, it is replaced by the maximum/small value of the auto exposure decomposition curve.
- Auto exposure P-aperture equivalent gain initial, valid only when the aperture type is P-aperture, the default initial value is the equivalent gain value corresponding to the maximum aperture supported by the P aperture. The meaning of equivalent gain is described in the Aperture Tuning Parameter IrisCtrl module.
- Auto exposure DC aperture duty cycle initial value, valid only when the aperture type is DC aperture, the default initial value is the MaxPwmValue value of DC aperture, at which point DC-iris will open the aperture at maximum speed. The duty cycle and the meaning of MaxPwmValue are described in the Aperture Tuning Parameter IrisCtrl module.
- InitIspDGainValue: The initial ISP digital gain value is temporarily invalid.

1.2.2.7 DySetpoint

【Description】

Dynamic target brightness value setting.

【Members】

Member name	Description
ExpLevel	Dynamic exposure node attribute, the node value is the current exposure value, the number of nodes is not limited, it is recommended to set at least 6 nodes to prevent the exposure transition from being smooth.
DySetpoint	Dynamic target brightness value node property, value range [0,255]. The node value changes dynamically with the exposure amount, and the larger the exposure node value, the smaller the target brightness node value, and corresponds to the exposure node one by one. The number of nodes is not limited, it needs to be consistent with the number of ExpLevel nodes, it is recommended to set at least 6 nodes to prevent the exposure transition from being smooth.

【Precautions】

- ExpLevel is the current exposure value, i.e. (Curgain * Curtime).
- If you need to set a fixed target value, the value of each node in DySetpoint can be set to the same value.
- When setting DySetpoint nodes, try to make the values of each node change smoothly with ExpLevel to prevent flickering.

1.2.2.8 BackLightCtrl

【Description】

The backlight compensation function, that is, in the backlight scene, supports the brightness of the dark area of the backlight to reproduce the details of the dark area.

【Members】

Member name	Description
Enable	Module enable bit, 1: enabled, 0: off
MeasArea	Dark area detection area, including a total of 6 modes: AECV2_MEASURE_AREA_AUTO/UP/BOTTOM/LEFT/RIGHT/CENTER
LumaDistTh	Regional growth tolerance
OEROILowTh	The minimum brightness value of the overexposed area, which distinguishes the overexposed area from the non-overexposed area
LvHighTh	Ambient brightness high threshold
LvLowTh	Ambient brightness low threshold
ExpLevel	Dynamic exposure node attribute, the node value is the current exposure value, the number of nodes is not limited, it is recommended to set at least 6 nodes to prevent the exposure transition from being smooth. The node value is the exposure value (gain*time, time in s)
NonOEPdfHighTh	The proportion threshold of non-overexposed area (0~1), the number of nodes is not limited, it is recommended to set at least 6 nodes to prevent the exposure transition from being smooth. The number of nodes needs to be consistent with ExpLevel, and the node value needs to correspond to ExpLevel.
LowLightPdfTh	The dark area ratio threshold (0~1), the number of nodes is not limited, it is recommended to set at least 6 nodes to prevent the exposure transition from being smooth. The number of nodes needs to be consistent with ExpLevel, and the node value needs to correspond to ExpLevel.
TargetLLLuma	Dynamic dark area luminance target value, value range [0,255]. The number of nodes is not limited, it is recommended to set at least 6 nodes to prevent unsmooth exposure transitions. The number of nodes needs to be consistent with ExpLevel, and the node value needs to correspond to ExpLevel one-to-one, and decrease as ExpLevel increases

【Precautions】

- An important step in the backlight compensation function is to determine the location of the dark area (area of interest) of the backlight, and then increase the brightness of the dark area by increasing the exposure. The detection of backlight dark areas is divided into automatic mode and manual mode, which are configured in MeasArea, and include a total of 6 modes: AUTO, UP, BOTTOM, LEFT, RIGHT, CENTER. When MeasArea is configured as AUTO, it means that the backlight dark area is automatically detected. When MeasArea is configured as UP, BOTTOM, LEFT, RIGHT or CENTER, it represents manual mode, and the position of the dark area is subject to manual settings.
- When MeasArea is configured as AUTO, dark areas are looked for based on the brightness distribution of the subwindow and the probability of backlighting in the current scene. The backlight probability of the current scene is mainly composed of three factors: ambient brightness factor (Lv_fac), dark area ratio factor (DarkPdf_fac), and contrast factor (Contrast_fac). The parameters associated with the three factors are described below.
- ambient brightness Lv=meanluma/exp/1000 (exp=gain*time, unit:s)

LvHighTh**:** High ambient brightness threshold, the higher the value, the less likely it is to trigger backlight compensation, and vice versa, it is easier to trigger backlight compensation. Equivalent to distinguishing between indoor and outdoor ambient brightness thresholds, LvHighTh=setpoint/ is recommended. This parameter is valid when MeasArea is configured as AUTO.

LvLowTh**:** low ambient brightness threshold, the higher the value, the less likely it is to trigger backlight compensation, and vice versa. Equivalent to the ambient brightness threshold that distinguishes between indoor light and dark environments, LvHighTh=setpoint/ is recommended. This parameter is valid when MeasArea is configured as AUTO.

The above high and low thresholds for ambient brightness are used to calculate the ambient brightness factor.

- LowLightPdfTh Dark area proportion threshold, which affects the calculation of dark area proportion factor. The proportion of dark areas should not be too large, otherwise it is easy to trigger backlight compensation, resulting in excessive brightness in the indoor environment. It is recommended that the proportion of dark areas in bright environments be controlled within 20%, and the proportion of dark areas increases as the ambient brightness decreases. This parameter is valid when MeasArea is configured as AUTO.

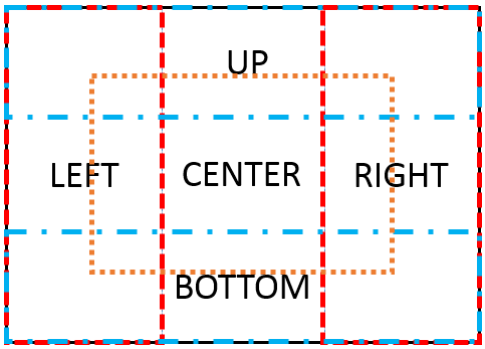


Figure 4-3 Backlit MeasArea area

- When MeasArea is configured as UP, BOTTOM, LEFT, RIGHT or CENTER, it represents manual mode, and the location of the dark area is subject to manual settings. As shown in Figure 4-3, where UP is designated as the area above 1/3 of the screen; BOTTOM is the bottom 1/3 of the area; LEFT is the left 1/3 of the area on the left side of the screen; RIGHT is the 1/3 area on the right side of the screen; CENTER is the area in the center of the screen 3/5. When the brightness of the specified area is lower than the target brightness value of the dark area, increase the exposure to increase the brightness of the specified area; When the brightness of the specified area is higher than the target brightness value of the dark area, it means that the specified area is not a dark area at this time, or the current scene is not a backlit scene, then the increase or decrease of exposure is determined by the global brightness. That is, in this mode, backlight compensation is only turned on when the brightness of the specified area is lower than the target brightness value of the dark area.
- TargetLLLuma dark area brightness target value. The target value of dark area brightness should not exceed **50**% of the global brightness target value, and it is recommended to control it at **40%~50**% of the global target brightness%, otherwise the brightness may be too bright in the backlight scene. MeasArea is configured with any value, and the parameter is valid.

1.2.2.9 OverExpCtrl

【Description】

Bright light suppression module to reduce exposure and reduce the degree of overexposure of the picture.

【Members】

Member name	Description
Enable	Module enable bit, 1: enabled, 0: off
HighLightTh	Brightness threshold for highlighted areas, value range [0,255]
LowLightTh	Brightness threshold for low-light areas, value range [0,255]
MaxWeight	Maximum weight value, value range [1,20]
OEPdf	The proportion of overexposed area, the number of nodes is not limited, it is recommended to set at least 6 nodes to prevent the exposure transition from not smooth, the proportion value changes from small to large, the value range is [0,1]
HighLightWeight	The weight of the highlighted area, the value range [1,20], the number of nodes is not limited, it is recommended to set at least 6 nodes to prevent the exposure transition from being smooth, corresponding to the proportion of the overexposed area node, the maximum value is limited by MaxWeight.
LowLightWeight	Low highlight area weight, value range [1,20], the number of nodes is not limited, it is recommended to set at least 6 nodes to prevent the exposure transition is not smooth, corresponding to the proportion of overexposed area nodes, the maximum value is limited by MaxWeight.

【Precautions】

- HighLightTh represents the brightness threshold of the highlighted area, and the areas above the brightness threshold are considered as the highlighted area, corresponding to the weight of HighLightWeight. LowLightTh represents the brightness threshold of the low-light area, and the area with a brightness below the threshold is considered a low-light area, and the corresponding weight is LowLightWeight. The brightness is located in the area between LowLightTh and HighLightTh, and its weight value is an interpolation of LowLightWeight and HighLightWeight.
- The larger the HighLightWeight, the greater the intensity of the suppression of strong light, and vice versa. The larger the LowLightWeight, the less powerful the suppression of strong light, and vice versa. It is recommended that HighLightWeight be controlled in the range of 1~4, and LowLightWeight be controlled in the range of 0.7~1.
- Bright light suppression module, if you suppress strong light in any scene with overexposed areas, many scenes will have the phenomenon that the overall picture is too dark. Therefore, HighLightWeight should not be too large, it is recommended that with the increase of the proportion of overexposed area, HighLightWeight is reduced, in order to avoid excessive suppression of strong light, resulting in the overall brightness of the picture is too dark.
- When the strong light suppression module is turned on, it is recommended to enable the linear TMO function at the same time to prevent the problem of too dark dark areas during the strong light suppression process.

1.2.3 4.1.2.3 AEC module HDR exposure debugging parameters

Parameter name	Parameter type	Brief description
ToleranceIn/Out	Debug parameters	User debugging parameters
StrategyMode	Debug parameters	User debugging parameters
EvBias	Debug parameters	User debugging parameters
ExpRatioCtrl	Debug parameters	User debugging parameters
Route	Debug parameters	User debugging parameters
InitExp	Debug parameters	User debugging parameters
LongFrmMode	Debug parameters	User debugging parameters
LframeCtrl	Debug parameters	User debugging parameters
MframeCtrl	Debug parameters	User debugging parameters
SframeCtrl	Debug parameters	User debugging parameters

1.2.3.1 ToleranceIn/Out

【Description】

The tolerance of the brightness of the picture. The unit is % and the value range is [0,100]

When the AE converges, the screen brightness value B should be within the range of [True Effective Target Luminance X(1-tolerance/100), True Effective Target Luminance X(1+Tolerance/100)].

ToleranceIn represents tolerance when exposure does not converge, and ToleranceOut represents tolerance when exposure converges. ToleranceIn < ToleranceOut is recommended to avoid excessive sensitivity to exposure changes and stabilize exposure.

1.2.3.2 StrategyMode

【Description】

Auto exposure strategy mode, highlight priority or low light priority.

【Members】

Highlight priority: AECV2_STRATEGY_MODE_HIGHLIGHT

Low light priority: AECV2_STRATEGY_MODE_LOWLIGHT

【Precautions】

- This parameter behaves differently in different exposure ratio modes, see ExpRatioCtrl parameter.

1.2.3.3 EvBias

【Description】

When adjusting the automatic exposure, the percentage deviation of the exposure amount in % is in the range of [-200, +200]. It is used to adjust the target brightness value in special scenarios. The true effective target brightness is the target value X [1+abs(EvBias)/100]^[EvBias/abs(EvBias)].

If EvBias=100 is set, the target brightness is twice the default parameter. When EvBias=-100, the target brightness is 1/2 of the default parameter.

【Precautions】

For example, the toleranceIn/Out setting above is large, which will affect the response speed of AE on the one hand, and the EvBias value on the other hand. When the interval value of EvBias adjustment is lower than toleranceIn/Out, it may cause the brightness adjustment to not take effect.

1.2.3.4 InitExp

【Description】

HDR exposure mode initial value setting.

【Members】

Member name	Description
InitTimeValue	Initial exposure time value in seconds
InitGainValue	The initial sensor gain value, where the gain value is the actual value, in units of 1x
InitIspDGainValue	The initial ISP digital gain value, where the gain value is the actual value, in units of 1x
InitPIrisGainValue	The initial P-aperture is equivalent to the gain value, where the gain value is the actual value in units of 1x
InitDCIrisDutyValue	The initial DC aperture duty cycle value in the range of [0,100]

【Precautions】

- When the initial auto exposure value is not set (that is, when each value is 0), the system default value is used.
- The size of the initial AE value, limited by the maximum/small value of the AE decomposition curve. When the size of the initial value of the auto exposure exceeds or falls below the maximum/small value of the auto exposure decomposition curve, it is replaced by the maximum/small value of the auto exposure decomposition curve.
- Some sensors have special requirements for initial exposure in HDR exposure mode, such as os04a10, which requires the initial exposure of short frames to be less than 0.005s.
- Auto exposure P-aperture equivalent gain initial, valid only when the aperture type is P-aperture, the default initial value is the equivalent gain value corresponding to the maximum aperture supported by the P aperture. The meaning of equivalent gain is described in the AecIrisCtrl module.
- Auto exposure DC aperture duty cycle initial value, valid only when the aperture type is DC aperture, the default initial value is the MaxPwmValue value of DC aperture, at which point DC-iris will open the aperture at maximum speed. The duty cycle and the meaning of MaxPwmValue are described in the AecIrisCtrl module.
- InitIspDGainValue: The initial ISP digital gain value is temporarily invalid.

1.2.3.5 Route

【Description】

Auto Exposure Decomposition strategy properties. Used to set the AE exposure decomposition route, the exposure calculated by the AE algorithm will be distributed according to the set route, and the user can set the route to exposure time priority (shutter priority), gain priority, and aperture priority according to the needs of the specific application.

【Members】

Member name	Description
Frm0/1/2TimeDot	Exposure time node, in seconds. In HDR 2 frame mode, only Frm0/1TimeDot is valid; In HDR 3 frame mode, Frm0/1/2TimeDot is valid. FRM0~3 is the frame sequence number from short to long exposure
Frm0/1/2GainDot	The sensor gain node in units of 1x. In Hdr 2 frame mode, only Frm0/1GainDot is valid; In HDR 3 frame mode, Frm0/1/2GainDot is valid. The gain value here is the actual value in units of 1x. FRM0~3 is the frame sequence number from short to long exposure
Frm0/1/2IspDGainDot	The ISO digital gain node in units of 1x. In Hdr 2 frame mode, only Frm0/1IspDGainDot is valid; In HDR 3 frame mode, Frm0/1/2IspDGainDot is valid. The gain value here is the actual value in units of 1x. FRM0~3 is the frame sequence number from short to long exposure
PIrisDot	The aperture is equivalent to the gain node, where the gain value is the actual value in units of 1x

【Precautions】

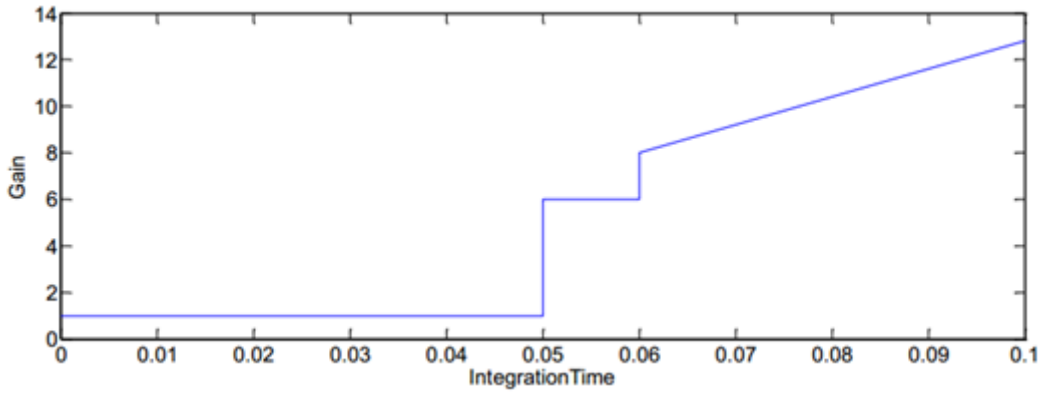


Figure 4-2 Schematic diagram of exposure decomposition

- There is no limit to the number of nodes per exposure component in the exposure decomposition route, **It is recommended to set at least 6 nodes** to prevent the exposure decomposition transition from being smooth, and the number of nodes for each exposure component needs to be consistent.
- It should be noted that in HDR 2 frame mode, only Frm0/1TimeDot, Frm0/1GainDot, Frm0/1IspDGainDot need to be set, corresponding to the actual short and long frames respectively; In HDR 3 frame mode, Frm0/1/2TimeDot, Frm0/1/2GainDot, Frm0/1/2IspDGainDot need to be set, corresponding to short, medium and long frames respectively. When setting the sensor exposure time for each frame in HDR mode, you need to allocate the exposure time reasonably, and the sum of the exposure time of each frame **cannot exceed the maximum exposure time allowed by the frame rate**!

- The exposure of a node is the product of each component such as exposure time, sensor gain, ISP digital gain, and aperture equivalent gain. The exposure of the node must be monotonically increasing, that is, the exposure of the latter node must be greater than the exposure of the previous node. The first node has the least exposure and the second node has the largest exposure.
- The exposure time component in the node is in seconds, the minimum value is allowed to be 0, and the actual minimum exposure time code is internally corrected according to the sensor limit.
- ISP digital gain node settings have the following limitations: Currently, ISP dgain can only be used as a gain supplement to increase brightness after the maximum gain defined in the sensor gain node has been exhausted. Therefore, for ISP digital gain nodes, only the last node is valid, fill in the maximum value of ISP digital gain that needs to be used. Each frame allows different sizes of ISP digital gain to be set.
- Aperture component only supports P-Iris, DC-Iris is not supported. The P-iris equivalent gain component is only valid when the Airis auto iris function is enabled, otherwise the default aperture is fixed to the initial value size. The calculation of the equivalent gain of P-iris is detailed in the IrisCtrl module.
- Note: The exposure decomposition route set is not necessarily the exposure decomposition route that will take effect in the end. The algorithm will internally perform a range check on the values of each node in the decomposition route according to the maximum/minimum value limit of the exposure component by the sensor or ISP (which can be viewed in SensorInfo), and the nodes that do not meet the restriction conditions will be corrected. Therefore, before setting the exposure decomposition route node, it is recommended to understand the exposure component range supported by the sensor or ISP through the parameters in the sensorinfo module, and then set the node value according to the product application.
- If the exposure of adjacent nodes increases, only one exposure component should increase and the others fixed. The added component determines the allocation strategy for that segment of the route. For example, if the gain component increases and the other components are fixed, then the distribution strategy of this segment of the route is gain first.

1.2.3.6 ExpRatioCtrl

【Description】

HdrAE exposure ratio control module.

【Members】

Member name	Description
ExpRatioType	Exposure ratio mode, valid only under HDR mode multi-frame compositing AUTO: Automatically calculates the exposure ratio of long and short frames according to the scene FIX: Fixed exposure ratio for long and short frames
RatioExpDot	Indicates the exposure node, according to the exposure amount, dynamically set the exposure ratio fixed value or the maximum exposure ratio, the two correspond one-to-one. The number of nodes is not limited, **It is recommended to set at least 6 nodes** to achieve smooth exposure transition.
M2SRatioFix	The exposure ratio of medium to short frames is fixed. The number of nodes is not limited, **It is recommended to set at least 6 nodes** to achieve smooth exposure transition. The number of nodes must be the same as the number of RatioExpDot nodes. ExpRatioType = AUTO, not valid. When ExpRatioType = FIX, it indicates the exposure ratio of medium frame to short frame, which corresponds to the exposure node RatioExpDot.
L2MRatioFix	A fixed value for the exposure ratio of long and medium frames. The number of nodes is not limited, **It is recommended to set at least 6 nodes** to achieve smooth exposure transition. The number of nodes must be the same as the number of RatioExpDot nodes. ExpRatioType = AUTO, not valid. When ExpRatioType = FIX, it represents the exposure ratio of long frames to medium frames, which corresponds to the exposure node RatioExpDot. HDR is not valid when compositing at 2 frames, and valid when compositing at 3 frames
M2SRatioMax	The maximum exposure ratio of medium to short frames. The number of nodes is not limited, **It is recommended to set at least 6 nodes** to achieve smooth exposure transition. The number of nodes must be the same as the number of RatioExpDot nodes. When ExpRatioType = AUTO, it indicates the dynamic maximum exposure ratio of medium and short frames, which corresponds to the exposure node RatioExpDot. ExpRatioType = FIX, invalid
L2MRatioMax	The maximum exposure ratio for long and medium frames. The number of nodes is not limited, **It is recommended to set at least 6 nodes** to achieve smooth exposure transition. The number of nodes must be the same as the number of RatioExpDot nodes. When ExpRatioType = AUTO, it indicates the dynamic maximum value of the exposure ratio between long and medium frames, which corresponds to the exposure node RatioExpDot. HDR is not valid for 2-frame synthesis and valid for 3-frame compositing. ExpRatioType = FIX, not valid.

【Precautions】

- ExpRatioType is AUTO, using auto exposure ratio mode. In 2-frame mode, the maximum exposure ratio of long and short frames is limited by M2SratioMax; In 3-frame mode, the maximum exposure ratio of short and medium frames is limited by M2SratioMax, and the maximum exposure ratio of long and medium frames is limited by L2MratioMax. The minimum exposure ratio is unlimited, and must not be less than 1. ExpRatioType is FIX, which uses a fixed exposure mode. In 2-frame mode, the exposure ratio of long and short frames is M2SRatioFix; In 3-frame mode, the exposure ratio is M2SRatioFix for short and medium frames, and L2MratioFix for long medium frames.
- Auto exposure ratio mode, 2-frame HDR mode, when the exposure ratio of long and short frames obtained by the AEC control algorithm module exceeds the maximum exposure ratio M2SratioMax limit, select the frame that needs to be prioritized to ensure exposure according to StrategyMode. StrategyMode =

HIGHLIGHT_PRIOR, priority is given to ensuring the exposure of short exposure frames, long exposure frame exposure = short exposure frame exposure * M2SratioMax; StrategyMode = LOWLIGHT_PRIOR, priority is given to ensuring exposure of long exposure frames, short exposure frame exposure = long exposure frame exposure/M2SratioMax. By analogy, in 3-frame HDR mode, when StrategyMode = HIGHLIGHT_PRIOR, priority is given to ensuring exposure of shorter frames; StrategyMode = LOWLIGHT _PRIOR, which prioritizes exposure for longer frames.

- Fixed exposure ratio mode, 2 frames HDR mode, StrategyMode = HIGHLIGHT_PRIOR, based on the exposure of short exposure frames, calculate long exposure frame exposure, equal to short exposure frame exposure * M2SRatioFix; StrategyMode = LOWLIGHT_PRIOR, based on the exposure of the long exposure frame, calculate the short exposure frame exposure, equal to the long exposure frame exposure / M2SRatioFix. 3 fps HDR mode, and so on.

1.2.3.7 LongFrmMode

【Description】

HdrAE long frame mode function control module

【Members】

Member name	Description
Mode	LONG FRAME MODES, INCLUDING: DISABLE/AUTO/ENABLE. DISABLE: Normal HDR, long frame mode is not enabled. The AE and HDR synthesis modules work in accordance with the manual/auto exposure ratio. AUTO: Auto Long Frame Mode. When the exposure exceeds the set threshold, the exposure time of long frames is close to the maximum allowed for 1 frame, and the compositing module only outputs long frames. ENABLE: Turn on long frame mode. AE sets the short frame exposure time to a fixed minimum, the long frame exposure time is close to the maximum allowed for 1 frame, and the compositing module only outputs long frames
SfrmMinLine	Long frame mode/auto long frame mode, short frame minimum exposure line. Due to some limitations of the sensor, the minimum exposure line for short frames in long frame mode may not reach the minimum exposure line allowed by the sensor, so it needs to be set separately
LfrmModeExpTh	In Auto Long Frame mode, when the exposure of long frames exceeds LfrmModeExpTh, switch to Long Frame Mode

1.2.3.8 LframeCtrl

【Description】

Long frame debugging parameters. In the HdrAE strategy, in the 2-frame mode, long frames need to be compatible with general dynamic range scenes and backlit scenes, so there are two brightness constraints: global target brightness and dark area target brightness. While ensuring that the global brightness of long frames is within the tolerance range of the global target brightness, the dark area brightness is required to be greater than or equal to the dark area target brightness.

【Members】

Member name	Description
OEROILowTh	The lowest brightness value of the overexposed area, which is used to distinguish the overexposed area from the non-overexposed area, the value range is [0,255].
LvHighTh	High ambient brightness threshold, dimensionless, value range [0,15]
LvLowTh	Ambient brightness low threshold, dimensionless, value range [0,15]
LExpLevel	Dynamic long frame exposure value node parameter, the number of nodes is not limited, **It is recommended to set at least 6 nodes** to achieve smooth exposure transition. ExpLevel = gain*time(time units are s)
LSetPoint	Dynamic long frame global target luminance value, value range [0,255]. The number of nodes needs to be consistent with LExpLevel, and the node value corresponds to the value of each node of LExpLevel.
NonOEPdfHighTh	The proportion threshold of non-overexposed area (0~1), the number of nodes needs to be consistent with LExpLevel, and the node value corresponds to LExpLevel one-to-one.
LowLightPdfTh	The proportion threshold of dark area (0~1), the number of nodes needs to be consistent with LExpLevel, and the node value corresponds to the value of each node of LExpLevel, which increases with the increase of ExpLevel.
TargetLLLuma	Dynamic long frame dark area luminance target value, value range [0,255]. The number of nodes needs to be consistent with LExpLevel, and the node value corresponds to the value of each node of LExpLevel, which decreases as ExpLevel increases.

【Precautions】

- ambient brightness Lv=meanluma/exp/1000 (exp=gain*time,unit:s)

  LvHighTh**:** High ambient brightness threshold, the higher the value, the less likely it is to trigger backlight compensation, and vice versa, it is easier to trigger backlight compensation. Equivalent to distinguishing between indoor and outdoor ambient brightness thresholds, LvHighTh=setpoint/ is recommended.

  LvLowTh**:** low ambient brightness threshold, the higher the value, the less likely it is to trigger backlight compensation, and vice versa. Equivalent to the ambient brightness threshold that distinguishes between indoor light and dark environments, LvHighTh=setpoint/ is recommended.

  The above high and low thresholds for ambient brightness are used to calculate the ambient brightness factor.

- LowLightPdfTh Dark area proportion threshold, which affects the calculation of dark area proportion factor. The proportion of dark areas should not be too large, otherwise it is easy to trigger backlight compensation, resulting in excessive brightness in the indoor environment. It is recommended that the proportion of dark areas in bright environments be controlled within 20%, and the proportion of dark areas increases as the ambient brightness decreases.
- It is recommended that the target value of the dark area should not exceed 50% of the global target value, and control it at 40%~50% of the global target brightness, otherwise the brightness may be too bright in the backlight scene.

1.2.3.9 MframeCtrl

【Description】

Medium frame debugging parameters (valid only at HDR 3 frames)

【Members】

Member name	Description
MExpLevel	Dynamic frame exposure value node parameter, the number of nodes is not limited, **It is recommended to set at least 6 nodes** to achieve smooth exposure transition. ExpLevel = gain*time(time units are s)
MSetPoint	The global target luminance value of the frame in motion, the value range [0,255]. The number of nodes needs to be consistent with MExpLevel, and the node value corresponds to the value of each node in MExpLevel. As exposure increases, the target decreases.

1.2.3.10 SframeCtrl

【Description】

Short frame debugging parameters

【Members】

Member name	Description
SExpLevel	Dynamic short frame maximum exposure value node parameter, the number of nodes is not limited, **It is recommended to set at least 6 nodes** to achieve smooth exposure transition. ExpLevel = gain*time(time units are s)
SSetPoint	Dynamic short frame global average luminance target value, value range [0,255]. The number of nodes needs to be consistent with MExpLevel, and the node value corresponds to the value of each node in MExpLevel. The brightness target value of the bright area in the same interval is required to be higher than the corresponding global luminance target value.
TargetHLLuma	The average target value of the dynamic short frame highlight area, the value range [0,255]. The number of nodes needs to be consistent with MExpLevel, and the node value corresponds to the value of each node of MExpLevel.
HLLumaTolerance	Set the target tolerance percentage of the highlight area of short frames in % value range [0,100].
HLROIExpandEn	Short frame highlight area extension enabled. =1, ignore the small highlight area, reduce the sensitivity of the highlight area; =0 to suppress the brightness of all highlighted areas and increase the sensitivity of the highlighted areas

1.2.4 4.1.2.4 AEC module aperture debugging parameters

IrisCtrl

【Description】

Aperture control parameters

【Members】

Member name	Description
Enable	Automatic iris control function enabled
IrisType	Aperture type, P (i.e. P-iris aperture) or DC (i.e. DC-iris aperture)
ManualEn	Manual Aperture Enable
InitAttr	Aperture Initial Value Parameter
DCIrisAttr	DC Aperture Control Parameters

- ManualAttr

Member name	Description
PIrisGainValue	Manual P-aperture equivalent gain value, where the gain value is the actual value, the unit is 1x, and the parameter value is limited by the P aperture device, the value range is [1,1024]
DCIrisHoldValue	Manual DC aperture HoldValue value, parameter value is related to DC aperture device, the value range is [0,100]

- InitAttr

Member name	Description
PIrisGainValue	P-aperture equivalent to the initial gain value, where the gain value is the actual value, the unit is 1x, and the parameter value is limited by the P aperture device, the value range is [1,1024]
DCIrisHoldValue	DC aperture HoldValue value, parameter value is related to DC aperture device, the value range is [0,100]

- PIrisAttr

Member name	Description
TotalStep	The total number of steps of the P-iris stepper motor, the specific size is related to the P-iris lens.
EffcStep	The number of steps available for the P-iris stepper motor, the specific size is related to the P-iris lens
ZeroIsMax	Whether the P-iris stepper motor step0 corresponds to the maximum aperture position, the specific value is related to the P-iris lens. This value is 0, which means that when the stepper motor position is step0, the aperture is turned to the minimum; The value is 1, which means that when the stepper motor position is step0, the aperture is turned to the maximum.
StepTable	A mapping table of the position of the P-iris stepper motor to the equivalent gain of the aperture, the specific value is related to the P-iris lens

- DCIrisAttr

Member name	Description
Kp	A scale factor that limits the switching speed of the aperture drastically changing timecircle, the larger the value, the slower the light aperture changes the timecircle opens and closes. If this value is too large, the adjustment process braking will be ahead, resulting in too long adjustment time; If this value is too small, the braking will lag behind during the adjustment process, resulting in an increase in overshoot. The reasonable setting of this value is related to the DC-iris lens and circuit characteristics. The recommended value is 0.5. The range of values is [0,1].
Ki	The integration coefficient that adjusts the switching speed of the aperture, the larger the aperture, the greater the speed at which the aperture opens and closes. This value is too large, and it is easy to overshoot and cause oscillation; If this value is too small, oscillations tend to occur when the aperture adjustment speed is slower and the ambient brightness changes sharply. The recommended value is 0.2. The range of values is [0,1].
Kd	A differential coefficient that adjusts the switching speed of the aperture, the larger the value, the greater the speed at which the aperture opens and closes. The recommended value is 0.3. The range of values is [0,1].
MinPwmDuty	Minimum PWM duty cycle, the specific size is related to the DC-iris lens and circuit characteristics, in %. The smaller the value, the faster the supported aperture closes, but tends to cause aperture oscillation. The value range is [0,100], and the default value is 0.
MaxPwmDuty	The maximum PWM duty cycle, the specific size is related to the DC-iris lens and circuit characteristics, in %. A higher value opens the supported aperture faster, and too small a value may cause the aperture control to exit before the maximum aperture has been reached. The value range is [0,100], and the default value is 100.
OpenPwmDuty	PWM duty cycle threshold when aperture open, aperture on when aperture PWM duty cycle is higher than (not included) OpenPwmDuty. The specific size is related to the DC-iris lens in % value range [0,100].
ClosePwmDuty	PWM duty cycle threshold when aperture is off, aperture off when aperture PWM duty cycle is less than (not included) ClosePwmDuty. The specific size is related to the DC-iris lens in % value range [0,100].

【Precautions】

- When the auto iris function is turned off, for DC-iris aperture, it will be turned on to the maximum by default; For the P-iris aperture, the stepper motor position corresponding to the maximum aperture is turned on by default. If you want to change the above aperture position, you can modify PIrisGainValue and DCIrisHoldValue in the InitAttr module.
- ManualIrisEn, manual iris control enabled. When the aperture type IrisType is P-aperture, only PirisGainValue is valid; When the aperture type is DC aperture, only DCIrisHoldValue is valid.
- DCIrisHoldValue, directly set the PWM duty cycle value of the motor in manual mode, the value range [0,100]. If the HoldValue value is set in manual mode (that is, the value in the ClosePwmDuty to OpenPwmDuty range in DCIrisAttr), the DC aperture aperture remains at the current size; If the value set is greater than OpenPwmDuty, the aperture is turned on, and the larger the value, the greater the opening speed; If the value set is less than ClosePwmDuty, the aperture is off, and the smaller the value, the greater the speed of closing.

- The basic control flow of the automatic iris Airis algorithm is as follows:

  For DC-iris lenses, Airis controls the aperture size of the DC-iris lens based on the deviation of the current brightness from the target brightness. When the exposure reaches the minimum value, and the current brightness exceeds the target brightness tolerance range, the AE control will be exited, and the exposure time and exposure gain will be fixed and enter the AIRIS control range. If the current screen brightness is stable and the PWM duty of DC-iris is greater than OpenPwmDuty, the current aperture is considered to have reached the maximum, and the Airis aperture control is withdrawn, and the control is handed over to AE.

  For P-iris lenses, aperture control is performed via the AecRoute module. The aperture size of the P-iris lens is converted to the equivalent gain and participates in the exposure decomposition calculation.

- P-iris stepper motor position and aperture equivalent gain mapping table StepTable is generally made according to the correspondence between stepper motor position and aperture aperture provided by lens manufacturers. The control of P-iris is controlled by AE's AecRoute module, which converts the aperture aperture size into equivalent gain, so P-iris control needs to have good linearity. The equivalent gain ranges from [1,1024], with an equivalent gain of 1024 for F1.0, an equivalent gain of 512 for F1.4, and so on, an equivalent gain of 1 for F32.0. When making a table, it is necessary to convert the aperture aperture corresponding to the stepper motor position to the equivalent gain, fill it in the StepTable, and fix it to increment according to the stepper motor position (i.e. step0, step1...). stepN).

- TotalStep represents the total number of steps of the P-iris stepper motor, and the specific size is related to the P-iris lens. EffcStep indicates the number of steps available for P-iris stepper motors, which is generally less than TotalStep. Because the position near the closed end of the aperture has a large error in the value corresponding to the equivalent gain, and oscillations are prone to occur during iris adjustment, the step position near the closed end of the aperture is usually not used.

- Table 4-1 is a table corresponding to the position of the P-iris stepper motor to the aperture aperture and equivalent gain, and use this table as an example to illustrate how to set the StepTable. The correspondence between the stepper motor position step and the aperture aperture area in columns 1-2 and 4-5 in Table 4-1 is provided by a lens manufacturer. The P-iris lens has a stepper motor adjustment total of 81 steps, with the largest aperture aperture at step0 and a nominal maximum aperture of 1.4. A number of apertures of 1.4 corresponds to an equivalent gain of 512, so the equivalent gain at step 0 is 512. The equivalent gain corresponding to the other aperture areas, here taking step 3 as an example, is calculated as follows: the aperture area of step 3 is 195.869, and the corresponding equivalent gain = 512* (195.869/201.062)=499(rounded). By analogy, the equivalent gain values corresponding to the positions of other stepper motors can also be calculated from this. It can be seen from Table 1-1 that when the stepper motor position is close to the closed end, the corresponding aperture area is very small, and the difference from the largest aperture area can be thousands of times, and the corresponding equivalent gain value error is large, so it is recommended that the stepper motor position close to the closed end of the aperture should not be used, so as not to cause exposure oscillation due to errors. The equivalent gain corresponding to each stepper motor position in the table is incremented according to the stepper motor position (i.e., step0, step1...). stepN) is filled in the StepTable.

- DC-iris' OpenPwmDuty and ClosePwmDuty values need to be measured and are related to DC-iris lenses. For some lenses, when the PWM duty cycle is greater than OpenPwmDuty, the aperture performs an open operation; When the PWM duty cycle is less than OpenPwmDuty, the aperture performs a closed operation; When the PWM duty cycle is greater than or equal to ClosePwmDuty and less than or equal to OpenPwmDuty, the aperture is stable at the current position, and the values in this interval are HoldValue. In addition, there are some lenses, and there is only a threshold of the aperture switch, that is, when the PWM duty cycle is greater than this threshold, the aperture performs an open operation; When the PWM duty cycle is less than this threshold, the aperture performs a off operation; When the PWM duty cycle is equal to this threshold, the aperture stabilizes at the current position, which is HoldValue. In this case, you can make ClosePwmDuty = OpenPwmDuty = HoldValue.

Table 4-1 P-iris stepper motor position and aperture aperture and equivalent gain correspondence table

Step	Aperture area(mm2)	Equivalent gain	Step	Aperture area(mm2)	Equivalent gain
0	201.062	512	41	56.653	144
1	200.759	511	42	53.438	136
2	198.583	506	43	50.282	128
3	195.869	499	44	47.188	120
4	192.879	491	45	44.159	112
5	189.677	483	46	41.197	105
6	186.293	474	47	38.307	98
7	182.744	465	48	35.49	90
8	179.035	456	49	32.751	83
9	175.271	446	50	30.093	77
10	171.484	437	51	27.519	70
11	167.681	427	52	25.034	64
12	163.865	417	53	22.642	58
13	160.036	408	54	20.347	52
14	156.198	398	55	18.154	46
15	152.351	388	56	16.068	41
16	148.499	378	57	14.096	36
17	144.642	368	58	12.245	31
18	140.783	359	59	10.522	27
19	136.925	349	60	8.935	23
20	133.069	339	61	7.484	19
21	129.217	329	62	6.169	16
22	125.371	319	63	4.987	13
23	121.535	309	64	3.936	10
24	117.709	300	65	3.014	8
25	113.897	290	66	2.22	6
26	110.1	280	67	1.55	4
27	106.321	271	68	1.003	3
28	102.562	261	69	0.577	1
29	98.826	252	70	0.268	1

Step	Aperture area(mm2)	Equivalent gain	Step	Aperture area(mm2)	Equivalent gain
30	95.115	242	71	0.075	0
31	91.431	233	72	close	0
32	87.777	224	73	close	0
33	84.156	214	74	close	0
34	80.569	205	75	close	0
35	77.02	196	76	close	0
36	73.51	187	77	close	0
37	70.043	178	78	close	0
38	66.621	170	79	close	0
39	63.247	161	80	close	0
40	59.923	153			

1.2.5 4.1.2.5 AEC module synchronously test parameters

SyncTest

【Description】

The synchronous test function of exposure and statistics supports cyclic setting of N groups of different exposure values according to the number of frames at a given interval. By cyclically setting the different exposure values of N groups, you can test whether the exposure time and exposure gain of the sensor, and the effective frame number of DCG switching are correct, and can also be used to test the linearity of the exposure, so as to confirm whether the register value conversion formula and related parameters of the exposure time and exposure gain are correct.

