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MT6771
AF Tuning introduction

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Outline

- Introduction
- AF Pre-check & Tuning Prepare
- AFv4.0 calibration (For contrast AF)
  - AF Table
  - AF HW threshold
  - Hysteresis/Damping
  - Posture Compensation
  - Zoom Effect Calibration
  - Temperature Calibration
  - Point light af calibration
  - Laser Calibration
  - G/Gyro Sensor Calibration
- AF flow Overall introduction
- AFv5.0 Parameters Introduction(new)
  - V5.0 improvement overall introduction
  - Common parameters(v5.0)
  - Hybrid AF parameters(v5.0)
  - FDAF parameters(v5.0)
  - PLAF parameters(v5.0)
- Tool
  - CCT
  - DebugParser V4.0
  - ParaParser
- Debug Parser introduction&log introduction
- How To Provide Valid Debug Data

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Introduction

- This document will focus on MT6771 AF v5.0 improvement detail introduction.
- Precheck/Tuning prepare/Calibration/Tuning parameter which are the same with AFv4.0/tool relative part/Log analysis,please reference to following documents:

MT6757_MT6763_Camera_AF_Tuning_SOP.pdf

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AF overall flow

AF流程主要动作为:
Trigger->Search->Move ->Monitor.
因支援hybrid AF(PD/Laser/Stereo)需在search前决定search type

Enter Camera

Monitor and trigger AF

1st time : 是否scene stable?
Other: 是否scene change and stable ?

Decide AF search type

1. 依照不同AF trigger scenario 设定参数 (TAF/CAF/Face AF)
2. 决定AF search的方式 : CDAF/PDAF/LDAF /SDAF…

PDAF search

以PD估算的target pos与confidence来协助search找到peak

CDAF search

以contrast AF方式来做AF search找到peak

Move lens to target pos

Search之后得到target pos (peak or fail pos…)，并将lens移动到此target pos

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Improvement

Category	Description	Improved issue
Low contrast improvement	• Add dynamic threshold	• Flat scene
PD Improvement	•PD new core •Add dynamic Search Range	• PD performance
Hybrid AF improvement	•Dynamic weak threshold by LV	Customize flexible
	•Hybrid scene change	
	•Mid-low Confidence Handling	•
Face AF improvement	• Accuracy – Landmark extension	• Small face
	• Smoothness – FD tracking by PD	•FDAF trigger time
Point light improvement	•PL core update	•Detail introduction

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Low contrast improvement

Version	Threshold type	Detail
AF v4.0	Fixed	Main/sub threshold from parameter directly
AF v5.0	Dynamic	Main/sub threshold is calculated by parameter each step

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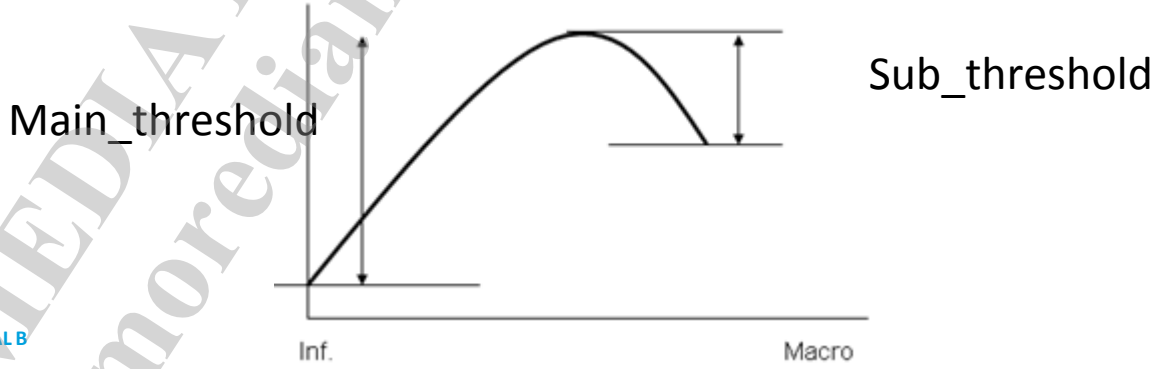
Fix threshold- v4.0

- Main_threshold (%)
  - Main criterion for AF stopping the search and getting the focus
- Sub_ threshold(%)
  - Second criterion for AF stopping the search and getting the focus
- If how FV rises exceeds Main_threshold and how it drops exceeds Sub_threshold, it will be considered fining the peak position. main/sub threshold always is fix parameter， and it can’t cover low contrast scene well.



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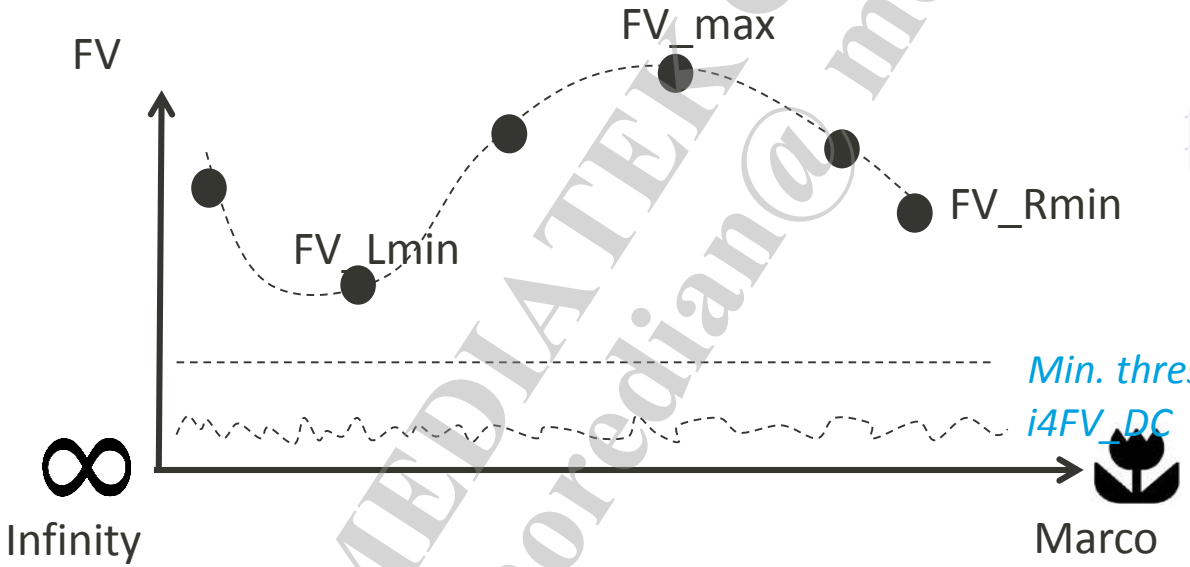
AF search stop criteria

- AF Search Stop Threshold
  - MainThres = MAX((FV_max – i4FV_DC) * Main_threshold, i4MIN_TH)
  - SubThres = MAX((FV_max – i4FV_DC) * Sub_threshold, i4MIN_TH)

```
12, //main_threshold
8, //sub_threshold
```

- AF Search Stop Condition:
  - If (FV_Max – FV_Lmin) > Main_Threshold && (FV_Max – FV_Rmin) > Sub_Threshold




```
8, // i4ISONum
{100, 150, 200, 300, 400, 600, 800, 1600},
// horizontal FV min. threshold
{2000, 2000, 2000, 1000, 1000, 1000, 800, 800},
```

It depends on current ISO.
Ex) ISO 600 : min_TH = 1000
ISO 800 : min_TH = 800
ISO 700 :
[interpolation] min_TH = 900

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Dynamic threshold-v5.0

- Concept
  - Each sample add to curve Main/sub TH re-calculated a appropriate value for new curve, and the threshold is calculated by parameter each step
  - More control method for flat scene

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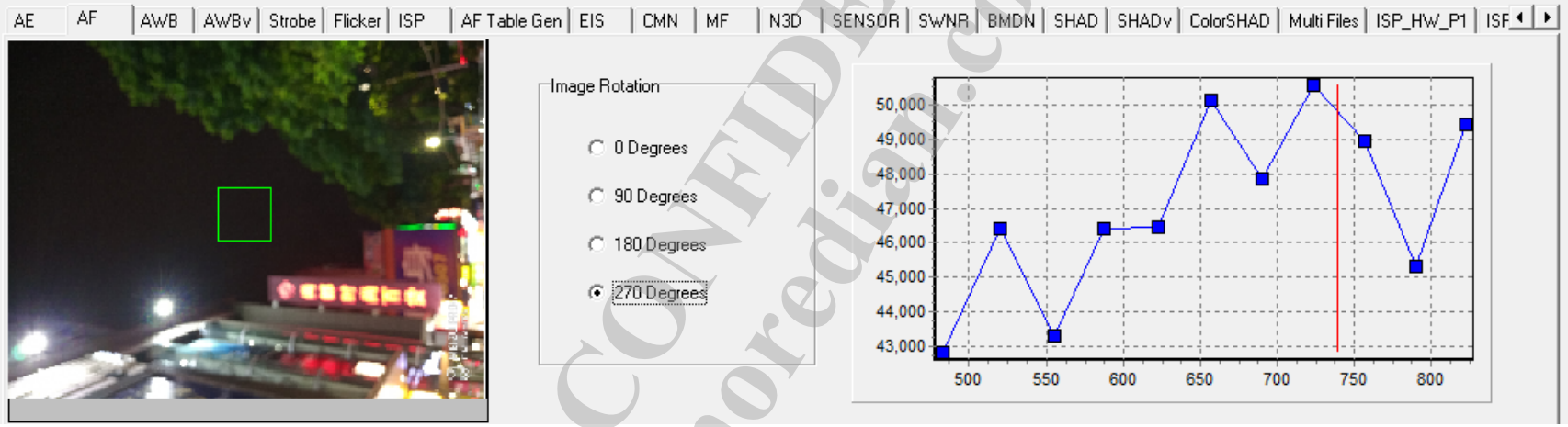
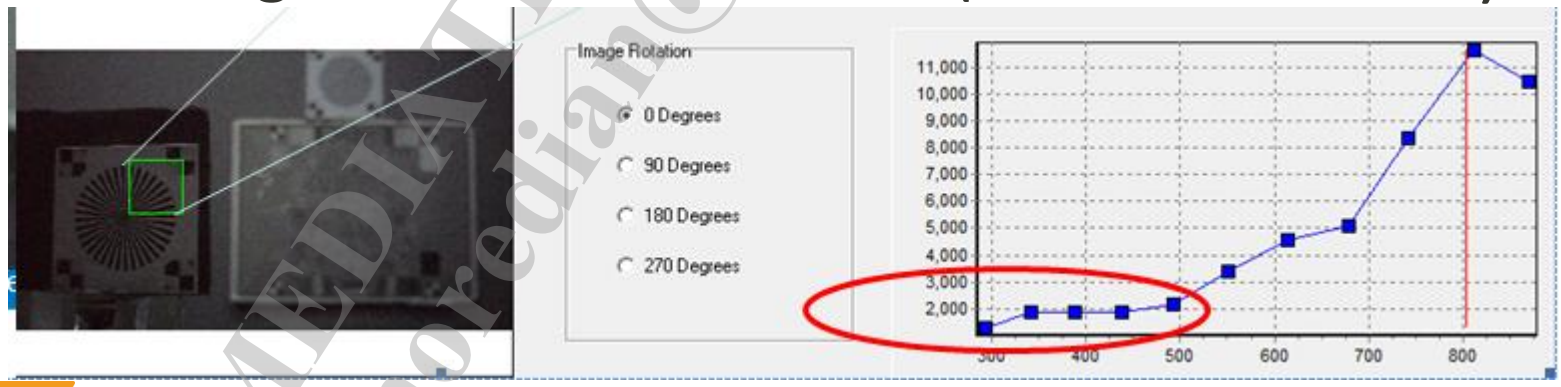
Some known AF issue from customer

