3DNR Parameter Configuration Description

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Notice

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About This Document

Related Versions

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

Product Name	Version
Hi3516C	V500
Hi3516D	V300
Hi3516A	V300
Hi3556	V200
Hi3559	V200

NOTE

This document uses Hi3516C V500 as an example. Unless otherwise specified, this document applies to the Hi3516D V300/Hi3516A V300/Hi3559 V200/Hi3556 V200.

Intended Audience

This document is intended for:

- Technical support engineers
- Software development engineers

Symbol Conventions

The symbols that may be found in this document are defined as follows.

Symbol	Description
DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

Symbol	Description
WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTICE	Indicates a potentially hazardous situation which, if not avoided, could result in equipment damage, data loss, performance deterioration, or unanticipated results. NOTICE is used to address practices not related to personal injury.
NOTE	Calls attention to important information, best practices and tips. NOTE is used to address information not related to personal injury, equipment damage, and environment deterioration.

Change History

Issue	Date	Description
01	2019-09-02	This is the first official release. In section 1.1, Figure 1-1 is updated. Sections 1.4 and 1.6 are modified.
00B05	2019-04-30	This issue is the fifth draft release. In section 1.1, Figure 1-1 and Figure 1-2 are modified. Sections 1.2, 1.3, and 1.4 are modified.
00B04	2019-03-12	This issue is the fourth draft release. The contents related to the Hi3516A V300 are added. In section 1.1, Figure 1-1 and Figure 1-2 are changed. Section 1.3 is modified.
00B03	2018-11-20	This issue is the third draft release. In section 1.1, Figure 1-1 and Figure 1-2 are modified. Section 1.2, section 1.5, section1.6, and section 1.3 are modified.
00B02	2018-10-30	This issue is the second draft release. Section 1.2 to section 1.4 as well as section 1.6 are modified.
00B01	2018-09-30	This issue is the first draft release.

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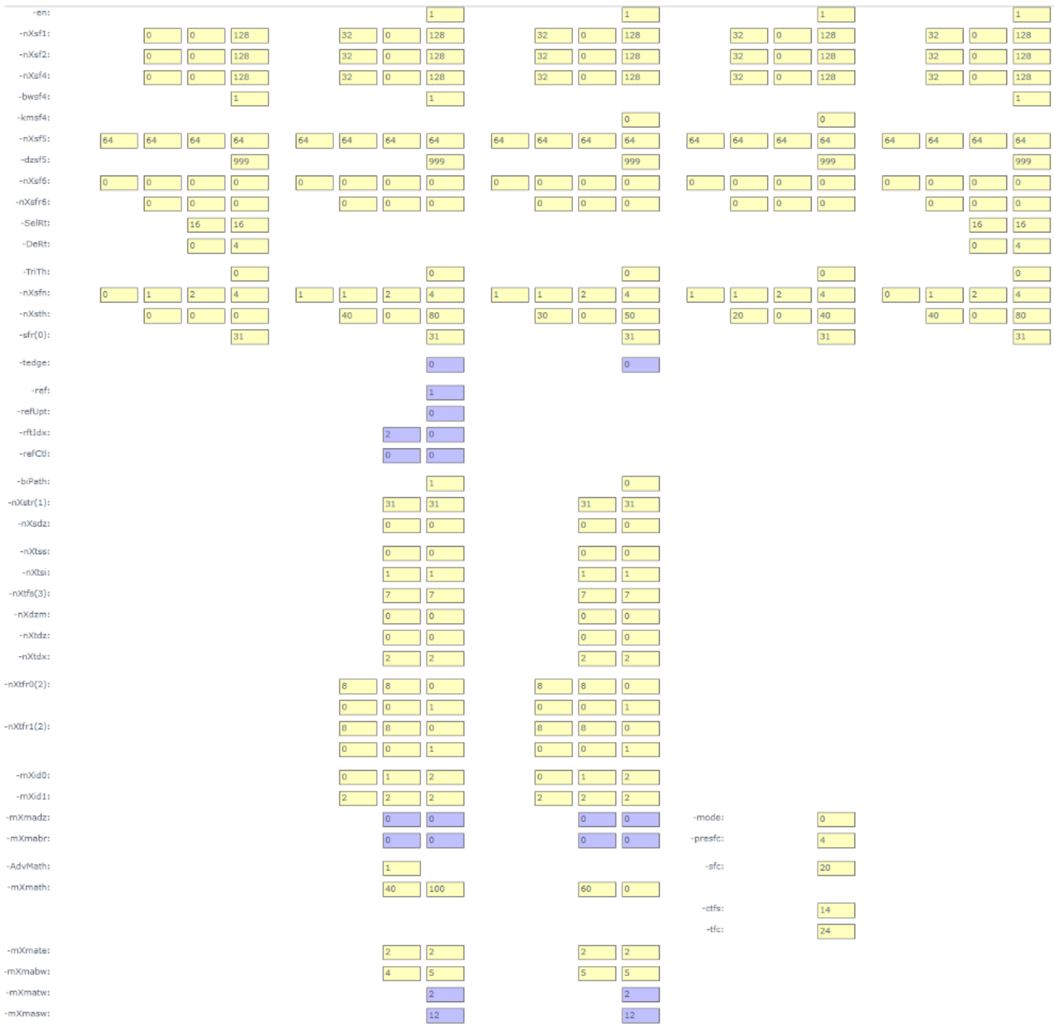
1 Description of 3DNR Parameter Configurations

1.1 Parameter Description

Figure 1-1 describes the default 3DNR parameters of Hi3516C V500.

Figure 1-1 GUI for 3DNR parameter settings



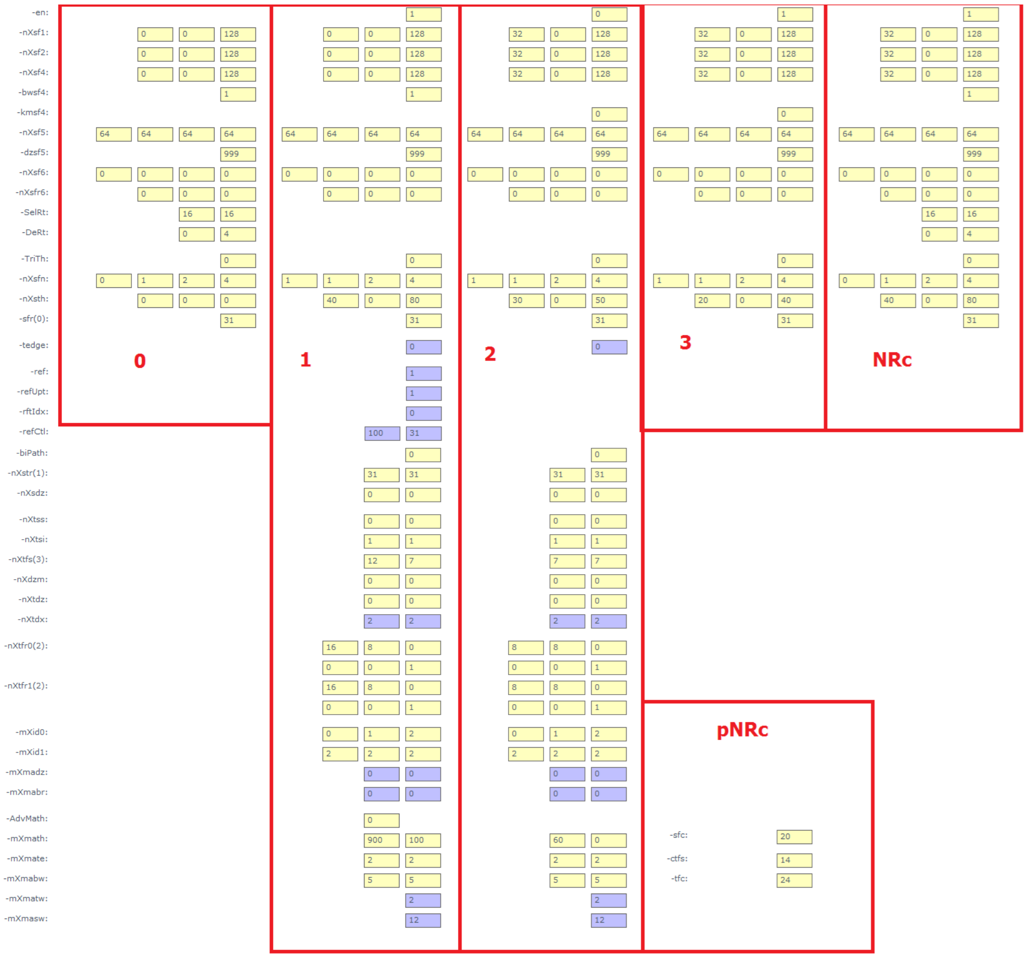
The three-dimension luminance noise reduction (NRy) consists of four levels of NR functions in series. Assume that the four levels are numbered as 0, 1, 2, and 3. For the filters with the same number and type at different levels, their effects vary due to the differences in implementation and serial connection effects.