【Members】

Member name	Description
Enable	Enables the simultaneous testing of exposure and statistics
IntervalFrm	Number of frames between exposure switching
AlterExp	Exposure switching parameters

- AlterExp

According to the different modes, it is divided into two sets of parameters: LinearAE and HdrAE.

Member name	Description
TimeValue	Exposure time value
GainValue	Exposure gain value
IspDgainValue	ISP digital gain value
DcgMode	DCG mode value
PIrisGainValue	P-iris equivalent gain

1.2.6 4.1.2.5 sensorinfo parameter

Parameter name	Parameter type	Brief description
Gain2Reg	CIS drive parameters	CIS datasheet prevails, non-debugging parameters
Time2Reg	CIS drive parameters	Based on CIS datasheet, the non-debug parameter is generally the default value, and there is no need to modify
CISGainSet	CIS drive parameters	CIS datasheet prevails, non-debugging parameters
CISTimeSet	CIS drive parameters	CIS datasheet prevails, non-debugging parameters
CISHdrSet	CIS drive parameters	CIS datasheet prevails, non-debugging parameters
CISDcgSet	CIS drive parameters	CIS datasheet prevails, non-debugging parameters
CISExpUpdate	CIS drive parameters	CIS datasheet prevails, non-debugging parameters
CISMinFps	CIS drive parameters	Generally, this is the default value, if you need to set a lower frame rate, you can modify
CISFlip	Debug parameters	User debugging parameters Flip and mirror according to product application settings

The sensorinfo parameter module, which is filled in by the driver or tuning personnel, is used to inform the CIS parameter information related to the exposure, which is convenient for debugging. Before tuning, you need to confirm whether the parameters of the module are consistent with the sensor datasheet, otherwise it may cause problems such as exposure flicker and HDR effect errors.

1.2.6.1 Gain2Reg

【Description】

The conversion formula configuration of the sensor gain value to register value. Due to the different gain conversion formulas of different sensor manufacturers, it can be roughly divided into linear (including piecewise linear, inverse proportional) and nonlinear. Nonlinearity is mainly for sensor manufacturers such as Sony, and currently only supports the gain conversion formula in dB mode.

【Members】

Member name	**Description**
GainMode	Gain conversion formula mode, EXPGAIN_MODE_NONLINEAR_DB nonlinear mode, EXPGAIN_MODE_LINEAR linear mode
GainRange	Linear gain conversion formula with piecewise linearity support. Valid when GainMode = EXPGAIN_MODE_LINEAR.

【Precautions】

- The sensor gain in the sensor gain register value formula means that the sensor's total gain = again*dgain. If the conversion formula of again and dgain is different, the segmentation setting is supported, as shown in the figure above, and the size needs to be adaptively modified.
- Linear sensor gain-to-register value formula, consisting of 3 coefficients (M0, C0, C1), the coefficients are described as follows:

  The conversion formula is: set to driver reg = (gain^M0)*C1 - C0+ 0.5
  XML parameters correspond to:

  First column: gain interval start value, second column gain interval end value, third column: C1, fourth column: C0,

  The fifth column: M0, the sixth column: gain start value corresponds to reg, and seventh column: gain end value corresponds to reg

- When GainMode = EXPGAIN_MODE_NONLINEAR_DB, using the nonlinear sensor gain conversion formula, only dB mode is currently supported. The conversion formula corresponding to the dB mode is: reg = 20xlog10(gain)x10/3, this formula does not need to be filled in, and the algorithm uses this formula by default.
- For DCG-enabled sensors and the conversion formula is linear, GainRange fills in the LCG's gain conversion formula.

【Example】

- s5kgm1sp

The analog gain and digital gain conversion formulas of this sensor are different, as shown in Fig. 4-3 and 4-4, the analog gain register value is 32 times the analog gain, and the digital gain register value is 256 times the digital gain.

Analog gain can be calculated by the following equation:

$$gain = \frac{x}{0x20}$$

NOTE: In S5KGM1ST03, Analog gain is global; there is no per-channel gain. $gain = \frac{x}{32}$ Gain is supported up to X16.

Figure 4-3 Example of analog gain-to-register value

- SMIA gain registers interface, which is coarse and supports fractional gain of 1/256 scale.

  Digital gain of the four Bayer channels is controlled separately using the four parameters shown in the following table. When digital gain is applied, the LSB(s) resulting data shall be padded with zeros.

Table 15 Digital Gain Examples

Gain Value	api_rw_digital_gain_code_XXX Register Value
X1	0x0100
X2	0x0200
X3	0x0300
X8	0x0800
X16	0x1000

Figure 4-4 Example of digital gain-to-register value

The maximum analog gain of s5kgm1sp is known to be 16X, the maximum digital gain is 16X, and total gain = again*dgain. When Total gain <=16X, again is valid, dgain=1X; When Total gain > 16X, again = 16X, dgain is valid. Therefore, when filling in the conversion formula, [1,16] times total gain and [16,256] times total gain need to be configured separately, and the specific configuration is as follows:

> [1.0000 16.0000 32.0000 0.0000 1.0000 32.0000 512.0000
> 16.0000 256.0000 16.0000 -512.0000 1.0000 768.0000 4608.0000]

[16,256] times Total gain interval, analog gain fixed at 16X (a_reg=16x32=512), digital gain d_reg = dgain x 256, and the corresponding configuration formula yields a register value reg=a_reg+d_reg = 512 + Total gain /16 x 256 = 512 + Total gain x 16, i.e. M0=1, C0=-512, C1=16. The total gain register value (hereinafter denoted by reg) issued by the application needs to be modified as follows:

```
if(reg <= 0x200){
    a_reg = reg;
    d_reg = 0x0100;
}else{
    a_reg = 0x200;
    d_reg = reg-0x200;
}
```

1.2.6.2 Time2Reg

【Description】

The conversion formula for the number of exposure rows in the sensor exposure time transfer register consists of four coefficients (C0, C1, C2, C3).

Conversion formula: line = C0*VTS + C1 + C2 * (time * pclk / HTS + C3)
XML corresponding parameters:
First: C0, second: C1, third C2, fourth C3
According to the formula, the exposure time is calculated in reverse:
Time = ((line - C0 x vts - C1) / C2 - C3)*hts/pclk

【Precautions】

- The default 4 coefficients are 0, 0, 1, 0.5, and the number of exposure lines obtained is incremented in 1 line. Generally, this value does not need to be modified.

1.2.6.3 CISGainSet

【Description】

CIS-related gain settings

【Members】

Member name	Description
CISAgainRange	The range supported by sensor analog gain/LCG is minimum and maximum, respectively, where the minimum value must not be less than 1. - When the sensor supports dual conversion gain, this item indicates the LCG range supported by the sensor. - If a digital gain is encountered to complement the accuracy, this can represent the total gain range of the sensor
CISExtraAgainRange	The sensor analog gain (HCG) range, respectively, is the minimum and maximum value, where the minimum value must not be less than 1. - When the sensor supports dual conversion gain, this item indicates the HCG range supported by the sensor. - Range generally = CISAgainRange * dcg_ratio, but there are exceptions, such as ov2718. The specific datasheet given by the sensor factory shall prevail. - When the sensor does not support dual conversion gain, this item is invalid, it is recommended to fill in 1 for both maximum and minimum values to facilitate debug reference.
CISDgainRange	The digital gain range supported by the sensor must not be less than 1. If digital gain is used to complement the accuracy, fill in 1
CISIspDgainRange	ISP digital gain range, the minimum value shall not be less than 1 1106 The ISP digital gain maximum is 32 times, which can be filled in [1,32]; If you do not need to use ISP, the digital gain can be written here as [1,1]
CISHdrGainIndSetEn	Whether the sensor exposure gain of multiple frames is supported in HDR mode is set independently - a value of 0 means that multiple frames share a gain, such as sensor GC2093; - A value of 1 indicates that multiple frames support independent setting of gain. This mode is only for HDR stagger mode, HDR DCG mode This parameter is not valid

1.2.6.4 CISTimeSet

【Description】

The exposure time settings related to CIS are divided into Linear and HDR modes depending on the mode of exposure, and HDR is divided into two configurations: 2 frames and 3 frames.

【Members】

Member name	Description
CISLinTimeRegMaxFac	In Linear exposure mode, the relationship between the maximum exposure time line and VTS consists of two coefficients (C0, C1) MaxTimeLine = C0*vts – The specific value of the C1 coefficient is detailed in the datasheet
CISHdrTimeRegSumFac	In HDR exposure mode, the sum of the maximum exposure times of multiple frames * *and VTS consists of* *two coefficients (C0, C1) MaxTimeLineSum = C0*vts – C1 The specific value of the coefficient is detailed in the datasheet
CISTimeRegMin	The minimum value allowed for the sensor's exposure time line (register value) in linear/HDR exposure mode is integer
CISTimeRegOdevity	Linear/HDR exposure mode sensor exposure time line parity, consisting of two coefficients (C0, C1) Line = C0*x+C1 - No parity limit: C0=1 C1=0- Fixed odd row: C0=2 C1=1 - Fixed even row: C0=2 C1=0 - Fixed integer multiple row of N: C0=N C1=0
CISTimeRegUnEqualEn	HDR mode Sensor does not limit the exposure time line of each frame (S/M/L) unequally- En=0 sensor HDR mode allows the exposure time line of each frame to be equal; - En=1 sensor HDR mode does not allow equal exposure time lines for each frame
CISTimeRegMax	HDR exposure mode: The maximum allowable maximum value of the sensor exposure time line (register value), which is integer. - This parameter consists of 3 elements, the first 2 elements are valid at HDR2 frame, representing the maximum exposure time line corresponding to short and long frames, respectively; All three elements are valid at HDR3 frames, representing the maximum exposure time lines corresponding to short, medium, and long frames. - Generally, the sensor has no limit on the maximum exposure time line of each frame in HDR mode, at which time this parameter can be filled with 0**, which means that the sensor has no limit on the maximum exposure time line. When the value is not 0, the maximum exposure time line for each frame is subject to this parameter. Taking IMX307 as an example, the sensor has a limit of 222 lines for the maximum exposure line for short frames, and no limit for frames in long frames. Therefore, this parameter can be filled in: [222 0 0]

1.2.6.5 CISTimeSet

【Description】

The exposure time settings related to CIS are divided into Linear and HDR modes depending on the mode of exposure, and HDR is divided into two configurations: 2 frames and 3 frames.

【Members】

Member name	Description
CISLinTimeRegMaxFac	In Linear exposure mode, the relationship between the maximum exposure time line and VTS consists of two coefficients (C0, C1) MaxTimeLine = C0*vts – The specific value of the C1 coefficient is detailed in the datasheet
CISHdrTimeRegSumFac	In HDR exposure mode, the sum of the maximum exposure times of multiple frames * *and VTS consists of* *two coefficients (C0, C1) MaxTimeLineSum = C0*vts – C1 The specific value of the coefficient is detailed in the datasheet
CISTimeRegMin	The minimum value allowed for the sensor's exposure time line (register value) in linear/HDR exposure mode is integer
CISTimeRegOdevity	Linear/HDR exposure mode sensor exposure time line parity, consisting of two coefficients (C0, C1) Line = C0*x+C1 - No parity limit: C0=1 C1=0- Fixed odd row: C0=2 C1=1 - Fixed even row: C0=2 C1=0 - Fixed integer multiple row of N: C0=N C1=0
CISTimeRegUnEqualEn	HDR mode Sensor does not limit the exposure time line of each frame (S/M/L) unequally- En=0 sensor HDR mode allows the exposure time line of each frame to be equal; - En=1 sensor HDR mode does not allow equal exposure time lines for each frame
CISTimeRegMax	HDR exposure mode: The maximum allowable maximum value of the sensor exposure time line (register value), which is integer. - This parameter consists of 3 elements, the first 2 elements are valid at HDR2 frame, representing the maximum exposure time line corresponding to short and long frames, respectively; All three elements are valid at HDR3 frames, representing the maximum exposure time lines corresponding to short, medium, and long frames. - Generally, the sensor has no limit on the maximum exposure time line of each frame in HDR mode, at which time this parameter can be filled with 0**, which means that the sensor has no limit on the maximum exposure time line. When the value is not 0, the maximum exposure time line for each frame is subject to this parameter. Taking IMX307 as an example, the sensor has a limit of 222 lines for the maximum exposure line for short frames, and no limit for frames in long frames. Therefore, this parameter can be filled in: [222 0 0]

1.2.6.6 CISHdrSet

【Description】

Relevant setting parameters for HDR mode

【Members】

Member name	Description
Enable	HDR mode enabled, = 0 HDR mode is not supported; =1 Supports HDR mode enable.
Support_mode	HDR uses four types of frame modes. MODE_2_LINE/MODE_3_LINE, MODE_2_FRAME/MODE_3_FRAME
Line_mode	The Line_mode used by HDR currently only supports DCG and STAGGER modes. NOTE: DOL IS EQUIVALENT TO STAGGER, AND IS UNIFORMLY WRITTEN AS STAGGER MODE

1.2.6.7 CISDcgSet

【Description】

The Dual conversion gain function sets parameter modules, including linear and HDR modes. This module is used to control DCG switching, and requires sensor to support DCG mode switching configuration. If the DCG function of the sensor is switched over internally, the module needs to be switched off.

【Members】

Member name	Description
Support_en	Whether to support the Dual conversion gain function, =1 is valid when the module parameter is valid, =0 indicates that the Dual conversion gain function is not supported.
dcg_optype	Dual conversion gain function switching mode, divided into RK_AIQ_OP_MODE_AUTO and RK_AIQ_OP_MODE_MANUAL. AUTO: LCG/HCG switching according to the threshold MANUAL: No automatic switching, a fixed value, subject to dcgmode_init.
dcgmode_init	The initial value of the Dual conversion gain mode for each frame.
dcg_ratio	Conversion gain value
sync_switch	Sync toggle switch (valid in HDR mode only). =1, each frame synchronously switches the Dual conversion gain mode, subject to the long frame; =0, each frame is out of sync Switch Dual conversion gain
gain_ctrl	Based on the exposure gain, switch to Dual conversion gain. lcg2hcg_th: LCG to HCG threshold hcg2lcg_th: HCG to LCG threshold

【Precautions】

- This module is used to control DCG switching, requiring the sensor to support the configuration of DCG mode switching. If the DCG function of the sensor is switched over internally, the module needs to be switched off.
- When the sensor uses HDR-DCG mode, the short exposure frame is fixed as LCG and the long exposure frame is fixed as HCG. Therefore, the dcg_optype needs to be set to MANUAL, dcgmode_init = [0 1 0] at 2 frames and dcgmode_init = [0 0 1] at 3 frames.
- If the sensor does not support the Dual conversion gain function, the dcg_ratio needs to be set to 1.

1.2.6.8 CISExpUpdate

【Description】

The module parameter of the exposure effect, which is generally known from the datasheet of the sensor. Since the effective frame number of exposure of some sensors in normal mode and HDR mode is different, this module needs to be filled in separately according to the mode.

【Members】

Member name	Description
time_update	Sensor exposure time effective frame number
gain_update	sensor: Exposure gain, effective frames
dcg_update	Dual conversion gain mode active frame

【Precautions】

- The value of the module needs to be based on the datasheet given by the sensor factory, and cannot be set arbitrarily. If the value of this module is incorrect, it may cause flicker during exposure adjustment.
- The general sensor's datasheet describes the exposure time and the number of frames in effect of the gain. If the exposure time and gain are written at frame n, and frame n+2 takes effect, then time_delay = 2, gain_delay = 2, and so on.
- The exposure time and gain effective frame number of some sensors are different, if the module parameters are wrong, it may cause the exposure time and gain effect to be out of sync during the exposure adjustment process, resulting in flicker.

1.2.6.9 CISMinFps

【Description】

Allow minimum frame rate, for automatic frame reduction mode, limit the minimum frame rate to prevent the frame rate from being too low in low-light environments, causing smear to seriously affect the effect.

1.2.6.10 CISFlip

【Description】

Sensor output image orientation control.

- bit 0, which is the mirror control bit
- bit 1, flip the flip control bit

1.2.7 4.1.2.5 moduleinfo parameter

【Description】

Module information parameters, which are generally obtained from the module's datasheet.

【Members】

Member name	Description
FNumber	The relative aperture size of the module lens, without debugging, is lens dependent
EFL	The focal length of the module lens, without debugging, is lens dependent
LensTavg	Lens transmittance, no debugging required, lens related
IRCutTavg	IRCut transmittance, no debugging required, lens dependent

【Precautions】

- This part of the parameter is currently invalid

1.3 4.1.3 Debugging steps

The debugging of AEC module mainly includes AE target value debugging, AE exposure decomposition path debugging, AE weight debugging, AE convergence speed debugging, etc. Before ISP debugging, it is necessary to confirm whether the sensor driver is working normally and whether the exposure parameters related to CIS are set correctly to avoid incorrect exposure settings.

Before debugging AEC, you also need to make sure that the following modules are calibrated and functionally correct: BLC, AWB, LSC, CCM, gamma modules can use the default gamma curves.

1.3.0.1 Step 1. Sensor exposure parameter setting

As described in Section 4.1.2, before formal debugging, it is necessary to ensure the correctness of the SensorInfo parameters to avoid problems such as incorrect exposure settings or flickering. The parameters of this module come from the original datasheet of the sensor, which requires the close attention of the debugging personnel and the responsible driver writers. After completing the module parameters, you can turn on the debugging of the above AE module synchronous test function SyncTest for testing. The SyncTest function can test whether the exposure time and exposure gain of the sensor, and the effective frame number of DCG switching are correct by cyclically setting N groups of different exposure values, and can also be used to test the linearity of the exposure, so as to confirm whether the register value conversion formula and related parameters of the exposure time and exposure gain are correct.

If the parameters have been confirmed before calibration, this step can be skipped.

1.3.0.2 Step 2.Set the AE Weight parameter

AEC's metering statistics module can count histogram information as well as block luminance information. By dividing the screen into NXN blocks at equal intervals, each block is given a corresponding weight. The weight can be increased for the area of interest, so the weight will be different depending on the application requirements. Generally, for IPC usage scenarios, the interested subject is generally located in the center of the

scene, it is recommended to increase the weight of the central area and lower the weight of the surrounding area to highlight the central area; For CVR usage scenarios, the subject of interest is generally located in the middle and lower areas of the scene (road area), and it is recommended to increase the weight of the middle and lower regions and decrease the weight of the upper area (sky area).

```
<AecGridWeight index="1" type="double" size="[15 15]">
   [0 1 1 1 1 1 1 1 1 1 1 1 1 1 0
   1 2 2 2 2 2 2 2 2 2 2 2 2 2 1
   1 2 5 5 5 5 5 5 5 5 5 5 5 2 1
   1 2 5 8 8  8  8  8  8  8  8  8 5 2 1
   1 2 5 8 10 10 10 10 10 10 10 8 5 2 1
   1 2 5 8 10 13 13 13 13 13 10 8 5 2 1
   1 2 5 8 10 13 15 15 15 13 10 8 5 2 1
   1 2 5 8 10 13 15 15 15 13 10 8 5 2 1
   1 2 5 8 10 13 15 15 15 13 10 8 5 2 1
   1 2 5 8 10 13 13 13 13 13 10 8 5 2 1
   1 2 5 8 10 10 10 10 10 10 10 8 5 2 1
   1 2 5 8  8  8  8  8  8  8  8  8 5 2 1
   1 2 5 5 5 5 5 5 5 5 5 5 5 2 1
   1 2 2 2 2 2 2 2 2 2 2 2 2 2 1
   0 1 1 1 1 1 1 1 1 1 1 1 1 1 0]
</AecGridWeight>
```

Figure 4-5 AEC weight parameters

It should be noted that some models of chip hardware support more block brightness statistics. In order to facilitate debugging, the weight of 15X15 is uniformly set in the debugging file, and the weight is expanded according to the number of blocks within the algorithm.

1.3.0.3 Step 3.Set AE exposure decomposition parameters

The exposure calculated by the AE control algorithm module needs to be decomposed into sensor exposure time component, sensor exposure gain component, ISP digital gain component and aperture component, and each component is set to the corresponding module to jointly realize the exposure setting to obtain the desired brightness image. The decomposition operation is completed by the parameters of the AecRoute module, and the parameter descriptions are described in Section 4.1.2. Different application scenarios need to set different AecRoutes: for daytime scenes, it is generally required to limit the exposure time and prioritize the gain to prevent motion smearing caused by excessive exposure time; For night scenes, it is generally required to prioritize the adjustment of the exposure time and then adjust the exposure gain in order to improve the signal-to-noise ratio of the picture and improve the brightness at night.

1.3.0.4 Step 4.Set the AE target brightness value

Linear exposure mode recommends turning on the dynamic target brightness function to meet the needs of different brightness scenes. The target brightness setting of linear mode involves DySetpoint, ToleranceIn/ToleranceOut, BackLightCtrl, OverExpCtrl parameters, etc., and the description of each parameter is detailed in Section 4.1.2. It is required to be suitable for indoor static scenes, and there is no large-scale overexposure. The environment transitions from light to dark, and the brightness can transition too smoothly.

HDR exposure mode, depending on the mode of exposure ratio and StrategyMode, the debugging steps of the target luminance value are also different. According to the exposure ratio mode and StrategyMode, adjust the target brightness parameter to the debug parameter module of the corresponding frame. The long-frame target brightness parameters involve LSetPoint and TargetLLLuma, which represent the global target brightness and the dark area target brightness, respectively. The target brightness parameter of the medium frame involves MSetPoint, which represents the global target brightness of the medium frame; The short frame target brightness

involves SSetPoint and TargetHLLuma, which represent the global target brightness of the short frame and the target brightness of the highlight area, respectively. The description of each parameter is described in Section 4.1.2.

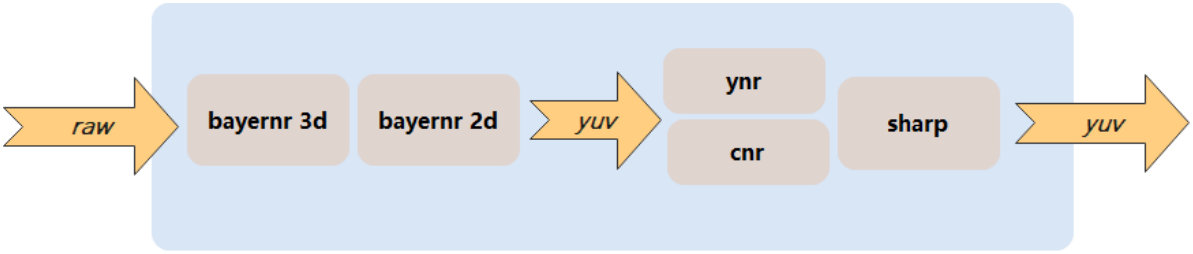
1.3.0.5 Step 5.Set AE convergence and response speed

The adjustment of AE convergence and response speed affects the exposure response speed, convergence speed and smoothness of the adjustment process. The parameters involved in this step include AecRunInterval, AecSpeed, AecDelayFrmNum, and the description of each parameter is described in Section 4.1.2. In indoor static scenes, the lights can be turned on and off to detect the convergence speed when the light changes sharply. Faster convergence can cause unsmooth transitions or overshoot when changing brightness slowly, so trade-offs are required.

2. 4.2 NR & SHARP

The ISP Denoising module consists of 4 modules: Bayernr 2D, Bayernr 3D, YNR and CNR.

The ISP sharpening module contains a SHARP module.



Block diagram of the NR pipeline

It is recommended to carry out noise debugging in the order of the pipeline, and each module debugging needs to consider the mutual influence and comprehensive effect of the previous and subsequent effects of the module.

During noise debugging, the effects of each step need to be viewed in order to clarify the impact of each step on denoising.

To view the Bayernr3D effect, compare the original undenoising image with only the Bayern3D rendering.

If you want to view the YNARR effect, you need to compare the Bayernr3D output with the image that has only been YNR but SHARP turned off.

And so on.

RV1106 differs from RK3588 on Pipe Line in the following ways:

1: Advance bayer3dnr to before bayer2dnr.

2: Bayer3DNR's BayE3D Gain instructs Bayer2DNR to set different denoising forces for moving and stationary areas.

3: The YNR, CNR, SHARP module will set different denoise intensity for the motion and stationary areas according to the local gain module.

2.1 4.2.1 BayerTnr (Bayer3dnr)

2.1.1 4.2.1.1 Feature description

This module performs time-domain noise reduction and soft threshold noise reduction processing on images on RAW domain data.

Among them, the motion judgment and weight calculation of the current frame and IIR frame data of thumbnails are carried out, and the image is superimposed on multiple frames to obtain a low-frequency overlapping frame noise reduction effect.

Among them, the motion judgment and weight calculation of the current frame and IIR frame data of the original image are carried out, and the image is superimposed on multiple frames to obtain the high-frequency superimposed frame noise reduction effect.

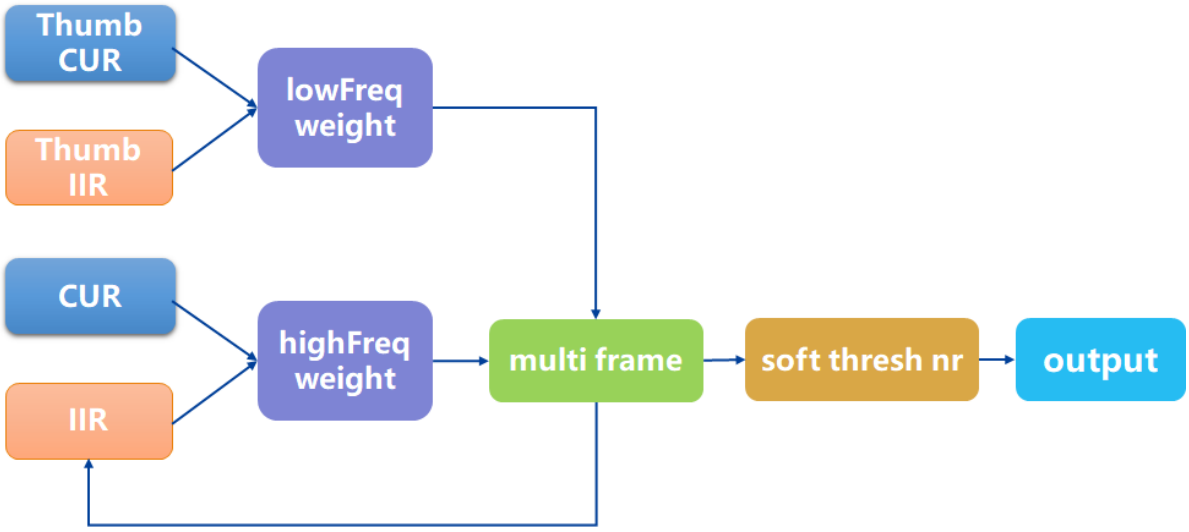
After multi-frame superposition, the soft threshold is calculated to obtain the final 3DNR output result.

This module tuning, the calibration data is required when the calibration data is used, and the Bayernr 2D module uses the same calibration data.

Based on the noise calibration results, the denoising module establishes a denoising model that is more in line with the noise characteristics.

- Support two kinds of noise calibration and noise parameters for high signal-to-noise ratio and low signal-to-noise ratio respectively.

For example, CIS that supports Dual convertion gain DCG, high conversion gain (HCG) for high signal-to-noise mode, and low conversion gain (HCG) for low signal-to-noise mode.



Bayernr3D block diagram

2.1.2 4.2.1.2 Key parameters

Parameter name	Parameter type	Brief description
Enable	Debug parameters	Frequently debug parameters
SNR_Mode	Mode parameters	DCG mode corresponds to high and low signal-to-noise ratio mode
sensor_Mode	Mode parameters	Sensor DCG mode
iso	Debug parameters	Frequently debug parameters
thumbds_w	Debug parameters	Infrequent debugging of parameters
thumbds_h	Debug parameters	Infrequent debugging of parameters
lo_enable	Debug parameters	Frequently debug parameters
hi_enable	Debug parameters	Frequently debug parameters
lo_med_en、lo_gsbay_en、lo_gslum_en	Debug parameters	Infrequent debugging of parameters
hi_med_en、hi_gslum_en	Debug parameters	Infrequent debugging of parameters
hi_wgt_comp	Debug parameters	Infrequent debugging of parameters
lo_clipwgt	Debug parameters	Infrequent debugging of parameters
global_pk_en	Debug parameters	Infrequent debugging of parameters
global_pksq	Debug parameters	Infrequent debugging of parameters
hidif_th	Debug parameters	Infrequent debugging of parameters
lo_filter_strength	Debug parameters	Frequently debug parameters
hi_filter_strength	Debug parameters	Frequently debug parameters
soft_threshold_ratio	Debug parameters	Frequently debug parameters

Parameter name	Parameter type	Brief description
lumapoint / sigma	Calibration data	The calibration tool generates parameters
lumapoint2 / lo_sigma	Calibration data	The calibration tool generates parameters
lumapoint2 / hi_sigma	Calibration data	The calibration tool generates parameters
lo_filter_rat0	Debug parameters	Frequently debug parameters
lo_filter_thed0	Debug parameters	Frequently debug parameters
hi_filter_rat0	Debug parameters	Frequently debug parameters
hi_filter_thed0	Debug parameters	Frequently debug parameters
hi_filter_rat1	Debug parameters	Frequently debug parameters
hi_filter_thed1	Debug parameters	Frequently debug parameters
trans_en	Debug parameters	Infrequent debugging of parameters
wgt_use_mode	Debug parameters	Infrequent debugging of parameters
wgt_mge_mode	Debug parameters	Infrequent debugging of parameters
hi_guass	Debug parameters	Infrequent debugging of parameters
kl_guass	Debug parameters	Infrequent debugging of parameters
hi_filter_abs_ctrl	Debug parameters	Infrequent debugging of parameters
hi_filter_filt_bay	Debug parameters	Infrequent debugging of parameters
hi_filter_filt_avg	Debug parameters	Infrequent debugging of parameters
hi_filter_filt_mode	Debug parameters	Infrequent debugging of parameters

Parameter name	Parameter type	Brief description
guass_guide_coeff0/1/2/3	Debug parameters	Infrequent debugging of parameters

2.1.2.1 Enable:

【Description】

Bayernr3d module enable bit, 0: off, 1: on.

2.1.2.2 SNR_Mode

【Description】

LCG and HCG correspond to different noise modes. HSNR corresponds to HCG, and LSNR corresponds to LCG mode.

2.1.2.3 sensor_Mode

【Description】

HCG and LCG modes supported by Sensor, if DCG mode is not supported, LCG parameters are used by default.

2.1.2.4 ISO

【Description】

Different ISO gears, corresponding to different debugging parameters. Currently only 13 gears are supported.

2.1.2.5 thumbds_w / thumbds_h

【Description】

Downsampling scale. There are 3 modes: 4x4, 8x4, and 8x8. By default, 8x4 mode is used.

In 4x4 and 4x8 modes, the memory can use SRAM or DDR memory.

In 8x8 mode, if SRAM memory is used, the resolution width cannot be greater than 1440.

8x8 mode, if DDR memory is used, the resolution is not limited above.

2.1.2.6 lo_enable

【Description】

The low-frequency motion determines whether it is on, 1 on, 0 off. On by default.

Under the bandwidth-saving modular type, the dynamic change of the lo_enable will cause the ISP to freeze, and the default lo_enable in the code is 1.

2.1.2.7 hi_enable

【Description】

High-frequency motion determines whether it is on, 1 on, 0 off. On by default.

2.1.2.8 lo_med_en、lo_gsbay_en、lo_gslum_en

【Description】

Internal low-frequency submodule switch, 1 on, 0 off. On by default.

2.1.2.9 hi_med_en、hi_gslum_en

【Description】

Internal high-frequency submodule switch, 1 on, 0 off. On by default.

2.1.2.10 hi_wgt_comp

【Description】

The scale coefficient value of superimposed weight complement is only useful when the high frequency is turned on;

The default value is 0.16, and the value range is [0.0, 1.0].

Generally, it is not adjusted very often, and the default value is used.

2.1.2.11 lo_clipwgt

【Description】

The weight limit value for the image low-frequency overlay. Smaller values place less weight restrictions.

The default value is 0.03215, and the value range is [0.0, 1.0].

Generally, it is not adjusted very often, and the default value is used.

2.1.2.12 global_pk_en

【Description】

Whether to use global PK or local PK for time-domain noise reduction, 1: Use global PK, 0: Use local PK.

The default value is 0.

2.1.2.13 global_pksq

【Description】

The squared value of the global pk, which is used only when the global_pk_en is 1.

The default value is 1024, and the value range is [0, 268435455].

Generally, it is not adjusted very often, and the default value is used.

2.1.2.14 hidif_th

【Description】

High-frequency difference threshold.

The default value is 32767, and the value range is [0, 65535].

Generally, it is not adjusted very often, and the default value is used.

2.1.2.15 lo_filter_strength

【Description】

Low-frequency motion determines the calculated image overlay intensity.

The higher the value, the stronger the superposition and the lower the accuracy of motion judgment.

The default value is 1, and the value range is [0.0, 16.0].

2.1.2.16 hi_filter_strength

【Description】

High-frequency motion determines the calculated image overlay intensity.

The higher the value, the stronger the superposition and the lower the accuracy of motion judgment.

The value range is [0.0, 16.0], and the default value is 1.

2.1.2.17 soft_threshold_ratio

【Description】

Soft threshold weights. The higher the value, the more noise is retained.

The value range is [0.0 1.0], and the default value is 0.

2.1.2.18 lumapoint / sigma

【Description】

The noise curve value corresponding to the different brightness of the pixel. A total of 16 points.

LumaPoint corresponds to pixel brightness, value range [0, 65535];

The sigma corresponds to the noise curve value in the range [0, 65535].

2.1.2.19 lumapoint2 / lo_sigma

【Description】

Low-frequency sigma of the noise curve of motion judgment. A total of 16 points.

lumapoint2 corresponds to pixel brightness, the value range [0, 65535];

lo_sigma corresponds to the noise curve value, the value range [0, 65535].

2.1.2.20 lumapoint2 / hi_sigma

【Description】

High-frequency sigma of motion judgment noise curve. A total of 16 points.

lumapoint2 corresponds to pixel brightness, the value range [0, 65535];

hi_sigma corresponds to the noise curve value, the value range [0, 65535].

2.1.2.21 lo_filter_rat0

【Description】

When calculating the weight of low-frequency motion judgment, the difference value should be subtracted from the data proportion parameter.

The value range is [0.0, 16.0], and the default value is 1.

2.1.2.22 lo_filter_thed0

【Description】

When calculating the weight of low-frequency motion judgment, the difference value should be subtracted from the data offset parameter.

The value range is [0, 4095], and the default value is 0.

2.1.2.23 hi_filter_rat0

【Description】

When the first weight is calculated for high-frequency motion judgment, the data proportion parameter that the difference value should be subtracted mainly has more influence on the high frequency in the stationary region.

The value range is [0.0, 16.0], and the default value is 1.

2.1.2.24 hi_filter_thed0

【Description】

When the high frequency motion is judged the first weight calculation, the data shift parameter that the difference value should be subtracted, mainly has more influence on the high frequency in the rest region.

The value range is [0, 4095], and the default value is 256.

2.1.2.25 hi_filter_rat1

【Description】

When calculating the second weight of high-frequency motion judgment, the data proportion parameter to be subtracted from the difference value mainly affects the high frequency with strong texture such as edges.

The value range is [0.0, 16.0], and the default value is 1.

2.1.2.26 hi_filter_thed1

【Description】

When the second weight is calculated, the data offset parameter to be subtracted from the difference value mainly affects the high frequency with strong texture such as edges.

The value range is [0, 4095], and the default value is 1024.

2.1.2.27 trans_en

【Description】

Whether the bandwidth saving mode is enabled.

0: Do not turn on, 1: On. The default value is 0.

In normal linear mode, this parameter can be set to 1.

HDR mode, this parameter is recommended to be set to 0, with image effects as the priority.

2.1.2.28 wgt_use_mode

【Description】

Whether to turn on the optimization function when weight fusion.

0: Do not turn on, 1: On. The default value is 0.

2.1.2.29 wgt_mge_mode

【Description】

The high-frequency weight calculation turns on the optimization function.

0: Do not turn on, 1: On. The default value is 1.

2.1.2.30 hi_guass

【Description】

High-frequency SIGMA uses filtered data, or raw unfiltered data.

0: Raw unfiltered data.

1: Data after filtering.

The default value is 0.

2.1.2.31 kl_guass

【Description】

PK Sigma uses filtered data, or raw unfiltered data.

0: Raw unfiltered data.

1: Data after filtering.

The default value is 0.

2.1.2.32 hi_filter_abs_ctrl

【Description】

Absolute value position selection when calculating high-frequency weights
0: Difference->median->Gaussian->abs
1: Difference->median->abs->Gaussian

The default value is 0.

2.1.2.33 hi_filter_filt_bay

【Description】

When calculating the high-frequency weights, Gaussian filters whether the 4 channels of Bayer data are calculated separately.
1: Calculate separately, 4 channels do 3x3 Gaussian
0: 4 channels are not calculated separately, do 5x7 Gaussian

The default value is 0.

2.1.2.34 hi_filter_filt_avg

【Description】

Whether the 5x5 filtering function is enabled when calculating the high-frequency weight.
0: Do not turn on, 1: On. The default value is 0.

2.1.2.35 hi_filter_filt_mode

【Description】

Filter mode selection when calculating high-frequency weights.

The value range is [0, 4]. The default value is 4.

0: Gaussian 3x3 filtering is not enabled

1: Use Gaussian 3x3 filter kernel2

2: Use Gaussian 3x3 filter kernel1

3: Use Gaussian 5x5 filtering

4: Gaussian 5x5 filtering is not used

2.1.2.36 guass_guide_coeff0-3

【Description】

Gaussian filter operators.

The value range is [0, 64]. The default values are 16,8,16,8.

2.1.3 4.2.1.3 Debugging steps

Turn off the Bayernr2D, YNR, CNR, SHARP modules, adjust filter_strength, lo_clipwgt, hi_clipwgt parameters, balance denoising and smear levels.

When debugging the high and low frequency strength, first adjust the low frequency, and then adjust the high frequency. The noise in the stationary area can be adjusted to stable without jumping, and then observe whether the moving area is transparent, and the debugging parameters should ensure that both are stable. If the noise is too large to exceed the boundaries of the algorithm, only one item can be satisfied, and a trade-off must be made.