- Flat scene move to false peak



- Converge at flat area of curve (local maximum)



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Previous solution

- Tuning AF parameters

```
//
// -------------------- sAF_TH --------------------
{
    8, // i4ISONum
    {100, 150, 200, 300, 400, 600, 800, 1600},

    // SGG1~7
{20, 19, 19, 19, 18, 18, 17, 16,
 29, 29, 29, 28, 28, 27, 27, 25,
 43, 42, 42, 42, 41, 41, 40, 39,
 62, 61, 61, 61, 60, 60, 59, 58,
 88, 88, 88, 88, 87, 87, 86, 85,
 126, 126, 126, 126, 125, 125, 125, 124,
 180, 180, 180, 180, 180, 179, 179, 179},

    // horizontal FV min. threshold
    {2000, 2000, 2000, 1000, 1000, 1000, 800, 800},

    // horizontal FV threshold
{2, 2, 2, 2, 2, 2, 2, 3},

    // horizontal FV min. threshold
    {2000, 2000, 2000, 1000, 1000, 1000, 800, 800},

    // horizontal FV threshold
{2, 2, 2, 2, 2, 2, 2, 3},

    // vertical FV min. threshold
    {2000, 2000, 2000, 1000, 1000, 1000, 800, 800},

    // vertical FV threshold
{2, 2, 2, 2, 2, 2, 2, 3},
},
```

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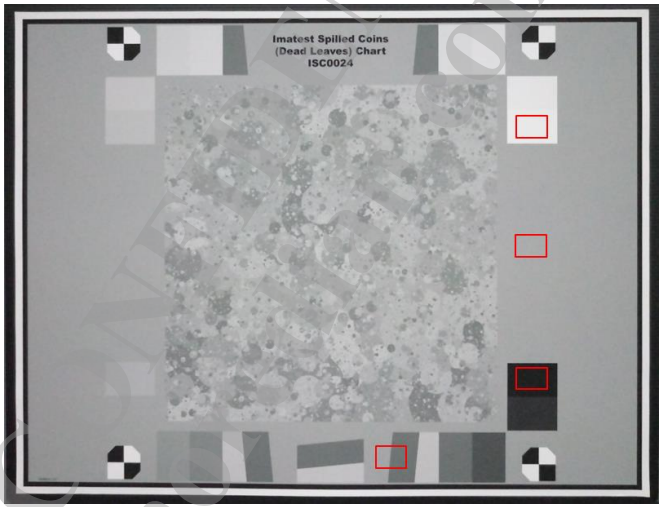
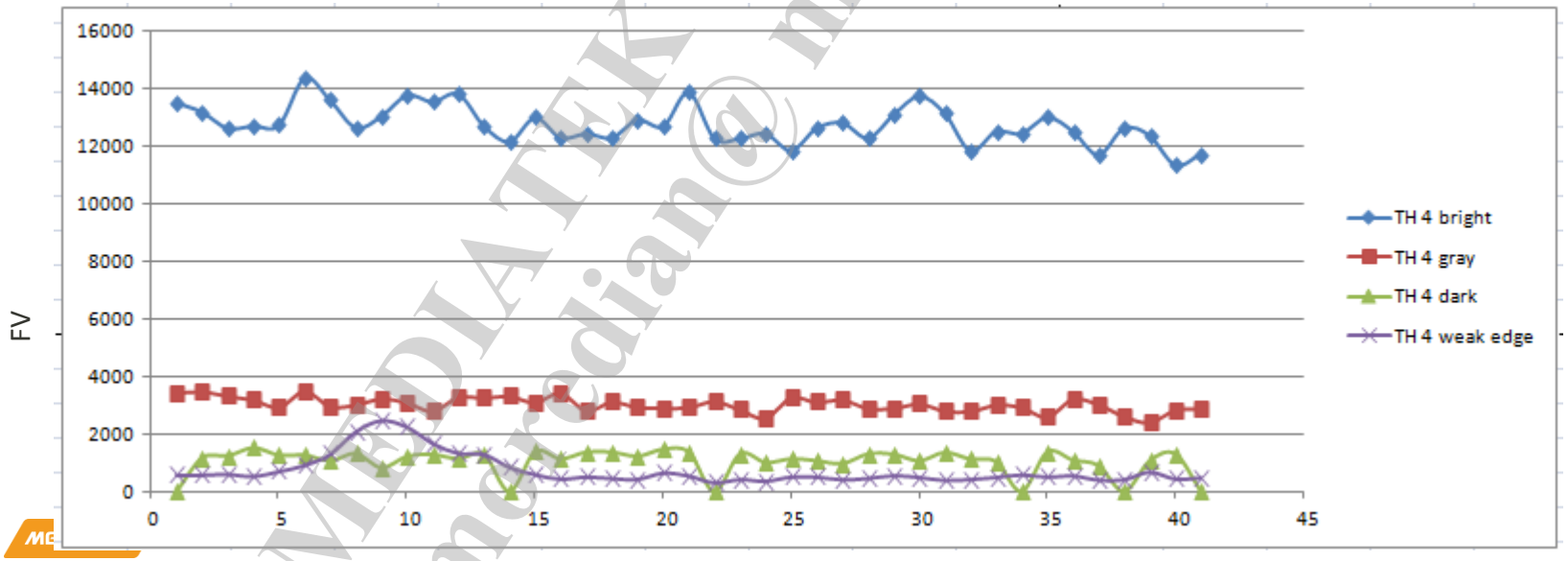
Some trade off must happened

- Compare different FV curve of gray level flat area & weak edge area





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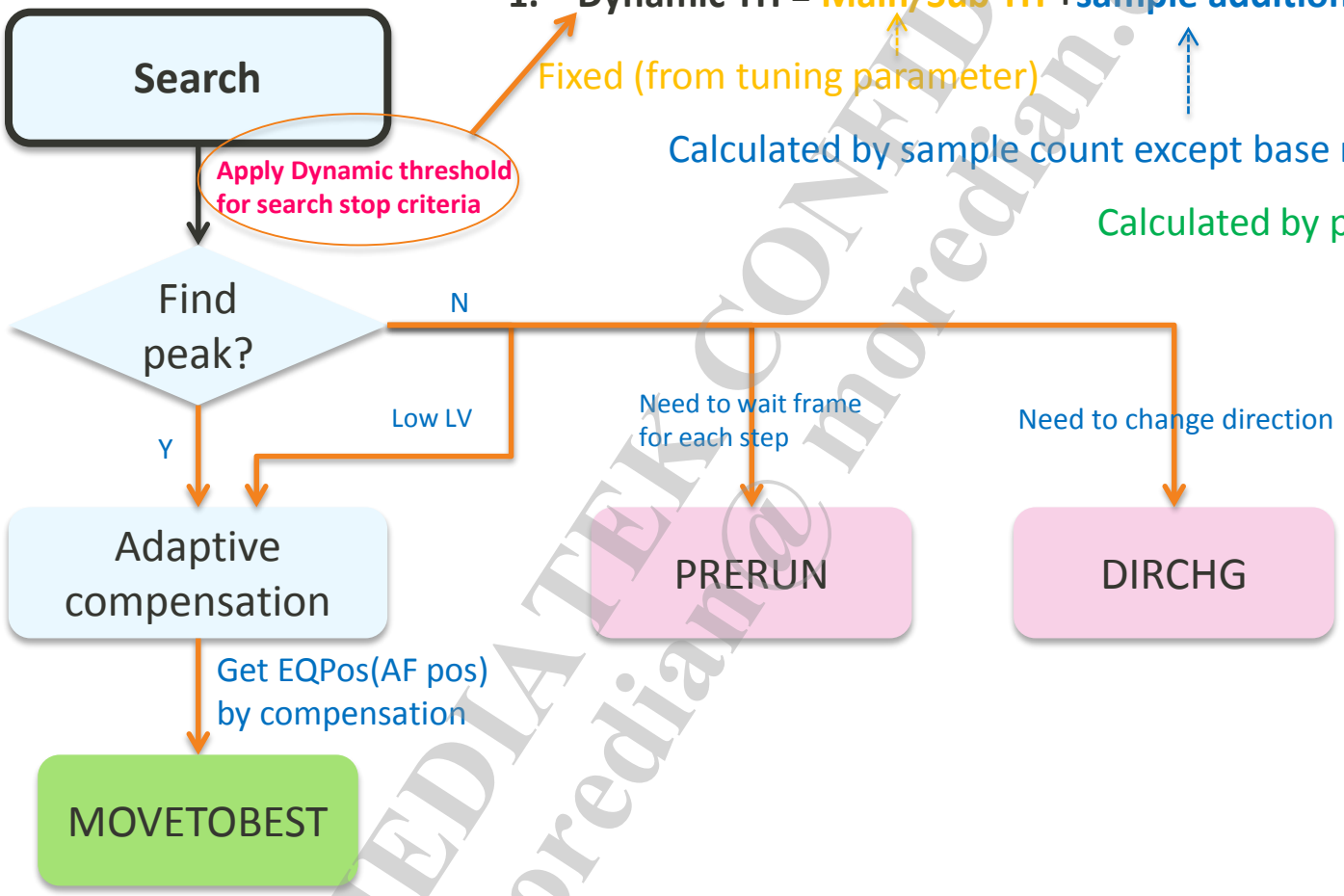
Dynamic converge ratio threshold