Levels 0 and 3 have only spatial filters, whereas levels 1 and 2 have both temporal filters and spatial filters. The chrominance filters are independent of the luminance filters, as shown in Figure 1-2.

Three-dimension chrominance NR consists of two groups of interfaces: **pNRc** and **NRc**. You can select either of them for chrominance NR.

- **pNRc** is a common interface used for video NR applications that do not have high NR requirements (for example, in IPC scenarios).
- **NRc** is an enhanced interface (whose settings are similar to those of **NRy**) used for applications that have high NR requirements (for example, in photographing applications). This interface is more powerful in chrominance NR and has richer adjustable styles. Compared with **pNRc**, the **NRc** interface requires more processing performance. This interface takes effect only when the 3DNR is offline.

Figure 1-2 Classification of 3DNR parameters by the filter level



NOTE

X in **nX**** and **mX**** indicates a level. For example, **n0sf2** is one of the nXsf2 series parameters, which corresponds to level 0, and **m1id0** is one of the **mXid0** series parameters, which corresponds to level 1.

en indicates whether to enable the NR function at a specific level. Value **0** indicates that this function is disabled, and value **1** indicates that this function is enabled. Parameters marked in red are not recommended for debugging.

1.2 Spatial Filter Parameters

Spatial filters include basic filters 0 – 4, namely, nXsf0, nXsf1, nXsf2, nXsf3, and nXsf4, and any combination of these basic filters. Different types of spatial filters are used at different levels. The level 0 and level 1 filters (referred to as the SFi filter group) have strong edge-preserving capabilities, but strip noise easily occurs. The level 2 and level 3 filters (referred to as the SFk filter group) have weak edge-preserving capabilities, but the side effects are small.

- **nXsf1**, **nXsf2**, and **nXsf4** are filter 1, filter 2, and filter 4, respectively, which have different features.
  - Filter 1 and filter 2 feature stronger NR capability for strong edges of images but weaker NR capability for flat regions. (The grains are more obvious in flat regions compared with the performance of filter 4.)

- Filter 4 features stronger NR capability for flat regions, which can better remove grains in the flat regions. It also features stronger edge-preserving capability (sharper image edge) but weaker NR capability for edges.
- Level 0 and level 1 use the SFi filter group. Filters 1, 2, and 4 in this filter group output independent results. Level 2 and level 3 use the SFk filter group. The processing result of filter 1 affects that of filters 2 and 4, while the processing result of filter 2 affects that of filter 4.

- Either interface **nXsf1**, **nXsf2** or **nXsf4** at each level has three parameters.
  - The first and second parameters are used to adjust the filter strength, which ranges from 0 to 255. Generally, you need to modify the first parameter only and keep the default value (**0**) of the second parameter. When the first parameter is set to a large value and the NR strength still needs to be improved, you need to adjust the second parameter. (Note that the NR strength of filter 1 is related only to the first parameter.)
  - The third parameter is used to debug the NR mode when the brightness and darkness of a picture are asymmetric. The default value is **128**, indicating the NR mode (default mode) when the brightness and darkness are symmetric. A value less than **128** indicates a stronger tendency for NR in bright regions, and a value greater than **128** indicates a stronger tendency for NR in dark regions. A larger deviation from **128** indicates a greater strength of asymmetry. The value range is [0, 255].
- **nXsf0** and **nXsf3** are the two filters not displayed in the GUI, but their parameters are adjustable.
  - Filter 0 is used for the input of the original input pixels of level 0.
  - The performance of filter 3 is between that of filters 2 and 4.
  - **nXsf3** and **nXsf4** use the same configuration parameters.
- **Bwsf4**: used for setting an effect difference for filter 4. The value is **0** or **1**. Value **1** indicates better edge-preserving effect but stronger residuals. This interface takes effect only at level 0 and level 1.
- **Kmsf4**: whether to determine the NR strength based on the luminance of level 2 and level 3 filters (that is, **SFk** filters).
  - Value **0**: Common mode. The NR strength cannot be determined based on the luminance.
  - Values **1**, **2**, or **3**: Filter 4 uses arrays (**SBSk[32]** and **SDSk[32]**) to indicate different NR parameter curves for different luminance. Different **Kmsf4** values indicate different luminance measurement methods. If the difference is minor, you are advised to retain the default value **1**.
- **SBSk SDSk**: available at level 2 and level 3. The luminance is divided to 32 levels. You can adjust the strength of filter 4 at level 2 and level 3 for the image content corresponding to each luminance level. **SBSk** and **SDSk** indicate the strength of spatial NR for the bright and dark regions, respectively. The value range is [0, 8191].
- **nXsf5**: filter 5, which is the result of combining filters 1 – 4 and used for combining NR or detail enhancement of different frequency bands. Four parameters are used to configure the NR strength of four filters in sequence, respectively.
  - If the value of an **nXsf5** parameter for a specific filter is less than **64**, the filter result is used for NR. A smaller value indicates a greater NR strength.
  - If the value is greater than **64**, the filter result is used for detail enhancement. A larger value indicates a stronger NR strength.

  - If the value is **64**, the filter's impact on the final combination result is disabled. The value range is [0, 255].
  - The final output of this interface is the blended result of four filter groups. If the average value of the four parameters is greater than **64**, the result with an enhancement tendency is output. If the average value of the four parameters is less than **64**, the result with an NR tendency is output.
  - The value of this parameter has the following restriction: For all the parameters less than **64**, the sum of the differences between their actual values and **64** must be less than **64**.
- **dzsf5**: Controls the range of the effect that the result of filter 5 has in the image. A smaller value indicates a larger range. When this parameter is set to **999**, the function of filter 5 is disabled. The value range is [0, 999].
- **nXsf6**: Configures the result of filter 6. It is the mixed result of two groups of filters. The first two parameters of this interface are the serial numbers of the mixed filters (which can be selected from filters 0 – 5). The last parameter is the mixing mode. The value range is [0, 4]. When this parameter is set to **0**, the output is the original value. When this parameter is set to other values, they indicate four different mixing modes.