If you want to retain more high frequencies, you can debug the parameters of the hi_filter_sig, the smaller the value, the more high frequency retention, the greater the noise in the stationary area.

Mainly debug off0 and off1, off0 mainly affects the high frequency of the stationary area, and off1 is the high frequency that affects the strong texture,

The motion area and the rest area are internally adaptive judgments of Bayer3DNR. It will be distinguished by the output GAIN data of the module, the larger the gain, the stronger the movement. Bayer3DNR will pass the GAIN data to Bayer2DNR and YNR respectively, which will enhance noise reduction in the motion area according to GAIN.

Normal time-domain multi-frame overlay denoising does not affect noise patterns.

However, after multi-frame superposition, there is also a soft threshold processing in Bayernr3D, so it will affect the noise pattern.

The stronger the soft threshold processing, the lower the frequency of the noise particles.

2.2 4.2.2 Bayer2dnr

2.2.1 4.2.2.1 Feature description

The Bayernr 2D module is mainly a module for spatial noise reduction of RAW data.

The module will determine whether it is HDR mode, and convert the denoising force to denoise the long and short frames of HDR at the same time.

Filter denoising is guided by whether Gaussian guidance is turned on, as well as the noise level calibrated, the gain multiple of HDR long and short frames, and Bayer3D gain.

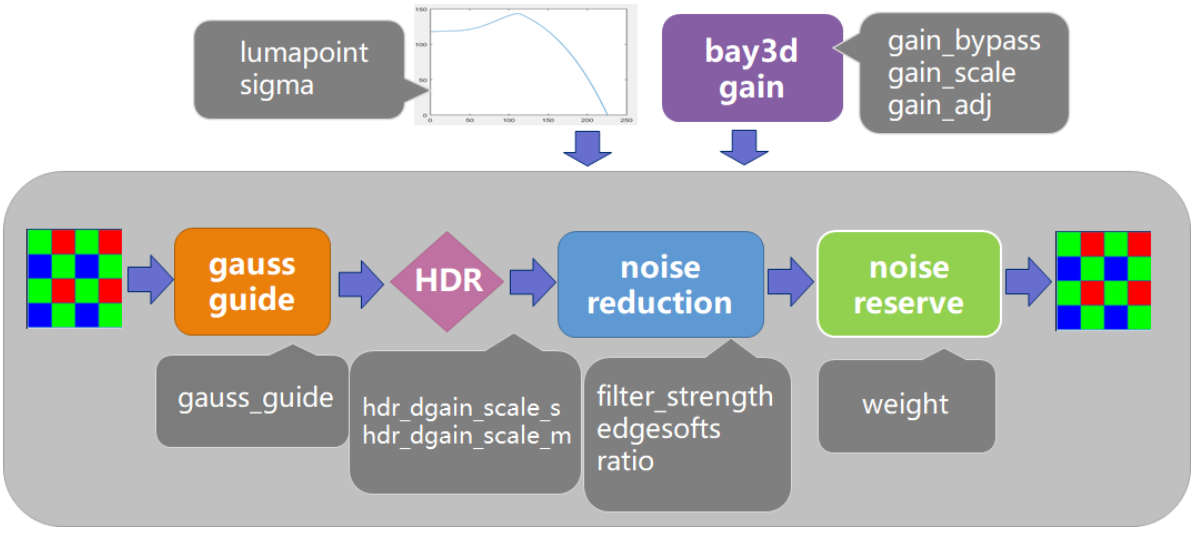
Finally, the denoising image and the undenoised image are weighted interpolated to retain some of the noise.

The tuning process requires the noise variance of the RAW data to be calibrated to obtain the corresponding calibration data.

Based on the noise calibration results, the denoising module establishes a denoising model that is more in line with the noise characteristics.

- Support two kinds of noise calibration and noise parameters for high signal-to-noise ratio and low signal-to-noise ratio respectively.

For example, CIS that supports Dual convertion gain DCG, high conversion gain (HCG) for high signal-to-noise mode, and low conversion gain (HCG) for low signal-to-noise mode.



Bayernr2D block diagram

2.2.2 4.2.2.2 Key parameters

Parameter name	Parameter type	Brief description
enable	Debug parameters	Frequently debug parameters
SNR_Mode	Mode parameters	DCG mode corresponds to high and low signal-to-noise ratio mode
Sensor_Mode	Mode parameters	Sensor DCG mode
ISO	Debug parameters	Frequently debug parameters
lumapoint	Calibration data	The calibration tool generates parameters
sigma	Calibration data	The calibration tool generates parameters
gauss_guide	Debug parameters	Frequently debug parameters
filter_strength	Debug parameters	Frequently debug parameters
edgesofts	Debug parameters	Frequently debug parameters
ratio	Debug parameters	Frequently debug parameters
weight	Debug parameters	Frequently debug parameters
pix_diff	Debug parameters	Infrequent debugging of parameters
diff_thld	Debug parameters	Infrequent debugging of parameters
gain_bypass	Debug parameters	Infrequent debugging of parameters
gain_scale	Debug parameters	Frequently debug parameters
gain_adj	Debug parameters	Frequently debug parameters
hdr_dgain_ctrl_en	Debug parameters	Frequently debug parameters
hdr_gain_scale_s	Debug parameters	Frequently debug parameters
hdr_gain_scale_m	Debug parameters	Frequently debug parameters

Parameter name	Parameter type	Brief description
trans_mode	Debug parameters	Infrequent debugging of parameters
trans_offset	Debug parameters	Infrequent debugging of parameters
itrans_offset	Debug parameters	Infrequent debugging of parameters
trans_datmax	Debug parameters	Infrequent debugging of parameters

2.2.2.1 enable:

【Description】

The module switch is enabled. 1: Module open, 0: Module off.

2.2.2.2 SNR_Mode

【Description】

LCG and HCG correspond to different noise modes.

HSNR corresponds to HCG, and LSNR corresponds to LCG mode.

2.2.2.3 Sensor_Mode

【Description】

HCG and LCG modes supported by Sensor, if DCG mode is not supported, LCG parameters are used by default.

2.2.2.4 ISO

【Description】

Different ISO gears, corresponding to different debugging parameters. Currently only 13 gears are supported.

2.2.2.5 filter_strength

【Description】

Denoising force parameters. The value range [0, 16], the larger the value, the greater the denoising force.

2.2.2.6 gauss_guide

【Description】

Whether Gaussian guidance is enabled. 1: Enable. 0: Off.

2.2.2.7 lumapoint/sigma

【Description】

Calibration data, different Pixel brightness corresponds to different noise SIGMA curve points. A total of 16 points.

LumaPoint corresponds to the abscissa pixel brightness, value range [0, 65535]

sigma corresponds to the ordinate noise value curve, the value range [0, 65535];

2.2.2.8 edgesofts

【Description】

Affects airspace weights. The value range is [1, 16], and the default value is 1.

2.2.2.9 ratio

【Description】

Soft threshold weights. The value range is [0, 1.0]. The smaller the value, the greater the denoising force.

The value range is [0, 1], and the default value is 0.01.

2.2.2.10 weight

【Description】

The greater the value of the filter output, the greater the denoising force.

The value range is [0, 1], and the default value is 0.5.

2.2.2.11 pix_diff

【Description】

5x5 window pixel difference threshold for bilateral filtering.

The value range is [0, 16383], and the default value is 16383.

2.2.2.12 diff_thld

【Description】

Calculate the squared difference threshold of the Euclidean distance for bilateral filtering.

The value range is [0, 1023], and the default value is 1023.

2.2.2.13 gain_bypass

【Description】

The bayer3dnr gain module guides whether denoising is enabled or not.

0: Enable. 1: Not enabled. The default configuration is 0.

2.2.2.14 gain_scale

【Description】

The Bayer3DNR Gain module guides the force magnification of denoising.

The higher the value, the stronger the denoising.

Value range[0.0, 16.0]. The default value is 1.0.

2.2.2.15 gain_adj

【Description】

Gain mapping table passed from bayer3dnr.

The horizontal axis gain_lumapoint, which represents the original size of the pass gain. Value range[0, 256].

The vertical axis gain_adj represents the size of the gain value after mapping. Value range[0, 256].

It is necessary to confirm the range of the motion area GAIN and the rest area GAIN.

The GAIN of the moving area is enlarged to increase the denoising force of the moving area.

2.2.2.16 hdr_dgain_ctrl_en

【Description】

In HDR mode, the Enable bit is controlled for the DGAIN of frames in short frames.

0: Do not enable, 1: Enable. Default value: 0.

2.2.2.17 hdr_dgain_scale_s

【Description】

HDR mode, and hdr_dgain_ctrl_en=1, magnify the DANet of short frames.

Value range[0.0, 128.0]. The default value is 1.0.

2.2.2.18 hdr_dgain_scale_m

【Description】

HDR mode, and hdr_dgain_ctrl_en=1, magnify the DAgain of the frame.

Value range[0.0, 128.0]. The default value is 1.0.

2.2.2.19 trans_mode

【Description】

The mode corresponding to the log domain transformation.

Value range: 0,1,2,3. The default value is 0.

Different modes correspond to different conversion coefficients, and need to be configured one by one.

Generally, it is not adjusted, and the default value is used.

2.2.2.20 trans_offset / itrans_offset

【Description】

trans_offset: Log domain conversion coefficient.

itrans_offset: The log domain inverse conversion coefficient.

5 sets of corresponding coefficient configurations:

trans_offset = 0x100 , itrans_offset = 0x8000;

trans_offset = 0x200 , itrans_offset = 0x9000;

trans_offset = 0x400 , itrans_offset = 0xa000;

trans_offset = 0x800 , itrans_offset = 0xb000;

trans_offset = 0x1000 , itrans_offset = 0xc000;

Default configuration:

trans_offset = 0x100 , itrans_offset = 0x8000;

Generally, it is not adjusted, and the default value is used.

2.2.2.21 trans_datmax

【Description】

One of the coefficients of change of log domain conversion.

The range of values is [0, 1048575]. Default value: 1048575.

Generally, it is not adjusted, and the default value is used.

2.2.3 4.2.2.3 Debugging steps

When debugging: open bayernr3d, close ynr, cnr, sharp and other modules.

Bayernr2D suppresses high-frequency noise, which affects image detail and noise morphology. When the force is high, the noise particles become low frequency and the details become less.

Adjust the dynamics of bayernr2D to balance noise and loss of detail.

At low ISO, the overall denoising force is smaller, the filter_strength is smaller, and the weight is smaller.

Under high ISO, it is recommended to increase the intensity appropriately and gradually, filter_strength larger and the weight larger.

According to the GAIN value of the motion area, the mapping table of the gain_adj is adjusted to increase the denoising intensity of the motion area.

2.3 4.2.3 YNR

2.3.1 4.2.3.1 Feature description

This module performs denoising and other processing on the image brightness signal on the YUV domain.

The YNNR module can be divided into pre-filter sub-module, low-frequency noise reduction module and high-frequency noise reduction module.

Low-frequency noise reduction is divided into two parts: large-range low-frequency filtering and soft threshold processing.

High-frequency noise reduction is achieved using 7x7 conformal filtering and adapted to the way noise is calculated adaptively to obtain noise estimates.

YNR will use the local noise size recorded by the GAIN module to denoise different areas of the local.

The ynr also sets different denoising forces in the radial direction with the center of the image as the origin to solve the problem that the corresponding corner noise becomes larger after LSC correction.

Based on the noise calibration results, the denoising module establishes a denoising model that is more in line with the noise characteristics.

- Support two kinds of noise calibration and noise parameters for high signal-to-noise ratio and low signal-to-noise ratio respectively.

For example, CIS that supports Dual convertion gain DCG, high conversion gain (HCG) for high signal-to-noise mode, and low conversion gain (HCG) for low signal-to-noise mode.

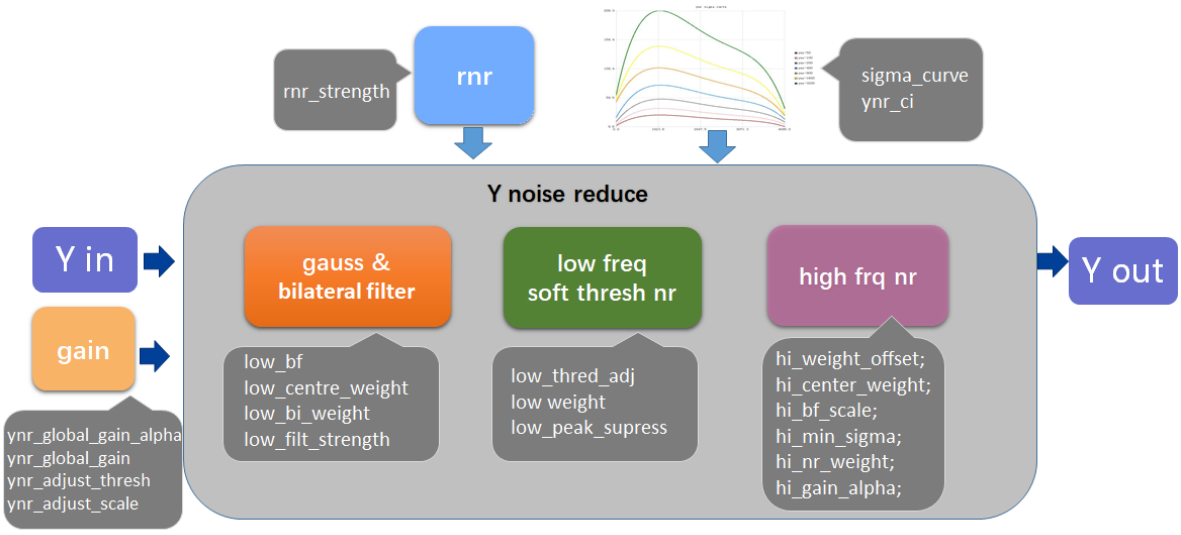


Fig. 4-2-3-1 YNNR functional block diagram

2.3.2 4.2.3.2 Key parameters

Parameter name	Parameter type	Brief description
Enable	Debug parameters	Frequently debug parameters
SNR_Mode	Mode parameters	DCG mode corresponds to high and low signal-to-noise ratio mode
Sensor_Mode	Mode parameters	Sensor DCG mode
iso	Debug parameters	Frequently debug parameters
lumaPoint / sigma	Calibration data	The calibration tool generates parameters
lci	Calibration data	The calibration tool generates parameters
hci	Calibration data	The calibration tool generates parameters
lo_lumaPoint / lo_ratio	Debug parameters	Frequently debug parameters
hi_lumaPoint / hi_ratio	Debug parameters	Frequently debug parameters
ynr_bft3x3_bypass	Debug parameters	Infrequent debugging parameters, switch internal module
ynr_lbft5x5_bypass	Debug parameters	Infrequent debugging parameters, switch internal module
ynr_lgft3x3_bypass	Debug parameters	Infrequent debugging parameters, switch internal module
ynr_flt1x1_bypass	Debug parameters	Infrequent debugging parameters, switch internal module
ynr_nlm11x11_bypass	Debug parameters	Infrequent debugging parameters, switch internal module
ynr_global_gain_alpha	Debug parameters	Infrequent debugging of parameters
ynr_global_gain	Debug parameters	Infrequent debugging of parameters
ynr_adjust_thres	Debug parameters	Frequently debug parameters
ynr_adjust_scale	Debug parameters	Frequently debug parameters

Parameter name	Parameter type	Brief description
rnr_strength	Debug parameters	Frequently debug parameters
low_bf	Debug parameters	Frequently debug parameters
low_thred_adj	Debug parameters	Frequently debug parameters
low_peak_supress	Debug parameters	Frequently debug parameters
low_edge_adj_thresh	Debug parameters	Frequently debug parameters
low_lbf_weight_thresh	Debug parameters	Frequently debug parameters
low_center_weight	Debug parameters	Frequently debug parameters
low_dist_adj	Debug parameters	Frequently debug parameters
low_weight	Debug parameters	Frequently debug parameters
low_filt_strength	Debug parameters	Frequently debug parameters
low_bi_weight	Debug parameters	Frequently debug parameters
hi_weight_offset	Debug parameters	Frequently debug parameters
hi_center_weight	Debug parameters	Frequently debug parameters
hi_bf_scale	Debug parameters	Frequently debug parameters
hi_min_sigma	Debug parameters	Frequently debug parameters
hi_nr_weight	Debug parameters	Frequently debug parameters
hi_gain_alpha	Debug parameters	Frequently debug parameters
hi_filter_coeff1_1/2/3	Debug parameters	Infrequent debugging of parameters

Parameter name	Parameter type	Brief description
hi_filter_coeff2_1/2/3	Debug parameters	Infrequent debugging of parameters

2.3.2.1 Enable:

【Description】

The ynr module enables the switch, 1: module on, 0: module off.

2.3.2.2 SNR_Mode

【Description】

LCG and HCG correspond to different noise modes.

HSNR corresponds to HCG, and LSNR corresponds to LCG mode.

2.3.2.3 Sensor_Mode

【Description】

HCG and LCG modes supported by Sensor, if DCG mode is not supported, LCG parameters are used by default.

2.3.2.4 ISO

【Description】

Different ISO gears, corresponding to different debugging parameters. Currently only 13 gears are supported.

2.3.2.5 lumaPoint / sigma

【Description】

The calibration tool generates a noise SIGMA curve.

2.3.2.6 lci

【Description】

The calibration tool generates a low-frequency noise sigma influence factor. The higher the value, the greater the noise sigma and the stronger the denoising force.

2.3.2.7 hci

【Description】

The calibration tool generates a high-frequency noise SIGMA influence factor. The higher the value, the greater the noise sigma and the stronger the denoising force.

2.3.2.8 lo_lumaPoint / lo_ratio

【Description】

Locally adjust the noise curve low-frequency sigma shape.

lo_lumaPoint Value range[0, 256].

lo_ratio Value range[0.0, 2.0].

2.3.2.9 hi_lumaPoint / hi_ratio

【Description】

Locally adjust the noise curve low-frequency sigma shape.

hi_lumaPoint Value range[0, 256].

hi_ratio Value range[0.0, 2.0].

2.3.2.10 ynr_bft3x3_bypass,ynr_lbft5x5_bypass,ynr_lgft3x3_bypass,ynr_flt1x1_bypass，ynr_nlm11x11_bypass

【Description】

The module is a sub-module bypass function. 0: Function enabled. 1: Function bypass.

In general, all submodules are enabled and these values are set to 0.

2.3.2.11 ynr_global_gain_alpha/ynr_global_gain

【Description】

Ynr denoising local mode and global mode interpolate force configuration.

Generally, the default value is used, no configuration, and all use the local gain method.

Formula: Gain = (global_gain_alpha*global_gain+(8-global_gain_alpha)*local_gain)>>3

Global gain alpha takes the value range [0.0 1.0], and the default value is 0.

Global gain takes the value range [0.0 64.0]. Default value 1.

2.3.2.12 ynr_adjust_thresh /ynr_adjust_scale

【Description】

Denoise force control for noise greater than the threshold ynr_adjust_thresh.

The design is to think that the noise in the moving area is relatively large, set an appropriate threshold, and enhance the YNR denoising force in the moving area.

ynr_adjust_thresh, the value range is [0.0, 1.0], and the default value is 1.

ynr_adjust_scale, the value range is [0, 16.0], and the default value is 1.

2.3.2.13 rnr_strength

【Description】

In the center of the image, different denoising forces are set in the direction of the radius r of the circle.

The value range is [0, 16.0], and the default value is 1.

2.3.2.14 low_bf

【Description】

Bilateral filtering force parameters.

The first line is the original 3x3 bilateral filtering force, the larger the value, the stronger the denoising.

The value range is [0.01, 32], and the default value is 1.

The second line is the 5x5 bilateral filtering force of the previous frame, the larger the value, the stronger the denoising.

The value range is [0.01, 32], and the default value is 1.

2.3.2.15 low_thred_adj

【Description】

The higher the value of the low-frequency soft threshold, the greater the low-frequency noise reduction force.

The value range is [0, 31], and the default value is 0.5.

2.3.2.16 low_peak_supress

【Description】

Controls the force with which isolated noise is removed, the smaller the value, the greater the denoising force.

The value range is [0, 1], and the default value is 0.5.

2.3.2.17 low_edge_adj_thresh

【Description】

The threshold of the adjustment factor for edge detection of the small plot, which is used to limit the maximum value that can be taken by the adjustment factor.

The smaller the value, the greater the denoising force and the blurrier the image. The value range [0, 1023] integer, default value 7.

2.3.2.18 low_lbf_weight_thresh

【Description】

The weight used to limit the 5x5 bilateral filtering, the higher the value, the weaker the low-frequency noise reduction.

The value range is [0.0, 1.0]. The default value is 0.25.

2.3.2.19 low_center_weight

【Description】

The weight of the center point during 5x5 bilateral filtering, the smaller the value, the stronger the noise reduction.

The value range is [0,1], and the default value is 0.5.

2.3.2.20 low_dist_adj

【Description】

Bilateral filter distance weight adjustment factor. The smaller the value, the stronger the denoising.

The value range is [0, 127.0], and the default value is 8.0.

2.3.2.21 low_weight

【Description】

The weight of the low-frequency denoising result, the larger the value, the greater the low-frequency noise reduction force.

The value range is [0, 1], and the default value is 0.5.

2.3.2.22 low_filt_strength

【Description】

The first row performs Gaussian filtering on the original graph with the filter kernel weight.

The value range is [0,1.0], and the default value is 0.7.

The second line performs the filter kernel weights of Gaussian filtering on the results of bilateral filtering.

The value range is [0,1.0], and the default value is 0.85.

2.3.2.23 low_bi_weight

【Description】

The first bilateral filter weight used in soft threshold processing, the higher the value, the greater the noise reduction.

The value range is [0, 1], and the default value is 0.3.

2.3.2.24 hi_weight_offset

【Description】

The calculated weighted weight is subtracted from this value to adjust the weight additionally, and the higher the value, the weaker the noise reduction.

The value range is [0, 1.0], and the default value is 0.05.

2.3.2.25 hi_center_weight

【Description】

The higher the weight of the high-frequency center point, the weaker the noise reduction.

The value range is [0, 1], and the default value is 0.8.

2.3.2.26 hi_bf_scale

【Description】

The force control of high-frequency noise reduction, the larger the denoising force.

The value range is [0.0, 16.0], and the default value is 1.0.

2.3.2.27 hi_min_sigma

【Description】

The minimum noise threshold is actually the noise estimate used in flat areas, and the higher the value, the stronger the noise reduction in flat areas.

The value range is [0.0, 1.0], and the default value is 0.0068.

2.3.2.28 hi_nr_weight

【Description】

The superposition weight of the high-frequency noise reduction result and the original image, the higher the value, the stronger the noise reduction.

The value range is [0, 1.0], and the default value is 0.8.

2.3.2.29 hi_gain_alpha

【Description】

The proportion of local gain used for high-frequency noise reduction, the higher the proportion of local gain used by the larger the value.

The value range is [0, 1.0], and the default value is 1.

2.3.2.30 hi_filter_coeff1_1 / hi_filter_coeff1_2 / hi_filter_coeff1_3

【Description】

Gaussian filter operator 1.

Value range[0, 15]. The default value is: 7,6,3.

2.3.2.31 hi_filter_coeff2_1 / hi_filter_coeff2_2 / hi_filter_coeff2_3

【Description】

Gaussian filter operator 2.

The default value range is: 6, 5, 3.

2.3.3 4.2.3.3 Debugging steps

Close the SHARP module.

Low-frequency noise reduction is divided into two parts: large-range low-frequency filtering and soft threshold processing.

Debugging mode:

- First adjust the overall low-frequency noise reduction intensity of the sw_low_bf2 and sw_low_center_weight control;
- Adjust sw_low_thred_adj controls the intensity of the soft threshold for adjusting the morphology of texture and large noise in the image;
- Weak lattice or obvious bandding, adjust sw_low_dist_adj, if there is a shadow-like shadow in motion, adjust the sw_low_lbf_weight_thresh.

High-frequency noise reduction is achieved using 7x7 conformal filtering and adapted to the way noise is calculated adaptively to obtain noise estimates.

Debugging mode:

- First debug the sw_hi_bf_scale and sw_hi_center_weight debug the overall strength of high-frequency noise reduction;
- If the strength of the flat area is not enough, adjust the sw_high_min_sigma;
- Adjust the sw_hi_gain_alpha, control the proportion of local gain, control the intensity of the movement area
- The sharpness of the textured area is adjusted with sw_high_weight_offset

2.4 4.2.4 CNR

2.4.1 4.2.4.1 Feature description

This module is mainly for color noise reduction processing for UV data.

The overall idea of the algorithm is to first downsample the original image with the mean, obtain the downsampled image, perform IIR filtering on the downsampled image, and protect the input image with the thumbnail after IIR filtering as the guide to remove the color noise of the image.

The module supports parameter settings for two noise modes, high signal-to-noise ratio and low signal-to-noise ratio.

For example, CIS that supports Dual convertion gain DCG, high conversion gain (HCG) for high signal-to-noise mode, and low conversion gain (HCG) for low signal-to-noise mode.

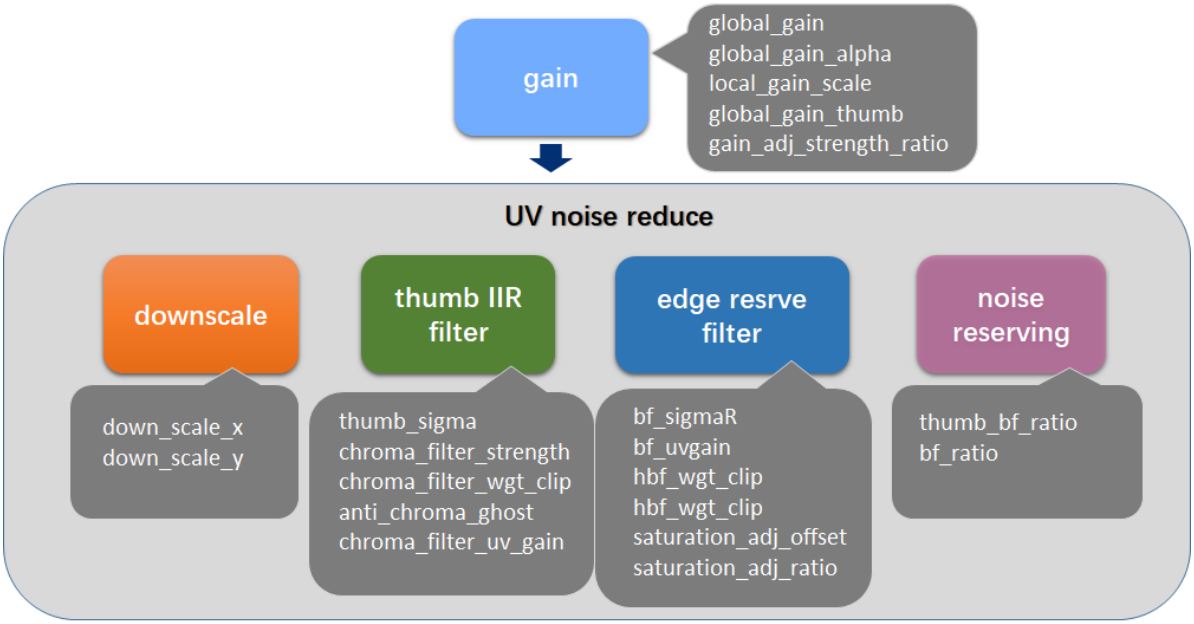


Fig. 4-2-3-1 CNR functional block diagram

2.4.2 4.2.4.2 Key parameters

Parameter name	Parameter type	Brief description
Enable	Debug parameters	Frequently debug parameters
SNR_Mode	Mode parameters	DCG mode corresponds to high and low signal-to-noise ratio mode
Sensor_Mode	Mode parameters	Sensor DCG mode
iso	Debug parameters	Frequently debug parameters
down_scale_x	Debug parameters	Infrequent debugging of parameters
down_scale_y	Debug parameters	Infrequent debugging of parameters
thumb_sigma	Debug parameters	Frequently debug parameters
thumb_bf_ratio	Debug parameters	Frequently debug parameters
chroma_filter_strength	Debug parameters	Frequently debug parameters
chroma_filter_wgt_clip	Debug parameters	Frequently debug parameters
anti_chroma_ghost	Debug parameters	Frequently debug parameters
chroma_filter_uv_gain	Debug parameters	Frequently debug parameters
wgt_slope	Debug parameters	Frequently debug parameters
gaus_ratio	Debug parameters	Frequently debug parameters
bf_sigmaR	Debug parameters	Frequently debug parameters
bf_uvgain	Debug parameters	Frequently debug parameters
bf_ratio	Debug parameters	Frequently debug parameters
hbf_wgt_clip	Debug parameters	Frequently debug parameters

Parameter name	Parameter type	Brief description
bf_wgt0_sel	Debug parameters	Frequently debug parameters
global_alpha	Debug parameters	Frequently debug parameters
saturation_adj_offset	Debug parameters	Frequently debug parameters
saturation_adj_ratio	Debug parameters	Frequently debug parameters
global_gain	Debug parameters	Infrequent debugging of parameters
global_gain_alpha	Debug parameters	Infrequent debugging of parameters
local_gain_scale	Debug parameters	Frequently debug parameters
global_gain_thumb	Debug parameters	Infrequent debugging of parameters
global_gain_alpha_thumb	Debug parameters	Infrequent debugging of parameters
gain_adj_strength_ratio	Debug parameters	Infrequent debugging of parameters
thumb_filter_wgt_coeff	Debug parameters	Infrequent debugging of parameters
gaus_coeff	Debug parameters	Infrequent debugging of parameters

2.4.2.1 Enable

【Description】

The module switch is enabled. 1: Module open, 0: Module off.

2.4.2.2 SNR_Mode

【Description】

LCG and HCG correspond to different noise modes. HSNR corresponds to HCG, and LSNR corresponds to LCG mode.

2.4.2.3 Sensor_Mode

【Description】

HCG and LCG modes supported by Sensor, if DCG mode is not supported, LCG parameters are used by default.

2.4.2.4 ISO

【Description】

Different ISO gears, corresponding to different debugging parameters. Currently only 13 gears are supported.

2.4.2.5 down_scale_x / down_scale_y

【Description】

Thumbnail downsampling scale.

At present, only 2x2, 4x4, 8x6 modes are supported.

By default, 4x4 mode is used.

2.4.2.6 thumb_sigma

【Description】

Thumbnail conformal edge filtering Y-channel sigma. The higher the value, the greater the filtering force.

The value range is [0.0, 1.0]. The default value is 0.01.

2.4.2.7 thumb_bf_ratio

【Description】

Thumbnail conformal filtering global fusion weights. The higher the value, the greater the filtering force.

The value range is [0.0, 1.0]. Default value 1.

2.4.2.8 chroma_filter_strength

【Description】

Thumbnail IIR filtering force, the higher the value, the greater the filtering force.

The value range is [0, 1.0]. The default value is 0.01.

2.4.2.9 chroma_filter_wgt_clip

【Description】

Thumbnail IIR filter IIR weight clip value, the larger the value, the greater the maximum filtering force.

The value range is [0, 16.0]. The default value is 0.9.

2.4.2.10 anti_chroma_ghost

【Description】

Thumbnail IIR filtering suppresses the smearing threshold, and the smaller the value, the more severe the chroma smearing.

The value range is [0.0, 1.0]. The default value is 0.0313.

2.4.2.11 chroma_filter_uv_gain

【Description】

The proportion of UV component difference in thumbnail IIR filtering, the larger the value, the larger the proportion of UV component.

The value range is [0.0, 1.0]. The default value is 0.333.

2.4.2.12 wgt_slope

【Description】

The slope of the exponential weight curve.

The value range is [0.0, 8.0]. The default value is 0.7.

2.4.2.13 gaus_ratio

【Description】

Enter the global fusion weight of Gaussian filter of the input image, the larger the value, the larger the proportion of Gaussian filter results.

The value range is [0.0, 1.0]. The default value is 0.

2.4.2.14 bf_sigmaR

【Description】

The greater the value of the pauring filtering force, the greater the filtering force.

The value range is [0.0, 1.0]. The default value is 0.03.

2.4.2.15 bf_uvgain

【Description】

The difference between UV components of the edge-preserving filter accounts for the proportion, and the smaller the value, the greater the filtering force.

The value range is [0.0, 8.0]. Default value 3.

2.4.2.16 bf_ratio

【Description】

The larger the value of the current point of the conformal filter, the smaller the filtering force.

The value range is [0.0, 1.0]. The default value is 0.0625.

2.4.2.17 hbf_wgt_clip

【Description】

conformal filtering weight clip value,

The value range is [0.0, 1.0]. The default value is 0.0078.

2.4.2.18 bf_wgt0_sel

【Description】

When the bilateral weight sum is 0, it is whether to output the original image or choose to output the Gaussian filtered image if no similarities are found on the small graph.

0: Output the original image.

1: Output Gaussian filter image.

2.4.2.19 global_alpha

【Description】

The larger the value, the greater the filtering force.

The value range is [0.0, 1.0]. Default value 1.

2.4.2.20 saturation_adj_offset

【Description】

Saturation-adjusted offet, the smaller the value, the more poorly saturated areas are backfilled.

The value range is [0.0, 511.0]. The default value is 0.

2.4.2.21 saturation_adj_ratio

【Description】

The force of the saturation adjustment, the larger the value, the more saturation is backfilled.

The value range is [0.0, 32.0]. The default value is 0.

2.4.2.22 global_gain / global_gain_alpha

【Description】

global_gain: Global gain, the larger the value, the greater the filtering force.

global_gain_alpha: The greater the weight of global GAIN and local GAIN fusion, the larger the proportion of global GA.

CNR denoising local gain and global gain interpolation force configuration.

Generally, the default value is used, no configuration, and all use the local gain method.

Formula: Gain=(global_gain_alpha * global_gain + (8-global_gain_alpha) * local_gain)>>3

Global gain alpha takes the value range [0.0 1.0], and the default value is 0.

Global gain takes the value range [0.0 64.0], and the default value is 1.

2.4.2.23 local_gain_scale

【Description】

The scale of the local gain scale, the larger the value, the larger the local gain.

The value range is [0.0, 1.0], and the default value is 0.5.

2.4.2.24 global_gain_thumb / global_gain_alpha_thumb

【Description】

global_gain_thumb: In thumbnail IIR filtering, the global filter intensity is adjusted, the larger the value, the smaller the filtering force.

global_gain_alpha_thumb: The proportion of global filtering intensity adjustment in thumbnail IIR filtering.

Currently the chip does not have this function, this value must be fixed at 1.0.

CNR thumbnail IIR frames correspond to Local Gain and Global Gain interpolation force configurations.

Generally, the default value is used, no configuration, and all use the local gain method.

Formula: Gain=(global_gain_alpha_thumb * global_gain_thumb + (8-global_gain_alpha_thumb)*local_gain)>>3

Global gain alpha_thumb Value range [1.0 1.0], default value 1.0.

global_gain_thumb Value range [0.0 64.0], default value 1.

2.4.2.25 gain_adj_strength_ratio

【Description】

According to the table of adjusting the denoising intensity according to gain, the higher the value, the smaller the filtering force.

The horizontal coordinate gain value is [0,4,8,12,16,24,32,48,64,128,256,512,1024].

The value range is [0.0, 4.0], and the default value is 1.0.

2.4.2.26 thumb_filter_wgt_coeff

【Description】

The larger the value, the greater the filtering force.

The value range is [0.0, 10], and the default value is 1.0.

2.4.2.27 gaus_coeff

【Description】

Enter the image Gaussian filter coefficient.

The value range is [0, 127].

The default coefficient configuration is: 48,28,6,28,17,4.

The condition is coef0 + 2*coef1* + 2coef2 + 2*coef3* + 4coef4 + 4*coef5 = 256

YUV420 处理高斯核：

Coeff5	Coeff4	Coeff3	Coeff4	Coeff5
Coeff2	Coeff1	Coeff0	Coeff1	Coeff2
Coeff5	Coeff4	Coeff3	Coeff4	Coeff5

2.4.3 4.2.4.3 Debugging steps

Close the SHARP module.

Prioritize the denoising intensity related parameters of the edge protection filter bf_sigmaR, bf_uvgain, bf_ratio, if the strength of the large picture is very large, the color noise still cannot be removed, and then adjust the thumbnail denoising intensity is not enough, and then adjust the thumbnail related denoising intensity parameters chroma_filter_strength, chroma_filter_uv_gain.

Control the removal of high- and low-frequency color noise, and weigh imperfections such as color infestation and saturation reduction.

2.5 4.2.5 SHARP

2.5.1 4.2.5.1 Feature description

The Sharpen module is used to enhance the clarity of the image.

The overall idea of the algorithm is to preprocess the image first, extract the high-frequency information on the result of the preprocessing, filter and enhance the extracted high-frequency information, and then superimpose it on the preprocessed image to obtain a sharpened image.

The Sharp module is mainly composed of sub-modules such as preprocessing module, high-frequency calculation and filtering module, weight calculation (distance, external gain, texture detection), and sharpening module.

- Support sharpening parameter setting for two noise modes: high signal-to-noise ratio and low signal-to-noise ratio, respectively.

  For example, CIS that supports Dual convertion gain DCG, high conversion gain (HCG) for high signal-to-noise mode, and low conversion gain (HCG) for low signal-to-noise mode.