•Calculate threshold for AF search stop criteria each step

1. Dynamic TH = Main/Sub TH +sample additional TH+ Peak additional TH



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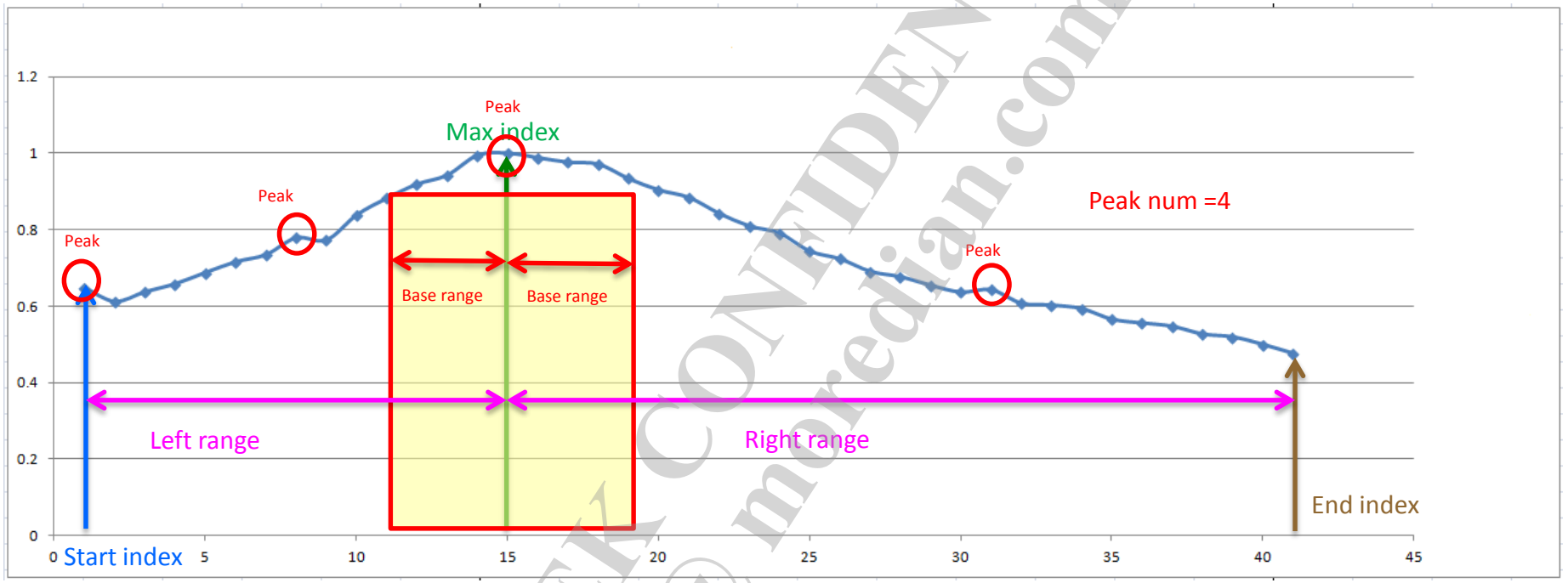
Dynamic converge ratio threshold



Dynamic TH = Main/Sub TH + Sample additional TH + Peak additional TH

Sample additional TH = (Left(Right) range – Base range) * Ratio Per Sample

Peak additional TH = (Peaknum – Base peak) * Ratio Per Peak

If Dynamic HW TH > TH limit , Dynamic HW TH = TH limit

For example, Tuning parameters as right bracket and above curve TH calculated as below:
Sample additional TH (Main)= (26 – 4) * 2 = 44
Sample additional TH (Sub)= (14 – 4) * 2 = 20
Peak additional TH = (4 – 1) * 3 = 9
Main TH = 15 + 44 + 9 = 68 > 50 → Main TH =50
Sub TH = 10 + 20 + 9 = 39

Tuning parameters

Ex:
Base range = 4
Ratio Per Sample = 2
Base peak = 1
Ratio Per Peak = 3
Threshold Limit = 50

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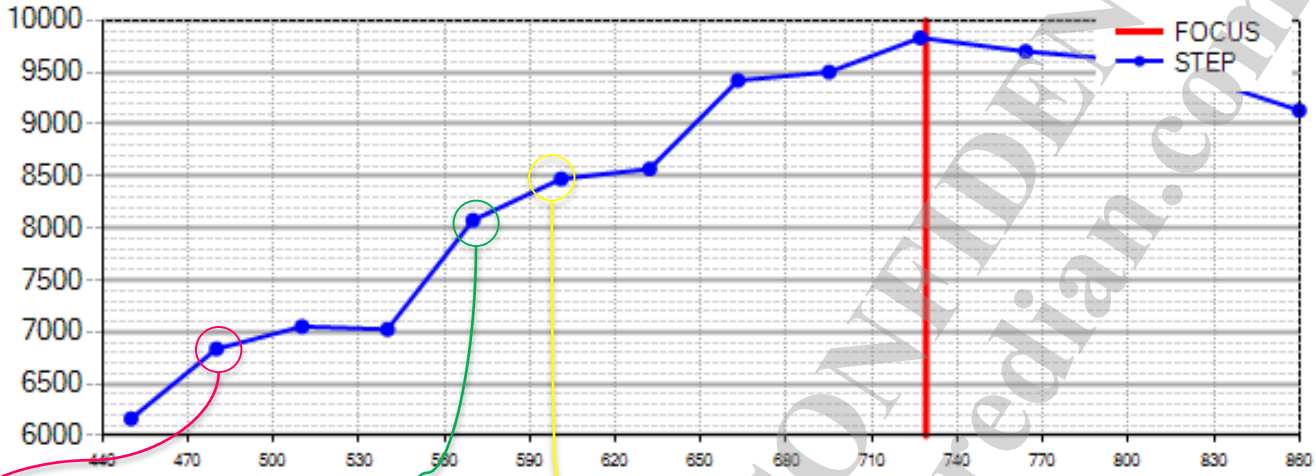
Dynamic converge ratio threshold - ex



Ex:
Base range = 3
Ratio Per Sample = 3
Base peak = 1
Ratio Per Peak = 2
Threshold Limit = 50

Dynamic TH = Main/Sub TH + Sample additional TH + Peak additional TH

```
[DYTH]MaxIdx:0 CurrIdx:1  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:1 CurrIdx:1  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:2 CurrIdx:2  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:2 CurrIdx:3  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:4 CurrIdx:4  peak_num:2 RatioP:2 Ratio1:3  Ratio2:0 Mian_ratio:17 Sub_ratio:10
[DYTH]MaxIdx:5 CurrIdx:5  peak_num:2 RatioP:2 Ratio1:6  Ratio2:0 Mian_ratio:20 Sub_ratio:10
[DYTH]MaxIdx:6 CurrIdx:6  peak_num:2 RatioP:2 Ratio1:9  Ratio2:0 Mian_ratio:23 Sub_ratio:10
[DYTH]MaxIdx:7 CurrIdx:7  peak_num:2 RatioP:2 Ratio1:12 Ratio2:0 Mian_ratio:26 Sub_ratio:10
[DYTH]MaxIdx:8 CurrIdx:8  peak_num:2 RatioP:2 Ratio1:15 Ratio2:0 Mian_ratio:29 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:9  peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:10 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:11 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:12 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:13 peak_num:2 RatioP:2 Ratio1:18 Ratio2:3 Mian_ratio:32 Sub_ratio:13
```

Left sample addi th Right sample addi th

Idx 1:
Main ratio = 12+ peak+sample
= 12+(1-1)*2+(0)* 3 =12
Sub ratio = 8+peak+sample
=8+(1-1)*2+0 = 8

Idx 4:
Main ratio = 12+ peak+sample
= 12+(2-1)*2+(4-3)* 3
=12+2+3 = 17
Sub ratio = 8+peak+sample
=8+(2-1)*2+0 = 10

Idx 5:
Main ratio = 12+ peak+sample
= 12+(2-1)*2+(5-3)* 3
=12+2+6= 20
Sub ratio = 8+peak+sample
=8+(2-1)*2+0 = 10

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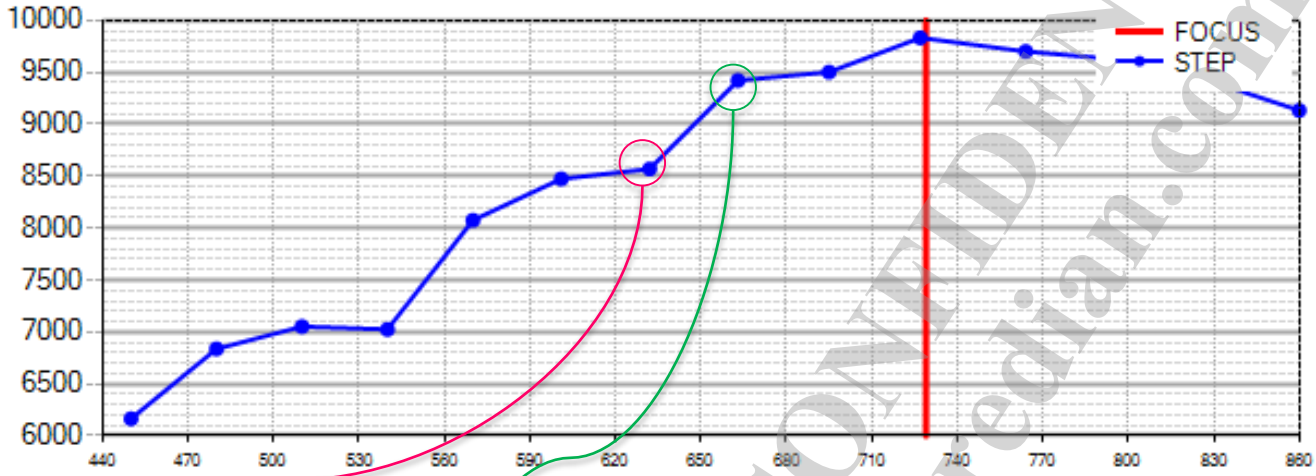
Dynamic converge ratio threshold - ex