  One type is mixing based on the ratio. The mixing weight is determined by the third parameter (value range: [0, 16]). The larger the mixing weight, the result of the last group of filters is preferred.

  When this parameter is set to **2 – 4**, the result of filter 2 is used as the output result. However, the result of filter 1 is preferred.
- **nXsfr6**: This interface takes effect when the fourth parameter of **sf6** is set to **4**. It is used for three constraint check mechanisms. A larger value indicates that the second result of **nXsf6** is preferred. The value range is [0, 31]. The mechanism closest to the second result prevails.
- **Trith**: Indicates the **nXsth** mode. The value can be **0** or **1**. For details, see the description of **[nXsfn][nXsth]**.
- **nXsfn/nXsth**: **nXsfn** indicates a filter type selected for a region based on the image features and used with **nXsth**. **nXsth** indicates the feature differentiation threshold of a region. The value range of **nXsfn** is [0, 6], and that of **nXsth** is [0, 511].

  If the **nXsfn/nXsth** parameters of a specific level are **sfna**, **sfnb**, **sfnc**, **sfnd**, **sthb**, **sthc**, and **sthd**:
  - When the region feature variance of the current filter in a given window size is less than **sthd**, the **sfnd** result is used.
  - When the region feature variance of the current filter in a given window size is greater than or equal to **sthd** but less than **sthc**, the **snfc** result is used.
  - When the region feature variance of the current filter in a given window size is greater than **sthc** but less than **sthb**, the **sfnb** result is used.
  - When the region feature variance of the current filter in a given window size is greater than **sthb**, the **sfna** result is used.

    This method can be used to implement different processing effects for different regions. **sthb**, **sthc**, and **sthd** use feature thresholds of different filters. Due to the measurement differences, they cannot be compared directly.
  - When **Trith** is set to **1**, the following take effect: **sfna**, **sfnb**, **sfnc**, **sfnd**, **sthb**, **sthc**, and **sthd**
  - When **Trith** is set to **0**, the following take effect: **sfna**, **sfnb**, **sfnd**, **sthb**, and **sthd**

- **sfr**: Controls the entire NR result of spatial filters. A larger value indicates a stronger spatial filtering effect. The value range is [0, 31]. When *n* is **0**, spatial filtering is disabled.
- **[DeRt]:** When the first parameter of this interface is set to **0**, it indicates the non-serial mode (common mode), as shown in **Figure 1-3**. When the value is greater than **0**, it indicates the serial mode, as shown in **Figure 1-4**. The serial mode applies only to level 0 of NRy and the NRc module.

Figure 1-3 Non-serial mode (common mode)

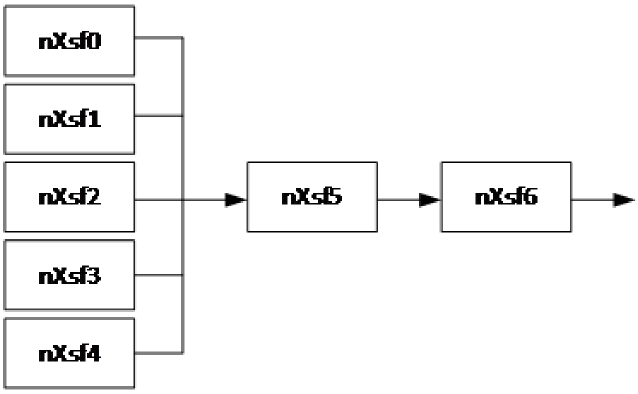
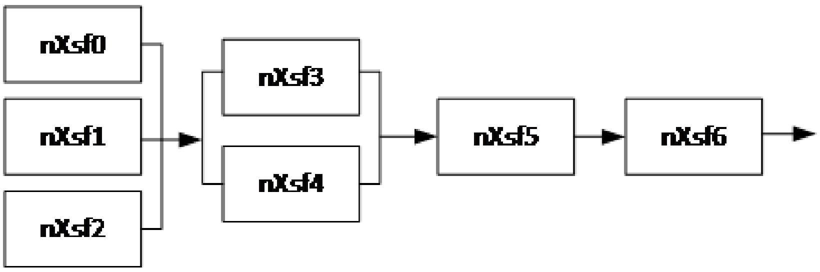


Figure 1-4 Serial mode



- The first parameter indicates the overlaying strength of the detail signal generated by the mixing of filter 0, filter 1, and filter 2. The value range is [0, 255]. The larger the value, the greater the overlaying strength of the detail. If the serial mode is used (that is, the value of this parameter is greater than **0**), increase the strength of filters 1 and 2 (about 150) to obtain more details.
- The second parameter indicates the serial number of the filter on which the detail obtained in serial mode is overlaid in the result. (The value range [3, 6] is used to indicate filters 3 – 6.)
- In serial mode, the results of filters 1 and 2 cannot be directly used in **nXsfn**.
- **SelRt:** Generates the mixing ratio of the results of filters 0, 1, and 2 for the overlaid detail in serial mode. The value range is [0, 16]. The first parameter determines the mixing ratio of the results of filters 0 and 1. The second parameter determines the mixing ratio of the results of filters 1 and 2. A larger value indicates more details are overlaid and more noises are generated as well.
  - The first parameter is overlaid with high-frequency fine-grained details. A smaller value indicates more fine-grained details but increased noise as well.

   - The second parameter is overlaid with intermediate frequency details. A larger value indicates more details but increased noise as well.

     It is recommended that the two values be set to **16** at the same time. In non-serial mode, the two values can only be **16**.

1.3 Temporal Interface Parameters

Level 1 and level 2 include temporal filtering. The time domain of each level can be processed based on layers (layer 0 and layer 1). There are two sets of interfaces in each time domain corresponding to two layers. If the interface has multiple parameters, interfaces with suffixes 0 and 1 are used to differentiate layers, for example, **nXtfr0** and **nXtfr1**. Each level has a switch **biPath** to determine whether to adopt layer-based processing. If **biPath** is set to **0**, only temporal parameters at layer 0 take effect. **For IPC application scenarios, layer-based processing is recommended. Layer 1 is set as the background layer, while layer 0 is set as the foreground layer.**

- **ref**: The first value indicates the reference frame switch. When **ref** is set to **0**, the reference frame is unavailable and the temporal filter function does not take effect. When ref is 1, the reference frame is available and the temporal filter function takes effect. For IPC application scenarios, the recommended value is **1**.
- **Tedge**: Indicates whether to process the regions with possible smearing. The value **0** indicates that this function is disabled. The value **1** indicates that the possible smearing is processed. The value **2** indicates that the possible blurring is processed. For IPC application scenarios, the recommended value is **0**.
- **biPath:** Indicates whether to perform layer-based processing at the current level. The value **0** indicates that this switch is disabled, while **1** indicates that this switch is enabled. If **biPath** is set to **0**, only temporal parameters at layer 0 take effect.
- **nXstr**: Indicates the spatial filtering strength for NR. Certain mask noises may be introduced. A larger value indicates better NR effect and a higher probability of introducing mask noises. The value range is [0, 31].
- **nXsdz:** Cooperates with the **nXstr** interface to limit the spatial filter. The value range is [0, 999]. A smaller value indicates a higher **nXstr** strength. The value **999** indicates that the spatial filter of this level is disabled.
- **nXtss**: A larger value indicates smoother static regions, but the image content in the static regions may become more blurred. The value range is [0, 15]. The two values represent different regions.
  - If the processing is not region-based, you are not advised to adjust this parameter. Instead, you are advised to retain the default value **0**.
  - If the processing is region-based, you can increase the first parameter to prevent foreground blurring in regions where the motion is not obvious. For the second parameter, you are advised to retain the default value.
- **nXtsi**: Cooperates with **nXtss**. The value can be **0** or **1**, indicating different processing modes. The value **0** indicates more noise but a higher definition. The value **1** indicates less noise but a lower definition.
- **nXtfs:** Indicates the temporal filter strength. When the current filter region uses temporal filter, this parameter indicates the strength of the temporal filtering effects. A larger value indicates a greater strength. The value range of Hi3516C V500/ Hi3516D V300/ Hi3516A V300 is [0, 15]. The value range of Hi3556 V200/ Hi3559 V200 is [0, 10].