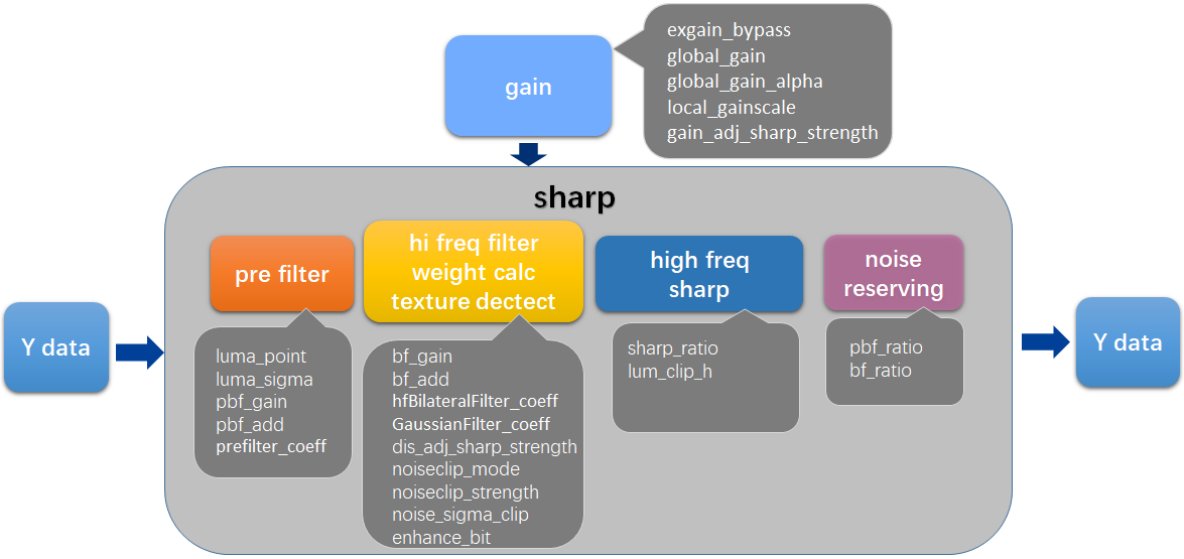


Fig. 4-2-5-1 SHARP functional block diagram

2.5.2 4.2.5.2 Key parameters

Parameter name	Parameter type	Brief description
Enable	Debug parameters	Frequently debug parameters
SNR_Mode	Mode parameters	DCG mode corresponds to high and low signal-to-noise ratio mode
Sensor_Mode	Mode parameters	Sensor DCG mode
iso	Debug parameters	Frequently debug parameters
pbf_gain	Debug parameters	Frequently debug parameters
pbf_add	Debug parameters	Frequently debug parameters
pbf_ratio	Debug parameters	Frequently debug parameters
gaus_ratio	Debug parameters	Frequently debug parameters
sharp_ratio	Debug parameters	Frequently debug parameters
bf_gain	Debug parameters	Frequently debug parameters
bf_add	Debug parameters	Frequently debug parameters
luma_point / luma_sigma	Debug parameters	Frequently debug parameters
luma_point / lum_clip_h	Debug parameters	Frequently debug parameters
global_clip_pos	Debug parameters	Frequently debug parameters
prefilter_coeff	Debug parameters	Frequently debug parameters
GaussianFilter_coeff	Debug parameters	Frequently debug parameters
hfBilateralFilter_coeff	Debug parameters	Frequently debug parameters
kernel_sigma_enable	Debug parameters	Frequently debug parameters

Parameter name	Parameter type	Brief description
prefilter_sigma	Debug parameters	Frequently debug parameters
hfBilateralFilter_sigma	Debug parameters	Frequently debug parameters
GaussianFilter_sigma	Debug parameters	Frequently debug parameters
GaussianFilter_radius	Debug parameters	Frequently debug parameters
exgain_bypass	Debug parameters	Frequently debug parameters
global_gain	Debug parameters	Frequently debug parameters
global_gain_alpha	Debug parameters	Frequently debug parameters
local_gainscale	Debug parameters	Frequently debug parameters
gain_adj_sharp_strength	Debug parameters	Frequently debug parameters
dis_adj_sharp_strength	Debug parameters	Frequently debug parameters
center_mode	Debug parameters	Infrequent debugging of parameters
center_x	Debug parameters	Infrequent debugging of parameters
center_y	Debug parameters	Infrequent debugging of parameters
noiseclip_mode	Debug parameters	Frequently debug parameters
noiseclip_strength	Debug parameters	Frequently debug parameters
noise_sigma_clip	Debug parameters	Frequently debug parameters
enhance_bit	Debug parameters	Frequently debug parameters

2.5.2.1 Enable:

【Description】

The Sharp module enables the switch.

1: Module open, 0: Module off.

2.5.2.2 SNR_Mode

【Description】

LCG and HCG correspond to different noise modes. HSNR corresponds to HCG, and LSNR corresponds to LCG mode.

2.5.2.3 Sensor_Mode

【Description】

HCG and LCG modes supported by Sensor, if DCG mode is not supported, LCG parameters are used by default.

2.5.2.4 ISO

【Description】

Different ISO gears, corresponding to different debugging parameters. Currently only 13 gears are supported.

2.5.2.5 pbf_gain

【Description】

The pre-filtered sigma is multiplied by the ratio, the larger the value, the stronger the filtering, the less noise and less detail.

The value range is [0.0, 2.0], and the default value is 1.0.

2.5.2.6 pbf_add

【Description】

The offset of the pre-filtered sigma superposition, the larger the value, the stronger the filtering, the less noise, and less detail.

The value range is [0, 1023], and the default value is 0.

2.5.2.7 pbf_ratio

【Description】

Pre-filter fusion weights, the larger the value, the stronger the filtering, the smaller the noise, and less detail.

The value range is [0.0, 1.0], and the default value is 0.5.

2.5.2.8 gaus_ratio

【Description】

The guided image of high-frequency bilateral filtering is the result of the fusion of Gaussian filtering and the original image.

The larger the value, the greater the guiding weight of the Gaussian bilateral filter.

The value range is [0.0, 1.0], and the default value is 0.

2.5.2.9 sharp_ratio

【Description】

Sharpening strength, the higher the value, the stronger the sharpening.

Value range [0.0, 32], default value 6.

2.5.2.10 bf_gain

【Description】

The proportion of high-frequency bilateral filtering sigma multiplied, the larger the value, the stronger the filtering, the smaller the noise, and the less detail.

The value range is [0.0, 2.0], and the default value is 1.0.

2.5.2.11 bf_add

【Description】

Offset of high-frequency bilateral filtering sigma superposition. The larger the value, the stronger the filtering, the smaller the noise, and the less detail.

The value range is [0, 1023], and the default value is 0.

2.5.2.12 bf_ratio

【Description】

High-frequency bilateral filter fusion weights. The larger the value, the stronger the filtering, the smaller the noise, and the less detail.

The value range is [0.0, 1.0], and the default value is 0.5.

2.5.2.13 luma_point / luma_sigma

【Description】

Different pixel brightness corresponds to different noise SIGMA curves.

luma_point is the curve brightness value, the value range [0, 1023].

luma_sigma is the noise intensity value, the value range [0, 1023] .

2.5.2.14 luma_point / lum_clip_h

【Description】

Range of different pixel brightness high-frequency values clips.

The higher the value, the stronger the maximum allowable sharpening strength.

The value range is [0, 1023]. The default value is 256.

2.5.2.15 global_clip_pos

【Description】

The value range is 0, 1, and 2. The default value is 0.

0:dis_adj_sharp_strength[21] is 0, lum_clip_h maximum value is unlimited.

1:dis_adj_sharp_strength[21] is 64, lum_clip_h maximum is 256.

2:dis_adj_sharp_strength[21] is 128, lum_clip_h maximum is 512.

2.5.2.16 prefilter_coeff:

【Description】

Pre-filter operators.

The value range is [0.0, 1.0], and the default value is 0.2042, 0.1238, 0.0751.

2.5.2.17 GaussianFilter_coeff

【Description】

Gaussian filter operators.

The default values are 0.1621, 0.0983, 0.0596, 0.0219, 0.0133, 0.003.

2.5.2.18 hfBilateralFilter_coeff

【Description】

High-frequency bilateral filtering operator.

The value range is [0.0, 1.0], and the default value is 0.2042, 0.1238, 0.0751.

2.5.2.19 kernel_sigma_enable:

【Description】

All filter operator coefficients use sigma to calculate the enable bits.

1: Use the sigma value input to automatically calculate the standard operator value.

0: Use the above algorithm coefficient configuration method.

2.5.2.20 prefilter_sigma:

【Description】

Pre-filtered operator sigma value.

The value range is [0, 100.0], and the default value is 1.

2.5.2.21 hfBilateralFilter_sigma

【Description】

The sigma value of the high-frequency bilateral wave operator.

The value range is [0, 100.0], and the default value is 1.

2.5.2.22 GaussianFilter_sigma

【Description】

Gaussian filter operator sigma value.

The value range is [0, 100.0], and the default value is 2.

2.5.2.23 GaussianFilter_radius

【Description】

The size of the radius of the Gaussian filter operator.

The value range is 1 or 2, and the default value is 2.

1: Use Gaussian 3x3 filter operator.

2: Use Gaussian 5x5 filter operators.

2.5.2.24 exgain_bypass

【Description】

Local gain module switch.

0: Use local gain.

1: Do not use local gain.

2.5.2.25 global_gain

【Description】

Global gain, the larger the value, the smaller the local sharpening weight

The value range is [0.0, 63.0], and the default value is 1.

2.5.2.26 global_gain_alpha

【Description】

The weight of the fusion of global GAIN and local GAIN is larger and the proportion of global GAIN is larger.

The value range is [0.0, 1.0], and the default value is 0.

2.5.2.27 local_gainscale

【Description】

The scale of the local gain scale, the larger the value, the larger the local gain.

The value range is [0.0, 1.0], and the default value is 0.

2.5.2.28 gain_adj_sharp_strength

【Description】

Table that adjusts sharpening weights based on the GAIN value, the larger the value, the larger the local sharpening weight.

The abscissa coordinate gain value is [1,2,4,8,16,24,32,48,64,128,256,512,1024].

The value range is [0.0, 31.0], and the default value is 1.

2.5.2.29 dis_adj_sharp_strength

【Description】

Radial sharpening intensity adjustment table, the larger the value, the greater the local sharpening weight.

The value range is [0.0, 1.0], and the default value is 1.

2.5.2.30 noiseclip_mode

【Description】

The value is 0, and the average of the small graph calculated in the previous frame is used as the clip, and the 1023 used in frame 0;

The value is 1, and the configured register value noise_sigma_clip is used as the upper limit of the global clip.

The default value is 0.

2.5.2.31 noise_sigma_clip

【Description】

The default value is 1023, which has no effect. The smaller the value, the greater the high-frequency superposition weight, and the lower the degree of noise suppression.

The value range is [0, 1023], and the default value is 1023.

2.5.2.32 noiseclip_strength

【Description】

The default value is 1.0, and the smaller the value, the greater the weight of the high-frequency overlay.

The value range is [0, 10.0], and the default value is 1.

2.5.2.33 enhance_bit

【Description】

The interior works in a power of 2, and the weight clip is normalized by dividing by 2^3 after 2^3.

The larger the value, the smaller the weight, and the area with the large weight has less impact.

The value range is [0, 9], and the default value is 3.

2.5.3 4.2.5.3 Debugging steps

Adjust sharp_ratio, local_sharp_strength, hf_clip, control the intensity of high-frequency edge enhancement.

Adjust the parameters of gaus_ratio, pbf_ratio, pbf_gain, pbf_add, bf_ratio, bf_gain, bf_add to reduce noise caused by sharpening, and to balance noise and sharpen details.

By adjusting the gain_adj_sharp_strength, the sharpening force in the moving area and the stationary area are adjusted separately.

By adjusting the dis_adj_sharp_strength, the degree of corner noise sharpening caused by LSC correction is adjusted, respectively.

Adjust the sharpness of textured areas and flat areas by adjusting noise_sigma_clip, enhance_bit, noiseclip_strength.

The Sharp module can enhance detail while suppressing noise, but ultimately it inevitably leads to an increase in overall noise.

2.6 4.2.6 gain

2.6.1 4.2.6.1 Feature description

The gain module is a local gain module that is stored externally.

Each module will output to this module, and the YNR, CNR, SHARP module will read the gain value of this module to adjust and control the parameters of the motion and rest areas respectively.

The internal enable bits of the module, as well as the input enable bits of each module, are controlled by the bottom layer according to whether the module is turned on.

- Support sharpening parameter setting for two noise modes: high signal-to-noise ratio and low signal-to-noise ratio, respectively.

  For example, CIS that supports Dual convertion gain DCG, high conversion gain (HCG) for high signal-to-noise mode, and low conversion gain (HCG) for low signal-to-noise mode.

2.6.2 4.2.6.2 Key parameters

Parameter name	Parameter type	Brief description
hdrgain_ctrl_enable	Debug parameters	Frequently debug parameters
SNR_Mode	Mode parameters	DCG mode corresponds to high and low signal-to-noise ratio mode
Sensor_Mode	Mode parameters	Sensor DCG mode
iso	Debug parameters	Frequently debug parameters
hdr_gain_scale_s	Debug parameters	Frequently debug parameters
hdr_gain_scale_m	Debug parameters	Frequently debug parameters

2.6.2.1 hdrgain_ctrl_enable

【Description】

In HDR mode, whether to enable the overall size control of Gain for short and medium frames.

0: Do not enable, 1: Enable. The default value is 0.

2.6.2.2 SNR_Mode

【Description】

LCG and HCG correspond to different noise modes. HSNR corresponds to HCG, and LSNR corresponds to LCG mode.

2.6.2.3 Sensor_Mode

【Description】

HCG and LCG modes supported by Sensor, if DCG mode is not supported, LCG parameters are used by default.

2.6.2.4 iso

【Description】

Different ISO gears, corresponding to different debugging parameters. Currently only 13 gears are supported.

2.6.2.5 hdr_gain_scale_s

【Description】

In HDR mode, the overall magnification of the GAIN module for short frames. The higher the value, the greater the denoising of short frames.

The value range is [0.0, 128.0], and the default value is 1.0.

2.6.2.6 hdr_gain_scale_m

【Description】

In HDR mode, the overall magnification of the GAIN module of the frame. The higher the value, the greater the denoising of the medium frame.

The value range is [0.0, 128.0], and the default value is 1.0.

2.6.3 4.2.6.3 Debugging steps

HDR mode can open this module for debugging. If the short frame noise in HDR mode is large, you can increase the value of the hdr_gain_scale_s to enhance the short frame denoising force. And so on hdr_gain_scale_m.

3. 4.3 MERGE

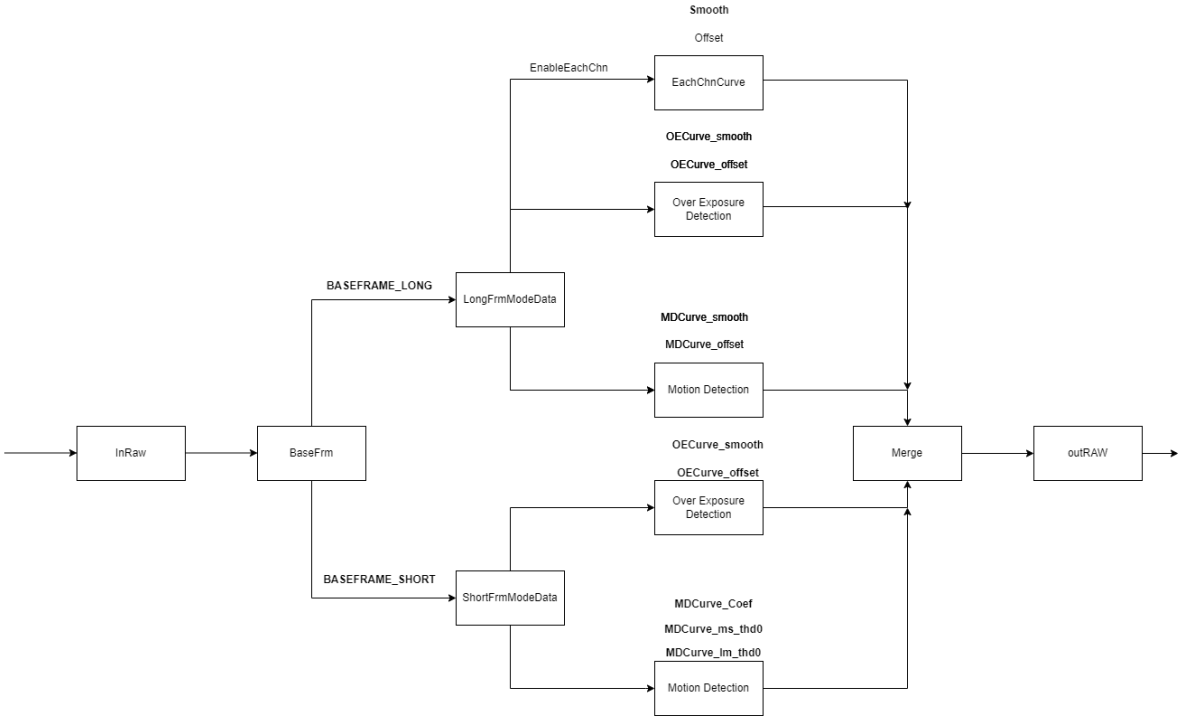
3.1 4.3.1 Feature description

With this module, it is possible to adjust the proportion of long (medium) short frames used during compositing. The proportion of using a frame is determined by the combination of the overexposure weight and the motion weight of the frame, which is a product relationship, where the overexposure weight is determined by the overexposure curve and the motion weight is determined by the motion curve.

During the fusion process, the reference frame can be selected as a long frame or a short frame, corresponding to the long frame mode and short frame mode, respectively.

In long frame mode, the overexposure curve is determined by two parameters, OECurve_smooth and OECurve_offset, in two-frame mode, whether overexposure is judged between long and short frames, and in three-frame mode, whether overexposure is judged between long and medium frames, at the same time,.

In the long frame mode, the motion curve contains the medium frame and short frame motion curve (determined by the two parameters of MS_smooth and MS_offset) and single-channel overexposure, and in the two-frame mode, only the medium frame and short frame motion curve take effect; In short frame mode, the curve is determined by three parameters: Coef, ms_thd0, and lm_thd0.



Merge block diagram

3.2 4.3.2 Key parameters

3.2.1 4.3.2.1 BaseFrm

【Description】

Represents the selection of a fiducial frame during the fusion process.

【Members】

Member name	Description
BASEFRAME_LONG	Long frames are the base
BASEFRAME_SHORT	Short frames are the base

【Precautions】

Using BASEFRAME_LONG and BASEFRAME_SHORT, the brightness is basically the same after fusion. The main differences are better motion smearing when using BASEFRAME_SHORT mode and better noise when using BASEFRAME_LONG mode.

When using BASEFRAME_LONG mode, the parameters in LongFrmModeData take effect, and when using BASEFRAME_SHORT mode, the parameters in ShortFrmModeData take effect.

3.2.2 4.3.2.2 ByPassThr

【Description】

Indicates the current module threshold of bypass, with a value range of [0,1]. When the percentage difference between the current ambient brightness and the ambient brightness of the previous frame is less than ByPassThr, the parameters of this module are not updated.

【Members】

【Precautions】

During debugging with the tool, write the value to 0, otherwise debugging may be invalid.

3.2.3 4.3.2.3 LongFrmModeData

【Description】

In long frame mode, merge parameter.

【Members】

Member name	Description
OECurve	Overexposure curve parameters
MDCurve	Motion profile parameters
OECurve_damp	The smoothing coefficient of the change of the overexposure curve is the proportion of the current frame parameter, the value range is [0,1], and the default value is 0.9.
MDCurveLM_damp	The smoothing coefficient of the change of motion curve between long frames and medium frames is the proportion of the current frame parameter, the value range is [0,1], and the default value is 0.9. In HDR x2 mode, it does not take effect
MDCurveMS_damp	The smoothing coefficient of the change of the motion curve between the middle frame and the short frame is the proportion of the current frame parameter, the value range is [0,1], and the default value is 0.9.

【Precautions】

3.2.3.1 4.3.2.3.1 EnableEachChn

【Description】

Single-channel overexposure detection switch. 0: Off, 1: On.

【Members】

【Precautions】

When there is a monochrome area in the picture that is overexposed, resulting in the monochrome overexposure area, it is recommended to turn it on when the noise is large after the merge.

3.2.3.2 4.3.2.3.2 OECurve

【Description】

In long frame mode, overexposure curve parameters.

【Members】

Member name	Description
EnvLv	Overexposure curve parameters
Smooth	The slope of the overexposure curve, the value range [0,1], the default value is 0.4, and the accuracy is 0.01.
Offset	The offset value of the overexposure curve is in the range [108,280], the default value is 210, and the accuracy is 0.1.

【Precautions】

3.2.3.3 4.3.2.3.3 MDCurve

【Description】

In long frame mode, motion curve parameters.

【Members】

Member name	Description
MoveCoef	The degree of screen motion, the value range [0,1], where 0 represents complete stationary, 1 represents full motion
LM_smooth	The slope of the motion curve between long and medium frames, the value range is [0,1], and the default value is 0.4. In HDR x2 mode, it does not take effect
LM_offset	The motion curve offset value between long and medium frames is in the range of [0.26,1], and the default value is 0.38. In HDR x2 mode, it does not take effect
MS_smooth	The slope of the motion curve between medium and short frames, the value range is [0,1], and the default value is 0.4.
MS_offset	The value of the motion curve offset between medium frame and short frame is [0.26,1], and the default value is 0.38.

【Precautions】

MoveCoef: Since the current scene detection is not done, the amount of motion cannot be obtained, and the actual use is that MoveComeEf is equal to 1

3.2.3.4 4.3.2.3.4 EachChnCurve

【Description】

In long frame mode, single-channel overexposure curve parameters.

【Members】

Member name	Description
EnvLv	Overexposure curve parameters
Smooth	The slope of the single-channel overexposure curve, the value range [0,1], the default value is 0.4, and the accuracy is 0.01.
Offset	The offset value of the single-channel overexposure curve is in the range of [0,1], the default value is 0.38, and the accuracy is 0.01.

【Precautions】

3.2.3.5 4.3.2.3.5 OECurve_damp

【Description】

Indicates the smoothing coefficient of the overexposure curve, which is the proportion of the current frame parameter, the value range is [0,1], and the default value is 0.9.

【Members】

【Precautions】

3.2.3.6 4.3.2.3.6 MDCurveLM_damp

【Description】

It indicates the smoothing coefficient of the motion curve of the long and medium frames, which is the proportion of the current frame parameter, the value range is [0,1], and the default value is 0.9.

【Members】

【Precautions】

HDR x2 mode does not take effect

3.2.3.7 4.3.2.3.7 MDCurveMS_damp

【Description】

Indicates the smoothing coefficient of the motion curve of short and medium frames, which is the proportion of the current frame parameter, the value range is [0,1], and the default value is 0.9.

【Members】

【Precautions】

3.2.4 4.3.2.4 ShortFrmModeData

【Description】

In short frame mode, merge parameter.

【Members】

Member name	Description
OECurve	Overexposure curve parameters
MDCurve	Motion profile parameters
OECurve_damp	The smoothing coefficient of the change of the overexposure curve is the proportion of the current frame parameter, the value range is [0,1], and the default value is 0.9.
MDCurve_damp	The smoothing coefficient of the change of the motion curve is the proportion of the current frame parameter, the value range is [0,1], and the default value is 0.9.

【Precautions】

3.2.4.1 4.3.2.4.1 OECurve

【Description】

In long frame mode, overexposure curve parameters.

【Members】

Member name	Description
EnvLv	Overexposure curve parameters
Smooth	The slope of the overexposure curve, the value range [0,1], the default value is 0.4, and the accuracy is 0.01.
Offset	The offset value of the overexposure curve is in the range [108,280], the default value is 210, and the accuracy is 0.1.

【Precautions】

3.2.4.2 4.3.2.4.2 MDCurve

【Description】

In long frame mode, overexposure curve parameters.

【Members】

Member name	Description
MoveCoef	The degree of screen motion, the value range [0,1], where 0 represents complete stationary, 1 represents full motion
Coef	Control coefficient, value range [0,1], default value is 0.05, accuracy 0.0001
ms_thd0	The medium and short frame control coefficient has a value range of [0,1], and the default value is 0.0 and the accuracy is 0.1.
lm_thd0	The long and medium frame control coefficient has a value range of [0,1], and the default value is 0.0 and the accuracy is 0.1. In HDR x2 mode, it does not take effect

【Precautions】

3.2.4.3 4.3.2.4.3 OECurve_damp

【Description】

Indicates the smoothing coefficient of the overexposure curve, which is the proportion of the current frame parameter, the value range is [0,1], and the default value is 0.9.

【Members】

【Precautions】

3.2.4.4 4.3.2.4.4 MDCurve_damp

【Description】

Indicates the smoothing coefficient of the motion curve, which is the proportion of the current frame parameter, the value range is [0,1], and the default value is 0.9.

【Members】

【Precautions】

HDR x2 mode does not take effect

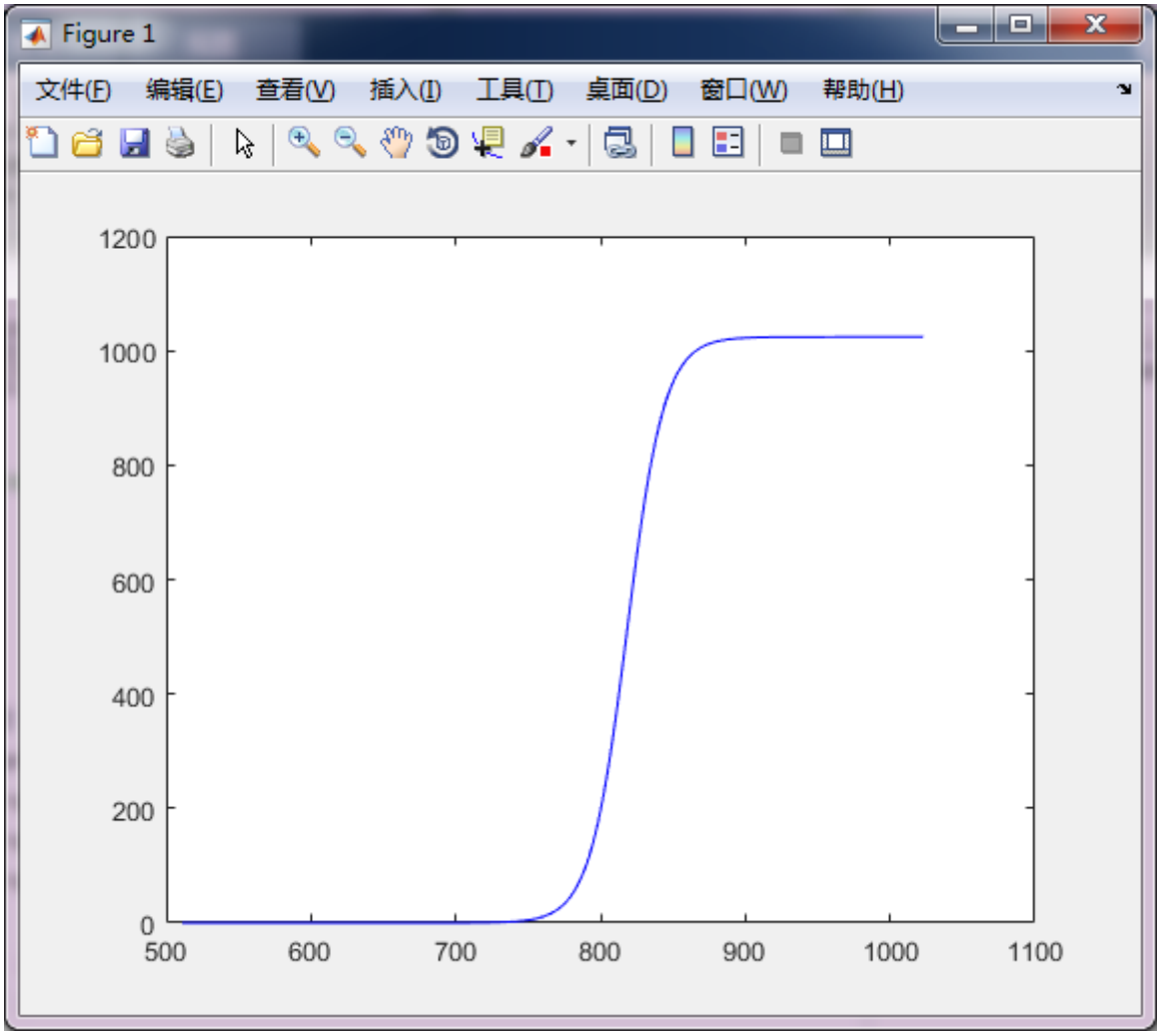
3.3 4.3.3 Debugging steps

Merge debugging mainly includes two parts: overexposure curve debugging and motion curve debugging.

3.3.1 4.3.3.1 Overexposure curve debugging

【Description】

The overexposure curve OECurve is determined by the OECurve_smooth and OECurve_offset (the curve is shown in the figure below), and at the same time, different overexposure curves are set under different Envlv.



Schematic diagram of OECurve

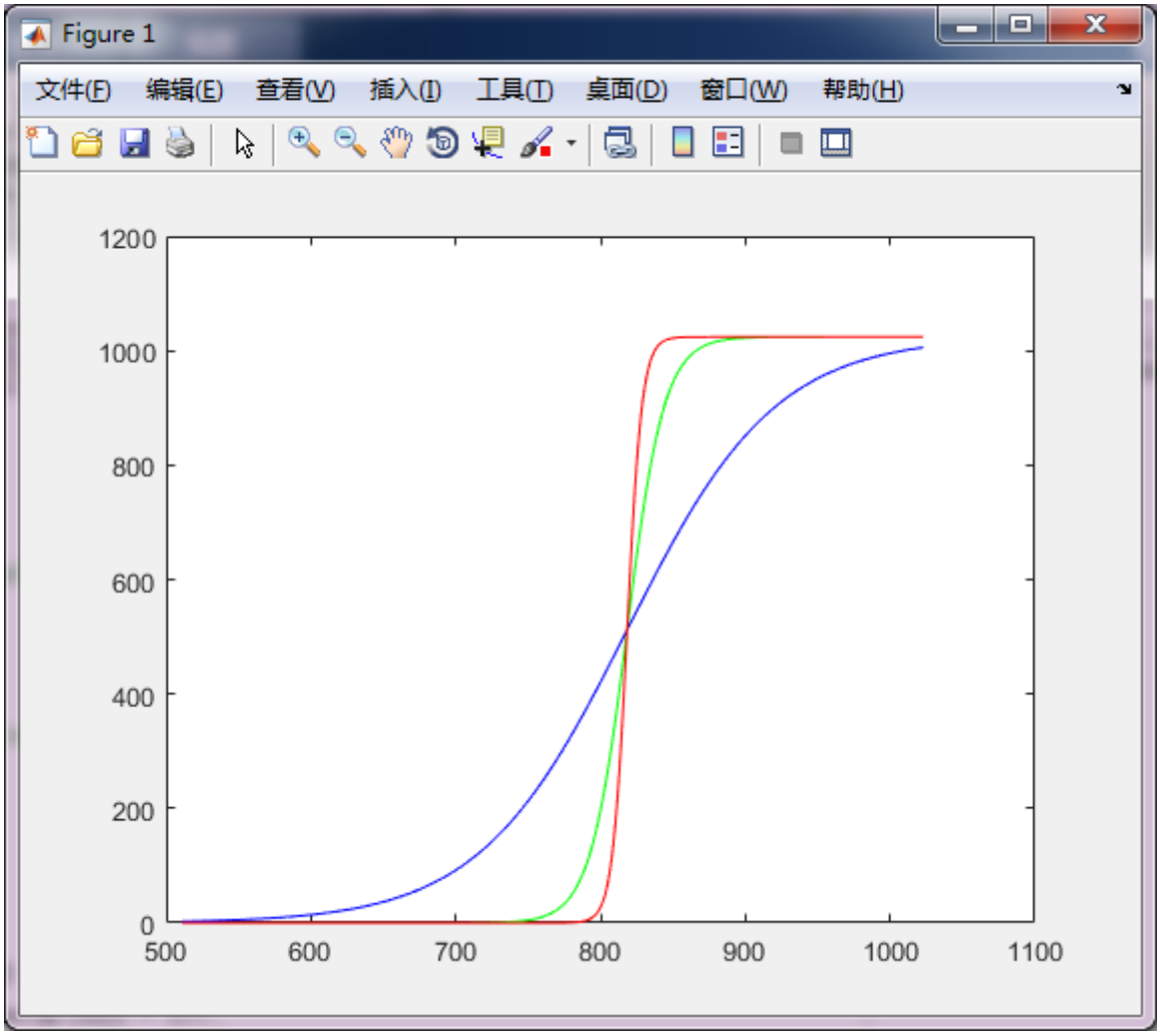
【Members】

Member name	Description
Smooth	Overexposure curve slope
Offset	Overexposure curve slope

【Precautions】

1.Smooth：

Image-wise, this value represents smoothing of areas of long and short frame transitions: the smaller the value, the smoother the transition between the overexposed and non-overexposed areas, and the larger the transition area, and conversely, the more abrupt the transition between the overexposed and non-overexposed areas, but the smaller the transition area. In the figure below, the red curve represents the value of 0, the green curve represents the value of 0.4, and the blue curve represents the value of 1.

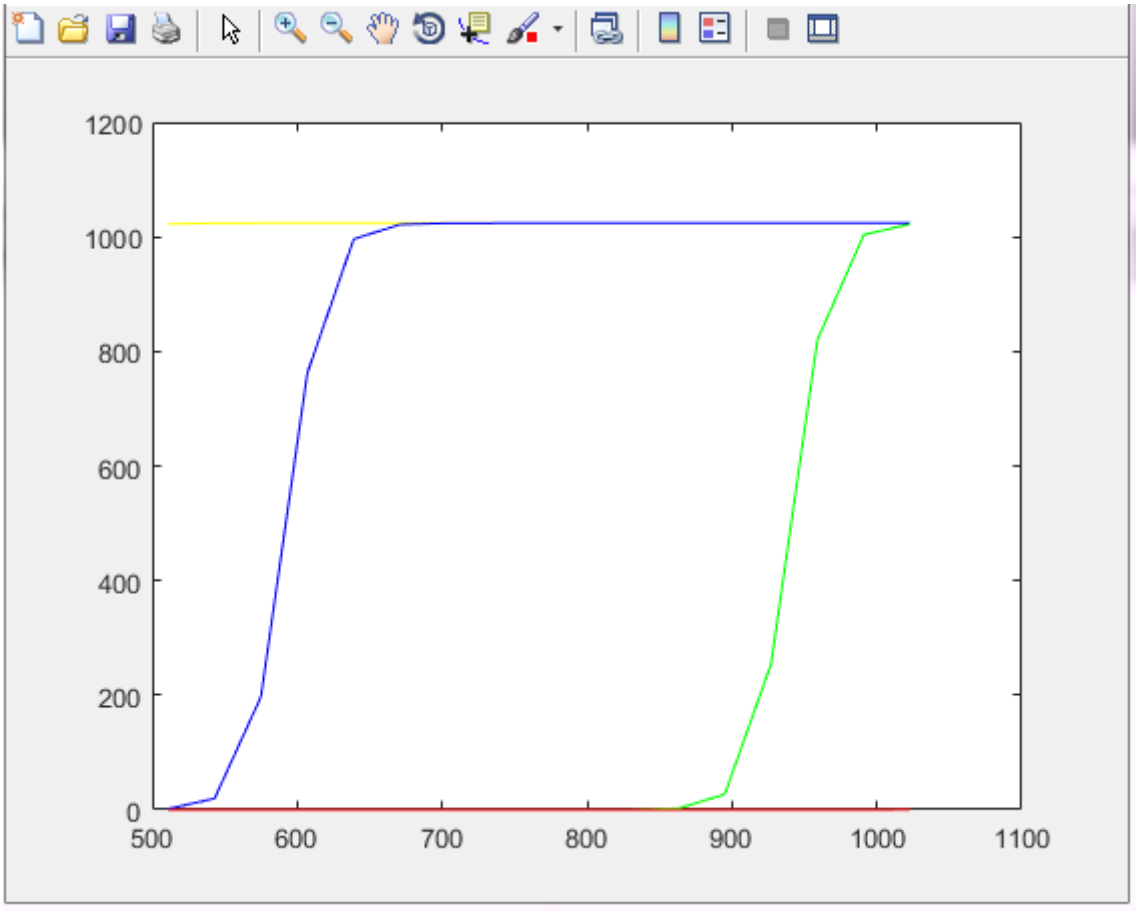


OECurve_smooth schematic

2.Offset：

Image-wise, this value represents the initial value of using short frames at overexposure. The smaller the value, the maximum weight is used for short frames.

Several special points: where 108 represents, the value of the overexposure curve set is all 1023, at this time, the weight used by the short frame is the largest, as shown in the yellow curve in the figure below; The value 128 represents that short frames may be used from the beginning of the brightness of 128, as shown in the blue curve in the figure below; 215 is the representative, 215 is the value represents that from the beginning of the brightness of 215, the short frame may be used, and just when it reaches 256, the weight of the short frame is exactly 1023, as shown in the green curve in the figure below; 280 is to represent that the overexposure curve value is all 0, and merge will not use short frames, as shown in the red curve in the following figure:

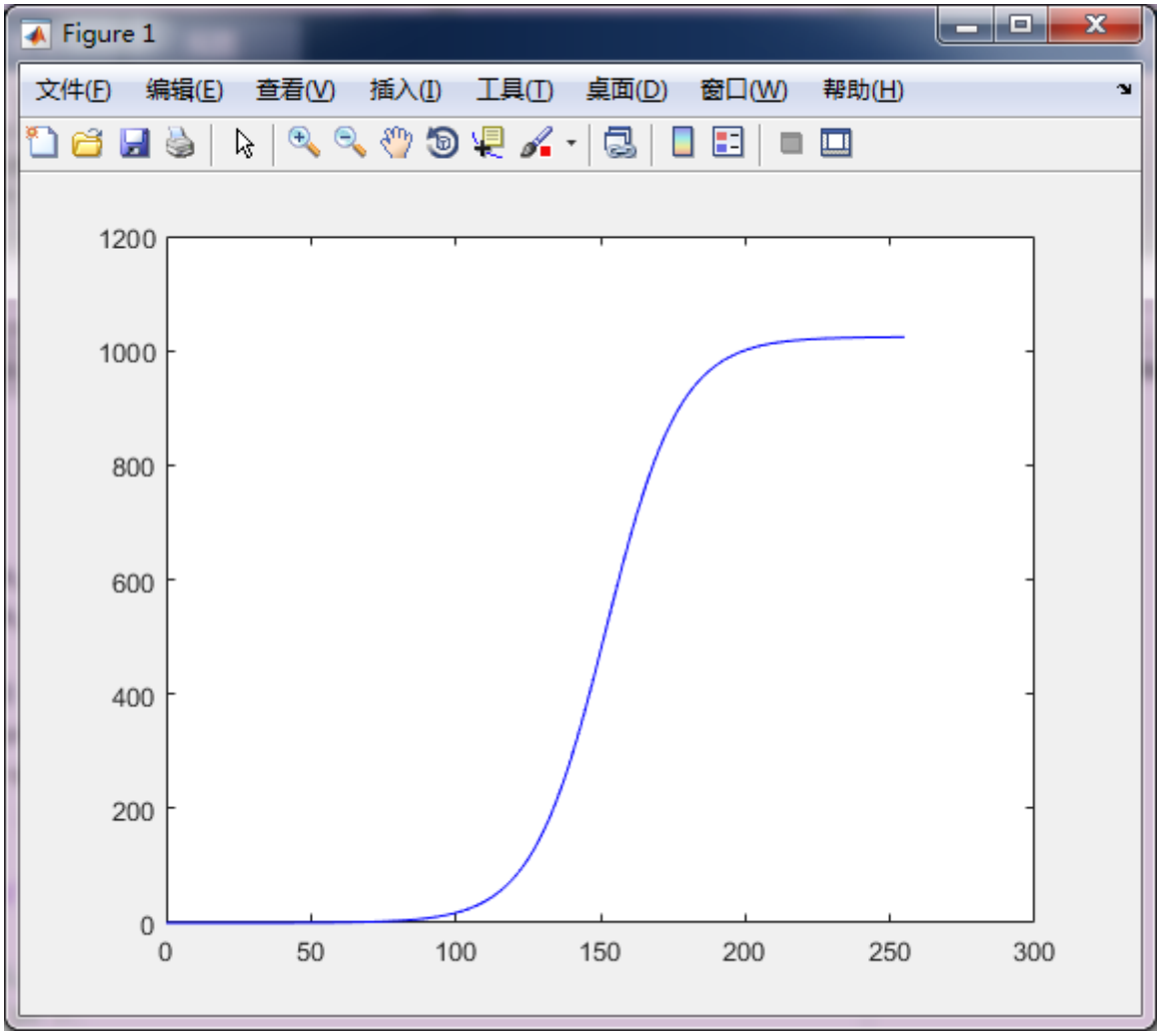


OECurve_offset schematic

3.3.2 4.3.3.2 Motion curve debugging in long frame mode

【Description】

The actual curve of the motion curve (MS_smooth and MS_offset, determined by two sets of parameters LM_smooth and LM_offset in long frame mode) is shown in the figure below.