Ex:
Base range = 3
Ratio Per Sample = 3
Base peak = 1
Ratio Per Peak = 2
Threshold Limit = 50

Dynamic TH = Main/Sub TH + Sample additional TH + Peak additional TH

```
[DYTH]MaxIdx:0 CurrIdx:1  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:1 CurrIdx:1  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:2 CurrIdx:2  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:2 CurrIdx:3  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:4 CurrIdx:4  peak_num:2 RatioP:2 Ratio1:3  Ratio2:0 Mian_ratio:17 Sub_ratio:10
[DYTH]MaxIdx:5 CurrIdx:5  peak_num:2 RatioP:2 Ratio1:6  Ratio2:0 Mian_ratio:20 Sub_ratio:10
[DYTH]MaxIdx:6 CurrIdx:6  peak_num:2 RatioP:2 Ratio1:9  Ratio2:0 Mian_ratio:23 Sub_ratio:10
[DYTH]MaxIdx:7 CurrIdx:7  peak_num:2 RatioP:2 Ratio1:12 Ratio2:0 Mian_ratio:26 Sub_ratio:10
[DYTH]MaxIdx:8 CurrIdx:8  peak_num:2 RatioP:2 Ratio1:15 Ratio2:0 Mian_ratio:29 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:9  peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:10 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:11 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:12 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:13 peak_num:2 RatioP:2 Ratio1:18 Ratio2:3 Mian_ratio:32 Sub_ratio:13
```

Idx 6:
Main ratio = 12+ peak+sample
= 12+(2-1)*2+(6-3)* 3
=12+2+9= 23

Idx 7:
Main ratio = 12+ peak+sample
= 12+(2-1)*2+(7-3)* 3
=12+2+12 = 26

Left sample addi th Right sample addi th

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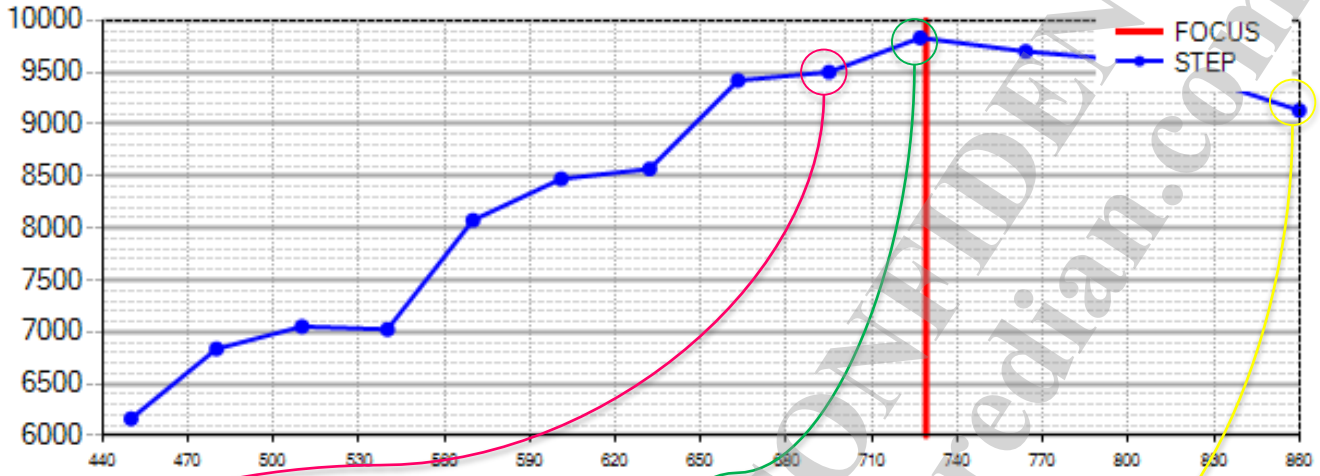
Dynamic converge ratio threshold - ex



Ex:
Base range = 3
Ratio Per Sample = 3
Base peak = 1
Ratio Per Peak = 2
Threshold Limit = 50

Dynamic TH = Main/Sub TH + Sample additional TH + Peak additional TH

```
[DYTH]MaxIdx:0 CurrIdx:1  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:1 CurrIdx:1  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:2 CurrIdx:2  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:2 CurrIdx:3  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:4 CurrIdx:4  peak_num:2 RatioP:2 Ratio1:3  Ratio2:0 Mian_ratio:17 Sub_ratio:10
[DYTH]MaxIdx:5 CurrIdx:5  peak_num:2 RatioP:2 Ratio1:6  Ratio2:0 Mian_ratio:20 Sub_ratio:10
[DYTH]MaxIdx:6 CurrIdx:6  peak_num:2 RatioP:2 Ratio1:9  Ratio2:0 Mian_ratio:23 Sub_ratio:10
[DYTH]MaxIdx:7 CurrIdx:7  peak_num:2 RatioP:2 Ratio1:12 Ratio2:0 Mian_ratio:26 Sub_ratio:10
[DYTH]MaxIdx:8 CurrIdx:8  peak_num:2 RatioP:2 Ratio1:15 Ratio2:0 Mian_ratio:29 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:9  peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:10 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:11 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:12 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:13 peak_num:2 RatioP:2 Ratio1:18 Ratio2:3 Mian_ratio:32 Sub_ratio:13
```

Left sample addi th Right sample addi th

Idx 8:
Main ratio = 12+ peak+sample
= 12+(2-1)*2+(8-3)* 3
=12+2+15= 29

Idx 9:
Main ratio = 12+ peak+sample
= 12+(2-1)*2+(9-3)* 3
=12+2+18 = 32

Idx 13:
Main ratio = 12+ peak+sample
= 12+(2-1)*2+(9-3)* 3
=12+2+18 = 32
Sub ratio = 8+peak+sample
=8+(2-1)*2+(4-3)*3 =13

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Dynamic converge ratio threshold

- Compatible with previous version
  - Configure base sample and base peak to very large
  - For example, configure to 30.

Base range = 30
Ratio Per Sample = 2
Base peak = 30
Ratio Per Peak = ~~3~~
Threshold Limit = 50

Dynamic TH = Main/Sub TH + Sample additional TH + Peak additional TH
Sample additional TH =0
Peak additional TH =0

Keep original threshold

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Dynamic threshold tuning parameters

- Locate at i4Coefs[100]

```
//==========================================================================================/
// name: m_i4DyBaseSample
// range: 0~30
// default: 3
// effect: While AF search sample(one side) larger than base sample, dynamic threshold will be raised.
//------------------------------------------------------------------------------------------/
3,      // [30] m_i4DyBaseSample
//==========================================================================================
// name: m_i4DyRatioPerSample
// range: 0~10
// default: 3
// effect: While AF search sample(one side) larger than base sample, dynamic threshold will be raised this ratio per over sam
//------------------------------------------------------------------------------------------/
3,      // [31] m_i4DyRatioPerSample
//==========================================================================================
// name: m_i4DyBasePeak
// range: 0~5
// default: 1
// effect: While AF search peak number larger than base peak number, dynamic threshold will be raised.
//------------------------------------------------------------------------------------------/
1,      // [32] m_i4DyBasePeak
//==========================================================================================/
// name: m_i4DyRatioPerPeak
// range: 0~10
// default: 2
// effect: While AF search peak number larger than base peak number, dynamic threshold will be this ratio per over peak number
//------------------------------------------------------------------------------------------/
2,      // [33] m_i4DyRatioPerPeak
//==========================================================================================/
// name: m_i4DyLimitTH
// range: 15~80
// default: 50
// effect: If dynamic threshold larger than limit the final threshold will be limit threshold
//------------------------------------------------------------------------------------------/
50,     // [34] m_i4DyLimitTH
```

Default value:
i4Coefs[30]: Base range(Base Sample) = 3
i4Coefs[31]:Ratio Per Sample = 3
i4Coefs[32]:Base peak = 1
i4Coefs[33]:Ratio Per Peak = 2
i4Coefs[34]:Threshold Limit = 50

- Default value for no parameters in NVRAM

```
m_i4DyBaseSample = (m_sAFNvram.i4Coefs[30]==0) ? 3   : clipValue(m_sAFNvram.i4Coefs[30], 0, 30);
m_i4DyRatioPerSample = (m_sAFNvram.i4Coefs[31]==0) ? 3   : clipValue(m_sAFNvram.i4Coefs[31], 0, 10);
m_i4DyBasePeak = (m_sAFNvram.i4Coefs[32]==0) ? 1   : clipValue(m_sAFNvram.i4Coefs[32], 0, 5);
m_i4DyRatioPerPeak = (m_sAFNvram.i4Coefs[33]==0) ? 2   : clipValue(m_sAFNvram.i4Coefs[33], 0, 10);
m_i4DyLimitTH = (m_sAFNvram.i4Coefs[34]==0) ? 50   : clipValue(m_sAFNvram.i4Coefs[34], 15, 80);
```