- **nXtfr**: Controls the balance between smearing and NR. There are six processing modes. A smaller value indicates stronger control over smearing but a weaker NR capability. The mode with the optimal NR effects prevails. The value range is [0, 31].
- **nXdzm**: Indicates the selection mode of **tdz**. The value range is [0, 1].
- **nXtdz**: Indicates the selection mode based on **dzm**. It is used to protect the texture or enhance the NR effect. The value range is [0, 999].
  - When **dzm** is set to **0**, the texture noise of the motion region is obvious but the texture does not disappear or get blurred. When **tdz** is set to a large value, the texture of the motion region can be protected, but the NR effect decreases.
  - When **dzm** is set to **1**, the temporal filtering strength of motion regions is increased. When **tdz** is set to a larger value, the temporal NR strength of motion regions is enhanced.
- **nXtdx**: Indicates the parameter function strength of **[nXtdz]**. The value range is [0, 3]. A smaller value indicates the stronger **[nXtdz]** parameter function. You are advised to retain the default value **2**.
- **mXmath**: Indicates the motion detection threshold. A larger value indicates that more pixels are judged as static by the motion detection unit, temporal filtering is performed on more pixels, and the picture noise is less obvious. Generally, you are advised to set TFS to the maximum value and adjust mXmath to suppress raindrops. Then, decrease the TFS value until no raindrop appears. If layer-based processing is used, the system divides the static region of the image based on the second value of the interface and uses it as the background layer (that is, absolute static region). The remaining image is used as the foreground layer, and the relative static region and the motion region are further divided according to the first parameter, and are processed separately.
  - The value range of Hi3516C V500/Hi3516D V300/Hi3516A V300 is [0, 999].
  - The value range of Hi3559 V200/Hi3556 V200 is [0, 511].
- **mXid**: Selects the output effect based on the regions distinguished according to the results of **mXmath**. The value range of each parameter is [0, 3], indicating the output result of **sfr**, **nXStr**, **nXtfr**, and **nXtfs**, respectively. A larger value indicates a stronger effect of the temporal parameter.
  - The first parameter indicates that spatial-domain processing is performed for the image content judged to belong to the motion region (where the feature variance is greater than or equal to the **math** value). You are advised to set this parameter to **0** or **1**.
  - The third parameter indicates the processing mode chosen for the image content judged to belong to the static region (where the feature variance is less than the **math** value). You are advised to set this parameter to **2** or **3**.
  - The second parameter takes effect only when **madz** and **mabr** are valid. The value range is [0, 3]. By default, the second parameter does not take effect. The effect is equivalent to performing extra processing in the static region based on **madz** and **mabr** after motion detection.
  - If layer-based processing is used, it is recommended that the three parameters of the background layer be set to **2** or **3** with strong temporal domain.
- **AdvMath**: used for selecting the common motion detection interface **math** or the enhanced motion detection interface **AdvMath**. It is recommended that this switch be enabled when layer-based processing is used. The enhanced mode applies only to the foreground layer of level 1. When the enhanced interface is used, the value of **math** at the foreground layer is usually smaller than that of the common interface. The value

range is [0, 1]. **0** indicates the common mode, and **1** indicates the enhanced mode. If the processing is not region-based, (that is, **biPath = 0**), the value is **0 for this interface**.

- **mXmabr** and **mXmadz**: Filter selection corresponds to the second parameter (that is, **mXid1**) of **mXid**.
  - **mXmabr**: Controls extra processing based on the luminance. A larger value indicates that more content is considered as the extra processing region, while less content is considered as the static region. The value range of each interface parameter is [0, 255].
  - **mXmadz**: Controls extra processing based on image features. A smaller value indicates that more content is considered as the static region. A larger value indicates that more content is considered as the extra processing region. The value range is [0, 511].

    Note: When madz is set to **0**, the mabr function is disabled. For IPC application scenarios, it is recommended that **mabr** and **madz** be set to **0**. Debugging is not recommended.
- **mXmate**: Indicates the motion detection index of flat regions. A larger value indicates that more pixels are judged as static by the motion detection unit, temporal filtering is performed on more pixels, and the picture noise is less obvious. Generally, you are advised to set **math** to a proper value, and then slightly set **mate** to balance raindrop noise and motion smearing. The value range is [0, 8].
- **mXmatw**: Indicates the smearing prevention index of temporal filtering. A larger value indicates faster motion smearing convergence, and vice versa. You are advised to retain the default value **2**. The value range is [0, 3].
- **mXmabw**: Indicates the selection of the window size of the motion detection content. This parameter is used in conjunction with **math**. A larger value indicates a larger window. In low light, if the raindrop phenomenon cannot be suppressed even when **math** is set to a large value, you are advised to set the **mabw** value to greater than 7, thereby relieving the burden of **math** to suppress raindrops and reducing side effects of the temporal domain. The value range is [0, 9]. If layer-based processing is used at a level, the value range of **mabw** of the background layer (layer 1) is [5, 9], and the value range of the foreground layer (layer 0) is [0, 9]. However, [0, 4] is recommended to prevent smearing. If layer-based processing is not used (that is, **biPath** = **0**), the value range of **mabw** is [5, 9].
- **mXmasw**: Indicates the raindrop prevention index of temporal filtering. A larger value indicates a higher possibility of reducing raindrops. The value range is [0, 15]. You are advised to retain the default value **12**.

The following parameters take effect when the MOTION_MODE_COMPENSATE mode is set in the 3DNR offline mode. The parameters are mainly used for action DVs and dash cams. Debugging is not recommended for IPC application scenarios.

- **rftIdx**: Indicates the level-1 motion compensation mode. The value range is [0, 4].
  - The value **0** indicates the common motion compensation mode.
  - The value **1** delivers a better effect to the static region in a motion image.
  - The value **2** delivers a better compensation effect to irregular motion, such as rotation motion.
  - The value **3** indicates the blended effect of values **0** and **2**.
  - The value **4** indicates the blended effect of values **2** and **1**.
  - In MOTION_MODE_COMPENSATE mode, you are advised to set this interface to **2**.

- In MOTION_MODE_NOMRAL mode, this interface can only be set to **2**.