Schematic diagram of MDCurve

When the picture is moving, the weight needs to be reduced, so as to reduce the use of short frames, thereby reducing the ghosting caused by the movement. At the same time, different motion curves are set under different MoveCoef

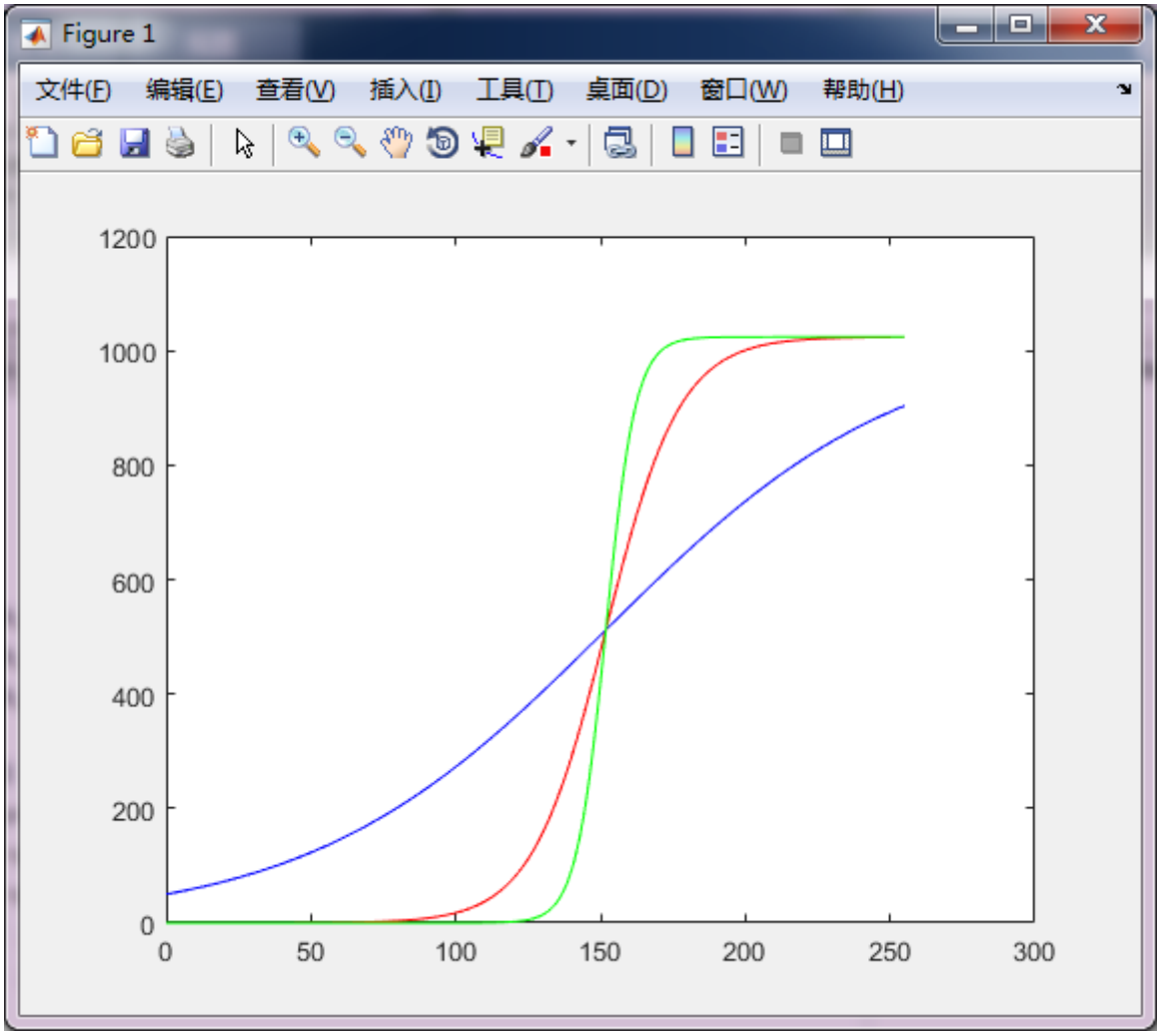
【Members】

Member name	Description
MS_smooth	Slope of the motion curve
MS_offset	Slope of the motion curve

【Precautions】

1.MS_smooth：

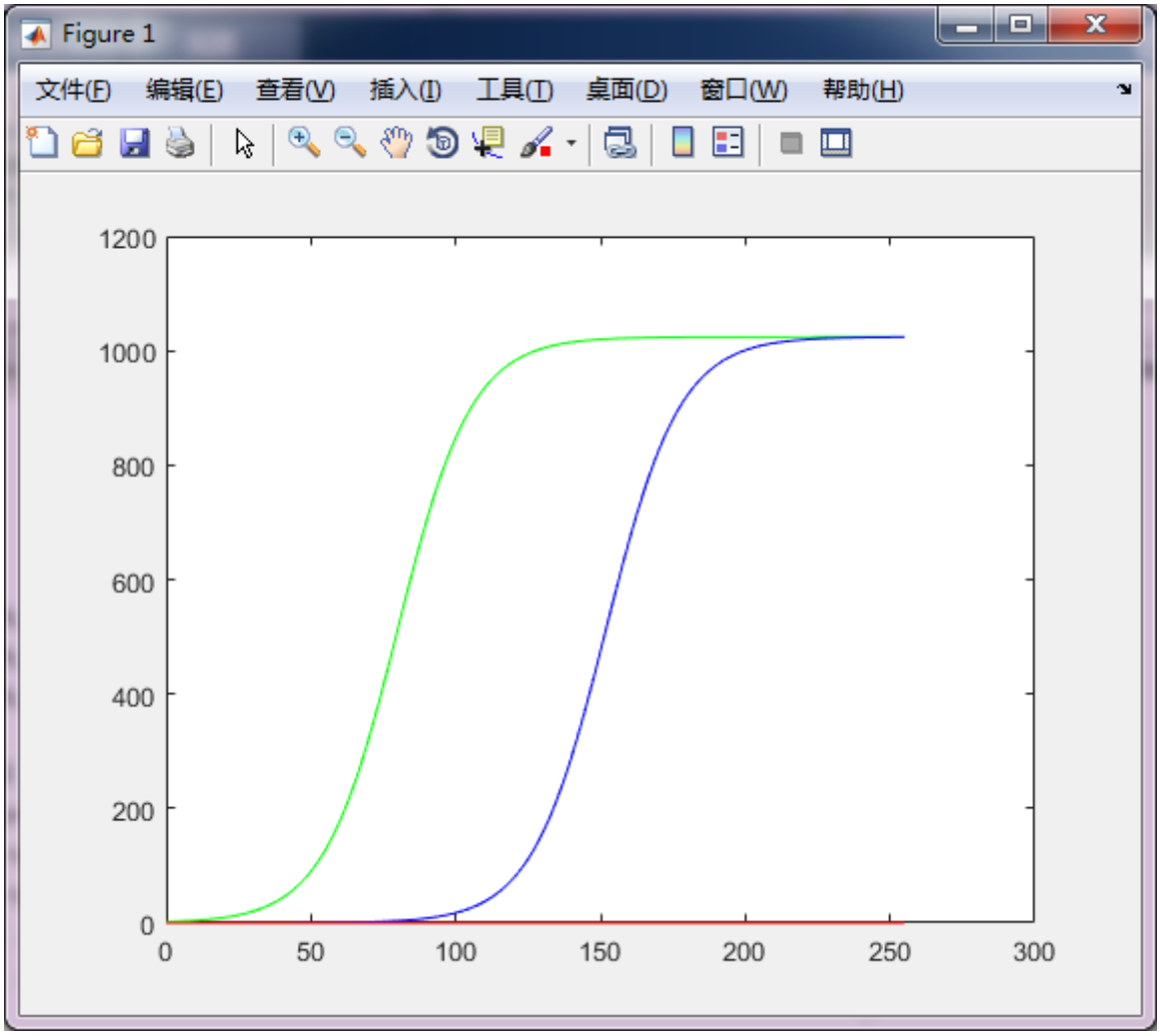
This value indicates the smoothing of the transition area of short and medium frames: the smaller the value, the smoother the transition between the overexposed and nonexposed areas, and the larger the transition area, and conversely, the more abrupt the transition between the overexposed and nonexposed areas, but the smaller the transition area. In the figure below, the green curve represents the value of 0, the red curve represents the value of 0.4, and the blue curve represents the value of 1.



MDCurve_smooth schematic

2.MS_offset：

Image-wise, this value represents the initial value of using short frames at overexposure. The smaller the value, the maximum weight is used for short frames. The green curve represents a value of 0, the blue curve represents a value of 0.38, and the red curve represents a value of 1.

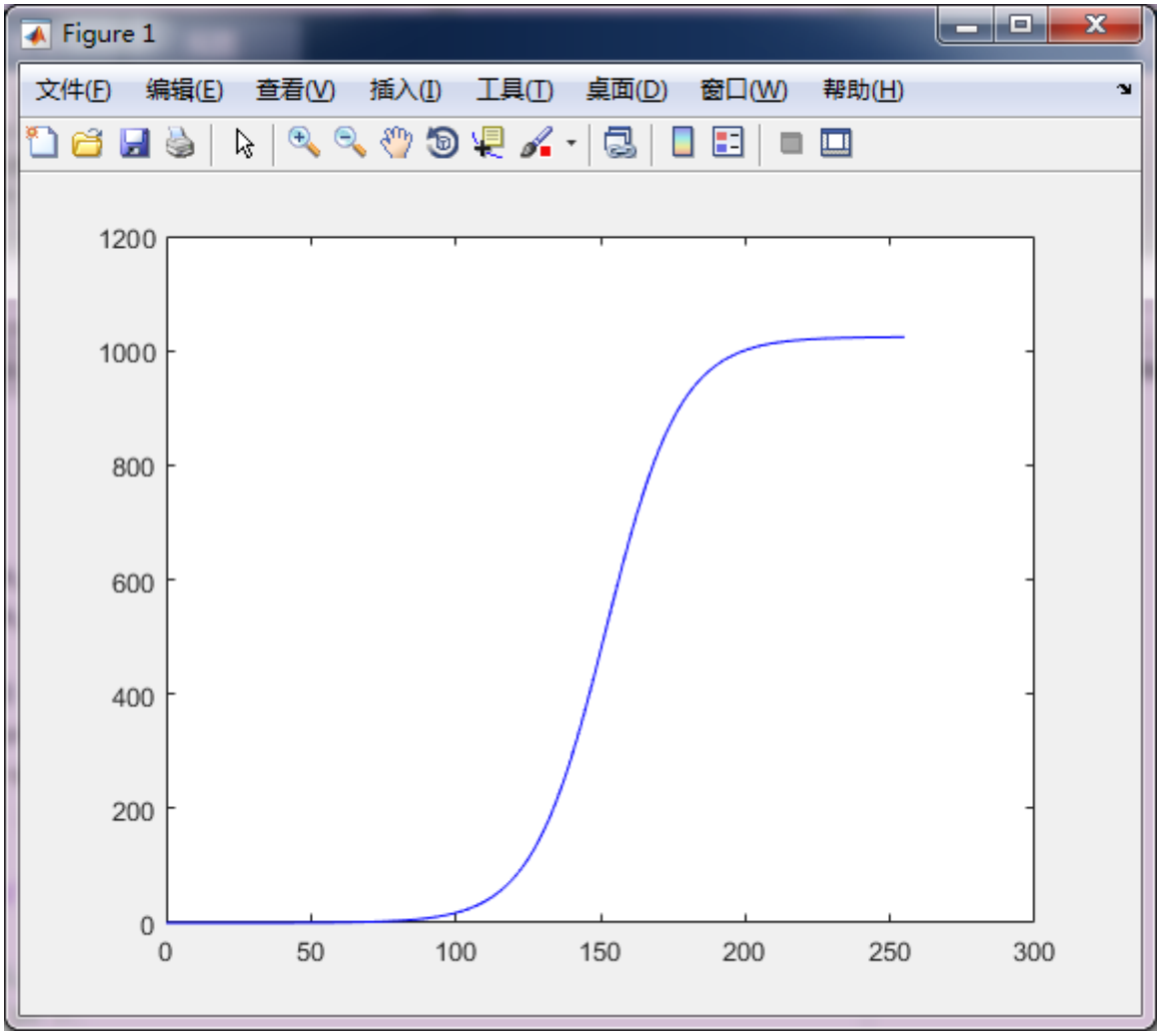


MDCurve_offset schematic

3.3.3 4.3.3.2 Motion curve debugging in short frame mode

【Description】

The actual curve of the motion curve (determined by Coef, ms_thd0, and lm_thd0 three parameters) in short frame mode is shown in the figure below.



Schematic diagram of MDCurve

When the picture is moving, the weight needs to be reduced, so as to reduce the use of short frames, thereby reducing the ghosting caused by the movement. At the same time, different motion curves are set under different MoveCoef.

【Members】

Member name	**Description**
Coef	Control coefficient, value range [0,1], default value is 0.05, accuracy 0.0001
ms_thd0	The medium and short frame control coefficient has a value range of [0,1], and the default value is 0.0 and the accuracy is 0.1.
lm_thd0	The long medium frame control coefficient has a value range of [0,1], the default value is 0.0, and the accuracy is 0.1.

【Precautions】

4. 4.4 DRC

4.1 4.4.1 Description of the feature

Dynamic range refers to the ratio of brightness between the brightest and darkest objects in a scene. A larger dynamic range usually indicates a richer level of brightness in the scene.

Category	Dynamic Range
Real-world scenario	>= 180 dB
Human Visual System Perception	Around 100 dB
Traditional image sensor pixels	Around 60 dB

If you shoot a scene with high dynamic range with a traditional image sensor, you will either be overexposed and lose detail; Either the dark areas are underexposed and the details are difficult to distinguish. In order to be able to record high dynamic range scenes, higher dynamic range sensors or multi-exposure image synthesis are required. And the current mainstream display devices have a limited dynamic range, and also can not display a wide dynamic image, in order to solve this problem, the DRC module can compress the dynamic range of the image. Enables both the observer of the real scene and the observer of the display device to get the same visual experience.

4.2 4.4.2 Key parameters

4.2.1 4.4.2.1 Enable

【Description】

Indicates the switch function, 0: off, 1: on.

【Members】

【Precautions】

In linear mode, the priority of the OB function switch is higher than that of the DRC switch, that is, the OB function is on, the linear DRC switch is forcibly turned on, the OB function is turned off, and the DRC switch can be switched independently.

Invalid in HDR mode (force on)

4.2.2 4.4.2.2 DrcGain

【Description】

The DrcGain module allows the input RAW to be adjusted brightly, i.e. the overall brightness or local brightness.

【Members】

Member name	Description
EnvLv	Ambient brightness, value range [0,1], 0: all black, 1: brightest.
DrcGain	DRC block gain, value range [1,8]
Alpha	Value range: [0,1]
Clip	Value range: [0,64]

【Precautions】

4.2.3 4.4.2.3 HiLight

4.2.3.1 4.4.2.3.1 HiLightData

【Description】

The HiLight module allows adjustments to the highlighted areas of the output RAW.

【Members】

Member name	Description
EnvLv	Ambient brightness, value range [0,1], 0: all black, 1: brightest.
Strength	Highlight area detail, value range [0,1]
gas_t	Detail at highlight edges, value range [0,2]

【Precautions】

Strength has a suppressive effect on the brightness of high-gloss accessories.

gas_t is only effective for highlight edges.

4.2.3.2 4.4.2.3.2 gas_lx

【Description】

Adjust the brightness domain moment.

【Members】

Member name	Description
gas_l0	The coefficient is 0, the value range is [0,64], and the default value is 24
gas_l1	Factor 1, value range [0,64], default value 10
gas_l2	Coefficient: 2, value range [0,64], default value 10
gas_l3	The coefficient is 3, the value range is [0,64], and the default value is 5

【Precautions】

The condition gas_l0 + 2 * gas_l1 + gas_l2 + 2 * gas_l3 = 64 needs to be met.

4.2.4 4.4.2.4 LocalSetting

【Description】

The LocalSetting module allows you to adjust the parameters related to Local.

4.2.4.1 4.4.2.4.1 LocalData

【Description】

LocalData is mainly to adjust the local weight and contrast.

【Members】

Member name	Description
EnvLv	Ambient brightness, value range [0,1], 0: all black, 1: brightest.
LocalWeit	Local weight, value range [0,1], 0:Global, 1: All Local, default value 0.
LocalAutoEnable	Automatic LocalWeit switch, value range [0,1], default value is 1, accuracy 1
LocalAutoWeit	Automatic LocalWeit value, value range [0,1], default value is 0.4, accuracy 0.01.
GlobalContrast	Global contrast, value range [0,1], default value is 0, precision 0.01.
LoLitContrast	Low brightness area contrast, value range [0,1], default value is 0, accuracy 0.01.

【Precautions】

When LocalAutoEnable is enabled, LocalAutoWeit takes effect, LocalWeit does not.

4.2.4.2 4.4.2.4.2 MotionData

【Description】

MotionData is mainly about adjusting the residual motion image.

【Members】

Member name	Description
MotionCoef	Motion coefficient, value range [0,1], 0: rest, 1: maximum motion.
MotionStr	Suppress the strength of the residual image, the value range is [0,1], and the default value is 0.

【Precautions】

The larger the MotionStr, the fewer residual motion and the worse the contrast.

4.2.4.3 4.4.2.4.3 curPixWeit

【Description】

Represents the bilateral weight of the current point, the value range is [0,1], the default value is 0.37, and the accuracy is 0.001.

【Members】

【Precautions】

4.2.4.4 4.4.2.4.4 preFrameWeit

【Description】

Indicates the bilateral weight of the current frame, with a value range of [0,1], and the default value is 0.8 and the accuracy is 0.001.

【Members】

【Precautions】

4.2.4.5 4.4.2.4.5 Range_force_sgm

【Description】

Represents the reciprocal of the bilateral value range sigma, with a value range of [0,1], a default value of 0, and an accuracy of 0.0001.

【Members】

【Precautions】

When the Range_force_sgm is nonzero, the Range_sgm_cur and Range_sgm_pre do not take effect.

4.2.4.6 4.4.2.4.6 Range_sgm_cur

【Description】

Represents the reciprocal of the bilateral airspace sigma of the current frame, the value range is [0,1], the default value is 0.2, and the accuracy is 0.0001.

【Members】

【Precautions】

4.2.4.7 4.4.2.4.7 Range_sgm_pre

【Description】

Represents the reciprocal of the bilateral airspace sigma in the previous frame, the value range is [0,1], the default value is 0.2, and the accuracy is 0.0001.

【Members】

【Precautions】

4.2.4.8 4.4.2.4.8 Space_sgm_cur

【Description】

Represents the reciprocal of the bilateral value range sigma of the current frame, the value range is [0,4095], the default value is 4068, and the accuracy is 1.

【Members】

【Precautions】

4.2.4.9 4.4.2.4.9 Space_sgm_pre

【Description】

Represents the reciprocal of the bilateral value range sigma in the previous frame, the value range is [0,4095], and the default value is 3068, and the accuracy is 1.

【Members】

【Precautions】

4.2.5 4.4.2.5 CompressSetting

【Description】

The compression curve can be adjusted via the CompressSetting module.

【Members】

Member name	Description
Mode	To enter the curve table selection mode

【Precautions】

By default, AUTO mode is used

4.2.6 4.4.2.6 Scale_y

【Description】

Indicates the gain-modified scale table, value range [0,2048]

【Members】

【Precautions】

4.2.7 4.4.2.7 ByPassThr

【Description】

Indicates the current module threshold of bypass, with a value range of [0,1]. When the percentage difference between the current ambient brightness and the ambient brightness of the previous frame is less than ByPassThr, the parameters of this module are not updated.

【Members】

【Precautions】

During debugging with the tool, write the value to 0, otherwise debugging may be invalid.

4.2.8 4.4.2.8 Edge_Weit

【Description】

Indicates the edge response scale value, the value range [0,1], the default value is 0.02, and the accuracy is 0.01. Used to reduce high-contrast edge artifacts.

【Members】

【Precautions】

4.2.9 4.4.2.9 OutPutLongFrame

【Description】

It means that only long frames are output, 0: off, 1: on.

【Members】

【Precautions】

This parameter is only used during the Debug phase.

4.2.10 4.4.2.10 IIR_frame

【Description】

Indicates the number of frames of the IIR filter, the value range [1,1000], the default value is 2, and the accuracy is 1.

【Members】

【Precautions】

This parameter is not valid in linear mode.

4.2.11 4.4.2.11 Tolerance

【Description】

Represents the tolerance value of the parameter (DrcGain, Alpha, Clip, Strength, LocalWeit, GlobalContrast, LoLitContrast) that changes with EnvLv. Value range[0,1].

【Members】

【Precautions】

4.2.12 4.4.2.12 damp

【Description】

The smoothing coefficient of the parameters (DrcGain, Alpha, Clip, Strength, LocalWeit, GlobalContrast, LoLitContrast) that changes with EnvLv is the proportion of the current frame parameters, the value range is [0,1], and the default value is 0.9.

【Members】

【Precautions】

4.3 4.4.3 Debugging steps

4.3.1 4.4.3.1 DrcGain debugging

【Description】

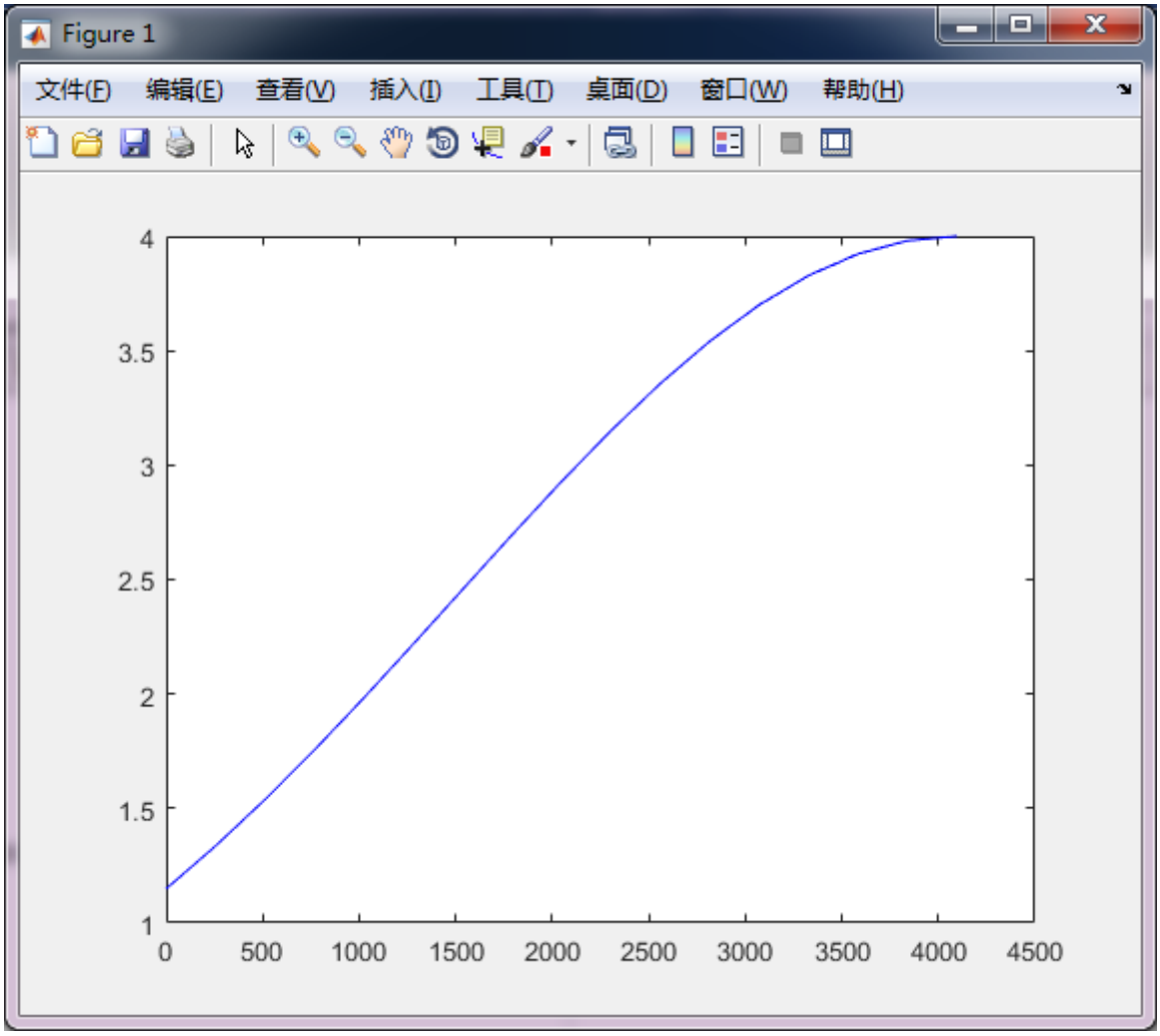
The DrcGain module allows the input RAW to be adjusted brightly, i.e. the overall brightness or local brightness.

【Members】

Member name	Description
DrcGain	DRC block gain, value range [1,8]
Alpha	Value range: [0,1]
Clip	Value range: [0,64]

【Precautions】

The DrcGain curve is composed of DrcGain, Alpha and Clip three parameters, and its approximate image is shown in the following figure:



In the illustration, the abscissa represents the pixel brightness of 0~4096, and the vertical coordinate represents the gain multiple of the current brightness pixel.

DrcGain：

DrcGain confirms the maximum gain multiple, which is limited by two conditions:

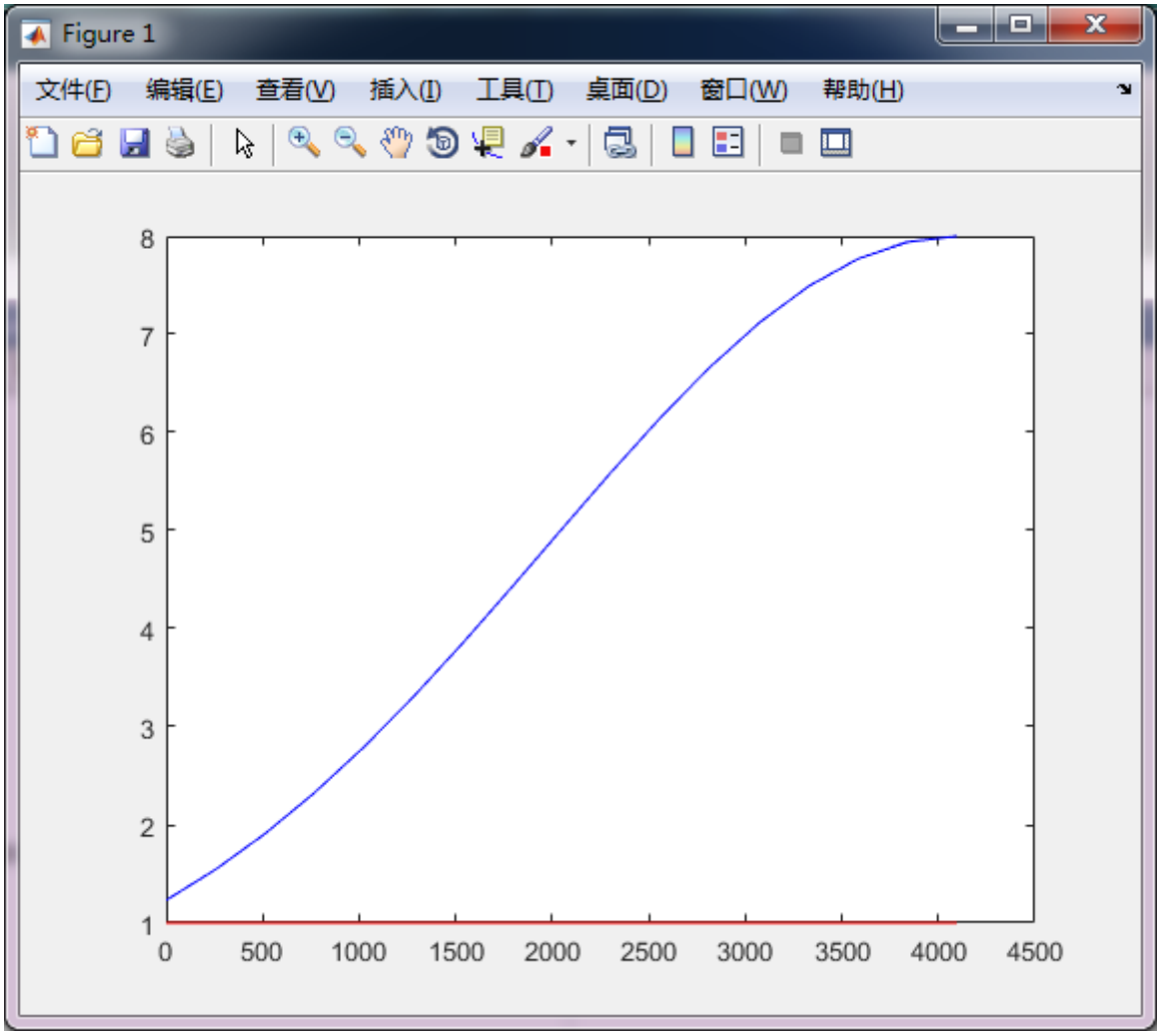
$$1 <= DrcGain <= 8$$

$$AERatio * DrcGain <= 256$$

There are the above two conditions to know that the actual DrcGain is less than 8x, during the debugging process, if DrcGain is set to 8x, but the product with AERatio is greater than 256x, the DrcGain will be clipped internally to meet the condition that the product is less than 256x.

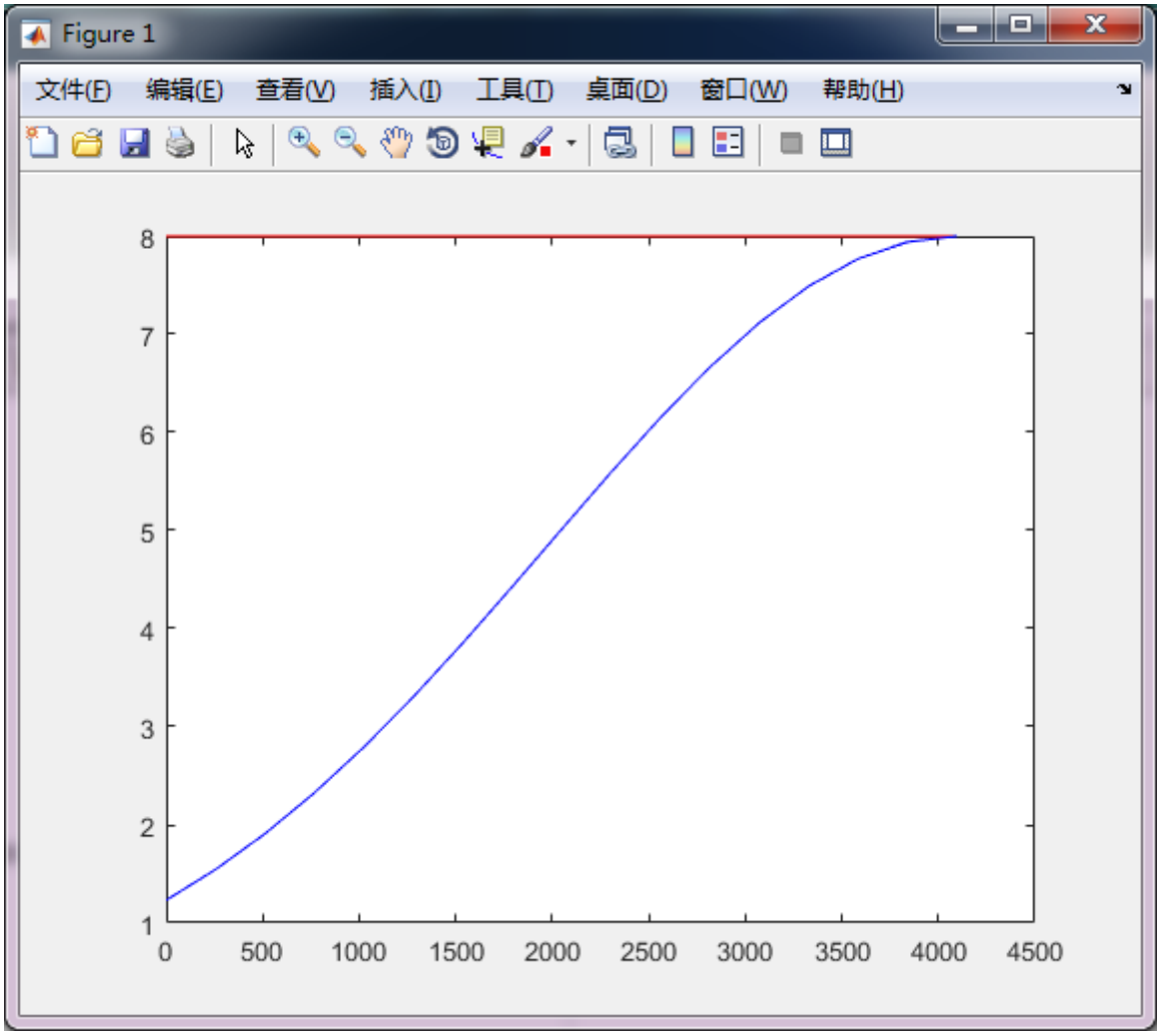
In actual debugging, the significance of DrcGain is that at the same brightness, adding DrcGain can reduce the displacement error of long and short frames (except for sensors other than DCG mode). In view of the noise effect caused by DrcGain, since DrcGain is digital, if the sensor is still in analog gain mode, increasing DrcGain will increase the noise level; Conversely, if the sensor is in digital gain mode, there is no significant difference in increasing the DrcGain noise level.

The following figure shows the approximate curve of DrcGain when equal to 1x (red line) and 8x (blue line):



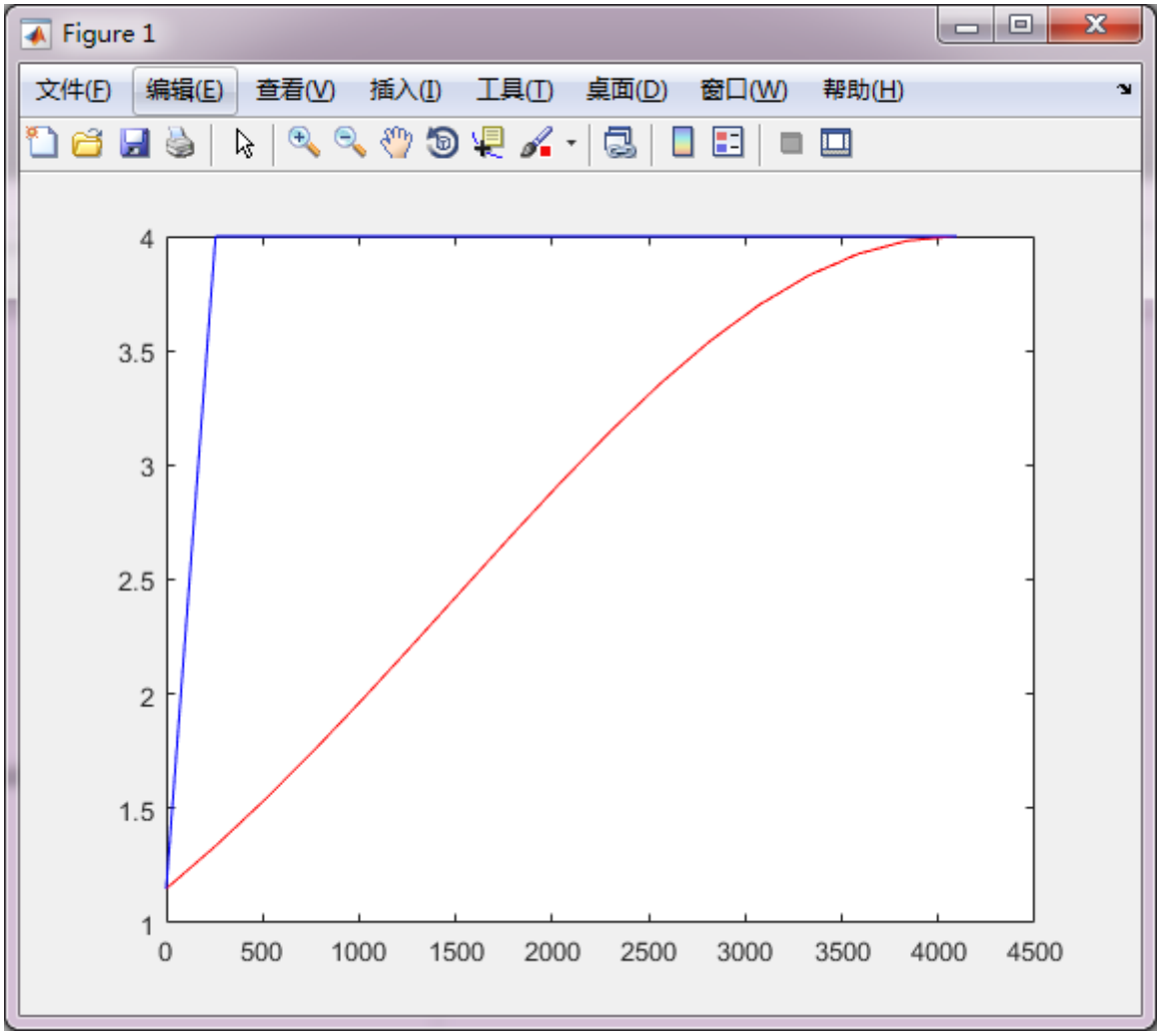
Alpha：

Alpha confirms the slope of the DrcGain curve, as shown in the figure below for the difference between 0 (red line) and 0.9 (blue line) for Alpha:



As can be seen from the figure above, when the alpha is smaller, the DrcGain curve is closer to a horizontal straight line, that is, each brightness will be magnified equally, which may introduce problems such as insufficient contrast and dark noise being amplified.

Clip：



4.3.2 4.4.3.2 HiLight debugging

【Description】

The HiLight module allows you to adjust the detail of the highlighted areas of the output RAW.