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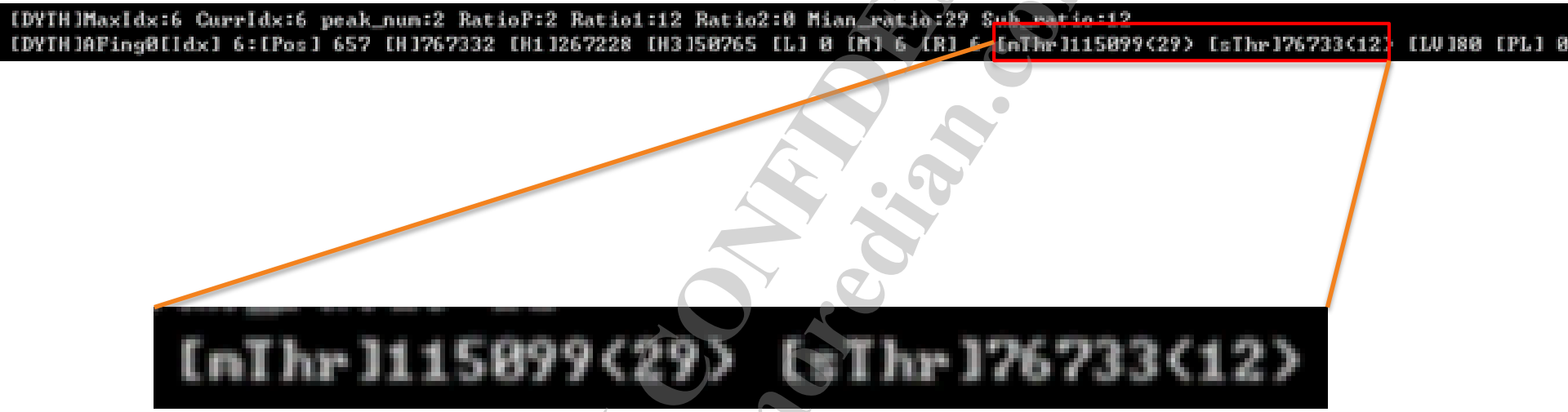
Dynamic threshold debug log

- Search keyword “DYTH”



[mThr] value <ratio> [sThr] value <ratio>

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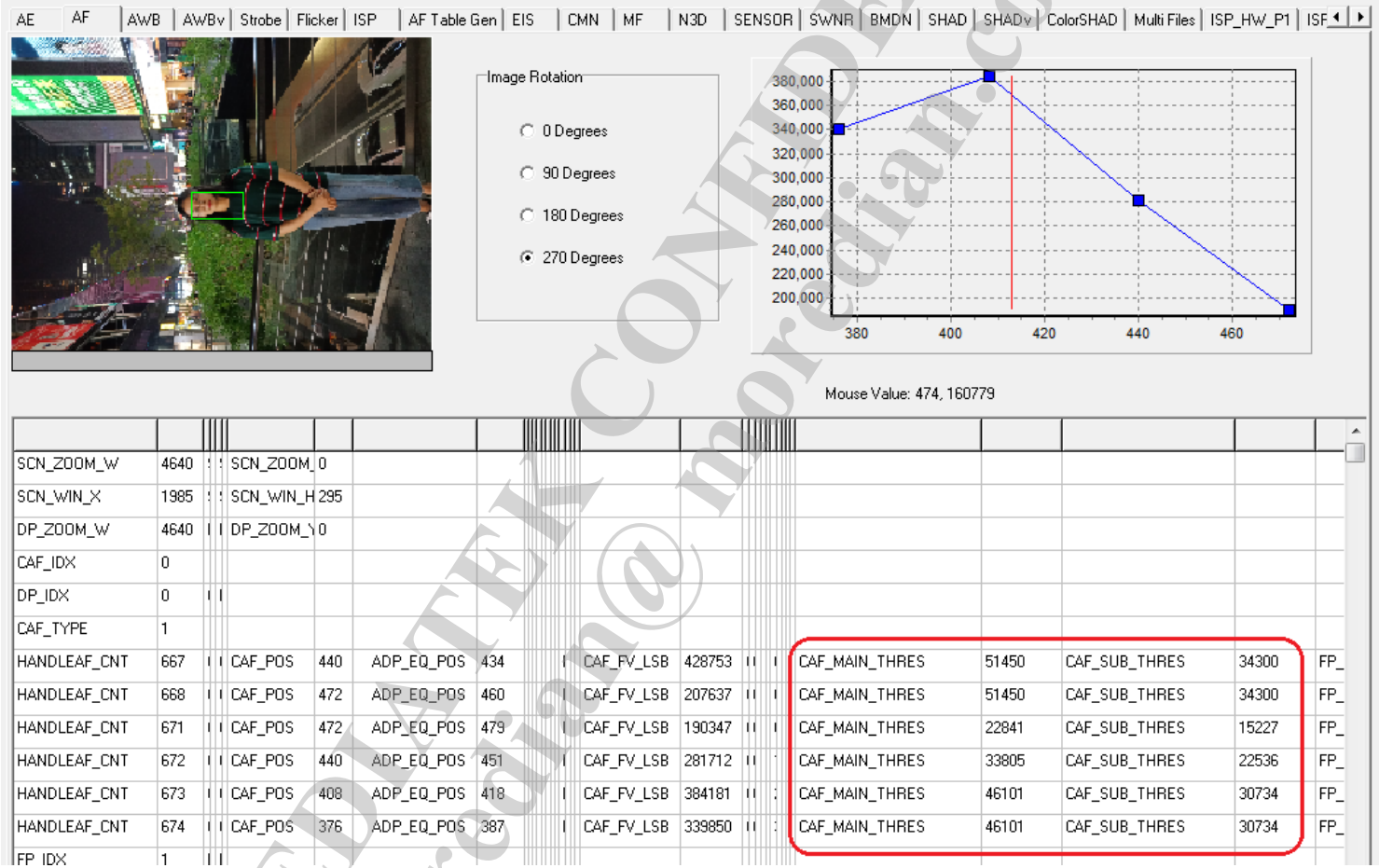
Dynamic threshold exif debug parser

- Original exif has included dynamic threshold info



Update main/sub threshold each frame

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PD improvement

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PD core tuning introduction

- **PD core tuning**
  1. PD confidence is calculated by PD core library
     (MTK lib or sensor vendor lib like SONY lib)
  2. By MTK lib, there is some tuning guide to influence PD confidence value.

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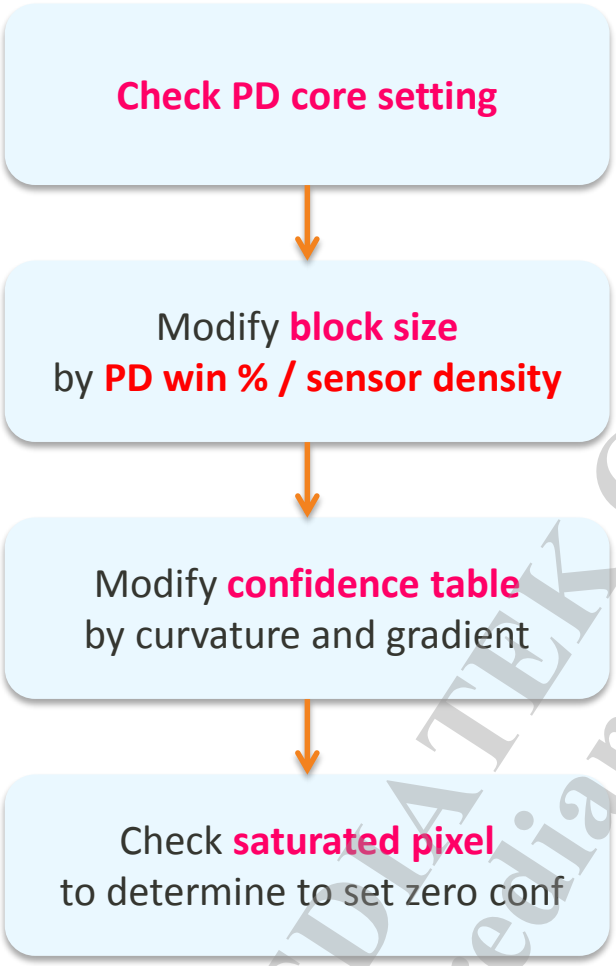
PD tuning flow



- **Check PD core setting**
  1. For AF v5.0 : enable new core
  2. For AF v5.0 new feature : enable dynamic search range(don't need tuning anything)

- **Modify block size**
  1. Modified by sensor density spec
  2. Tuning the percentage : PD win / image size

- **Modify confidence table**
  1. Tuning confidence table by gradient value
  2. Keep default similarity setting is recommended

- **Check saturated pixel**
  1. If saturated pixel number exceeds threshold, confidence will be set to zero.

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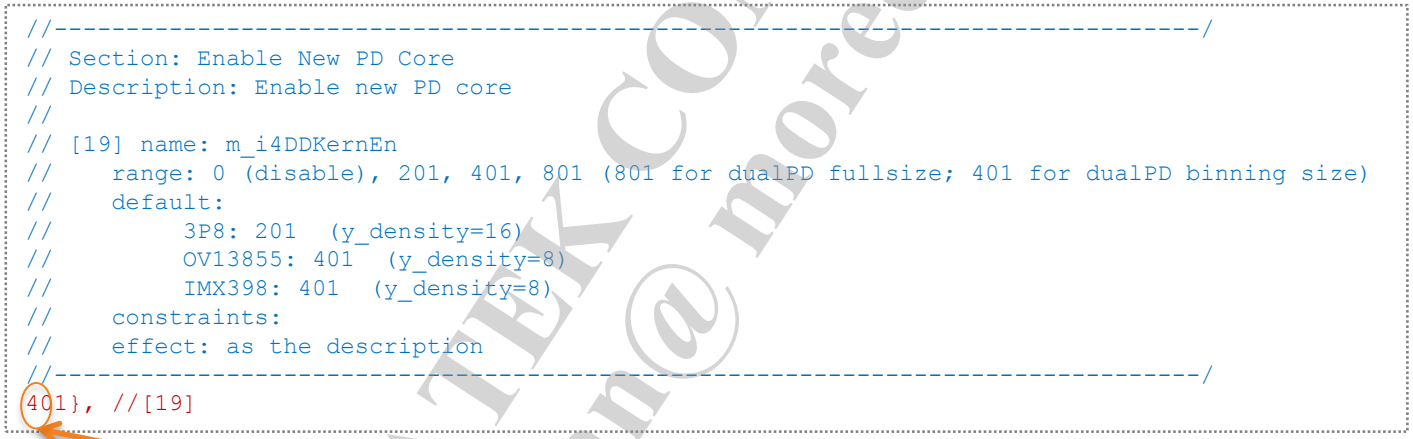
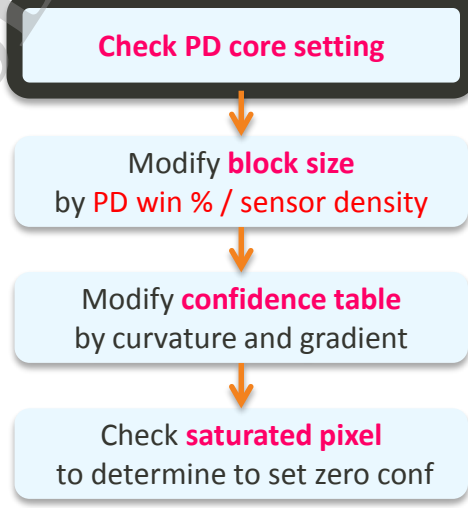
Enabling New Core

- PD ALG 5.0 has two different cores. We strongly recommend using the new core.
- Parameter
  - 201 or 401 (enable): The new core is used.
    To set 201 or 401 depends on sensor density.
  - 0 (disable): The old core is used.