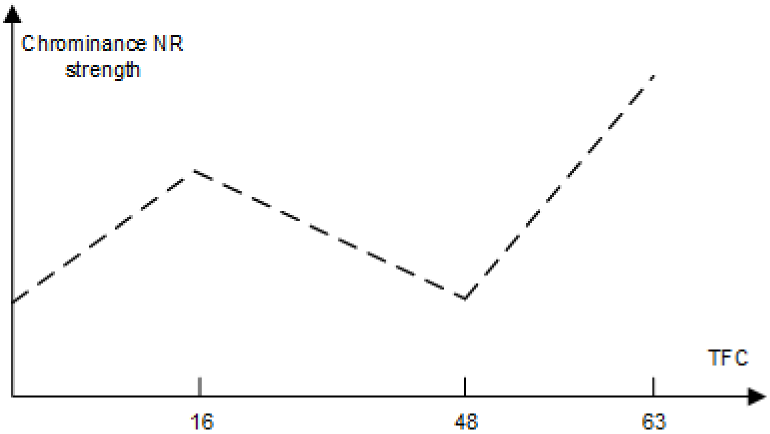
- **refCtl**: The two parameters indicate the blending threshold and strength when **rftIdx** is set to **3** or **4**. The first parameter indicates the blending threshold. The value range is [0, 511]. The value range of the second parameter is [0, 31]. For example, when **rftIdx** is set to **3**, the smaller the first value is, and the more likely the effect of value **0** is selected; the larger the second value is, the more likely the effect of value **0** effect is selected.
- **refUpt**: Indicates the level-2 motion compensation mode. The value range is [0, 4], corresponding to the results of **rftIdx** with different values, respectively.

1.4 Chrominance NR Parameters

The main debugging parameters for the chrominance NR interface **pNRc** include **sfc**, **tfc**, **ctfs**, **mode**, and **presfc**.

- **sfc**: Indicates the mixing strength of spatial filtering at level 0 for three-dimensional chrominance NR. The value range is [0, 255]. A larger value indicates stronger capability of removing low-frequency chrominance noise but greater color loss of the overall image.
- **tfc**: Indicates the mixing strength of temporal filtering for chrominance 3DNR. The value range is [0, 63]. This parameter is used to tune the chrominance NR strength (as shown in **Figure 1-5**). Within the ranges of [0, 16] and [49, 63], the chrominance NR effect is stronger with the increase of **tfc**. Within the range of [17, 48], the chrominance NR effect is weaker with the increase of **tfc**. During the tuning, you need to balance the removal degree of chrominance noise, color smearing, and image hue change.

Figure 1-5 Serial mode



- **ctfs**: Indicates the temporal filtering strength for three-dimensional chrominance NR. The value range of **ctfs** is [0, 15].
- **[mode]**: Indicates the chrominance filtering mode. When **mode** is set to **0**, the traditional chrominance filtering mode is used. When **mode** is set to **1**, a new chrominance filtering mode is used. In this mode, the chrominance spatial preprocessing filter can be enabled. The value range is [0, 1].
- **[presfc]**: Indicates the strength of the chrominance spatial preprocessing filter. It takes effect only when **mode** is set to **1**, in which case the **presfc** parameter can be used with **sfc** to improve the spatial chrominance NR capability. The value range is [0, 32].

- **pNRc** is invalid in photographing mode or when the raw data of a single frame is repeatedly imported.

NRc is used for noise reduction in photographing. The interface and debugging mode are similar to those of luminance NR. For details, see the description of the luminance NR interface.

2 Recommendations for Debugging 3DNR Interfaces in Typical Scenarios

2.1 IPCs for Non-Human Face Capture

Similar to chip optimization, this scenario mainly relies on the temporal domain for NR. The spatial domain provides the auxiliary function. The main new difference is that the chip supports layer-based processing. It can divide an image into foreground and background layers, and configure corresponding temporal and spatial coefficients. Specifically, perform the following steps to reduce the noise:

Step 1 Set the three parameters of **m1id0** and **m2id0** to **0**, **1**, and **2** respectively. Set the three parameters of **m1id1** and **m2id1** to **2**, **2**, and **2** respectively. Set the two parameters of **m1madz** and **m2madz** to **0** and **0** respectively. It is recommended that layer-based processing be used at level 1 and single-layer processing be used at level 2. You can set **biPath** to **1** or **0**. Enable the **AdvMath** mode at the foreground layer. Then, adjust the temporal NR parameters of the intermediate two levels (level 1 and level 2), including **mXtfs**, **mXmath**, **mXmabw**, and **mXmate**.

- Layers 0 and 1 of level 1 may be respectively used as the foreground layer and the background layer. Debug **m1math** of the background layer to suppress the raindrop noise of the background image. Then debug **m1math** of the foreground layer to control the noise of the foreground motion.
- Debug **n1tfs** at level 1 to suppress the overall noise level of the image. Consider the temporal NR effect as well as the motion smearing of the image. Generally, you need to adjust **tfs** of the foreground layer to be smaller than that of the background layer to prevent the smearing of moving objects.
- If **biPath** at level 2 is **0**, adjust the first value of **m2math** and **n2tfs** at level 2 to control the quietness and noise amplitude of the overall noise. The value of **m2math** at level 2 is usually smaller than that of **m1math** at level 1 to prevent smearing.
- In low illumination, to relieve the burden of raindrop noise suppression for **math**, you can debug **mabw**. In extremely low illumination, you can debug **mate** to suppress the overall picture noise. In layer-based processing mode, the small windows 0 – 4 are recommended for **mabw** of the foreground layer. In **AdvMath** mode, the window for **mabw** of the foreground layer can only be **4**.

- You are advised to use filter 6 as spatial filters at the intermediate two levels. The weight of level-1 filter 2 is increased to improve the over NR capability, but picture edges are not sharpened. The weight of level-2 filter 4 is increased to sharpen picture edges and reduce the noise in non-edge regions.
- For layer-based processing at level 1, a certain ratio of spatial filtering results may be mixed into the foreground layer by increasing the value of **n1tss** of the foreground layer. This enhances the NR effect of moving objects.

Step 2 In non-serial mode, set **DeRate** to **0**. Use level-0 spatial-domain filter 5. Adjust the strength of filters 2 and 4 and mixing weight of filters 0 – 4 based on the characteristics of current noises to reduce losing concerned content. You are advised to increase the NR weight for the small window and reduce the filtering strength.

In serial mode, set **DeRate** to a value greater than **0**. Increase the strength of filters 1 and 2 (about 150). Set the strength of filter 4 to a proper value (for example, 40). Then select details to enhance the strength of **DeRate** (between 100 and 200). Set **DeIdx** to **4** to add the details to the result of filter 4. Finally, the result of filter 4 is output.

Note that the serial mode or the non-serial (traditional) mode may be used for level 0. The advantages of the serial mode are that the low-frequency noise can be removed, the pressure of removing raindrop phenomena at level 1 and level 2 can be reduced, and the detail can be protected through detail overlaying. In addition, the picture can be quieter, but grains are more serious than that of the non-serial mode. In low illumination, if the raindrop phenomenon is difficult to control, you are advised to enable the serial mode to suppress the low-frequency noise.

Step 3 It is recommended that filter 5 be used as the pure spatial filter of the last level. At the same time, you can use filter 6 to control the strength and range of filter 5, and increase the weight of filter 4. By adjusting parameters of filter 4, you can reduce the grains in flat regions and improve the image definition. The final result is output through combined effect of **sth** and **sfn**.

Step 4 On the basis of proper chrominance noise debugging, debug the chrominance NR interface **pNRc**. Generally, you are advised to set **sfc** to a value greater than **0** and use **sfc**, **tfc**, and **ctfs** together to perform NR. The recommended NR parameter setting is as follows: **sfc** = 25, **tfc** = 25, and **ctfs** = 14.