【Members】

Member name	Description
Strength	Highlight area detail, value range [0,1]
Strength	Highlight area detail, value range [0,1]

【Precautions】

The higher the Stength value, the better detail will be pressed in the highlights, but halos are more likely to appear at the highlight boundary. As shown in the figure below, the left figure shows when Strength is 0, and the right figure shows Strength when it is 1:

4.3.3 4.4.3.3 LocalSetting debugging

【Description】

The LocalSetting module allows you to adjust the parameters related to Local. All parameters in this module do not take effect when LocalAutoEnable=0 and LocalWeit=0, or LocalAutoEnable=1 and LocalAutoWeit=0.

4.3.3.1 4.4.3.3.1 LocalData debugging

【Description】

LocalTMOData mainly adjusts the LocalTMO weight, global contrast and dark area contrast.

【Members】

Member name	Description
LocalWeit	Local TMO weight, value range [0,1], 0: Global TMO, 1: All Local TMO
LocalAutoEnable	Automatic LocalWeit switch, value range [0,1], default value is 1, accuracy 1
LocalAutoWeit	Automatic LocalWeit value, value range [0,1], default value is 0.4, accuracy 0.01.
GlobalContrast	Global contrast, value range [0,1], default value is 0, precision 0.01.
LoLitContrast	Low brightness area contrast, value range [0,1], default value is 0, accuracy 0.01.

【Precautions】

DRC is Global mode when LocalAutoEnable = 0 and LocalWeit = 0, or when LocalAutoEnable = 1 and LocalAutoWeit=0. When LocalAutoEnable=0 and LocalWeit > 0, or LocalAutoEnable=1 and LocalAutoWeit>0

GlobalContrast: The higher the value, the stronger the overall contrast (excluding dark areas). As shown in the figure below, the left figure shows when GlobalContrast is 0, and the right figure shows when GlobalContrast is 1.

LoLitContrast: The higher the value, the stronger the contrast in the dark areas. As shown in the figure below, the left figure shows when LoLitContrast is 0, and the right figure shows when LoLitContrast is 1.

4.3.3.2 4.4.3.3.2 MotionData

【Description】

MotionData is mainly about adjusting the residual motion image.

【Members】

Member name	Description
MotionStr	Suppress the strength of the residual image, the value range is [0,1], and the default value is 0.

【Precautions】

4.3.4 4.4.3.4 Edge_Weit debugging

【Description】

Reduce the high-contrast edge Artifact by varying this value.

【Members】

【Precautions】

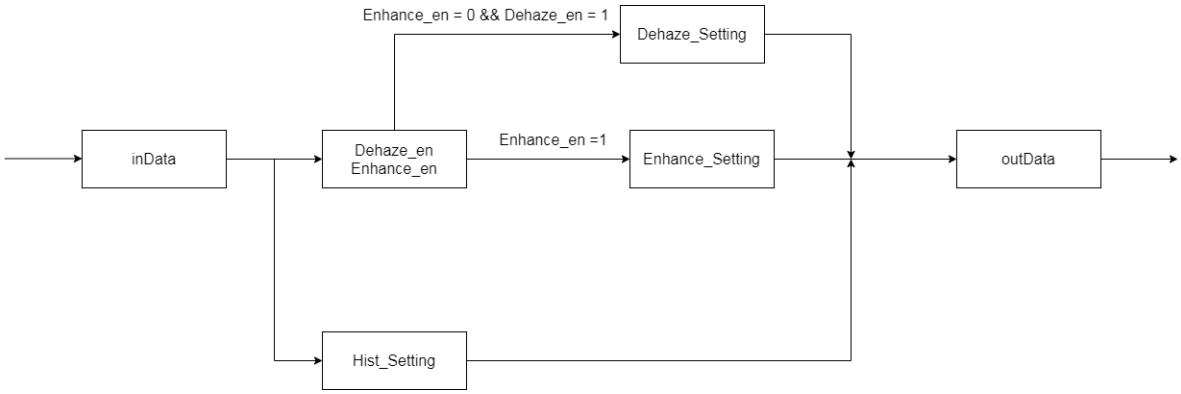
5. 4.5 Dehaze & Enhance

5.1 4.5.1 Feature description

In bad weather such as fog and haze, the quality of the collected images will be seriously reduced due to atmospheric scattering, so that the image color is grayish white, the contrast is reduced, and the object features are difficult to identify. So image dehazing technology is needed to enhance or fix to improve the visual effect.

This module consists of three modules, Dehaze, Enhance, and Hist. Dehaze is mainly used when the fog and haze are large in the picture, and the Enhanced and Hist are mostly used to enhance the contrast of the picture. Among them, Dehaze and Enhance two modules can only be opened at the same time, if two are turned on at the same time, only the Add module takes effect, and Hist can be opened together with other modules.

! [] (Resources/Dehaze Block Diagram .png)



Block diagram of the Dehaze module

5.2 4.5.2 Key parameters

5.2.1 4.7.2.1 Enable

【Description】

Dehaze & Enhanced switch function

0: Off

1: Open

【Members】

【Precautions】

5.2.2 4.5.2.2 CtrlDataType

【Description】

Control parameter selection.

CTRLDATATYPE_ENVLV: Use EnvLv as a control parameter

CTRLDATATYPE_ISO: Use ISO as the control parameter

【Members】

【Precautions】

5.2.3 4.5.2.3 cfg_alpha

【Description】

The proportion of software configuration, the value range [0,1], the default value is 1, and the accuracy is 0.01.

0: All adaptive parameters are used

1: All use software configuration parameters, you can control the adaptive parameters and software configuration parameters according to the proportion

【Members】

【Precautions】

When the value is 0, the cfg_wt, cfg_air, cfg_tmax in Dehaze and the cfg_gratio in Hist are not valid; Conversely, when the value is 1, the Dehaze parameter is determined entirely by the cfg_wt, cfg_air, and cfg_tmax, and the Hist parameter is determined entirely by the cfg_gratio.

5.2.4 4.5.2.4 ByPassThr

【Description】

Indicates the current module threshold of bypass, with a value range of [0,1]. When the percentage difference between the current ambient brightness and the ambient brightness of the previous frame is less than ByPassThr, the parameters of this module are not updated.

【Members】

【Precautions】

During debugging with the tool, write the value to 0, otherwise debugging may be invalid.

5.2.5 4.5.2.5 Dehaze_Setting

5.2.5.1 4.5.2.5.1 en

【Description】

Dehaze function switch. 0: Off, 1: On.

【Members】

【Precautions】

5.2.5.2 4.5.2.5.2 air_lc_en

【Description】

Whether to use AirLight Base to switch AirLight with a minimum cutoff. 0: Off, 1: On.

【Members】

【Precautions】

5.2.5.3 4.5.2.5.3 stab_fnum

【Description】

The maximum value for frame stability.

【Members】

【Precautions】

5.2.5.4 4.5.2.5.4 sigma

【Description】

IIR-controlled sigma.

【Members】

【Precautions】

5.2.5.5 4.5.2.5.5 wt_sigma

【Description】

Inter-frame WT filtering coefficient.

【Members】

【Precautions】

5.2.5.6 4.5.2.5.6 air_sigma

【Description】

Inter-frame AIR filtering factor.

【Members】

【Precautions】

5.2.5.7 4.5.2.5.7 tmax_sigma

【Description】

Inter-frame tmax filtering factor.

【Members】

【Precautions】

5.2.5.8 4.5.2.5.8 pre_wet

【Description】

Reference data IIR filtering coefficient.

【Members】

【Precautions】

Member name	Description
EnvLv	Ambient brightness
dc_min_th	wt adaptive statistical range, value range [16, 120], default value 64.
dc_max_th	WT adaptive high exposure area statistical range, value range [170, 255], default value 192.
yhist_th	Statistical range of high exposure area of the y component, value range [170, 255], default value 249.
yblk_th	Y component block number proportional threshold, value range [0.002, 0.01], default value 0.002.
dark_th	wt adaptive y component block minimum threshold, value range [230, 250], default value 250.
bright_min	The minimum value of the AIR adaptive threshold, the value range [160, 200], the default value is 180.
bright_max	The maximum value of the AIR adaptive threshold, the value range [210, 250], the default value is 240.
wt_max	The maximum value limit of wt adaptation, the value range is [0.75, 0.9], and the default value is 0.9.
air_min	The minimum value limit of AIR's adaptive value, the value range is [200, 220], and the default value is 200.
air_max	The maximum limit of AIR's adaptive value, the value range [230, 250], the default value is 250.
tmax_base	tmax adaptive base value, default 125, corresponding configuration as follows, 200 (131), 210 (125), 220 (119), 230 (114), 240 (109), 250 (105), recommended 131-105
tmax_off	Tmax adaptive fixed value, value range [0.1, 0.5], default value 0.1.
tmax_max	The maximum value of tmax adaptation, the value range is [0.1, 0.5], and the default value is 0.5.
cfg_wt	Software configuration wt, image dehazing force, value range [0, 1], default value 0.8.
cfg_air	Software configuration air, atmospheric light coefficient, value range [0, 255], default value 210.
cfg_tmax	Software configuration tmax, the maximum value of dehazing, the value range [0, 1], the default value 0.2.
bf_weight	The synthetic weights of the two bilateral filters are in the range of [0, 1], and the default value is 0.5.
dc_weitcur	The bilateral weight of the dark channel part, the value range [0, 1], the default value.
range_sigma	The two-sided filter range sigma value, the value range [0, 1], the default value is 0.4.
range_sigma_len	range_sigma array length

Member name	Description
space_sigma_pre	When using IIR data as a reference, the bilateral filter airspace sigma value is in the range of [0, 1], and the default value is 0.4.
space_sigma_cur	When using the current data as a reference, the bilateral filter airspace sigma value is in the range of [0, 1], and the default value is 0.8.

【Precautions】

stab_fnum: The parameter of dehaze is to gradually reach a stable value from 0, sw_dhaze_stab_fnum is the number of frames specified by the software to reach stability, generally 10 frames is more appropriate, the maximum value of this parameter can be allocated to 31, and the time of up to 1s will enter a stable state;

5.2.6 4.5.2.6 Enhance_Setting

5.2.6.1 4.5.2.6.1 en

【Description】

Enhance function switch. 0: Off, 1: On.

【Members】

【Precautions】

5.2.6.2 4.5.2.6.2 color_deviate_en

【Description】

Chromatic aberration correction switch. 0: Off, 1: On.

【Members】

【Precautions】

When the enhance_chroma value is large, there is a situation where the color deviation caused by channel overflow occurs, and turning on this can correct this situation.

5.2.6.3 4.5.2.6.3 enh_luma_en

【Description】

enh_luma curve switch. 0: Off, 1: On.

【Members】

【Precautions】

When it is turned on enh_luma it takes effect, and enhance_value it fails; Conversely, when closed, the enh_luma becomes invalid and enhance_value takes effect.

5.2.6.4 4.5.2.6.4 enhance_curve

【Description】

Low frequency curve.

【Members】

【Precautions】

5.2.6.5 4.5.2.6.5 enh_luma

【Description】

enh_luma curve. The value range is [0,16], and the recommended range is [1, 2].

【Members】

【Precautions】

The curve allows different general contrast forces to be set in different brightness point attachments.

The X axis has different brightness values, and its value is

```
{ 64,128,192,256,320,384,448,512,576,640,704,768,832,896,960,1023};
```

5.2.6.6 4.5.2.6.6 EnhanceData

【Description】

The image contrast is adjusted through this module.

【Members】

Member Name	Description
EnvLv	Ambient brightness
enhance_value	General contrast force, value range [0,16], recommended range [1, 2]
enhance_chroma	Enhanced adjustment parameters for chromaticity, value range [0,16], recommended range [1, 2]

【Precautions】

enhance_value: The larger the contrast

enhance_chroma: The larger the saturation, the higher the saturation

5.2.7 4.5.2.7 Hist_Setting

5.2.7.1 4.5.2.7.1 en

【Description】

Hist function switch.

【Members】

【Precautions】

5.2.7.2 4.5.2.7.2 hist_para_en

【Description】

Histogram stretch control switch. 0: Off, 1: On.

【Members】

【Precautions】

When the dehaze or enhance function is turned on, it can be switched on and off independently; Force enable when both dehaze or enhance functions are turned off.

When turned on, the hist_scale takes effect; When closed, and the cfg_alpha is 0, the hist_gratio takes effect; When closed, and the cfg_alpha is 1, the cfg_gratio takes effect.

5.2.7.3 4.5.2.7.3 HistData

【Description】

This module adjusts the image contrast, which is usually used when the contrast is not sufficient after dehazing.

【Members】

Member Name	Description
EnvLv	Ambient brightness
hist_gratio	Histogram stretch multiplier, histogram equilibrium control coefficient, value range [0, 32]
hist_th_off	Histogram statistical threshold, value range [0, 255], default value 64
hist_k	Histogram adaptive threshold magnification, value range [0, 7), default value 2
hist_min	The minimum value of the histogram statistical threshold, the value range [0,2], the default value 0.016
hist_scale	Histogram equilibrium control coefficient, value range [0, 32]
cfg_gratio	Software configuration histogram stretch multiplier, histogram equalization control coefficient, value range [0, 32)

【Precautions】

hist_para_en: When the value is 1, the hist_scale takes effect, but the hist_gratio does not take effect; Conversely, when the value is 0, the hist_scale does not take effect, hist_gratio takes effect.

hist_gratio: The higher the value, the more the histogram is stretched and the overall brightness of the image is higher.

hist_th_off: The higher the value, the larger the statistical value of the histogram and the higher the overall brightness of the image.

hist_k: The higher the value, the larger the statistical value of the histogram and the higher the overall brightness of the image.

hist_min: The larger the value, the larger the statistical value of the histogram and the higher the overall brightness of the image.

5.3 4.5.3 Debugging steps

Dehaze debugging mainly includes three parts: Dehaze, Enhanced and Hist debugging.

5.3.1 4.5.3.1 Dehaze debugging

【Description】

The defogging intensity is recommended to be adjusted by the following three parameters. The following three parameters vary according to ISO. During the adjustment process, the cfg_alpha needs to be set to 1.

【Members】

Member name	Description
cfg_wt	Software configuration wt, image dehazing force
cfg_air	Software configuration air, atmospheric light curtain coefficient
cfg_tmax	Software configuration tmax, maximum dehazing

【Precautions】

1.cfg_wt: The larger the value, the greater the dehazing force, it should be noted that wt is best not to exceed 0.9, in most cases wt more than 0.9 will appear unnatural processing effect, unless the fog in the scene is very large. (As shown in the figure below, from left to right, Dehaze_en= 0, Dehaze_en = 1 and cfg_wt= 0.4, Dehaze_en = 1 and cfg_wt= 0.8)

cfg_wt comparison chart

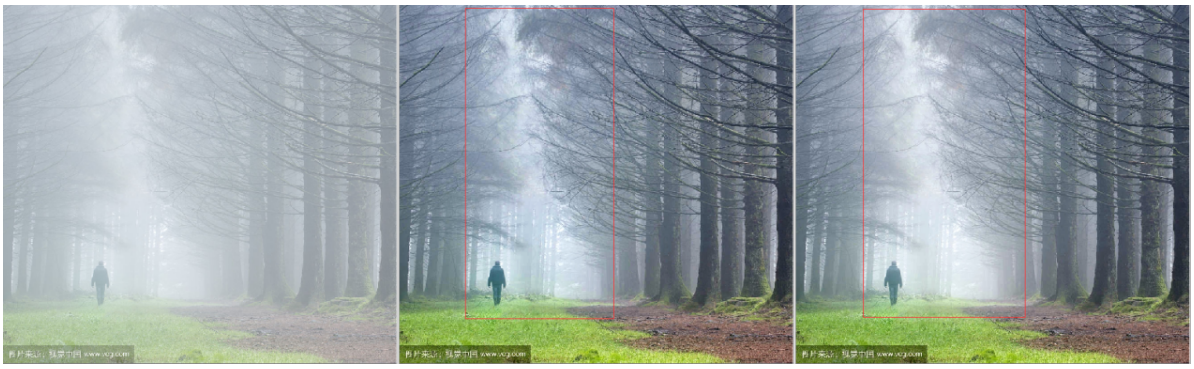
2.cfg_air: It can also control the dehazing intensity, and at the same time affect the dehazing effect of the overexposed area of the image, which is used with sw_dhaz_cfg_wt.

As can be seen as shown in the figure below, for the following input image, the more natural the dehazing effect at the junction of the larger the sky in the cfg_air, the more natural the defogging effect when the cfg_air is 250, there will be no intermediate layering problem, the debugging of AIR mainly considers whether there is a sky and overexposure area in the image, if there is a need to increase AIR, to avoid the problem of layering or loss of details. (As shown in the figure below, from left to right, Dehaze_en= 0, Dehaze_en= 1 and cfg_air= 200, Dehaze_en= 1 and cfg_air= 250)

cfg_air comparison chart

3.cfg_tmax: The smaller the value, the greater the dehazing force in the depth of field direction, and the larger the value, the smaller the dehazing force in the depth of field direction.

As can be seen as shown in the figure below, when the cfg_tmax is 0.1, the fog in the depth of field direction is removed relatively cleanly, some details can already be seen, and when the cfg_tmax is 0.5, it is much weaker, the fog in the depth of field direction is not removed as much as possible, removing too much will destroy the layering of the image, usually 0.2 is a more suitable value. (As shown in the figure below, from left to right, Dehaze_en= 0, Dehaze_en= 1 and cfg_tmax= 0.1, Dehaze_en= 1 and cfg_tmax= 0.5)



cfg_tmax comparison chart

5.3.2 4.5.3.2 Enhanced debugging

【Description】

Universal Contrast Enhancement is adjusted by enhance_value. enhance_value varies according to ISO.

【Members】

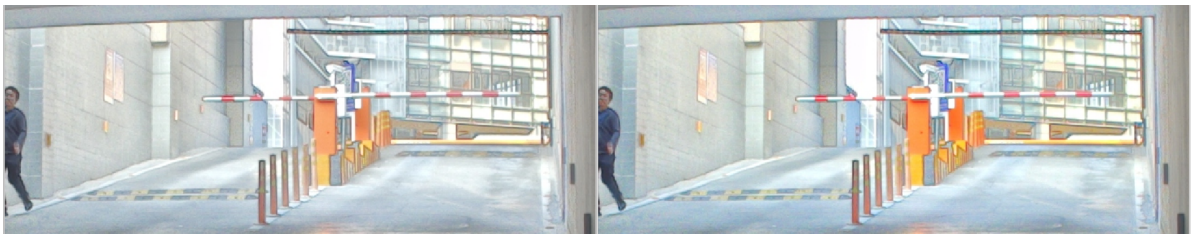
Member name	Description
enhance_value	General contrast force
enhance_chroma	Enhanced adjustment parameters for chromaticity
enh_curve	Low frequency curve

【Precautions】

1.enhance_value: The larger the value, the stronger the contrast. (As shown in the figure below, from left to right, Enhance_en = 0, Enhance_en = 1 and enhance_value = 1.5)

enhance_value comparison chart

2.enhance_chroma: The larger the saturation, the higher the saturation (as shown in the figure below, from left to right, Enhance_en = 0, Enhance_en = 1 and enhance_chroma = 1.5)



enhance_chroma comparison chart

3.enh_curve：Dark area brightness and contrast can be improved by lowering the dark area parameter.

5.3.3 4.5.3.3 Hist debugging

【Description】

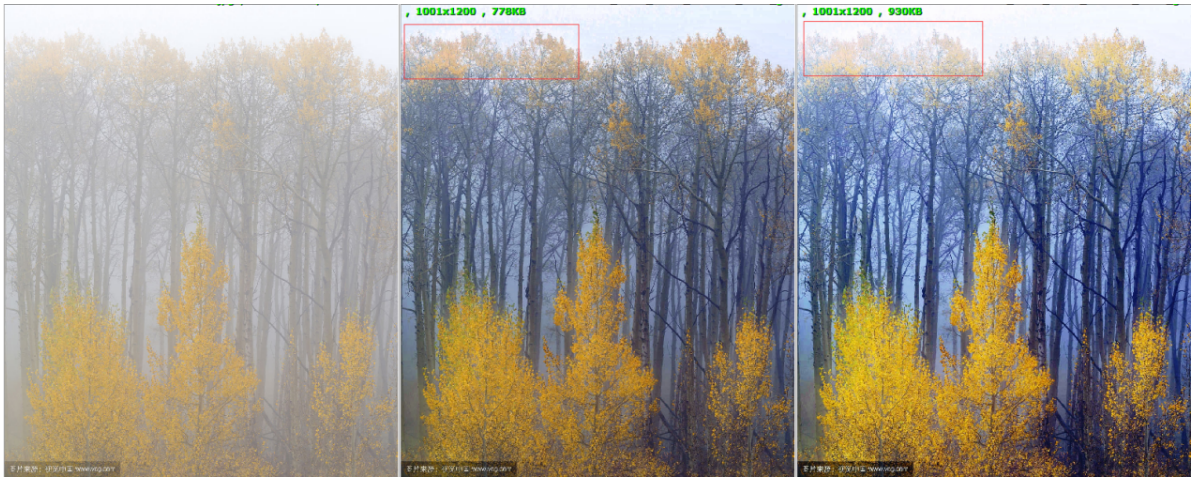
Histogram equalization Hist recommends adjusting by the following two parameters. The following two parameters vary according to ISO. During the adjustment process, the cfg_alpha needs to be set to 1.

【Members】

Member name	**Description**
cfg_gratio	Software configuration histogram stretch multiplier, histogram equalization control factor

【Precautions】

cfg_gratio: Related to WT, the larger WT Gratio, the larger the GT, the smaller the GRATIO, the smaller the GT. The parameters are too large to make the effect look unnatural, the overall color is blue, and some other details will be lost again, gratio is a coefficient of histogram stretching, its size is related to wt, the larger wt gratio needs to be appropriately adjusted, the smaller wt gratio, to avoid wt is smaller but configured with a relatively large gratio. (As shown in the figure below, from left to right, Hist_en = 0, Hist_en = 1 and cfg_gratio = 0.768, Hist_en = 1 and cfg_gratio= 2)

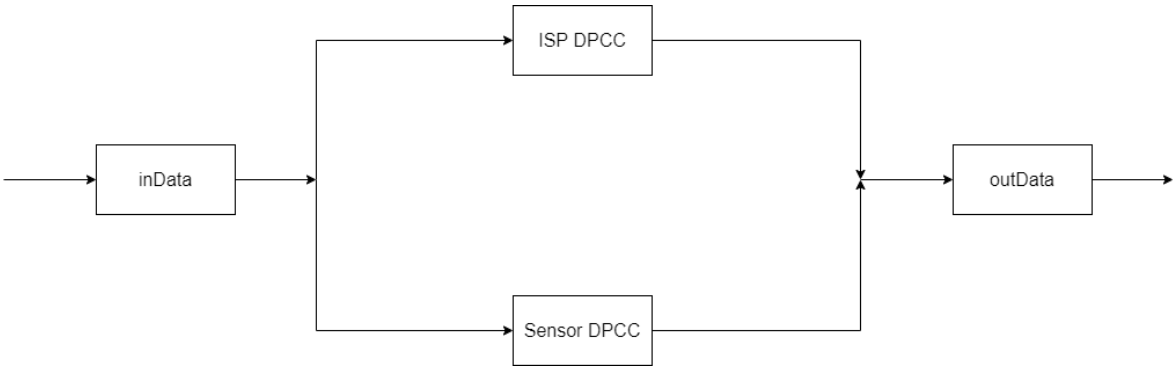


cfg_gratio comparison chart

6. 4.6 DPCC

6.1 4.6.1 Description of the feature

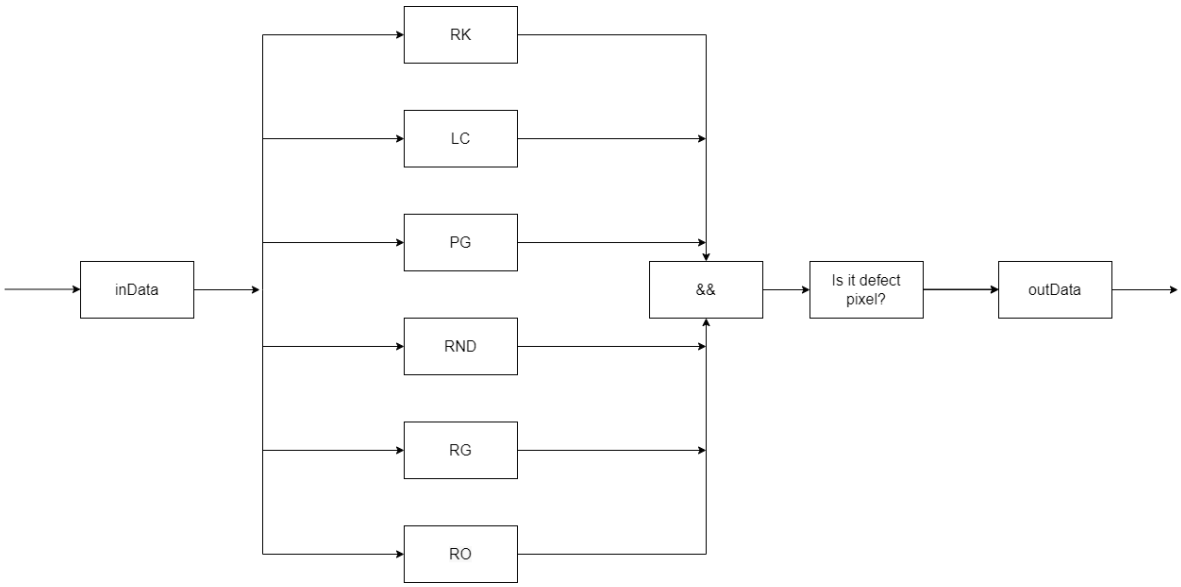
The DPCC module includes ISP DPCC and Sensor DPCC.



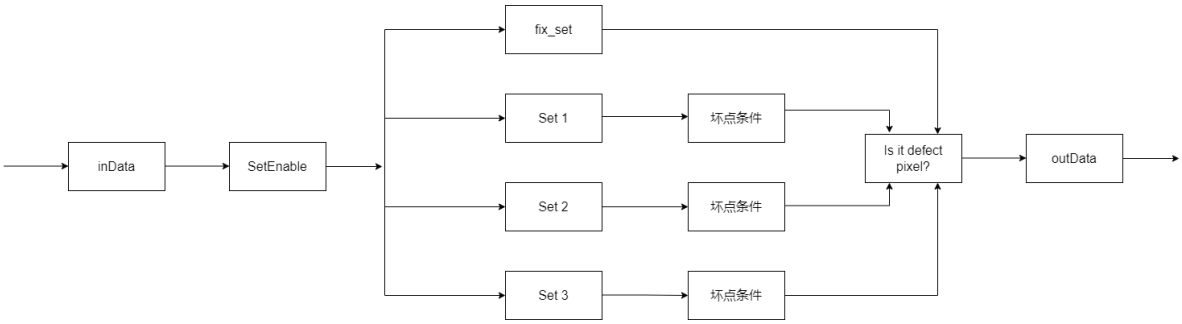
6.1.1 4.6.1.1 ISP DPCC

The ISP DPCC hardware module provides six dead pixel determination algorithms, namely RK, LC, PG, RND, RG, and RO to detect dead pixels, and remove dead pixels after detection. Each decision algorithm has independent switching and threshold parameter adjustment. The six dead pixel determination algorithms can detect bright spots, dark spots and dynamic dead pixels, and the detection capabilities are different for different dead pixels. RO and PG are more effective for two kinds of dead pixels of single bright spots and dark spots, and RK, RG and RND are more effective for multiple dead pixels.

Support six dead pixel determination algorithms, select several algorithm enablement, and combine into a dead pixel determination scheme. When all the dead pixel determination algorithms enabled by the scheme are judged to be dead pixels, the point is determined to be dead pixels by the scheme. For example, if the four algorithms RK, LC, PG, RND can be used, the conditions of the four algorithms must be met to determine that the point to be measured is a dead value. The following is a dead pixel determination scheme that enables six dead pixel determination algorithms.



The ISP DPCC module supports up to three configurable dead pixel determination schemes (Set1~3) and one dead pixel decision scheme (fix_set) that only supports the combination of fixed dead pixel determination algorithm enabled by the switch, for a total of four decision schemes. As long as the pixel to be measured is judged as a dead pixel by any enabled dead pixel determination scheme, it is judged as a dead pixel by the DPCC module and performs a dead pixel compensation action.



6.1.1.1 4.6.1.1.1 Expert_mode

In Expert_mode mode, users can directly configure ISP DPCC hardware, which mainly includes four dead pixel determination schemes: fix_set, set1, set2, and set3.

6.1.1.2 4.6.1.1.2 Fast_mode

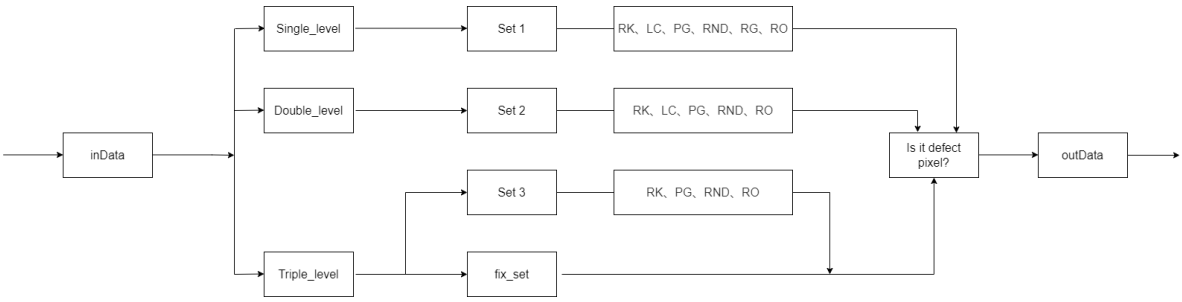
Fast_mode mode is a working mode for dead pixel type differentiation organized by RK based on the ability abstraction of each dead pixel determination algorithm of ISP DPCC hardware module, which mainly includes the following methods:

Single_level: For the mode that is more effective for a single isolated dead pixel, only the dead pixel determination scheme Set1 is enabled, which enables six dead pixel determination algorithms, and as the level increases, the number of algorithms used decreases, the threshold changes, and the ability to remove dead pixels is stronger;

Double_level: A pattern that is valid for two adjacent dead pixels, such as a 1x2, 2x1 dead pixel cluster. Among them, only the dead pixel determination scheme Set2 is enabled, which enables four dead pixel determination algorithms such as RK, LC, PG, RND, RO and with the increase of the level, the threshold changes and the ability to remove dead pixels is stronger;

Triple_leve: Dead pixel clusters for three or more pixels within a neighborhood are more effective. Among them, the dead pixel determination scheme Set3 and fix_set are enabled, in which set3 uses RK, PG, RND, RO four dead pixel determination algorithms, with the increase of the level, the threshold changes and the ability to remove dead pixels is stronger.

Since the above three modes are not duplicated in the hardware dead pixel determination scheme, they are allowed to be enabled at the same time, but the Triple_level will increase the strength of the Double_level and Single_level, and the Double_level will enhance the strength of the Single_level.



6.1.2 4.6.1.2 Sensor DPCC

Sensor DPCC is the DPCC function that comes with the sensor side, and in the case of sensor driver implementation support, AIQ supports controlling the Sensor side DPCC module through the parameters under the module in the JSON parameter file.

6.2 4.6.2 Key parameters

6.2.1 4.6.2.1 Enable

【Description】

DPCC switch function

0: Off

1: Open

【Members】

【Precautions】

6.2.2 4.6.2.2 Fast_mode

【Description】

Use this section to adjust the relevant parameters of the Fast_mode.

【Members】

Member name	Description
Fast_mode_enable	Fast_mode switch function, 0: off, 1: on
ISO	Environmental ISO
Single_enable	Single dead pixel removal switch, 0: off, 1: on
Single_level	Single dead pixel removal force, value range [0, 10]
Double_enable	Double dead pixel removal switch, 0: off, 1: on
Double_level	Double dead pixel removal force, value range [0, 10]
Triple_enable	Multi-dead pixel removal switch, 0: off, 1: on
Triple_level	Multiple dead pixel removal force, value range [0, 10]

【Precautions】

Fast_mode_enable: When the value is 0, the Fast_mode is turned off and the Expert_mode is turned on; Conversely, when the value is 1, the Fast_mode is turned on and Expert_mode off.

Double dead pixels and multiple dead pixels refer to multiple dead pixels in each other.

Dead pixel removal force, 0 means no treatment, 1~10 represents different intensity dead pixel removal force, the greater the value, the greater the force.

If you do not use the Fast_mode to achieve the desired pressure, use Expert_mode.

6.2.3 4.6.2.3 Expert_mode

【Description】

Use this section to adjust the relevant parameters of the Expert_mode.

【Members】

Member name	Description
stage1_Enable	Default value 1
grayscale_mode	Black and white mode switch, 0: off, 1: on
rk_out_sel	The use of ro_lim in the RK dead pixel algorithm, 0:ro_lim1,1:ro_lim2,2:ro_lim3
dpcc_out_sel	Dead pixel correction mode, 0: median mode, 1: RK mode
stage1_rb_3x3	Default value: 0
stage1_g_3x3	Default value: 0
stage1_inc_rb_center	When the red/blue channel is removed for dead pixels with the median mode, whether to include the point to be removed, 0:No, 1:Yes, the default value is 1
stage1_inc_g_center	When the green channel removes dead pixels with the median mode, whether to include the points to be removed, 0:No, 1:Yes, the default value is 1
set	Scenario conditions

【Precautions】

grayscale_mode: When the sensor is colored, set to 0; Conversely, when the sensor is black and white, it is set to 1.

6.2.3.1 4.6.2.3.1 SetEnable

【Description】

Four scheme switches in the Expert_mode.

【Members】

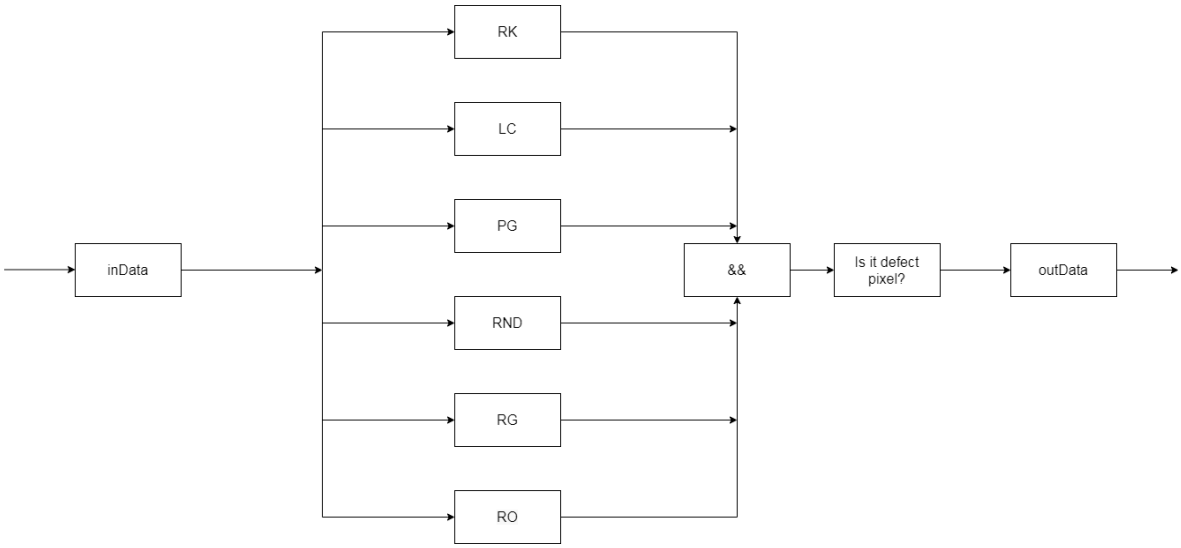
Member name	Description
ISO	Environmental ISO
stage1_use_fix_set	Built-in dead pixel condition switch, 0: off, 1: on
stage1_use_set3	The third dead pixel judgment condition switch in the set_cell, 0: off, 1: open
stage1_use_set2	The second dead pixel judgment condition switch in the set_cell, 0: off, 1: on
stage1_use_set1	The first dead pixel judgment condition switch in the set_cell, 0: off, 1: on

【Precautions】

6.2.3.2 4.6.2.3.2 set

【Description】

Through this part, the threshold of dead pixel conditions can be adjusted, mainly including six judgment conditions of RK, LC, PG, RND, RG and RO, and the relationship between the six conditions is and.



set_cell block diagram

【Members】

Member name	Description
RK	RK dead pixel determination algorithm
LC	LC dead pixel determination algorithm
PG	PG dead pixel determination algorithm
RNG	RND dead pixel determination algorithm
RG	RG dead pixel determination algorithm
RO	RO dead pixel determination algorithm

【Precautions】

6.2.3.2.1 4.6.2.3.2.1 RK

【Description】

This section allows you to adjust the parameters related to the RK algorithm in the dead pixel detection algorithm.

【Members】

Member name	Description
RK_red_blue_enable	RK dead pixel determination algorithm red/blue channel switch, 0: off, 1: on
RK_green_enable	RK dead pixel determination algorithm green channel switch, 0: off, 1: on
rb_sw_mindis	RK dead pixel determination algorithm red/blue channel threshold 1, value range [0,255]
g_sw_mindis	The green channel threshold of the RK dead pixel determination algorithm is 1, and the value range is [0,255]
sw_dis_scale_min	RK dead pixel determination algorithm threshold 2, value range [0,63]
sw_dis_scale_max	RK dead pixel determination algorithm threshold 3, value range [0,63]

【Precautions】

6.2.3.2.2 4.6.2.3.2.2 LC

【Description】

This section allows you to adjust the LC algorithm parameters in the dead pixel detection algorithm.

【Members】

Member name	Description
LC_red_blue_enable	LC dead pixel determination algorithm red/blue channel switch, 0: off, 1: on
LC_green_enable	LC dead pixel determination algorithm green channel switch, 0: off, 1: on
rb_line_thr	LC dead pixel determination algorithm red/blue channel threshold, value range [0,255], default value 16
g_line_thr	LC dead pixel determination algorithm green channel threshold, value range [0,255], default value 12
rb_line_mad_fac	LC dead pixel determination algorithm red/blue channel coefficient, value range [0,63], default value 34
g_line_mad_fac	The green channel coefficient of LC dead pixel determination algorithm, value range [0,63], default value 16

【Precautions】

6.2.3.2.3 4.6.2.3.2.3 PG

【Description】

This section allows you to adjust the PG algorithm parameters in the dead pixel detection algorithm.

【Members】

Member name	Description
PG_red_blue_enable	PG dead pixel determination algorithm red/blue channel switch, 0: off, 1: on
PG_green_enable	PG dead pixel determination algorithm green channel switch, 0: off, 1: on
rb_pg_fac	PG dead pixel determination algorithm red/blue channel coefficient, value range [0,63], default value 4
g_pg_fac	PG dead pixel determination algorithm green channel coefficient, value range [0,63], default value 3

【Precautions】

6.2.3.2.4 4.6.2.3.2.4 RND

【Description】

This section allows you to adjust the parameters related to the RND algorithm in the dead pixel detection algorithm.