- Example log

```
PdAlgo   : KenrEn = 1, DZFctr = 4, SmplFctr = 1
```



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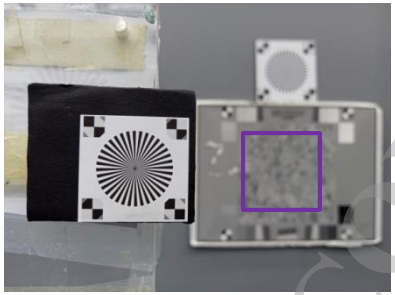
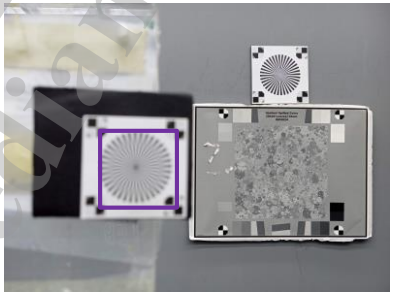
Dynamic Search Range

- The search range can be dynamically determined according to the current position, minimum position, and maximum position.
- The following problems can be alleviated.



The ideal PD value is very big(not within the search range).



The ideal PD value is very small(not within the search range).

- Parameter

```
//-----------------------------------------------------------------------------/
// Section: Dynamic Search Range (PD Core 5.0)
// Description: The search range will be dynamically determined according to current position,
//    min position, and max position.
//
// [17] name: m_i4DSREn
//    range: 0 to 1
//    default: 1  (enable)
//    constraints:
//    effect: as the description
//-----------------------------------------------------------------------------/
1, //[17]
```

- Example log

```
PdAlgo  : [DSR] En=1
```

```
PdAlgo  : [calSrchRng] Start=-12, End=28, En=1, MinPos=200, MaxPos=800
```

Check PD core setting

↓

Modify **block size** by **PD win % / sensor density**

↓

Modify **confidence table** by curvature and gradient

↓

Check **saturated pixel** to determine to set zero conf

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Block Size

Modified by tuning Modified by sensor spec

- $Size_X = (Width_{RAW} \times M\,\%) / density_X$
  - E.g., $(4640 \times (36\,\%/3)) / 16 = 34.8$
  - The largest multiple of 4 that is less than 34.8->32
- $Size_Y = (Height_{RAW} \times N\,\%) / density_Y$
  - E.g., $(3488 \times (36\%/3)) / 16 = 26.2$
  - The largest multiple of 4 that is less than 26.4->24
- Parameter

```
//------------------------------------------------------------------------------/
// Section: PD Block Size
// Description: Determine PD block width and height
//
// i4FocusPDSizeX (width)
// i4FocusPDSizeY (height)
//    range: [0]  32 to (raw_width/x_density),  [0]  24 to (raw_height/y_density)
//    default:
//         3P8: SizeX=32,  SizeY=24 (x_density=16, y_density=16)
//         OV13855: SizeX=32,  SizeY=48 (x_density=16, y_density=8)
//         IMX258: SizeX=64,  SizeY=24  (x_density=8, y_density=16)
//         IMX398: SizeX=64,  SizeY=48 (x_density=8, y_density=8)
//    constraints: must be a multiplier of 4
//    effect: A large block takes longer computation time than a small block.
//------------------------------------------------------------------------------/
32,  // i4FocusPDSizeX
24,  // i4FocusPDSizeY
```

- Example log

```
PdAlgo   : m_tuningData.X = 32, m_tuningData.Y = 24
```

Check PD core setting

Modify **block size** by PD win % / sensor density

Modify **confidence table** by curvature and gradient

Check **saturated pixel** to determine to set zero conf

```
36, //[1] tracking_width
36, //[2] tracking_height
3, //[3] max_pd_win_x
3, //[4] max_pd_win_y
```

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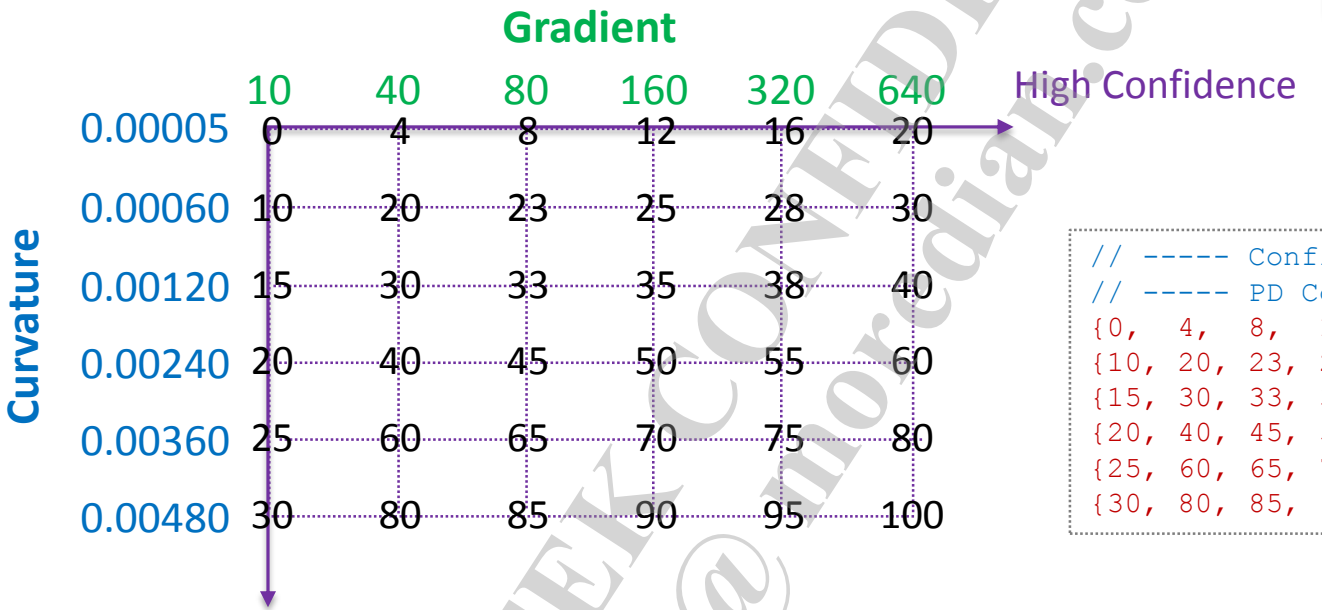
Confidence Level

- The confidence is determined by the gradient and the curvature.



Check PD core setting

↓

Modify **block size** by PD win % / sensor density

↓

Modify **confidence table** by curvature and gradient

↓

Check **saturated pixel** to determine to set zero conf

```
// ----- Confidence Table -----
// ----- PD Core 5.0  ----
{0,  4,  8,  12, 16, 20},
{10, 20, 23, 25, 28, 30},
{15, 30, 33, 35, 38, 40},
{20, 40, 45, 50, 55, 60},
{25, 60, 65, 70, 75, 80},
{30, 80, 85, 90, 95, 100}
```

- The gradient and curvature thresholds can be adjusted.
- The higher the threshold, the lower the confidence.
- Example log

```
PdAlgo : [calConf] conf=36, curv=0.00124, grad=207, idx=(3,4), sat=0.00000
PdAlgo : [calConf] conf=86, curv=0.00405, grad=590, idx=(5,5), sat=0.00000
```

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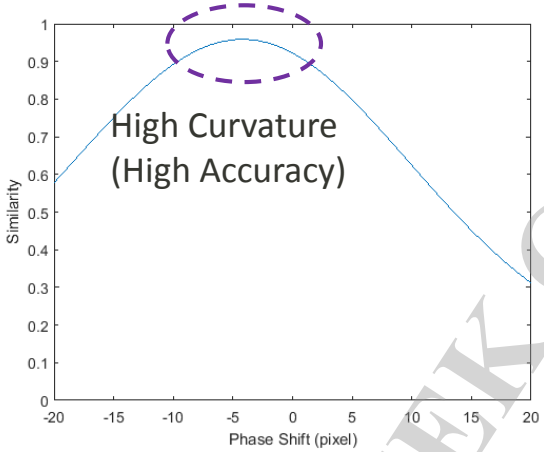
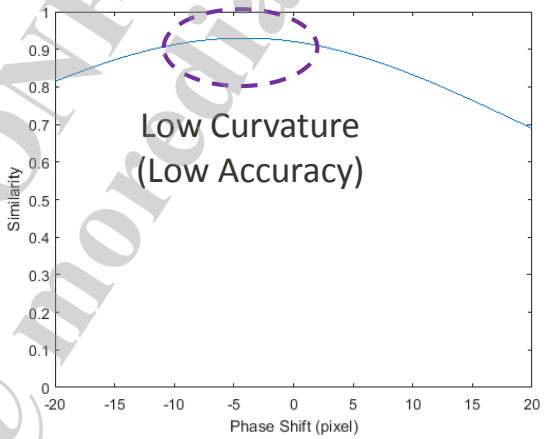
Curvature (1/2)

- The curvature of the similarity function is used as the primary index for determining the confidence.