----End

2.2 Mapping Between the 3DNR Debugging Parameters and MPIs

The current 3DNR X interface mainly includes the following MPIs:

```
typedef struct hiVPSS_NR_ATTR_S
{
    VPSS_NR_TYPE_E        enNrType;
    COMPRESS_MODE_E       enCompressMode;
    NR_MOTION_MODE_E      enNrMotionMode;
} VPSS_NR_ATTR_S;
```

3DNR MPI in the VI (Level 0 of 3DNR)

```
typedef struct
{
```



```
    tV500_VI_IEy  IEy;
    tV500_VI_SFy  SFy;
} VI_PIPE_NRX_PARAM_V2_S;
```

The structure of **IEy** is defined as follows:

```
typedef struct
{
    HI_U8  IES0, IES1, IES2, IES3;
    HI_U16 IEDZ : 10, _rb_ : 6;
} tV500_VI_IEy;
```

The structure of **SFy** is defined as follows:

```
typedef struct
{
    HI_U8  SPN6 : 3, SFR  : 5;
    HI_U8  SBN6 : 3, PBR6 : 5;
    HI_U16 SRT0 : 5, SRT1 : 5, JMODE : 3,  DeIdx : 3;
    HI_U8  DeRate, SFR6[3];

    HI_U8  SFS1, SFT1, SBR1;
    HI_U8  SFS2, SFT2, SBR2;
    HI_U8  SFS4, SFT4, SBR4;

    HI_U16 STH1 : 9, SFN1 : 3, NRyEn : 1, SFN0  : 3;
    HI_U16 STH2 : 9, SFN2 : 3, BWSF4 : 1, kMode : 3;
    HI_U16 STH3 : 9, SFN3 : 3, TriTh : 1, _rb0_ : 3;
} tV500_VI_SFy;
```

3DNR MPI in the VPSS

```
typedef struct
{
    tV500_VPSS_IEy  IEy[3];
    tV500_VPSS_SFy  SFy[3];
    tV500_VPSS_MDy  MDy[2];
    tV500_VPSS_RFs  RFs;
    tV500_VPSS_TFy  TFy[2];
    tV500_VPSS_pNRc pNRc;
    tV500_VPSS_NRc  NRc;
} VPSS_NRX_V2_S;
```

The structure of **NRc** is defined as follows:

```
typedef struct
{
    tV500_VPSS_IEy  IEy;
    tV500_VPSS_SFy  SFy;
    HI_U8 NRcEn : 1, _rb_ : 7;
} tV500_VPSS_NRc;
```

The structure of **IEy** is defined as follows:

```
typedef struct
{
    HI_U8  IES0, IES1, IES2, IES3;
    HI_U16 IEDZ : 10, _rb_ : 6;
} tV500_VPSS_IEy;
```

The structure of **SFy** is defined as follows:

```
typedef struct
{
```

```
    HI_U8  SPN6 : 3, SFR  : 5;
    HI_U8  SBN6 : 3, PBR6 : 5;
    HI_U16 SRT0 : 5, SRT1 : 5, JMODE : 3,  DeIdx : 3;
    HI_U8  DeRate, SFR6[3];

    HI_U8  SFS1,  SFT1,  SBR1;
    HI_U8  SFS2,  SFT2,  SBR2;
    HI_U8  SFS4,  SFT4,  SBR4;

    HI_U16 STH1  : 9,  SFN1 : 3, SFN0  : 3, NRyEn : 1;
    HI_U16 STH2  : 9,  SFN2 : 3, BWSF4 : 1, kMode : 3;
    HI_U16 STH3  : 9,  SFN3 : 3, TriTh : 1, _rb0_ : 3;
    HI_U16 SBSk[32], SDSk[32];
} tV500_VPSS_SFy;
```

The structure of **MDy** is defined as follows:

```
typedef struct
{
    HI_U16 MADZ0   : 9,  MAI00    : 2,  MAI01  : 2,  MAI02    : 2,
biPath  : 1;
    HI_U16 MADZ1   : 9,  MAI10    : 2,  MAI11  : 2,  MAI12    : 2,
_rb0_ : 1;
    HI_U8  MABR0, MABR1;

    HI_U16 MATH0   : 10,  MATE0   : 4,  MATW  : 2;
    HI_U16 MATH1   : 10,  MATE1   : 4, _rb1_  : 2;
    HI_U8  MASW    :  4,  _rb2_   : 4;
    HI_U8  MABW0   :  4,  MABW1   : 4;
} tV500_VPSS_MDy;
```

The structure of **TFy** is defined as follows:

```
typedef struct
{
    HI_U16 TFS0  :  4, TDZ0   : 10, TDX0    : 2;
    HI_U16 TFS1  :  4, TDZ1   : 10, TDX1    : 2;
    HI_U16 SDZ0  : 10, STR0   : 5,  DZMode0 : 1;
    HI_U16 SDZ1  : 10, STR1   : 5,  DZMode1 : 1;

    HI_U8  TFR0[6],    TSS0   : 4,  TSI0    : 4;
    HI_U8  TFR1[6],    TSS1   : 4,  TSI1    : 4;

HI_U8  RFI   : 3, tEdge : 2, bRef  : 1, _rb_  :  2;
} tV500_VPSS_TFy;
```

The structure of **RFs** is defined as follows:

```
typedef struct
{
   HI_U16  advMATH : 1, RFDZ   :  9, _rb_ : 6;
   HI_U8   RFUI      : 3, RFSLP  : 5;
} tV500_VPSS_RFs;
```

The structure of **pNRc** is defined as follows:

```
typedef struct
{
    HI_U8  SFC;
    HI_U16 CTFS : 4, TFC : 6, _rb_ : 6;
    HI_U8  MODE : 1, _rb1_ : 7;
    HI_U8  PRESFC : 6, _rb2_ : 2;
} tV500_VPSS_pNRc;
```


- The mapping between the 3DNR X interface IE parameters and MPIs is as follows:
  - **nXsf5** at level 0 corresponds to **VI_PIPE_NRX_PARAM_V2_S.IEy. IES0**, **VI_PIPE_NRX_PARAM_V2_S.IEy.IES1**, **VI_PIPE_NRX_PARAM_V2_S.IEy.IES2**, and **VI_PIPE_NRX_PARAM_V2_S.IEy.IES3**.
  - **nXsf5** at level 1 corresponds to **VPSS_NRX_V2_S. IEy[0].IES0**, **VPSS_NRX_V2_S.IEy[0].IES1**, **VPSS_NRX_V2_S.IEy[0].IES2**, and **VPSS_NRX_V2_S. IEy[0].IES3**.
  - **nXsf5** at level 2 corresponds to **VPSS_NRX_V2_S. IEy[1].IES0**, **VPSS_NRX_V2_S.IEy[1].IES1**, **VPSS_NRX_V2_S.IEy[1].IES2**, and **VPSS_NRX_V2_S. IEy[1].IES3**.
  - **nXsf5** at level 3 corresponds to **VPSS_NRX_V2_S.IEy[2].IES0**, **VPSS_NRX_V2_S.IEy[2].IES1**, **VPSS_NRX_V2_S.IEy[2].IES2**, and **VPSS_NRX_V2_S.IEy[2].IES3**.
  - **dzsf5** at level 0 corresponds to **VI_PIPE_NRX_PARAM_V2_S.IEy.IEDZ**.
  - **dzsf5** at level 1 corresponds to **VPSS_NRX_V2_S.IEy[0].IEDZ**.
  - **dzsf5** at level 2 corresponds to **VPSS_NRX_V2_S.IEy[1].IEDZ**.
  - **dzsf5** at level 3 corresponds to **VPSS_NRX_V2_S.IEy[2].IEDZ**.
- The mapping between the 3DNR X interface spatial filter parameters and MPIs is as follows:

  There are four levels of **nXsf1**, **nXsf2**, **nXsf4**, **bwsf4**, **kmsf4**, **nXsf6**, **nXsfn**, **nXsth**, **trith**, and **sfr**. (Note: **bwsf4** is valid only at level 0 and level 1. **kmsf4** is valid only at level 2 and level 3.)
  - **nXsf1** at level 0 corresponds to **SFy.SFS1**, **SFy.SFT1**, and **SFy.SBR1**.
  - **nXsf2** at level 0 corresponds to **SFy.SFS2**, **SFy.SFT2**, and **SFy.SBR2**.
  - **nXsf4** at level 0 corresponds to **SFy.SFS4**, **SFy.SFT4**, and **SFy.SBR4**.
  - **bwsf4** at level 0 corresponds to **SFy.BWSF4**.
  - **nXsf6** at level 0 corresponds to **SFy.SPN6**, **SFy.SBN6**, **SFy.PBR6**, and **SFy.JMODE**.
  - **nXsfr6** at level 0 corresponds to **SFy.SFR6[0]**, **SFy.SFR6[1]**, and **SFy.SFR6[2]**.
  - **nXsfn** at level 0 corresponds to **SFy.SFN0**, **SFy.SFN1**, **SFy.SFN2**, and **SFy.SFN3**.
  - **nXsth** at level 0 corresponds to **SFy.STH1**, **SFy.STH2**, and **SFy.STH3**.
  - **trith** at level 0 corresponds to **SFy.TriTh**.
  - **sfr** at level 0 corresponds to **SFy.SFR**.
  - **SelRt** at level 0 corresponds to **SFy.SRT0** and **SFy.SRT1**.
  - **DeRt** at level 0 corresponds to **SFy.DeRate** and **SFy.DeIdx**.
  - **nXsf1** at level 1 corresponds to **SFy[0].SFS1**, **SFy[0].SFT1**, and **SFy[0].SBR1**.
  - **nXsf2** at level 1 corresponds to **SFy[0].SFS2**, **SFy[0].SFT2**, and **SFy[0].SBR2**.
  - **nXsf4** at level 1 corresponds to **SFy[0].SFS4**, **SFy[0].SFT4**, and **SFy[0].SBR4**.
  - **bwsf4** at level 1 corresponds to **SFy[0].BWSF4**.
  - **nXsf6** at level 1 corresponds to **SFy[0].SPN6**, **SFy[0].SBN6**, **SFy[0].PBR6**, and **SFy[0].JMODE**.
  - **nXsfr6** at level 1 corresponds to **SFy[0].SFR6[0]**, **SFy[0].SFR6[1]**, and **SFy[0].SFR6[2]**.

- **nXsfn** at level 1 corresponds to **SFy[0].SFN0**, **SFy[0].SFN1**, **SFy[0].SFN2**, and **SFy[0].SFN3**.
- **nXsth** at level 1 corresponds to **SFy[0].STH1**, **SFy[0].STH2**, and **SFy[0].STH3**.
- **trith** at level 1 corresponds to **SFy[0].TriTh**.
- **sfr** at level 1 corresponds to **SFy[0].SFR**.
- **en** at level 1 corresponds to **SFy[0].NRyEn**.

- **nXsf1** at level 2 corresponds to **SFy[1].SFS1**, **SFy[1].SFT1**, and **SFy[1].SBR1**.
- **nXsf2** at level 2 corresponds to **SFy[1].SFS2**, **SFy[1].SFT2**, and **SFy[1].SBR2**.
- **nXsf4** at level 2 corresponds to **SFy[1].SFS4**, **SFy[1].SFT4**, and **SFy[1].SBR4**.
- **kmsf4** at level 2 corresponds to **SFy[1].kMode**.
- **SBSk** at level 2 corresponds to **SFy[1].SBSk[32]**.
- **SDSk** at level 2 corresponds to **SFy[1].SDSk[32]**.
- **nXsf6** at level 2 corresponds to **SFy[1].SPN6**, **SFy[1].SBN6**, **SFy[1].PBR6**, and **SFy[1].JMODE**.
- **nXsfr6** at level 2 corresponds to **SFy[1].SFR6[0]**, **SFy[1].SFR6[1]**, and **SFy[1].SFR6[2]**.
- **nXsfn** at level 2 corresponds to **SFy[1].SFN0**, **SFy[1].SFN1**, **SFy[1].SFN2**, and **SFy[1].SFN3**.
- **nXsth** at level 2 corresponds to **SFy[1].STH1**, **SFy[1].STH2**, and **SFy[1].STH3**.
- **trith** at level 2 corresponds to **SFy[1].TriTh**.
- **sfr** at level 2 corresponds to **SFy[1].SFR**.
- **en** at level 2 corresponds to **SFy[1].NRyEn**.

- **nXsf1** at level 3 corresponds to **SFy[2].SFS1**, **SFy[2].SFT1**, and **SFy[2].SBR1**.
- **nXsf2** at level 3 corresponds to **SFy[2].SFS2**, **SFy[2].SFT2**, and **SFy[2].SBR2**.
- **nXsf4** at level 3 corresponds to **SFy[2].SFS4**, **SFy[2].SFT4**, and **SFy[2].SBR4**.
- **kmsf4** at level 3 corresponds to **SFy[2].kMode**
- **SBSk** at level 3 corresponds to **SFy[2].SBSk[32]**.
- **SDSk** at level 3 corresponds to **SFy[2].SDSk[32]**.
- **nXsf6** at level 3 corresponds to **SFy[2].SPN6**, **SFy[2].SBN6**, **SFy[2].PBR6**, and **SFy[2].JMODE**.
- **nXsfr6** at level 3 corresponds to **SFy[2].SFR6[0]**, **SFy[2].SFR6[1]**, and **SFy[2].SFR6[2]**.
- **nXsfn** at level 3 corresponds to **SFy[2].SFN0**, **SFy[2].SFN1**, **SFy[2].SFN2**, and **SFy[2].SFN3**.
- **nXsth** at level 3 corresponds to **SFy[2].STH1**, **SFy[2].STH2**, and **SFy[2].STH3**.
- **trith** at level 3 corresponds to **SFy[2].TriTh**.
- **sfr** at level 3 corresponds to **SFy[2].SFR**.
- **en** at level 3 corresponds to **SFy[2].NRyEn**.

- The mapping between the 3DNR motion detection parameter **MDy** and MPIs is as follows:

  There are two levels of **mXid0**, **mXid1**, **mXmabr**, **mXmadz**, **mXmath**, **mXmate**, **mXmabw**, **mXmatw**, and **mXmasw**.