【Members】

Member name	Description
RND_red_blue_enable	RND dead pixel determination algorithm red/blue channel switch, 0: off, 1: on
RND_green_enable	RND dead pixel determination algorithm green channel switch, 0: off, 1: on
rb_rnd_thr	RND dead pixel determination algorithm red/blue channel threshold, value range [0,255], default value 8
g_rnd_thr	The green channel threshold of the RND dead pixel determination algorithm, the value range is [0,255], and the default value is 8
rb_rnd_offs	RND dead pixel determination algorithm red/blue channel offset value, value range [0,3], default value 3
g_rnd_offs	The green channel offset value of the RND dead pixel determination algorithm, the value range is [0,3], and the default value is 3

【Precautions】

6.2.3.2.5 4.6.2.3.2.5 RG

【Description】

This section allows you to adjust the parameters of the RG algorithm in the dead pixel detection algorithm.

【Members】

Member name	Description
RG_red_blue_enable	RG dead pixel determination algorithm red/blue channel switch, 0: off, 1: on
RG_green_enable	RG dead pixel determination algorithm green channel switch, 0: off, 1: on
rb_rg_fac	RG dead pixel determination algorithm red/blue channel coefficient, value range [0,63], default value 8
g_rg_fac	The green channel coefficient of RG dead pixel determination algorithm, the value range [0,63], the default value is 8

【Precautions】

6.2.3.2.6 4.6.2.3.2.6 RO

【Description】

This section allows you to adjust the parameters related to the RO algorithm in the dead pixel detection algorithm.

【Members】

Member name	Description
RO_red_blue_enable	RO dead pixel determination algorithm red/blue channel switch, 0: off, 1: on
RO_green_enable	RO dead pixel determination algorithm green channel switch, 0: off, 1: on
rb_ro_lim	RO dead pixel determination algorithm red/blue channel threshold, value range [0,3], default value 1
g_ro_lim	RO dead pixel determination algorithm green channel threshold, value range [0,3], default value 1

【Precautions】

6.2.4 4.6.2.5 sensor_dpcc

【Description】

This section allows you to adjust the dead pixel removal force of the sensor itself.

【Members】

Member name	Description
sensor_dpcc_auto_en	Sensor DPCC switch function, 0: off, 1: on
max_level	Maximum force to remove dead pixels
ISO	Environmental ISO
level_single	Remove individual dead pixel force
level_multiple	Remove multiple dead pixel forces

【Precautions】

6.3 4.6.3 Debugging steps

DPCC debugging mainly includes three parts: Fast_mode, Expert_mode and sensor_dpcc debugging. Fast_mode and Expert_mode are mutually exclusive, determined by the Fast_mode_enable in the Fast_mode, when the Fast_mode_enable value is 0, the Fast_mode is closed and the Expert_mode is on; Conversely, when the Fast_mode_enable value is 1, the Fast_mode is turned on and Expert_mode closed.

In the actual debugging process, it is recommended to use the Fast_mode to remove dead pixels first, and if the Fast_mode cannot achieve the desired dead pixel removal force, then use Expert_mode.

6.3.1 4.6.3.1 Fast_mode debugging

【Description】

In Fast_mode, single dead pixels are mainly removed by Single_level, two adjacent dead pixels Double_level removed, and more than three adjacent dead pixels Triple_level removed.

The three functions do not affect each other, but Triple_level will increase the force of the Double_level, and the Double_level will increase the strength of the Single_level.

【Members】

Member name	Description
Fast_mode_enable	Fast_mode switch function, 0: off, 1: on
Single_level	Single dead pixel removal force, value range [0, 10]
Double_level	Double dead pixel removal force, value range [0, 10]
Triple_level	Multiple dead pixel removal force, value range [0, 10]

【Precautions】

Dead pixel removal force, 0 means no treatment, 1~10 represents different intensity dead pixel removal force, the greater the value, the greater the force.

When a certain dead pixel mode is turned on, the corresponding dead pixel removal force cannot be 0. For example, when the Single_enable is turned on, the value in the Single_level cannot be 0.

6.3.2 4.6.3.2 Expert_mode debugging

【Description】

The Expert_mode is mainly removed by stage1_use_fix_set, stage1_use_set1, stage1_use_set2, stage1_use_set3 and set_cell dead pixels,

Among them, stage1_use_fix_set, stage1_use_set1, stage1_use_set2 and stage1_use_set3 are four methods to detect dead pixels, and the four methods do not affect each other, that is, if all four methods are enabled, as long as any of them detect a point as a dead pixel, the point is a dead pixel.

The conditions of the stage1_use_fix_set detection method are fixed in hardware, and the conditions of the three methods of stage1_use_set1, stage1_use_set2 and stage1_use_set3 correspond to cell1, cell2 and cell3 in the set_cell, respectively.

The set_cell contains six dead pixel determination algorithms of RK, LC, PG, RND, RG and RO, and the relationship between the six algorithms is "and", that is, if the six judgment conditions are enabled, the point to be measured needs to meet six conditions to be judged as a dead pixel.

【Members】

Member name	Description
stage1_use_fix_set	Built-in dead pixel condition switch, 0: off, 1: on
stage1_use_set1	The first dead pixel judgment condition switch in the set_cell, 0: off, 1: on
stage1_use_set3	The third dead pixel judgment condition switch in the set_cell, 0: off, 1: open
set_cell	Dead pixel judgment condition

【Precautions】

The six algorithms of RK, LC, PG, RND, RG and RO are divided into green, red and blue channels to judge the dead pixels, and it is recommended that the two channels be turned on and off synchronously.

The six algorithms can be turned on and off independently, and because the relationship between the six algorithms is "and", the more algorithms are turned on, the less likely it is to determine that it is a dead pixel. However, due to the presence of noise, when the algorithm is turned on less, there may be "edge jitter" in the picture, that is, wavy lines appear on fixed edges in the picture, and there is a difference between frames. Therefore, in actual use, it is recommended that at least three algorithms be enabled under each set.

6.3.2.1 4.6.3.2.1 RK

【Description】

This section allows you to adjust the parameters related to the RK algorithm in the dead pixel detection algorithm.

【Members】

Member name	Description
enable	RK dead pixel determination algorithm switch, 0: off, 1: on
ro_lim	RK dead pixel determination algorithm offset value, value range [0,3]
sw_mindis	RK dead pixel determination algorithm threshold 1, value range [0,255]
sw_dis_scale_min	RK dead pixel determination algorithm threshold 2, value range [0,63]
sw_dis_scale_max	RK dead pixel determination algorithm threshold 3, value range [0,63]

【Precautions】

ro_lim: The larger the value, the easier it is to judge as a dead pixel.

sw_mindis: The smaller the value, the easier it is to judge as a dead pixel.

sw_dis_scale_max: The smaller the value, the easier it is to judge as a dead pixel.

sw_dis_scale_max : The smaller the value, the easier it is to judge as a dead pixel.

6.3.2.2 4.6.3.2.2 LC

【Description】

This section allows you to adjust the LC algorithm parameters in the dead pixel detection algorithm.

【Members】

Member name	Description
enable	LC dead pixel determination algorithm switch, 0: off, 1: on
line_thr	LC dead pixel determination algorithm channel threshold, value range [0,255], default value 12
line_mad_fac	LC dead pixel determination algorithm channel coefficient, value range [0,63], default value 16

【Precautions】

line_thr: The smaller the value, the easier it is to judge as a dead pixel.

line_mad_fac: The smaller the value, the easier it is to judge as a dead pixel.

6.3.2.3 4.6.3.2.3 PG

【Description】

This section allows you to adjust the PG algorithm parameters in the dead pixel detection algorithm.

【Members】

Member name	Description
enable	PG dead pixel determination algorithm switch, 0: off, 1: on
pg_fac	PG dead pixel determination algorithm channel coefficient, value range [0,63], default value 3

【Precautions】

pg_fac: The smaller the value, the easier it is to judge as a dead pixel.

6.3.2.4 4.6.3.2.4 RND

【Description】

This section allows you to adjust the parameters related to the RND algorithm in the dead pixel detection algorithm.

【Members】

Member name	Description
enable	RND dead pixel determination algorithm switch, 0: off, 1: on
rnd_thr	RND dead pixel determination algorithm channel threshold, value range [0,255], default value 8
rnd_offs	RND dead pixel determination algorithm channel offset value, value range [0,3], default value 3

【Precautions】

rnd_thr: The smaller the value, the easier it is to judge as a dead pixel.

rnd_offs: The smaller the value, the easier it is to judge as a dead pixel.

6.3.2.5 4.6.3.2.5 RG

【Description】

This section allows you to adjust the parameters of the RG algorithm in the dead pixel detection algorithm.

【Members】

Member name	Description
enable	RG dead pixel determination algorithm switch, 0: off, 1: on
rg_fac	RG dead pixel determination algorithm channel coefficient, value range [0,63], default value 8

【Precautions】

rg_fac: The smaller the value, the easier it is to judge as a dead pixel.

6.3.2.6 4.6.3.2.6 RO

【Description】

This section allows you to adjust the parameters related to the RO algorithm in the dead pixel detection algorithm.

【Members】

Member name	Description
enable	RO dead pixel determination algorithm channel switch, 0: off, 1: on
ro_lim	RO dead pixel determination algorithm channel threshold, value range [0,3], default value 1

【Precautions】

ro_lim: The larger the value, the easier it is to judge as a dead pixel.

6.3.3 4.6.3.3 sensor_dpcc debugging

【Description】

sensor_dpcc mainly controls the dead pixel removal function on the sensor side through max_level, level_single, and level_multiple. This function requires the sensor itself to have the function of removing dead pixels, and the driver configuration is completed before it can be used.

【Members】

Member name	Description
max_level	Maximum force to remove dead pixels
level_single	Remove individual dead pixel force
level_multiple	Remove multiple dead pixel forces

【Precautions】

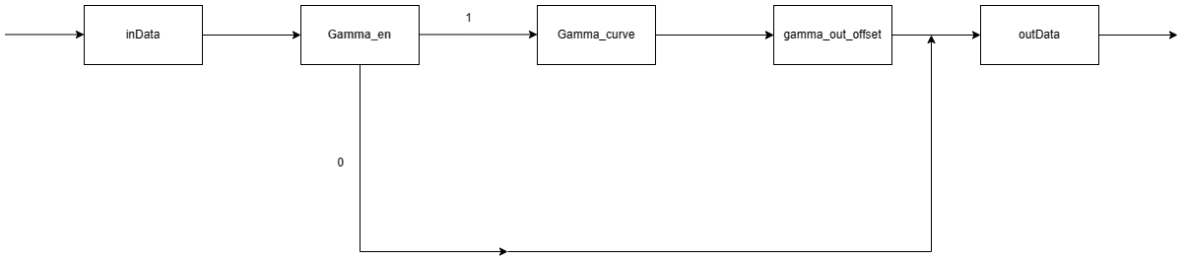
max_level: Define the maximum value of the dead pixel removal force at the sensor end, mainly to subdivide a single level of dead pixel removal force.

The intensity of level_single and level_multiple cannot exceed max_level.

7. 4.7 Gamma

7.1 4.7.1 Feature description

The Gamma curves are adjusted with this module, including three Gamma curves, curve_normal, curve_hdr and curve_night.



GAMMA block diagram

7.2 4.7.2 Key parameters

7.2.1 4.7.2.1 Gamma_en

【Description】

Gamma switch function

0: Off

1: Open

【Members】

【Precautions】

7.2.2 4.7.2.2 Gamma_out_offset

【Description】

Gamma curve correction function, value range [-2048, 2048], default value 0.

【Members】

【Precautions】

The final gamma curve used is, Gamma_curve-Gamma_out_offset.

7.2.3 4.7.2.3 Gamma_curve

【Description】

49-point Gamma curve Y-axis value, value range [0,4095].

【Members】

【Precautions】

The Gamma curve X-axis point is fixed at 49 points, i.e

```
int X_isp30[49] = { 0, 1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 14, 16, 20, 24, 28, 32,
40, 48, 56, 64, 80, 96, 112, 128, 160, 192, 224, 256, 320, 384, 448, 512, 640,
768, 896, 1024, 1280, 1536, 1792, 2048, 2304, 2560, 2816, 3072, 3328, 3584,
3840, 4095};
```

7.3 4.7.3 Debugging steps

8. 4.8 Debayer

8.1 4.8.1 Feature description

Since most color cameras use a single sensor to obtain image information, and each sensor surface is covered with a CFA (Color Filter Array), so that each pixel can only obtain one of the three primary colors of R, G, and B. Since only one color component per pixel of the color filter array is known, in order to obtain a color image, the other two missing color components need to be interpolated using the known color information, a process known as demosaic (Debayer or Demosaic). The module supports four pattern modes: RGGB, BGGR, GRBG, and gbrg, and does not support RGBIR mode.

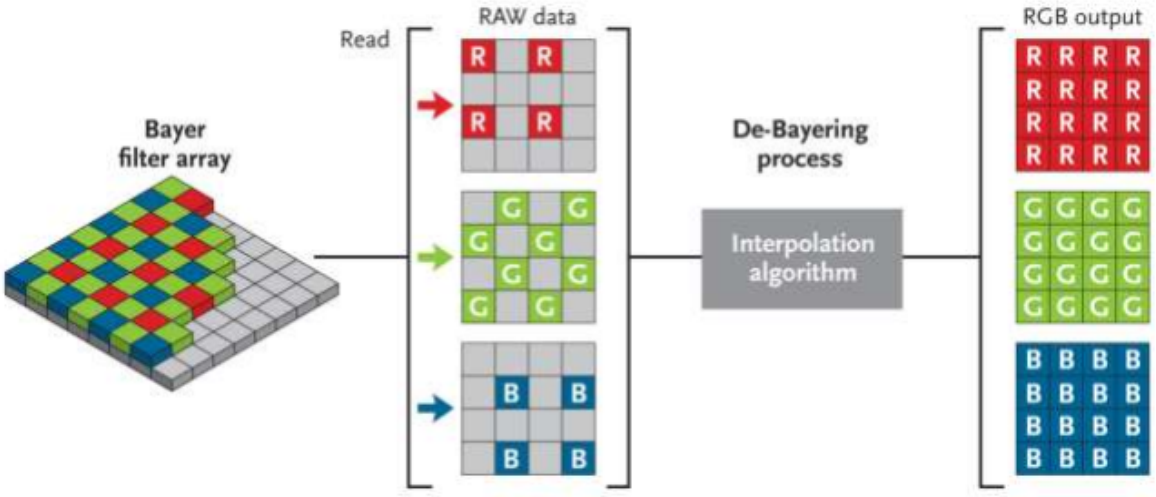


Fig. 4-10-1 Schematic diagram of Debayer function

8.2 4.8.2 Key parameters

8.2.1 4.8.2.1 control parameter

Parameter name	Parameter type	Brief description
Enable	Debug parameters	User debugging parameters
lowfreq_filter1	Debug parameters	User debugging parameters generally use the default value
highfreq_filter2	Debug parameters	User debugging parameters generally use the default value
c_alpha_gaus_coe	Debug parameters	User debugging parameters generally use the default value
c_guid_gaus_coe	Debug parameters	User debugging parameters generally use the default value
c_ce_gaus_coe	Debug parameters	User debugging parameters generally use the default value

8.2.1.1 Enable

【Description】

Debayer module enable bit, 0: off, 1: on. When configured to 0, the image is in black and white mode, and when configured as 1, it is in RGB mode.

8.2.1.2 lowfreq_filter1

【Description】

Low-frequency gradient filter, containing four parameters (coe1~coe4), the value range is -16~15, generally use the default value, the distribution of coe1~coe4 is shown in the figure below:

coe1	0	coe2
coe3	0	coe4
coe1	0	coe2

Filter1

8.2.1.3 highfreq_filter2

【Description】

High-frequency gradient filter, containing four parameters (coe1~coe4), the value range is -16~15, generally use the default value, the distribution of coe1~coe4 is shown in the figure below:

coe1	coe2	coe1
coe3	coe4	coe3
coe1	coe2	coe1

Filter2

8.2.1.4 c_alpha_gaus_coe

【Description】

The alpha edge filter coefficient contains three parameters (coe1~coe3), and the value range is 0~255. Respectively indicate the center point of the filter coefficient, the four points of the upper and lower left and right, and the four points of the 45 degree angle, you need to ensure that the sum of the 9 coefficients is 256, generally use the default value, the distribution of coe1~coe3 is shown in the figure below:

coe3	coe2	coe3
coe2	coe1	coe2
coe3	coe2	coe3

8.2.1.5 c_guid_gaus_coe

【Description】

The filter coefficient of the guide diagram contains three parameters (coe1~coe3), and the value range is 0~255. Respectively, the center point of the filter coefficient, four points of upper and lower left and right, four points of 45 degree angle, need to ensure that the sum of 9 coefficients is 256, generally use the default value, the distribution of coe1~coe3 is shown in the c_alpha_gaus_coe parameters.

8.2.1.6 c_ce_gaus_coe

【Description】

The chromatic aberration filter coefficient contains three parameters (coe1~coe3), and the value range is 0~255. Respectively, the center point of the filter coefficient, four points of upper and lower left and right, four points of 45 degree angle, need to ensure that the sum of 9 coefficients is 256, generally use the default value, the distribution of coe1~coe3 is shown in the c_alpha_gaus_coe parameters.

8.2.2 4.8.2.2 g_interp parameters

Parameter name	Parameter type	Brief description
iso	Debug parameters	User debugging parameters
debayer_clip_en	Debug parameters	User debugging parameters generally use the default value
debayer_gain_offset	Debug parameters	User debugging parameters generally use the default value
debayer_max_ratio	Debug parameters	User debugging parameters

8.2.2.1 iso

【Description】

The gain value, which is the actual gain value * 50. All parameters in the g_interp module change with the ISO value, and a one-to-one correspondence needs to be maintained.

8.2.2.2 debayer_clip_en

【Description】

G-channel interpolation clip switch, 0: off, 1: on.

8.2.2.3 debayer_gain_offset

【Description】

To calculate the gradient offset value of the G channel interpolation sharpening coefficient, the default value is generally used, and the value range is 0~4095.

8.2.2.4 debayer_max_ratio

【Description】

The maximum value of the G channel interpolation sharpening coefficient, the larger the value, the greater the sharpening force, the value range is 0~63.

8.2.3 4.8.2.3 g_drctwgt parameters

Parameter name	Parameter type	Brief description
iso	Debug parameters	User debugging parameters
debayer_hf_offset	Debug parameters	User debugging parameters
debayer_thed0	Debug parameters	User debugging parameters generally use the default value
debayer_thed1	Debug parameters	User debugging parameters generally use the default value
debayer_dist_scale	Debug parameters	User debugging parameters generally use the default value
debayer_select_thed	Debug parameters	User debugging parameters generally use the default value

8.2.3.1 iso

【Description】

The gain value, the function is the same as the ISO in the above module, and will not be repeated here.

8.2.3.2 debayer_hf_offset

【Description】

Gradient offset, the larger the value, the weaker the directionality, which is conducive to reducing the pseudo-texture caused by noise, the value range [0, 65535].

8.2.3.3 debayer_thed0

【Description】

Control the selection of high-frequency weights, the larger the value, the smaller the probability of selecting high-frequency weights, generally use the default value, the value range [0,15].

8.2.3.4 debayer_thed1

【Description】

Control the selection of low-frequency weights, the larger the value, the smaller the probability of selecting low-frequency weights, generally use the default value, the value range [0,15].

8.2.3.5 debayer_dist_scale

【Description】

The threshold for high-frequency detail judgment generally uses the default value, and the value range is [0,15].

8.2.3.6 debayer_select_thed

【Description】

The threshold value of the high and low frequency gradient selection method is generally used in the default value, and the value range is [0,255].

8.2.4 4.8.2.4 g_filter parameters

Parameter name	Parameter type	Brief description
iso	Debug parameters	User debugging parameters
debayer_gfilter_en	Debug parameters	User debugging parameters
debayer_gfilter_offset	Debug parameters	User debugging parameters

8.2.4.1 iso

【Description】

The gain value, the function is the same as the ISO in the above module, and will not be repeated here.

8.2.4.2 debayer_gfilter_en

【Description】

G-channel interpolation result filter switch, 0: off, 1: on.

8.2.4.3 debayer_gfilter_offset

【Description】

G-channel clip offset, the larger the value, the larger the clip range, the smaller the filtering force, the value range is [0,2047]

8.2.5 4.8.2.5 c_filter parameters

Parameter name	Parameter type	Brief description
iso	Debug parameters	User debugging parameters
debayer_cfilter_en	Debug parameters	User debugging parameters
debayer_loggd_offset	Debug parameters	User debugging parameters generally use the default value
debayer_cfilter_str	Debug parameters	User debugging parameters
debayer_wet_clip	Debug parameters	User debugging parameters generally use the default value
debayer_wet_ghost	Debug parameters	User debugging parameters generally use the default value
debayer_wgtslope	Debug parameters	User debugging parameters generally use the default value
debayer_bf_sgm	Debug parameters	User debugging parameters
debayer_bf_clip	Debug parameters	User debugging parameters
debayer_bf_curwgt	Debug parameters	User debugging parameters
debayer_loghf_offset	Debug parameters	User debugging parameters generally use the default value
debayer_alpha_offset	Debug parameters	User debugging parameters
debayer_alpha_scale	Debug parameters	User debugging parameters
debayer_edge_offset	Debug parameters	User debugging parameters
debayer_edge_scale	Debug parameters	User debugging parameters

8.2.5.1 iso

【Description】

The gain value, the function is the same as the ISO in the above module, and will not be repeated here.

8.2.5.2 debayer_cfilter_en

【Description】

Chromatic pattern filter switch, 0: off, 1: on.

8.2.5.3 debayer_loggd_offset

【Description】

The guide diagram log transformation offset, generally using the default value, the value range [0,4095].

8.2.5.4 debayer_cfilter_str

【Description】

Chromatic difference diagram IIR filter intensity, the larger the value, the greater the filtering force, the value range (0,1).

8.2.5.5 debayer_wet_clip

【Description】

IIR filter weight clip value, which controls the maximum filter intensity, the larger the value, the greater the maximum IIR filtering force. Generally, the default value is used, and the value range is [0,15.875].

8.2.5.6 debayer_wet_ghost

【Description】

IIR filtering suppresses the smearing threshold, the larger the value, the more severe the smearing, generally use the default value, the value range [0,0.98].

8.2.5.7 debayer_wgtslope

【Description】

The slope of the weight curve of the IIR filter index, generally using the default value, the value range is [0,31.992].

8.2.5.8 debayer_bf_sgm

【Description】

The greater the value of the protected edge filtering force, the greater the filtering force, the value range [0,1].

8.2.5.9 debayer_bf_clip

【Description】

The chromatic aberration bilateral filter weight clip value, which works together with the debayer_bf_curwgt, the value range [0,127].

8.2.5.10 debayer_bf_curwgt

【Description】

The current point weight of chromatic aberration bilateral filtering, the value range [0,127].

8.2.5.11 debayer_loghf_offset

【Description】

When calculating the fusion weight, the default value is generally used, and the value range is [0,8191].

8.2.5.12 debayer_alpha_offset

【Description】

The offset value of the moleline region fusion weight alpha is calculated by adaptation, and the smaller the value, the greater the chromatic aberration filter fusion weight of the moiré region, and the value range is [0,4095].

8.2.5.13 debayer_alpha_scale

【Description】

The scaling ratio of the moleline region fusion weight alpha is calculated by adaptation, the larger the value, the larger the alpha magnification, the greater the color difference filtering of the moiré region, the larger the fusion weight, and the value range is [0,1023.999].

8.2.5.14 debayer_edge_offset

【Description】

The offset value of the high-frequency region fusion weight edge, the smaller the value, the larger the edge chromatic aberration filter fusion weight, the value range is [0,4095].

8.2.5.15 debayer_edge_scale

【Description】

The scaling ratio of the high-frequency region fusion weight edge, the larger the edge magnification, the greater the high-frequency edge chromatic aberration filter fusion weight, and the value range is [0,1023.999].

8.3 4.8.3 Explanation of terms

Abbreviation	Description
CFA	Color Filter Array
Go Mosaic	Debayer or Demosaic, the process of converting a single-pixel monochrome Bayer RGB to a three-color RGB
Filter	A set of filtering parameters to remove unwanted signals from the digital image
Chromatic aberration map	The interpolated G-channel image is inferior to the original raw image

9. 4.10 GIC

9.1 4.10.1 Description of the feature

This module allows the GIC parameters to be adjusted. The main parameters of GIC are divided into two parts: GIC related parameters and noise-related parameters in the GIC_ISO, in which the noise-related parameters are obtained by calibration, and the GIC related parameters can adjust the GIC strength.

9.2 4.10.2 Key parameters

9.2.1 4.10.2.1 enable

【Description】

GIC switch function

0: Off

1: Open

【Members】

【Precautions】

9.2.2 4.10.2.3 gr_ration

【Description】

Determine the gr and GB compensation value parameters, the value range [0,3], and the default value is 0.

【Members】

【Precautions】

9.2.3 4.10.2.5 SettingV21

【Description】

Interpolate the relevant parameters according to the ISO.

【Members】

Member name	Description
iso	Environmental iso
min_busy_thre	Busy area detection capability, value range [0, 1023], default value 160
min_grad_thr1	The number threshold of non-edge areas is 1, the GIC intensity control value, the value range [0, 1023], and the default value is 32
min_grad_thr2	The number threshold of non-edge areas is 2, the GIC intensity control value, the value range [0, 1023], and the default value is 32
k_grad1	The response threshold of the edge (horizontal and vertical gradient) is 1, the value range is [0, 15], and the default value is 5
k_grad2	The response threshold of the edge (horizontal and vertical gradient) is 2, the value range is [0, 15], and the default value is 1
gb_thre	Scale factor for scale, value range [0, 15], default value 7
maxCorV	Limit the maximum compensation value of GB in the edge area, the value range is [0, 1023], and the default value is 40
maxCorVboth	Limit the maximum compensation value of GB in flat (non-edge) areas, the value range is [0, 1023], and the default value is 8
dark_thre	Define the threshold value of the dark area 1, the value range [0, 2047], the default value 120
dark_threHi	Define the threshold value of the dark area 2, the value range [0, 2047], the default value is 240
k_grad1_dark	The threshold value of the edge (horizontal and vertical gradient) of the dark part of the image is 1, the value range is [0, 15], and the default value is 6
k_grad2_dark	The threshold of the response degree of the edge (horizontal and vertical gradient) of the dark part of the image is 2, the value range is [0, 15], and the default value is 1
min_grad_thr_dark1	The threshold for the number of non-marginal areas in the dark part of the image is 1, the value range is [0, 1023], and the default value is 64
min_grad_thr_dark2	The number threshold of the number of non-marginal areas in the dark part of the image is 2, the value range [0, 1023], and the default value is 32
noiseCurve_0	Noise curve parameter 1
noiseCurve_1	Noise profile parameter 2
globalStrength	Global control adjusts the intensity of the GB compensation value, the value range [0, 2], the default value 1
NoiseScale	According to the noise curve, obtain the standard deviation of the current point noise, and use noise_std *noise_scale to determine the maximum GB compensation value

Member name	Description
NoiseBase	Penalty image edge adjustment threshold, calculate the result according to the first gradient and the second gradient plus noise_offset, and then compare the gradx > in just one direction 2*grady is considered to be an edge, and no adjustment
diff_clip	Limit the maximum compensation value of the maximum GB

【Precautions】

9.3 4.10.3 Debugging steps

In the debugging process of GIC, the GIC related parameters in the GIC_ISO are mainly adjusted.

9.3.1 4.10.3.1 GIC_ISO debugging

Member name	Description
min_busy_thre	Busy area detection capability, value range [16, 120], default value 64
min_grad_thr1	The number of non-marginal areas is threshold1, GIC intensity control value
min_grad_thr2	The number threshold of non-marginal areas is 2, GIC intensity control value
k_grad1	Threshold for the responsiveness of edges (horizontal, vertical gradients)1
k_grad2	Threshold for responsiveness of edges (horizontal, vertical gradients)2
gb_thre	Scale factor for scaling
maxCorV	Limit the maximum compensation value of GB in the edge area
maxCorVboth	Limit the maximum compensation value of GB in flat (non-edge) areas
dark_thre	Define the threshold for dark areas1
dark_threHi	Define the threshold for dark areas2
k_grad1_dark	The edge (horizontal, vertical gradient) of the dark part of the image is responsive to a threshold of 1
k_grad2_dark	The edge (horizontal, vertical gradient) of the dark part of the image is responsive to a threshold of 2
min_grad_thr_dark1	The number threshold of non-marginal areas in the dark part of the image is 1
min_grad_thr_dark2	The threshold for the number of non-marginal areas in the dark part of the image2

min_busy_thre: This value mainly corrects the detection ability of the busy area of the dark area (such as the irregular and high-contrast area such as text), that is, the darker area is given a threshold embedding. The higher the value, the more BUSY areas in the dark area and less vice versa. For the BUS area, GIC does not do any processing. Therefore, the more BUSY areas are detected, some edge details can be preserved, but at the same time, GIC residues will be caused for false detection areas.

min_grad_thr1. min_grad_thr2: Their size directly affects the number of non-marginal areas. The greater the number of non-marginal areas, the stronger the GIC effect, the harder the image is smeared, and the less detail is preserved. The smaller the number of non-marginal areas, there may be GIC residues, manifested by some typical GIC textures (horizontal and vertical light and dark stripes, pseudo-edges) being preserved. The higher this value, the more likely it is to be judged as a flat (non-edged) area when making directional judgments. It is a parameter that controls the intensity of GIC.

min_grad_thr_dark1. min_grad_thr_dark2: The role and debugging method are the same as min_grad_thr1 and min_grad_thr2, and the general value ratio is larger than min_grad_thr.

k_grad1. k_grad2: adjust the degree of response to the edge (horizontal and vertical gradient), the larger this value, the greater the threshold for determining whether it is an edge, and the result is to judge the weak edge as a flat area; If you decrease this parameter, you can increase the number of edges.

k_grad1_dark. k_grad2_dark: The role and debugging method are the same as k_grad1 and k_grad2, and generally larger than k_grad, that is, reduce the edge response of the dark part of the image.

gb_thre: It is a scale factor for scaling, not an absolute threshold for direct judgment. The larger it is, the smaller the GB that is allowed to compensate, and vice versa. It has a lot to do with sensors and lenses.

maxCorV: Assuming that the compensation value of gb has an upper bound, if the calculated value exceeds the assumed threshold, it is considered a calculation error, and in order to reduce the impact of the calculation error, the compensation value of gb is embedded down.

maxCorVboth: The purpose is the same as maxCorV.

dark_thre: Used to determine the lower boundary between the dark area of the image and the normal area.

dark_threHi: Used to determine the upper boundary between the dark area of the image and the normal area.

10. 4.11 BLC

10.1 4.11.1 Description of the feature

The BLC module contains three submodules, BLC0, BLC1, blc_ob 3 parts.

BLC0: RAW input, black level correction at the outset.

BLC1: Black level correction is performed only after Bayer3DNR has been processed.

blc_ob: This section is a module for adjusting the details of the shadows.

In linear mode, you can choose to do black level correction in BLC0, black level correction in BLC1, or part of each of the two modules.

In HDR mode, only BLC0 can be used for black level correction, and the blc_ob module cannot be enabled.

10.2 4.11.2 Key parameters

10.2.1 4.11.2.1 Blc0TuningPara 、Blc1TuningPara

10.2.1.1 enable

【Description】

Module enable bit.

0: Do not enable, 1: Enable. Default value 1.

10.2.1.2 ISO

【Description】

Different ISOs correspond to different black level correction values.

10.2.1.3 R_Channel 、Gr_Channel、Gb_Channel、B_Channel

【Description】

The black level correction values corresponding to the 4 channels of R, GR, GB, B 4.

10.2.2 4.11.2.2 BlcObPara

10.2.2.1 enable

【Description】

Module enable bit.

0: Do not enable, 1: Enable. Default value 1.

10.2.2.2 ISO

【Description】

Different ISOs correspond to different black level correction values.

10.2.2.3 isp_ob_Offset

【Description】

Dark detail boosts the offset value.

The value range is [0, 511], and the default value is 0.

10.2.2.4 isp_ob_preDgain

【Description】

Dark detail improvement multiplied by multiplier.

The value range is [0.0, 256.0], and the default value is 1.

10.3 4.11.3 Debugging steps

The total values of BLC0 and BLC1 should add up to the nominal BLC value.

blc_ob, in extremely dark ambient brightness, if you want to indicate dark details, you can increase the isp_ob_Offset and isp_ob_preDgain.

11. 4.12 AF

11.1 4.12.1 Description of the feature

The AF module is mainly composed of two parts: focus measurement statistics module (hardware) and focus control algorithm (software) module. The former is used to measure the sharpness of the image during focusing, and the statistical results (focus value, abbreviated as FV) change with the focus position; The latter determines the trigger of the motor according to the trend of the statistical curve, the appropriate focusing motor stepping, and determines the optimal focusing position.

11.2 4.12.2 Key parameters

Member name	Parameter type	Description
af_mode	Functional parameter	Functional parameter
win_h_offs	Debugging parameter	User debugging parameter
win_v_offs	Debugging parameter	User debugging parameter
win_h_size	Debugging parameter	User debugging parameter
win_v_size	Debugging parameter	User debugging parameter
video_win_h_offs	Debugging parameter	User debugging parameter
video_win_v_offs	Debugging parameter	User debugging parameter
video_win_h_size	Debugging parameter	User debugging parameter
video_win_v_size	Debugging parameter	User debugging parameter
fixed_mode	Debugging parameter	User debugging parameter
macro_mode	Debugging parameter	User debugging parameter
infinity_mode	Debugging parameter	User debugging parameter
contrast_af.enable	Debugging parameter	User debugging parameter
contrast_af.Afss	Debugging parameter	User debugging parameter
contrast_af.FullDir	Debugging parameter	User debugging parameter
contrast_af.FullRangeTbl	Debugging parameter	User debugging parameter
contrast_af.AdaptiveDir	Debugging parameter	User debugging parameter
contrast_af.AdaptRangeTbl	Debugging parameter	User debugging parameter
contrast_af.TrigThers	Debugging parameter	User debugging parameter

Member name	Parameter type	Description
contrast_af.TrigThersFv	Debugging parameter	User debugging parameter
contrast_af.LumaTrigThers	Debugging parameter	User debugging parameter
contrast_af.ExpTrigThers	Debugging parameter	User debugging parameter
contrast_af.StableThers	Debugging parameter	User debugging parameter
contrast_af.StableFrames	Debugging parameter	User debugging parameter
contrast_af.StableTime	Debugging parameter	User debugging parameter
contrast_af.SceneDiffEnable	Debugging parameter	User debugging parameter
contrast_af.SceneDiffThers	Debugging parameter	User debugging parameter
contrast_af.SceneDiffBlkThers	Debugging parameter	User debugging parameter
contrast_af.CenterSceneDiffThers	Debugging parameter	User debugging parameter
contrast_af.ValidMaxMinRatio	Debugging parameter	User debugging parameter
contrast_af.ValidValueThers	Debugging parameter	User debugging parameter
contrast_af.OutFocusValue	Debugging parameter	User debugging parameter
contrast_af.OutFocusPos	Debugging parameter	User debugging parameter
contrast_af.WeightEnable	Debugging parameter	User debugging parameter
contrast_af.Weight	Debugging parameter	User debugging parameter
contrast_af.SearchPauseLumaEnable	Debugging parameter	User debugging parameter
contrast_af.SearchPauseLumaThers	Debugging parameter	User debugging parameter
contrast_af.SearchLumaStableFrames	Debugging parameter	User debugging parameter

Member name	Parameter type	Description
contrast_af.SearchLumaStableThers	Debugging parameter	User debugging parameter
contrast_af.Stage1QuickFoundThers	Debugging parameter	User debugging parameter
contrast_af.Stage2QuickFoundThers	Debugging parameter	User debugging parameter
contrast_af.FlatValue	Debugging parameter	User debugging parameter
contrast_af.PointLightLumaTh	Debugging parameter	User debugging parameter
contrast_af.PointLightCntTh	Debugging parameter	User debugging parameter
contrast_af.ZoomCfg.QuickFoundThersZoomIdx	Debugging parameter	User debugging parameter
contrast_af.ZoomCfg.QuickFoundThers	Debugging parameter	User debugging parameter
contrast_af.ZoomCfg.SearchStepZoomIdx	Debugging parameter	User debugging parameter
contrast_af.ZoomCfg.SearchStep	Debugging parameter	User debugging parameter
contrast_af.ZoomCfg.StopStepZoomIdx	Debugging parameter	User debugging parameter
contrast_af.ZoomCfg.StopStep	Debugging parameter	User debugging parameter
contrast_af.ZoomCfg.SkipHighPassZoomIdx	Debugging parameter	User debugging parameter
contrast_af.ZoomCfg.SkipHighPassGain	Debugging parameter	User debugging parameter
contrast_af.ZoomCfg.SwitchDirZoomIdx	Debugging parameter	User debugging parameter
contrast_af.ZoomCfg.SpotlightHighlightRatio	Debugging parameter	User debugging parameter
contrast_af.ZoomCfg.SpotlightLumaRatio	Debugging parameter	User debugging parameter
contrast_af.ZoomCfg.SpotlightBlkCnt	Debugging parameter	User debugging parameter
video_contrast_af	Debugging parameter	User debugging parameter

Member name	Parameter type	Description
laser_af.enable	Reserved debugging parameters	User debugging parameter
laser_af.vcmDot	Reserved debugging parameters	User debugging parameter
laser_af.distanceDot	Reserved debugging parameters	User debugging parameter
pdaf.enable	Debugging parameter	User debugging parameter
pdaf.pdVsCdDebug	Debugging parameter	User debugging parameter
pdaf.pdDumpDebug	Debugging parameter	User debugging parameter
pdaf.pdDataBit	Debugging parameter	User debugging parameter
pdaf.pdBlkLevel	Debugging parameter	User debugging parameter
pdaf.pdSearchRadius	Debugging parameter	User debugging parameter
pdaf.pdMirrorInCalib	Debugging parameter	User debugging parameter
pdaf.pdVsImgoutMirror	Debugging parameter	User debugging parameter
pdaf.pdWidth	Debugging parameter	User debugging parameter
pdaf.pdHeight	Debugging parameter	User debugging parameter
pdaf.pdConfdMwinFactor	Debugging parameter	User debugging parameter
pdaf.pdStepRatio[7]	Debugging parameter	User debugging parameter
pdaf.pdStepDefocus[7]	Debugging parameter	User debugging parameter
pdaf.pdIsoPara.iso	Debugging parameter	User debugging parameter
pdaf.pdIsoPara.pdNoiseFactor	Debugging parameter	User debugging parameter
pdaf.pdIsoPara.pdConfdRatio1	Debugging parameter	User debugging parameter