Check PD core setting

↓

Modify **block size**
by PD win % / sensor density

↓

Modify **confidence table**
by curvature and gradient

↓

Check **saturated pixel**
to determine to set zero conf

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Curvature (2/2)

- Parameter
  - The higher the threshold, the lower the confidence.

```
//-------------------------------------------------------------------------------/
// Section: Curvature Threshold (PD Core 5.0)
// Description: The curvature is compared with these thresholds.
//
//[5] name: m_fCurvThd[0]
//[6] name: m_fCurvThd[1]
//[7] name: m_fCurvThd[2]
//[8] name: m_fCurvThd[3]
//[9] name: m_fCurvThd[4]
//[10] name: m_fCurvThd[5]
//    range: 1 to 100000
//    default: [5] 5 [6]  60 [7] 120 [8] 240 [9] 360 [10] 480
//    constraints: The latter should be larger than the former.
//        [6] should be larger than [5]. [7] should be larger than [6].
//    effect: The higher the threshold, the lower the confidence.
//-------------------------------------------------------------------------------/
5, 60, 120, 240, 360, 480,  //[5] to [10]
```

Check PD core setting

↓

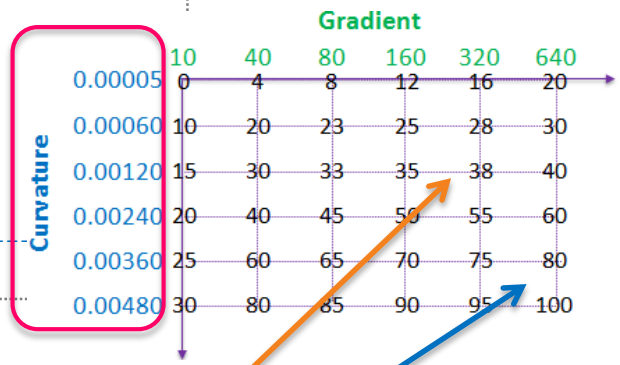
Modify **block size** by PD win % / sensor density

↓

Modify **confidence table** by curvature and gradient

↓

Check **saturated pixel** to determine to set zero conf



- Example log

```
PdAlgo  : CurvThd = 0.00005 0.00060 0.00120 0.00240 0.00360 0.00480
```

```
PdAlgo : [calConf] conf=36, curv=0.00124, grad=207, idx=(3,4), sat=0.00000
PdAlgo : [calConf] conf=86, curv=0.00405, grad=590, idx=(5,5), sat=0.00000
```

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Gradient

- The gradient is used as the secondary index for determining the confidence.

High Gradient

Low Gradient

- Parameter
  - The higher the threshold, the lower the confidence.

```
//-----------------------------------------------------------------------
// Section: Gradient Threshold (PD Core 5.0)
// Description: The gradient is compared with these thresholds.
//
//[11] name: m_i4GradThd[0]
//[12] name: m_i4GradThd[1]
//[13] name: m_i4GradThd[2]
//[14] name: m_i4GradThd[3]
//[15] name: m_i4GradThd[4]
//[16] name: m_i4GradThd[5]
//     range: 1 to 16368
//     default: [11] 10 [12] 40 [13] 80 [14] 160 [15] 320 [16] 640
//     constraints: The latter should be larger than the former.
//         [6] should be larger than [5]. [7] should be larger than [6].
//     effect: The higher the threshold, the lower the confidence.
//-----------------------------------------------------------------------/
10, 40, 80, 160, 320, 640,  //[11] to [16]
```

Curvature \ Gradient	10	40	80	160	320	640
0.00005	0	4	8	12	16	20
0.00060	10	20	23	25	28	30
0.00120	15	30	33	35	38	40
0.00240	20	40	45	50	55	60
0.00360	25	60	65	70	75	80
0.00480	30	80	85	90	95	100

- Example log

```
PdAlgo  : GradThd = 10 40 80 160 320 640
```

```
PdAlgo : [calConf] conf=36, curv=0.00124, grad=207, idx=(3,4), sat=0.00000
PdAlgo : [calConf] conf=86, curv=0.00405, grad=590, idx=(5,5), sat=0.00000
```

Check PD core setting

Modify **block size** by PD win % / sensor density

Modify **confidence table** by curvature and gradient

Check **saturated pixel** to determine to set zero conf

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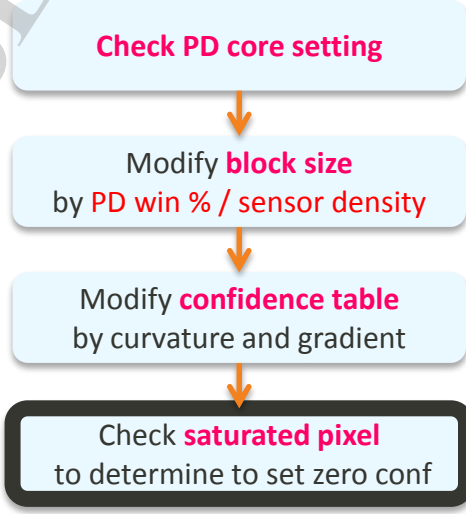
Saturation Level



- If the value of a pixel is larger than or equal to the saturation level, the pixel will be determined as a saturated pixel.

- Parameter

```
//----------------------------------------------------------------------------/
// Section: Saturation Level
// Description: If the value of a pixel is larger than or equal to the saturation level,
//    the pixel will be determined as a saturated pixel.
//
// name: i4SaturateLevel
//    range: 230 to 256
//    default: 240 (240/256)
//    constraints:
//    effect: as the description
//----------------------------------------------------------------------------/
240,  // i4SaturateLevel
```

- Example log

```
PdAlgo  : m_tuningData.SL = 240, m_tuningData.ST = 512
```

```
PdAlgo  : [sPDBlock] PD block = (2040, 1544, 576, 384), S var. = 268, S Cnt. = 201
```

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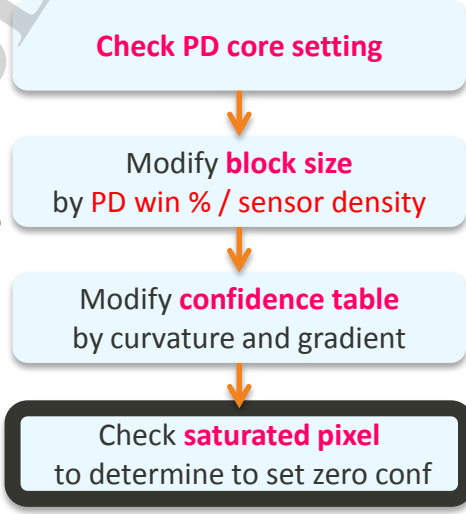
Saturation Threshold



- If the percentage (= the number of saturated pd pixels / the number of all pd pixels in one pd block) is larger than or equal to the threshold, the confidence level will be set to zero.
- The number of all pixels = PD block $Size_X \times Size_Y$
- Parameter

```
//-----------------------------------------------------------------------------/
// Section: Saturation Threshold
// Description: If the percentage (the number of saturated pixels over the number of pixels) is larger
//    than or equal to the threshold, the confidence level will be set to zero.
//
// name: i4SaturateThr
//    range: 1  to 512
//    default: 512 (100%)
//    constraints:
//    effect: as the description
//-----------------------------------------------------------------------------/
512,  //i4SaturateThr
```

512 :100%, means saturation pd num don't effect confidence

- Example log

```
PdAlgo  : m_tuningData.SL = 240, m_tuningData.ST = 512
```

```
PdAlgo  : [sPDBlock] PD block = (2040, 1544, 576, 384), S var. = 268, S Cnt. = 201
PdAlgo  : [calConf] conf=35, curv=0.00121, grad=204, idx=(3,4), sat=0.05815
```

In this example:
pd density x=8 pd density y=8
Total pd num=(576/8)*(384/8)=3456
Sat = 201/3456=0.05815=5.815%

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Log

- The log can be enabled via the following command.
  - adb shell setprop debug.pd.enable 1
- Example log

PD Value

```
PdAlgo  : [sPDBlock] PD block = (2072, 1544, 512, 384), S var. = 1759, S Cnt. = 0
PdAlgo  : [calSrchRng] Start=-20, End=20, En=1, MinPos=0, MaxPos=0
PdAlgo  : [cPD2D] pd=11.29095, r.=0.99470, r var.=0.00381
PdAlgo  : [calF] cur.=760, s=10.75738, foc.=639
PdAlgo  : [calConf] conf=82, curv=0.00381, grad=586, idx=(5,5), sat=0.00000
```

Confidence

Target Position
=cur. pos-pd*s
=760-11.29095*10.75738=638

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Hybrid AF improvement

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DYNAMIC WEAK THRESHOLD BY LV

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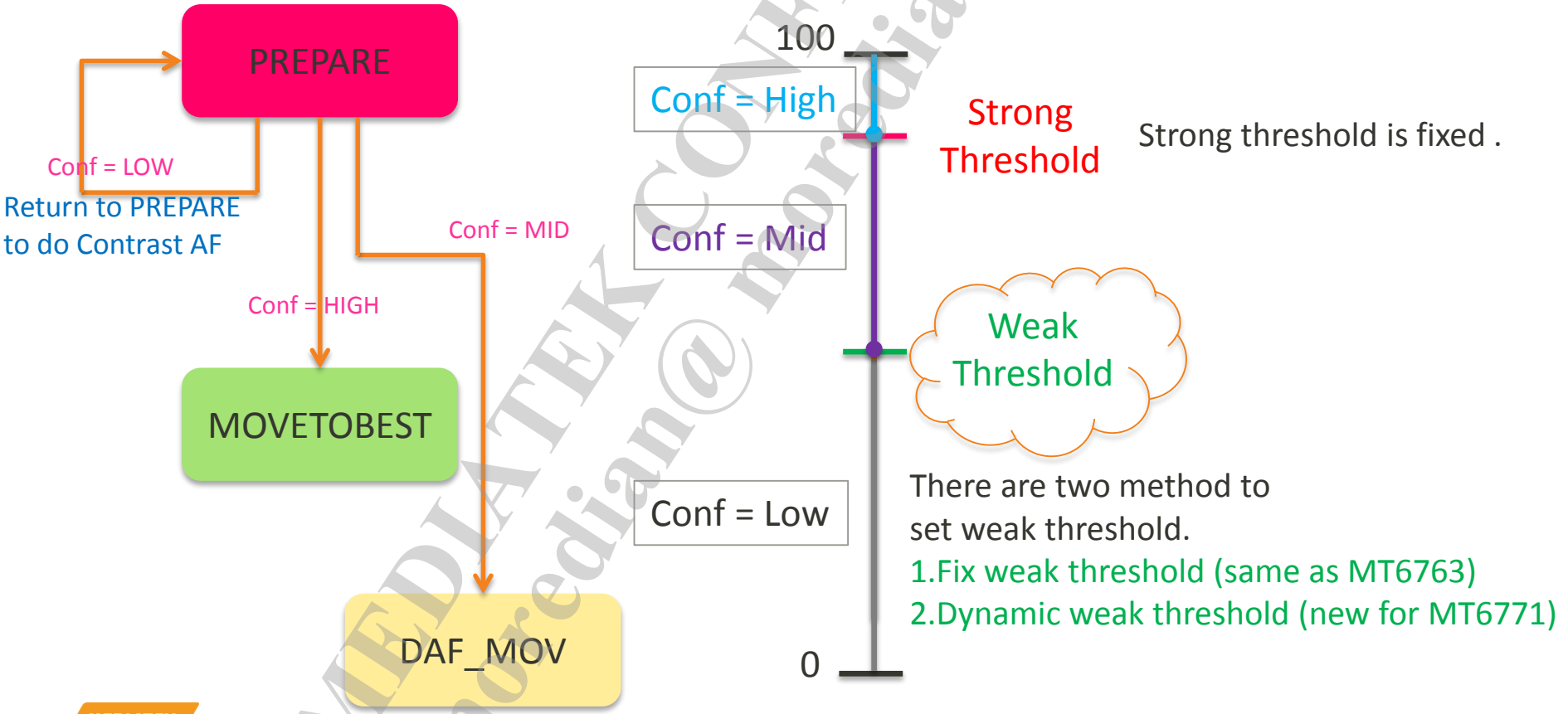
Dynamic Weak Threshold by LV