- **mXid0** corresponds to **MDy[0].MAI00**, **MDy[0].MAI01**, and **MDy[0].MAI02** as well as **MDy[1].MAI00**, **MDy[1].MAI01**, and **MDy[1].MAI02**.
- **mXid1** corresponds to **MDy[0].MAI10**, **MDy[0].MAI11**, and **MDy[0].MAI12** as well as **MDy[1].MAI10**, **MDy[1].MAI11**, and **MDy[1].MAI12**.
- **mXmabr** corresponds to **MDy[0].MABR0** and **MDy[0]. MABR1** as well as **MDy[1].MABR0** and **MDy[1].MABR1**.
- **mXmadz** corresponds to **MDy[0].MADZ0**, **MDy[0].MADZ1**, **MDy[1].MADZ0**, and **MDy[1].MADZ1**.
- **mXmath** corresponds to **MDy[0].MATH0**, **MDy[0].MATH1**, **MDy[1].MATH0**, and **MDy[1].MATH1**.
- **mXmate** corresponds to **MDy[0].MATE0**, **MDy[0].MATE1**, **MDy[1].MATE0**, and **MDy[1].MATE1**.
- **mXmabw** corresponds to **MDy[0].MABW0**, **MDy[0].MABW1**, **MDy[1].MABW0**, and **MDy[1].MABW1**.
- **mXmasw** corresponds to **MDy[0].MASW** and **MDy[1].MASW**.
- **mXmatw** corresponds to **MDy[0].MATW** and **MDy[1].MATW**.
- **biPath** corresponds to **MDy[0].biPath** and **MDy[1].biPath**.

- The mapping between the 3DNR X interface temporal filter parameter **TFy** and MPIs is as follows:

  ref and **rftIdx** correspond to **TFy[0].bRef** as well as **TFy[0].RFI**, respectively. Interfaces **TFy[1].bRef** and **TFy[1]. RFI** is meaningless to the image effect.

  There are two levels of **nXstr**, **nXsdz**, **nXtss**, **nXtfs**, **nXtfr**, **nXtdz**, **nXtdx**, **nXtdm**, and **tEdge**.

  - **nXstr** corresponds to **TFy[0].STR0** and **TFy[0].STR1** as well as **TFy[1].STR0** and **TFy[1].STR1**.
  - **nXsdz** corresponds to **TFy[0].SDZ0** and **TFy[0].SDZ1** as well as **TFy[1].SDZ0** and **TFy[1].SDZ1**.
  - **nXtss** corresponds to **TFy[0].TSS0** and **TFy[0].TSS1** as well as **TFy[1].TSS0** and **TFy[1].TSS1**.
  - **nXtsi** corresponds to **TFy[0].TSI0** and **TFy[0].TSI1** as well as **TFy[1].TSI0** and **TFy[1].TSI1**.
  - **nXtfs** corresponds to **TFy[0].TFS0** and **TFy[0].TFS1** as well as **TFy[1].TFS0** and **TFy[1].TFS1**.
  - **nXdzm** corresponds to **TFy[0].DZMode0** and **TFy[0].DZMode1** as well as **TFy[1].DZMode0** and **TFy[1].DZMode1**.
  - **tEdge** corresponds to **TFy[0].tEdge** as well as **TFy[1].tEdge**.
  - **nXtdz** corresponds to **TFy[0].TDZ0** and **TFy[0].TDZ1** as well as **TFy[1].TDZ0** and **TFy[1].TDZ1**.
  - **nXtdx** corresponds to **TFy[0].TDX0** and **TFy[0].TDX1** as well as **TFy[1].TDX0** and **TFy[1].TDX1**.
  - **nXtfr0** corresponds to **TFy[0].TFR0[0]**, **TFy[0].TFR0[1]**, **TFy[0].TFR0[2]**, **TFy[0].TFR0[3]**, **TFy[0].TFR0[4]**, and **TFy[0].TFR0[5]** as well as **TFy[1].TFR0[0]**, **TFy[1].TFR0[1]**, **TFy[1].TFR0[2]**, **TFy[1]. TFR0[3]**, **TFy[1].TFR0[4]**, and **TFy[1].TFR0[5]**.
  - **nXtfr1** corresponds to **TFy[0].TFR1[0], TFy[0].TFR1[1], TFy[0].TFR1[2], TFy[0].TFR1[3]**, **TFy[0].TFR1[4]**, and **TFy[0].TFR1[5]** as well as

TFy[1].TFR1[0], TFy[1].TFR1[1], TFy[1].TFR1[2], TFy[1].TFR1[3], **TFy[1].TFR1[4]**, and **TFy[1].TFR1[5]**.

- The mapping between 3DNR **RFs**-related parameters and MPIs is as follows:

  AdvMath, **refUpt**, and **refCtl** are used for level 1 of 3DNR.

  - **AdvMath** corresponds to **RFs.advMATH**.
  - **refUpt** corresponds to **RFs.RFUI**.
  - **refCtl** corresponds to **RFs.RFDZ** and **RFs.RFSLP**.

- The mapping between the 3DNR common chrominance NR parameters and MPIs is as follows:

  - **sfc** corresponds to **pNRc.SFC**.
  - **tfc** corresponds to **pNRc.TFC**.
  - **ctfs** corresponds to **pNRc.CTFS**.
  - **mode** corresponds to **pNRc.MODE**
  - **presfc** corresponds to **pNRc.PRESFC**

- The mapping between the 3DNR enhanced chrominance NR (**NRc**) parameters and MPIs is as follows:

  The mapping between IE parameters and MPIs is as follows:

  - **nXsf5** of **NRc** corresponds to **VPSS_NRX_V2_S.NRc.IEy.IES0**, **VPSS_NRX_V2_S.NRc.IEy.IES1**, **VPSS_NRX_V2_S.NRc.IEy.IES2**, and **VPSS_NRX_V2_S.NRc.IEy.IES3**.
  - **dzsf5** of **NRc** corresponds to **VPSS_NRX_V2_S.NRc.IEy.IEDZ**.

  The mapping between temporal filter parameters and MPIs is as follows:

  - **nXsf1** of **NRc** corresponds to **SFy.SFS1**, **SFy.SFT1**, and **SFy.SBR1**.
  - **nXsf2** of **NRc** corresponds to **SFy.SFS2**, **SFy.SFT2**, and **SFy.SBR2**.
  - **nXsf4** of **NRc** corresponds to **SFy.SFS4**, **SFy.SFT4**, and **SFy.SBR4**.
  - **bwsf4** of **NRc** corresponds to **SFy.BWSF4**.
  - **nXsf6** of **NRc** corresponds to **SFy.SPN6**, **SFy.SBN6**, **SFy.PBR6**, and **SFy.JMODE**.
  - **nXsfr6** of **NRc** corresponds to **SFy.SFR6[0]**, **SFy.SFR6[1]**, and **SFy.SFR6[2]**.
  - **nXsfn** of **NRc** corresponds to **SFy.SFN0**, **SFy.SFN1**, **SFy.SFN2**, and **SFy.SFN3**.
  - **nXsth** of **NRc** corresponds to **SFy.STH1**, **SFy.STH2**, and **SFy.STH3**.
  - **trith** of **NRc** corresponds to **SFy.TriTh**.
  - **sfr** of **NRc** corresponds to **SFy.SFR**.
  - **SelRt** of **NRc** corresponds to **SFy.SRT0** and **SFy.SRT1**.
  - **DeRt** of **NRc** corresponds to **SFy.DeRate** and **SFy.DeIdx**.
  - **en** of **NRc** corresponds to **NRcEn**.

For a parameter whose MPI does not correspond to the interface on the debugging GUI, you are advised to set the parameter to the default value **0**.