Member name	Parameter type	Description
pdaf.pdIsoPara.pdConfdRatio2	Debugging parameter	User debugging parameter
pdaf.pdIsoPara.pdNoiseBias	Debugging parameter	User debugging parameter
pdaf.pdIsoPara.pdConfdThresh	Debugging parameter	User debugging parameter
pdaf.pdIsoPara.defocusPdThresh	Debugging parameter	User debugging parameter
pdaf.pdIsoPara.stablePdRatio	Debugging parameter	User debugging parameter
pdaf.pdIsoPara.stablePdOffset	Debugging parameter	User debugging parameter
pdaf.pdIsoPara.stableCntRatio	Debugging parameter	User debugging parameter
pdaf.pdIsoPara.noconfCntThresh	Debugging parameter	User debugging parameter
pdaf.pdIsoPara.fineSearchTbl.confidence	Debugging parameter	User debugging parameter
pdaf.pdIsoPara.fineSearchTbl.range	Debugging parameter	User debugging parameter
pdaf.pdIsoPara.fineSearchTbl.stepPos	Debugging parameter	User debugging parameter
vcmcfg.startCurrent	Debugging parameter	User debugging parameter
vcmcfg.ratedCurrent	Debugging parameter	User debugging parameter
vcmcfg.stepMode	Debugging parameter	User debugging parameter
vcmcfg.extraDelay	Debugging parameter	User debugging parameter
vcmcfg.posture_diff	Debugging parameter	User debugging parameter
zoomfocus_tbl.widemod_deviate	Debugging parameter	User debugging parameter
zoomfocus_tbl.telemod_deviate	Debugging parameter	User debugging parameter
zoomfocus_tbl.focus_backval	Debugging parameter	User debugging parameter

Member name	Parameter type	Description
zoomfocus_tbl.zoom_move_dot	Debugging parameter	User debugging parameter
zoomfocus_tbl.zoom_move_step	Debugging parameter	User debugging parameter
zoomfocus_tbl.focal_length	Debugging parameter	User debugging parameter
zoomfocus_tbl.zoomcode	Debugging parameter	User debugging parameter
zoomfocus_tbl.focuscode.pos	Debugging parameter	User debugging parameter
zoomfocus_tbl.focuscode.code	Debugging parameter	User debugging parameter
zoomfocus_tbl.ZoomSearchTbl	Debugging parameter	User debugging parameter
zoomfocus_tbl.ZoomSearchRefCurveIdx	Debugging parameter	User debugging parameter
zoomfocus_tbl.FocusSearchMargin	Debugging parameter	User debugging parameter
zoomfocus_tbl.FocusSearchPlusRange	Debugging parameter	User debugging parameter
zoomfocus_tbl.FocusStage1Step	Debugging parameter	User debugging parameter
zoomfocus_tbl.QuickFndRate	Debugging parameter	User debugging parameter
zoomfocus_tbl.QuickFndMinFv	Debugging parameter	User debugging parameter
zoomfocus_tbl.searchZoomRange	Debugging parameter	User debugging parameter
zoomfocus_tbl.searchFocusRange	Debugging parameter	User debugging parameter
zoomfocus_tbl.searchEmax	Debugging parameter	User debugging parameter
zoomfocus_tbl.searchEavg	Debugging parameter	User debugging parameter
zoomfocus_tbl.IsZoomFocusRec	Debugging parameter	User debugging parameter
zoomfocus_tbl.ZoomInfoDir	Debugging parameter	User debugging parameter

Member name	Parameter type	Description
zoom_meas.zoom_idx	Debugging parameter	User debugging parameter
zoom_meas.measiso.iso	Debugging parameter	User debugging parameter
zoom_meas.measiso.idx	Debugging parameter	User debugging parameter
zoom_meas.measiso.spotlt_scene_idx	Debugging parameter	User debugging parameter
meascfg_tbl.tbl_idx	Debugging parameter	User debugging parameter
meascfg_tbl.afmThres	Debugging parameter	User debugging parameter
meascfg_tbl.gammaY	Debugging parameter	User debugging parameter
meascfg_tbl.v1fv_reliable	Debugging parameter	User debugging parameter
meascfg_tbl.v2fv_reliable	Debugging parameter	User debugging parameter
meascfg_tbl.v1_fir_sel	Debugging parameter	User debugging parameter
meascfg_tbl.v1_band	Debugging parameter	User debugging parameter
meascfg_tbl.v1_iir_coe	Debugging parameter	User debugging parameter
meascfg_tbl.v1_fir_coe	Debugging parameter	User debugging parameter
meascfg_tbl.v2_band	Debugging parameter	User debugging parameter
meascfg_tbl.v2_iir_coe	Debugging parameter	User debugging parameter
meascfg_tbl.v2_fir_coe	Debugging parameter	User debugging parameter
meascfg_tbl.h1_band	Debugging parameter	User debugging parameter
meascfg_tbl.h1_iir1_coe	Debugging parameter	User debugging parameter
meascfg_tbl.h1_iir2_coe	Debugging parameter	User debugging parameter

Member name	Parameter type	Description
measCfg_tbl.h2_band	Debugging parameter	User debugging parameter
measCfg_tbl.h2_iir1_coe	Debugging parameter	User debugging parameter
measCfg_tbl.ldg_en	Debugging parameter	User debugging parameter
measCfg_tbl.ve_ldg_lumth_l	Debugging parameter	User debugging parameter
measCfg_tbl.ve_ldg_gain_l	Debugging parameter	User debugging parameter
measCfg_tbl.ve_ldg_gslp_l	Debugging parameter	User debugging parameter
measCfg_tbl.ve_ldg_lumth_h	Debugging parameter	User debugging parameter
measCfg_tbl.ve_ldg_gain_h	Debugging parameter	User debugging parameter
measCfg_tbl.ve_ldg_gslp_h	Debugging parameter	User debugging parameter
measCfg_tbl.ho_ldg_lumth_l	Debugging parameter	User debugging parameter
measCfg_tbl.ho_ldg_lumth_h	Debugging parameter	User debugging parameter
measCfg_tbl.v_fv_thresh	Debugging parameter	User debugging parameter
measCfg_tbl.h_fv_thresh	Debugging parameter	User debugging parameter
measCfg_tbl.highlit_thresh	Debugging parameter	User debugging parameter
measCfg_tbl.v_fv_ratio	Debugging parameter	User debugging parameter

11.2.1 4.12.2.1 af_mode

【Description】

Default focus mode

```
CalibDbV2_AFMODE_NOT_SET = -1,
CalibDbV2_AFMODE_AUTO,
CalibDbV2_AFMODE_MACRO,
CalibDbV2_AFMODE_INFINITY,
CalibDbV2_AFMODE_FIXED,
CalibDbV2_AFMODE_EDOF,
CalibDbV2_AFMODE_CONT_VIDEO,
CalibDbV2_AFMODE_CONT_PICTURE,
CalibDbV2_AFMODE_ZOOM_ONESHOT,
```

【Member】

【Note】

11.2.2 4.12.2.2 win_h_offs/win_v_offs/win_h_size/win_v_size

【Description】

Focus window in normal mode.

【Member】

h_offs are the starting horizontal coordinate of the focus area;

v_offs are the starting ordinate of the focus area;

h_size is the width of the focus area;

v_size is the height of the focus area;

【Note】

The value ranges from 0 to 2000. The code is converted based on the input of the sensor.
If all four values are set to 0, they are automatically set within the code.

11.2.3 4.12.2.3 video_win_h_offs/video_win_v_offs/video_win_h_size/video_win_v_size

【Description】

Focus window in video mode.

【Member】

h_offs are the starting horizontal coordinate of the focus area;

v_offs are the starting ordinate of the focus area;

h_size is the width of the focus area;

v_size is the height of the focus area;

【Note】

The value ranges from 0 to 2000. The code is converted based on the input of the sensor.
If all four values are set to 0, they are automatically set within the code.

11.2.4 4.12.2.4 fixed_mode/macro_mode/infinity_mode

【Description】

fixed_mode: fixed focus mode.

macro mode indicates the near focus mode.

infinity mode is the far-focus mode;

【Member】

In fixed_mode, the code value is the location where lens is to stay. The value ranges from 0 to 64.

The code value in macro mode is the end of focus position and the start code value is 0.

The code value in infinity mode is the starting position of focus and the ending code value is 64.

【Note】

11.2.5 4.12.2.5 contrast_af/video_contrast_af

【Description】

Set the contrast af algorithm parameter in general mode and video mode

【Member】

enable indicates the contrast af algorithm switch.

AfSearchStrategy is the contrast af algorithm strategy, including FULL_RANGE and ADAPTIVE_RANGE. ADAPTIVE_RANGE is generally used.

FullDir indicates the search direction in the FULL_RANGE policy. The value can be POSITIVE, NEGATIVE, or ADAPTIVE. ADAPTIVE is usually used.

FullRangeTbl is the search table under the FULL_RANGE policy.

AdaptiveDir Indicates the search direction in the ADAPTIVE_RANGE policy. The value can be POSITIVE, NEGATIVE, or ADAPTIVE. ADAPTIVE is usually used.

TrigThers is the threshold to trigger refocusing. When the current Fv value is compared with the Fv value of the last successful focusing, the change rate exceeds TrigThers, the focus will be triggered.

TrigThersFv is used in conjunction with TrigThers. The value of TrigThers is determined by the absolute value of the current Fv. The logic code is as follows.

```
for (i = TrigThersNums - 1; i >= 0; i--) {
    if (curFv >= TrigThersFv[i])
        break;
}

if (i < 0)
    i = 0;

TrigThers = TrigThers[i];
```

LumaTrigThers is the threshold to trigger refocusing. When the current brightness value is compared with the brightness value of the last successful focusing, the change rate exceeds LumaTrigThers, the focus will be triggered.

ExpTrigThers is the threshold to trigger refocusing. When the current exposure setting value is compared with the exposure setting value in the last successful focusing, the change rate exceeds ExpTrigThers, the focus will be triggered. The exposure setting value includes exposure time and exposure gain value.

StableThers indicates that after meeting the trigger focusing condition, if the change rate of the current Fv value compared with the last Fv value is less than this value, the scene is considered to be stable.

If StableFrames meet the focusing trigger condition and the number of frames with a change rate smaller than StableThers is greater than this value, the scene is considered stable.

StableTime is not used.

SceneDiffEnable/SceneDiffThers/SceneDiffBlkThers/CenterSceneDiffThers is not in use.

ValidMaxMinRatio is the change rate threshold of maximum fv and minimum fv used when searching reliable blocks using the 15*15 fv value of the main window when the middle independent window cannot be focused.

ValidValueThers is the maximum fv threshold used when searching for reliable blocks using the main window 15*15 fv value when the middle independent window cannot focus;

OutFocusValue: If the Fv value is smaller than this value, the focusing result is considered unreliable.

If OutFocusPos indicates that the Fv value is less than OutFocusValue and the focusing result is unreliable, set the lens to this position.

WeightEnable is a switch that makes use of the fv value calculated by weighting the main window 15*15 fv value.

Weight is the weight coefficient to weigh the 15*15 fv value of the main window when WeightEnable is 1.

SearchPauseLumaEnable is the switch to check brightness changes during af search.

SearchPauseLumaThers is the threshold for checking the brightness change rate in the af search process. When the brightness change exceeds the threshold, the search will be suspended.

SearchLumaStableThers is the threshold for determining whether the brightness change is stable after the pause due to the large brightness change in the af search process. If the change rate is less than this value, the brightness change is considered stable.

SearchLumaStableFrames is the threshold that determines whether the brightness change is stable after the af search is paused due to too much brightness change. If the change rate is smaller than the number of frames of SearchLumaStableThers is larger than this value, the brightness change is considered to be stable.

FlatValue indicates that when the maximum fv value is less than this value in the af search process, the current focusing area is judged to be flat.

PointLightLumaTh and PointLightCntTh are thresholds for light source judgment using brightness statistics, and 7 * 7 blocks in the middle of the brightness statistics module are selected for judgment. The specific logic is as follows.

```
for (i = 0;  i < 225;  i++) {
if (isInCentor[i]) {
if (luma[i] >= PointLightLumaTh)
LightBlkCnt++;
}
}
```

```
if (LightBlkCnt >= PointLightCntTh) {
LOG("light source detected, move to inf position\n");
}
```

The following parameters are mainly used when the optical zoom function is enabled.

ZoomCfg.QuickFoundThers indicates the fast search threshold. If the change rate of the current Fv value to the maximum value is greater than this threshold, the search ends prematurely.

ZoomCfg QuickFoundThersZoomIdx used with QuickFoundThers, according to the zoom index value, can set up multiple QuickFoundThers value,

The zoom index values need to be sorted from smallest to largest;

ZoomCfg.SearchStep refers to the number of search steps in each focus search, that is, whether it is a coarse search or a fine search. The search scope is divided into SearchStep+1 for search.

ZoomCfg SearchStepSearchStepZoomIdx used with SearchStep, according to the zoom index value, can set up multiple SearchStep value;

ZoomCfg.StopStep Indicates the threshold for stopping the focus search. When the search step is smaller than this value, the search ends.

ZoomCfg.StopStepZoomIdx is used together with SearchStep. Multiple StopStep values can be set based on the zoom index.

ZoomCfg. SkipHighPassZoomIdx and ZoomCfg. SkipHighPassGain in rk1106 unused;

ZoomCfg. SpotlightHighlightRatio threshold for judging by highlighting counter highlight scene, when the proportion of high number of highlights in the image block over the threshold

, the image block is determined to be a highlight block;

ZoomCfg. SpotlightLumaRatio for judging by brightness value image block for low intensity, medium intensity and high brightness of the image block threshold;

ZoomCfg.SpotlightBlkCnt is the threshold for judging whether the scene is highlighted by the proportion of low brightness, medium brightness and high brightness image blocks in the total image blocks.

【Note】

11.2.6 4.12.2.6 laser_af

【Description】

Parameter setting of laser af algorithm

【Member】

enable indicates the laser af algorithm switch.

vcmDot and distanceDot are mapping tables of vcm code value and distance;

【Note】

11.2.7 4.12.2.7 pdaf

【 Description 】

pdaf algorithm parameter Settings

【 Member 】

enable indicates the switch of the pdaf algorithm.

pdVsCdDebug is a full scan switch. After this switch is turned on, each motor position will be traversed, and fv value and phase difference value will be printed.

pdDumpDebug Indicates the debug function. After this function is enabled, pdaf debugging data is dumped into /data/pdafdebug/.

pdDataBit is pd pixel bit;

pdBlkLevel is the black level of pd pixel.

pdSearchRadius is the matching radius of the left and right pixels of pd. Generally, 3 can be set.

pdMirrorInCalib represents the difference between the mirror setting of sensor pd during calibration and that of sensor pd during use. When the two are different, it is 1, and when they are the same, it is 0.

pdVsImgoutMirror is the difference between the normal pixel and the pd pixel in the mirror, which is 1 when they are different and 0 when they are the same.

pdWidth is the width of pd pixel;

pdHeight is the height of pd pixel;

pdStepRatio[7] To smooth AF, the moving step of pd is weighted. final_move_step = calc_move_step * pdStepRatio[i];

pdStepDefocus[7] is used with pdStepRatio, and the corresponding weighting coefficient pdStepRatio[i] is selected according to the current phase difference.

When pdConfdMwinFactor is multiple sub-windows, pd confidence adjustment coefficient can be set as 3 in general.

Pdisopara. iso is the iso value, which is the index value of pdIsoPara. The iso value should be arranged from small to large.

pdIsoPara.pdNoiseFactor is the calculation factor of pd noise, pd noise = pdNoiseFactor * x + pdNoiseBias;

pdIsoPara.pdNoiseBias Please refer to the instructions of pdNoiseFactor;

pdIsoPara.pdConfdRatio1 is the noise adjustment coefficient of pd confidence;

pdIsoPara.pdConfdRatio2 is the adjustment coefficient of pd confidence matching degree;

pdIsoPara.pdConfdThresh is the reliability threshold of pd confidence, and pd is considered reliable when the confidence exceeds this value.

PdIsoPara defocusPdThresh for pd out-of-focus threshold, phase difference more than the value triggered when pd focus;

pdIsoPara.stablePdRatio is the stable threshold of pd phase difference 1, the phase difference of the last three frames is counted, and the maximum phase difference maxPd, minimum phase difference minPd and average phase difference meanPd are calculated. When (maxPd-minPd) < stablePdOffset + meanPD * stablePdRatio, the phase difference of the frame is considered to be stable;

pdIsoPara.stablePdOffset is the stable threshold of pd phase difference 2, refer to the description of stablePdRatio;

pdIsoPara.stableCntRatio is the threshold of stable frame number of pd phase difference 3, and the stable frame number of phase difference = stableCntRatio/confidence;

PdIsoPara. NoconfCntThresh for pd unreliable frames threshold, unreliable frames exceeds the value to contrast focus to deal with;

PdIsoPara. FineSearchTbl. Confidence for pd search is complete, use contrast focus search when confidence threshold, the confidence is greater than the threshold, using the corresponding search range and fine search, search step stepPos confidence to be arranged from big to small;

PdIsoPara. FineSearchTbl. Range for the use of contrast focusing precision range of search in the search range, when the range is 0, no contrast af fine search;

PdIsoPara. FineSearchTbl. StepPos contrast af fine search for use of the search step length stepPos;

【Note】

11.2.8 4.12.2.8 vcmcfg

【Description】

vcm configuration is usually set in kernel dts, but kernel compilation is difficult. In order to facilitate debugging, xml also adds an interface to set it.

【Member】

startCurrent indicates the starting current of vcm.

ratedCurrent is the cut-off current of vcm;

stepMode is vcm working mode, usually LSC/SAC, etc.

extraDelay adds a certain delay after the end time of lens movement to facilitate debugging. The value can be positive, negative or zero.

postureDiff indicates that when OTP records the starting current and stopping current in the module, the range of moving current of the motor can be appropriately expanded through this value to make up for the posture difference.

【Note】

11.2.9 4.12.2.9 zoomfocus_tbl

【Description】

Zoom curve table settings

【Members】

Member name	Description
WideModuleDeviation	After the module is calibrated, the calibration results are fine-tuned, and the additional search range in the near focus section during the focusing process is set, and the search range of the focus is [minFocus - ModuleDeviation after calibration, minFocus + ModuleDeviation after calibration]
TeleModuleDeviation	After the module is calibrated, the calibration results are fine-tuned, and the additional search range of the telefocal focus during the focusing process is set, and the search range of the focus is [minFocus after calibration - ModuleDeviation, minFocus + ModuleDeviation] after calibration Generally, you can set WideModuleDeviation and TeleModuleDeviation to the same value
zoom_move_step	During zoom (also known as zooming), zoom and focus move at the same time and synchronize the position, that is, the synchronization of zoom and focus motors every zoom_move_step
zoom_move_dot	Used with ZoomMoveStep, each ZoomMoveDot position, you can set a zoom_move_step to synchronize zoom and focus, For convenience, here is the zoom index value, that is, the zoomcode in the focus curve table from near focus to far focus from 0
focal_length	The focal length data in the focus curve table needs to be copied as is
zoomcode	The zoom step data in the focus curve table if the module is a module with optocoupler (reset switch), the zoom step data needs to be converted to the starting coordinates with the photocoupler indicating origin; If the module is a module without optocoupler (reset switch), the zoom step data can directly copy the zoom step data in the focus curve table; can refer to the focus curve below.
focuscode	Including POS and Code two fields, POS as the focusing distance, code as the focus step data, if the module is a module with optocoupler (reset switch), the focus step data needs to be converted to the photocoupler indication origin as the starting coordinates; If the module is a module without optocoupler (reset switch), the Focus Step data can directly copy the Zoom Step data in the focus curve table; must contain the focus step data of infinite distance and the nearest distance, and the focus step data length of each distance must be consistent, and the length of the and zoomcode data must also be consistent;
ZoomSearchTbl	The lookup table used for module calibration searches for the focus coordinate value of the clearest position at a certain distance according to the table< the data in the br/> table is the zoom coordinate value, the photocoupler indicates the origin as the starting coordinate, and the position near the inflection point of the focus curve table must be included in the

Member name	Description
ZoomSearchRefCurveIdx	The focusPosition curve number that is referenced during module calibration, for example, use a distance of 1.5 meters for calibration, find the number of this distance in focusPosition as 0, and then fill in here
FocusSearchMargin	In order to protect the lens from hitting both ends of the module and affecting the calibration accuracy, the focus search range during module calibration is limited, and the focus is [focus_minimum + FocusSearchMargin, focus_maximum - FocusSearchMargin] focus_minimum and focus_ Maximum is the minimum and maximum values of the focus movable range that drives reporting
FocusSearchPlusRange	When searching for the focus coordinate value of the clearest position during module calibration, before the module, the mechanical backfocus of each module has a large gap, and it is necessary to set the additional search range on the basis of the focus curve table, and the search range of the is [focus curve table indicates focus coordinate value - PlusRange, focus curve table indicates focus coordinate value + PlusRange]
FocusStage1Step	The module calibration is divided into two stages: rough search and fine search, and FocusStage1Step is the step size during fine search, which is generally set to 1
QuickFndRate	When the current FV decline rate relative to the maximum FV exceeds this value, the search is ended early to improve the module calibration speed
QuickFndMinFv	QuickFndRate takes effect only when the current FV value is greater than this value
searchZoomRange	After the [Zoom Focus] coordinate pair is searched for the module calibration, the comparison range of Zoom when calculating the deviation from the focus curve table
searchFocusRange	After the [zoom focus] coordinate pair is searched for during module calibration, the comparison range of focus when calculating the deviation from the focus curve table
searchEmax	The maximum allowable deviation value when calculating the deviation of the focus curve table, and the module calibration fails when the result exceeds this value
searchEavg	The average deviation value allowed when calculating the deviation of the focus curve table, and the module calibration fails when the result exceeds this value
IsZoomFocusRec	Whether to record the [Zoom Focus] coordinate after focusing, generally set to 0
ZoomInfoDir	The storage location of optical zoom-related information is recorded

【Precautions】

Focus curve:

11.2.10 4.12.2.10 zoom_meas

【Description】

Configure the index of each focal length AF statistics configuration under each ISO.

【Members】

zoom_idx is the index of each focal segment in the zoom curve table.

Measiso.iso is the ISO value;

measiso.idx is the index configured for AF statistics for common scenarios under the iso, which is the tbl_idx in the meascfg_tbl;

measiso.spotlt_scene_idx index of the AF statistical configuration for the point light scene, which is the tbl_idx in the meascfg_tbl;

【Precautions】

11.2.11 4.12.2.11 meascfg_tbl

【Description】

AF statistics configuration table.

【Members】

tbl_idx is the index value of the AF statistics configuration table.

When the from_awb is 1, the AF statistics come from AWB, which is affected by the AWB selection path and other module settings on the path, and is generally not used.

When the from_ynr is 1, the AF statistics come from the YNR, which are affected by the settings of other modules in the YNR path, and are generally not used.

afmThres is the AF statistical threshold of win b (independent window), when the calculated fv value is less than this value, the fv value is changed to 0, which can reduce the influence of noise, and the value range is 0-0xFFFF;

gammaY is the y value of the gamma table, with a value range of 0-1023; The x-coordinate segment is 0 to 1023: 16 16 16 16 32 32 32 32 64 64 64 128 128 128 128 128;

gaus_coe can be pre-denoised, generally no treatment is required, as follows.

0 64 0

0 64 0

0 0 0;

dnscl_mode downsampling of the input AF statistical signal helps to support lower frequency filter bands;

v1fv_reliable and v2fv_reliable are the reliability of vertical FV, because the flexibility of vertical FV setting is not as good as that of horizontal direction, a coefficient is needed to attenuate its reliability;

v1_fir_sel is generally set to 1;

v1_band the band-pass selection range used for V1 channel, which is used to identify what band-pass range the coefficient of V1 channel is generated by, and what actually works is the following specific coefficient

v1_iir_coe 1X3 IIR coefficient for V1 channel, set according to the output of the AF filter coefficient generation tool;

v1_fir_coe 1x3 FIR factor for V1 channel, set according to the output of the AF filter coefficient generation tool;

v2_band the band-pass selection range for the V2 channel, which is used to identify what band-pass range the coefficient of the V2 channel is generated by, and the specific coefficient that actually plays a role is the following;

v2_iir_coe 1x3 IIR coefficient for V2 channel, set according to the output of the AF filter coefficient generation tool;

v2_fir_coe 1x3 FIR factor for V2 channel, set according to the output of the AF filter coefficient generation tool;

h1_band the bandpass selection range used for the H1 channel, which is used to identify what band-pass range the coefficient of the H1 channel is generated by, and the specific coefficient that actually plays a role is the following;

h1_iir1_coe 1X6 IIR1 coefficient for H1 channel, set according to the output of the AF filter coefficient generation tool;

h1_iir2_coe 1X6 IIR2 coefficient for H1 channel, set according to the output of the AF filter coefficient generation tool;

h2_band the band-pass selection range for the H2 channel, which is used to identify what band-pass range the coefficient of the H2 channel is generated by, and the specific coefficient that actually works is the following;

h2_iir1_coe 1X6 IIR1 coefficient for H2 channel, set according to the output of the AF filter coefficient generation tool;

h2_iir2_coe 1X6 IIR2 coefficient for H2 channel, set according to the output of the AF filter coefficient generation tool;

ldg_en ldg module switch for V1/V2/H1/H2 channels;

ve_ldg_lumth_l the brightness threshold coefficient of the ldg module used for V1/V2 channels, 0 is set for the left dark area, 1 is the right highlight area, and the value range is 0~255;

ve_ldg_gain_l minimum gain value of the ldg module used for V1/V2 channels, set for the left dark area, the value range is 0~255;

ve_ldg_gslp_l slope coefficient of the ldg module used for V1/V2 channels, set for the left dark area, the value range is 0~65535;

ve_ldg_lumth_h brightness threshold coefficient of the ldg module used for V1/V2 channels, set for the highlight area on the right, the value range is 0~255;

ve_ldg_gain_h minimum gain value of the ldg module used for V1/V2 channels, set for the highlight area on the right, the value range is 0~255;

ve_ldg_gslp_h slope coefficient of the ldg module used for V1/V2 channel, set for the highlight area on the right, the value range is 0~65535;

ho_ldg_lumth_l brightness threshold coefficient of the ldg module used for H1/H2 channels, set for the left dark area, the value range is 0~255;

ho_ldg_gain_l minimum gain value of the ldg module used for H1/H2 channels, set for the left dark area, the value range is 0~255;

ho_ldg_gslp_l slope coefficient of the ldg module used for H1/H2 channels, set for the left dark area, the value range is 0~65535;

ho_ldg_lumth_h brightness threshold coefficient of the ldg module used for H1/H2 channels, set for the highlight area on the right, the value range is 0~255;

ho_ldg_gain_h minimum gain value of the ldg module used for H1/H2 channels, set for the highlight area on the right, the value range is 0~255;

ho_ldg_gslp_h slope coefficient of the ldg module used for H1/H2 channel, set for the highlight area on the right, the value range is 0~65535;

v_fv_thresh the AF statistical threshold used for V1/V2 channels, when the calculated fv value is less than this value, the fv value is changed to 0, which can reduce the influence of noise, and the value range is 0-0x0FFF;

h_fv_thresh the AF statistical threshold used for H1/H2 channels, when the calculated fv value is less than this value, the fv value is changed to 0, which can reduce the influence of noise, and the value range is 0-0x0FFF;

highlit_thresh indicates the threshold of the highlight statistics, when it is higher than this value, it is considered to be high highlights, included in the statistics, only the number of high highlights in each area is accumulated, and the value range is 0-0x0FFF;

v_fv_ratio coefficient when weighting vertical Fv and horizontal Fv;

- **Luminance pretreatment**

Currently, two locations are available as input data for AF statistics: 1. (Short/Medium/Long Exposure) WBGain+DPCC output; 2. DEBAYER input; 3. AWB input; 4. YNAR input.

Gamma mapping can be used to improve dark area contrast.

GAUSE can be pre-denoised.

downscale downsamples the incoming AF statistical signal to help support lower frequency filter bands.

- **Filter and band settings**

The FV statistical curve is not only affected by equipment parameters such as lens focal length and motor step size, but also by scene ** brightness/contrast/dynamic range/overexposure area/noise**, etc. In various application scenarios, the frequency band of the filter should be selected according to its typical spectral characteristics.

For example, the larger the focal length of the lens, the larger the step length, and the more severe the defocus, the lower the frequency band of the filter required to distinguish different degrees of out-of-focus. For scenes with rich daytime detail, different focuses can be distinguished in a wide frequency range, but when the brightness of the same scene decreases (analog gain increases), due to the increase in noise influence, a lower frequency band is required to distinguish the change in focus.

Generally speaking, the higher the frequency band, the sharper the peak value, but when away from the peak, the flat area (tail) is also more because more high-frequency components are retained; The bandpass filtering with a lower frequency band, although the peak is not sharp enough, can still retain a certain gradient change when it is far from focus. The combination of the two can realize "rough search + fine search".

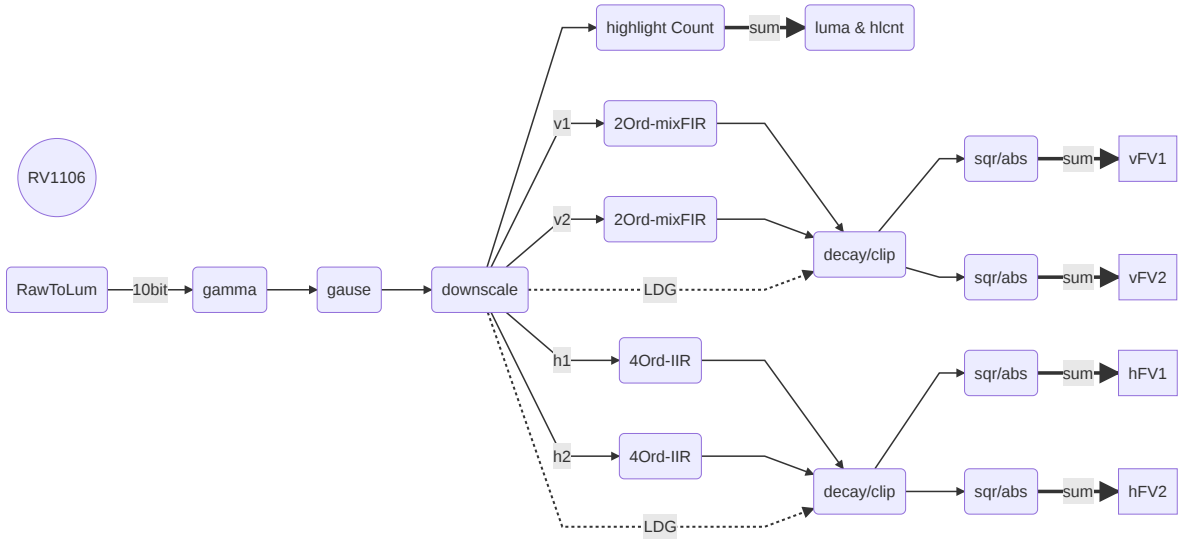
With the Filter Factor Generation Tool, users can set two different sets of frequency bands to generate horizontal/vertical filter coefficients. Common typical band configurations can use [0.04n ~ 0.1n], and n is the scaling ratio, such as [0.01 ~ 0.025], [0.02 ~ 0.05], [0.04 ~ 0.1], [0.08 ~ 0.2], etc.

- **Highlight pixel statistics**

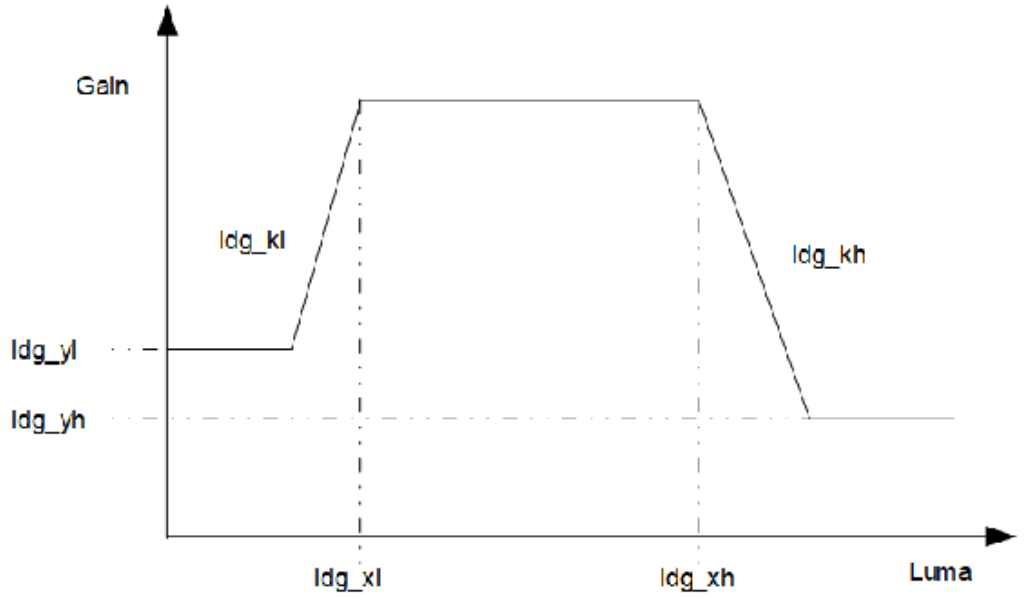
Night scenes with point lights, low contrast around the scene, predominance of light and dark contrast edges around the light source, sharp but reduced area when in focus; When out of focus, the edges are blurred due to diffusion but the area increases (strong edges become longer), and the brightness of the picture increases. This flare edge can lead to inaccurate FV focus statistics.

In this case, the FV focus statistics can be optimized by using the highlight count function, modifying the filter to the higher frequency band, and attenuating the contribution of pixels near the light source area to FV statistics.

The following figure shows the parameters related to the ldg function, which attenuates the contribution of pixels near the light source area to FV statistics



- **Luminance pretreatment**



- **ROI Window Statistics**

  The hardware supports independent statistics of 15x15 subwindows, which can count the sum of squares or absolute values of the filter results. The output bit width of a single pixel of the hardware filter is 10bit, and the bit width of the cumulative register is 31bit, in order to avoid overflow when the window statistics accumulate, it is necessary to configure the appropriate shift shift register according to the statistical mode and window size, shift the pixel FV value to the right and then perform window accumulation.

  At present, the register used for shift is only 3 bits, and the maximum support is sum_shift=7, the maximum supported window in absolute mode is 2^(31+7-10)=2^28, the FV value in square mode does not exceed 20bit, and the maximum supported window is 2^(31+7-20)=2^18 (in fact, most of the FV values obtained in a typical bandpass configuration do not meet the above thresholds, so larger windows can be supported).

4. 4.12.3 Zoom lens tuning steps

    1. Lens motor drive debugging, please refer to the driver related documents.
    2. Import the focus curve table to the IQ file.
       Corresponds to focal_length/zoomcode/focuscode in the IQ file.
       It should be noted that if the module is an integrated movement and other modules with optocouplers, the Zoom Code/Focus Code data needs to be converted to the starting coordinates with the origin of the photocoupler indication.
       Generally, refer to the data in the Cam lifting map in the lens specification sheet, and add a fixed offset to the zoom/focus data.
    3. Set lens calibration parameters.
       Corresponds to ZoomSearchTbl / FocusSearchPlusRange / ZoomSearchRefCurveIdx / FocusSearchMargin / FocusStage1Step / searchZoomRange / searchFocusRange / searchEavg / searchEmax in IQ files.
       ZoomSearchTbl needs to contain locations near the inflection point of the focus curve table
    4. Set the zoom focus search process parameters.

    AdaptiveDir / QuickFoundThersZoomIdx / QuickFoundThers
    SearchStepZoomIdx / SearchStep / StopStepZoomIdx / StopStep / SkipHighPassZoomIdx / SkipHighPassGain
    WideModuleDeviation / TeleModuleDeviation / ZoomMoveStep / ZoomMoveDot / SpotlightHighlightRatio / SpotlightLumaRatio / SpotlightBlkCnt

12. 4.13 CAC

12.1 4.13.1 Description of the feature

CAC-related parameters can be adjusted with this module. The main parameters of CAC are in the CAC_ISO, and CAC related parameters can adjust the strength and effect of CAC.

12.2 4.13.2 Key parameters

12.2.1 4.13.2.1 Setting Para

【Description】

Initialize read-only parameters.

【Members】

Member Name	Description
enable	Enabled, not dynamically switched
psf_path	The calibration table storage path, no '/' starts with the relative path of the JSON path
center_en	When calculating the radial distance, the center point configuration mode 0: center point default image center 1: center point is configured by the parameter
center_x	When center_en, the center point x coordinates

12.2.2 4.13.2.2 Tuning Para

【Description】

Interpolate the relevant parameters according to the ISO.

【Members】

Member Name	Description
iso	Environmental ISO
bypass	bypass CAC processing
strength_table	CAC radial force curve, calibrated 7 bit
clip_g_mode	B-channel clip mode: 0: Do not clip high frequency 1: clip with G-channel minimum 2: clip with G-channel mean clip
neg_clip0_enable	When B <G, do you need to clip B
edge_detect_en	When correcting, whether edge detection is performed to adjust the correction force
flat_thed_b	The threshold for judging the flat area of channel B, the larger the value, the easier it is to judge the flat area, and the weaker the correction force
flat_thed_r	The threshold for judging the flat area of the R channel, the larger the value, the easier it is to judge the flat area, and the weaker the correction force
offset_b	The offset when judging the flat area of the B channel, the larger the value, the easier it is to judge the flat area, and the weaker the correction force
offset_r	The offset when judging the flat area of the R channel, the larger the value, the easier it is to judge the flat area, and the weaker the correction force
expo_det_b_en	B-channel overexposure area detection switch
expo_det_r_en	R-channel overexposure area detection switch
expo_thed_b	B-channel overexposure area threshold
expo_thed_r	R-channel overexposure area threshold
expo_adj_b	B-channel overexposure area adjustment value
expo_adj_r	R channel overexposure area adjustment value

12.3 4.13.3 Debugging steps

During the debugging process of CAC, it is mainly to adjust the CAC-related parameters.

12.3.1 4.13.3.1 CAC debugging

Recommended steps:

1. First turn off clip mode, edge detection, and overexposure detection, and observe the processing effect of the calibration table after the CAC module is turned on/off.
2. After the intensity table is processed, the greater the force, the more obvious the effect difference of the whole figure, adjust the intensity to a suitable value.
3. Then turn on the clip mode, edge detection, check the purple fringing processing effect, if the flat area has been treated, you can adjust the flat area judgment condition, but pay attention to the effect of the non-flat

area.

4. Finally, the detection of the overexposure area is turned on, and the overexposure threshold is adjusted, usually the number of bits of input raw is related, 1 << raw_bits, and the internal processing will be reprocessed according to HDR ratio. The adjustment value can be adjusted slowly from the larger setting first.

Test Scenario:

Highlight areas with high contrast, such as: sunlight through foliage areas, street lamp poles under sunlight, surface light source edges, etc.