- Determine the next state by confidence level
  - There are two method to set weak threshold : **Fix and dynamic**



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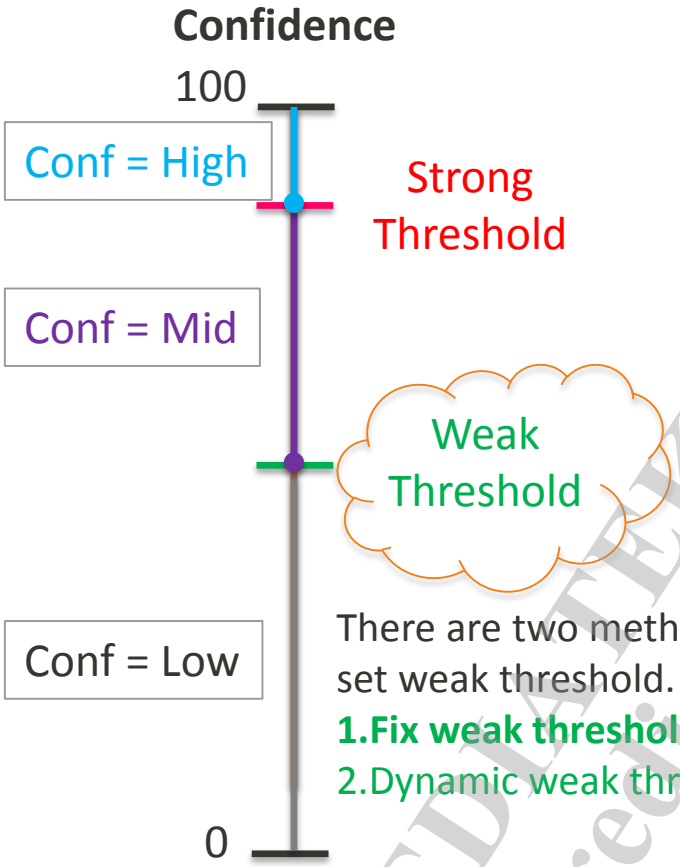
Dynamic Weak Threshold by LV - fixed

- Strong/weak threshold are fixed by parameter setting



There are two method to set weak threshold.

1.Fix weak threshold (same as MT6763)

2.Dynamic weak threshold (new for MT6771)

•Para @PDAF

[2]	Confidence weak threshold for CAF
[3]	Confidence strong threshold for CAF
[4]	Confidence weak threshold for TAF
[5]	Confidence strong threshold for TAF

•CAF/TAF can apply different threshold

```
50,  //[2] pd_weak_caf
110, //[3] pd_strong_caf
50,  //[4] pd_weak_taf
110, //[5] pd_strong_taf
```

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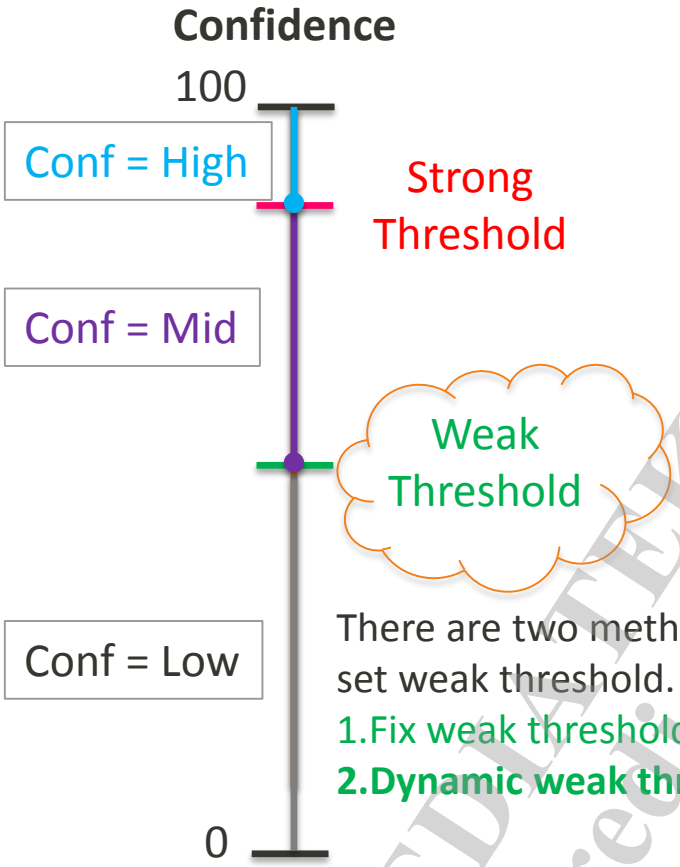
Dynamic Weak Threshold by LV - dynamic

- Strong/weak threshold are calculated by current LV



There are two method to set weak threshold.

1.Fix weak threshold (same as MT6763)

2.Dynamic weak threshold (new for MT6771)

•Para @PDAF

i4PDAFCoefs	Description
[51]	Dynamic weak threshold – Hight LV define
[52]	Dynamic weak threshold – Mid LV define
[53]	Dynamic weak threshold – Low LV define
[54]	Dynamic weak threshold at LV Hight
[55]	Dynamic weak threshold at LV Mid
[56]	Dynamic weak threshold at LV Low

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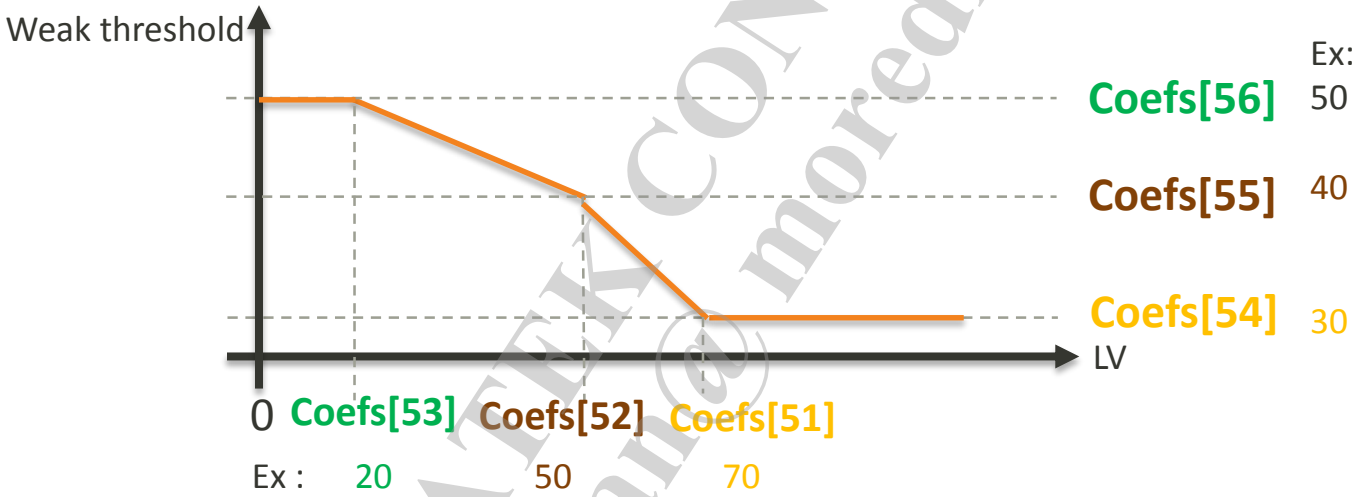
DYNAMIC WEAK THRESHOLD BY LV

- Dynamic weak threshold can use lower confidence in outdoor and use higher confidence in night scene
- Once this section Config. Original fix weak trehsold coef[2] will lose effectiveness



If curLV < 20 : thr is 50
If 20 < curLV < 50 : thr is 50~40
If 50 < curLV < 70 : thr is 40~30
If 70 < curLV : thr is 30

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Hybrid AF – Dynamic Weak Threshold by LV

Name	Description	Default Value	Note
[51] pd_dynamic_weak_lv_high	Dynamic weak threshold – Hight LV define	70	
[52] pd_dynamic_weak_lv_mid	Dynamic weak threshold – Mid LV define	50	
[53] pd_dynamic_weak_lv_low	Dynamic weak threshold – Low LV define	20	
[54] pd_dynamic_weak_threshold_high	Dynamic weak threshold at LV Hight	30	
[55] pd_dynamic_weak_threshold_mid	Dynamic weak threshold at LV Mid	40	
[56] pd_dynamic_weak_threshold_low	Dynamic weak threshold at LV Low	50	

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HYBRID SCENE CHANGE

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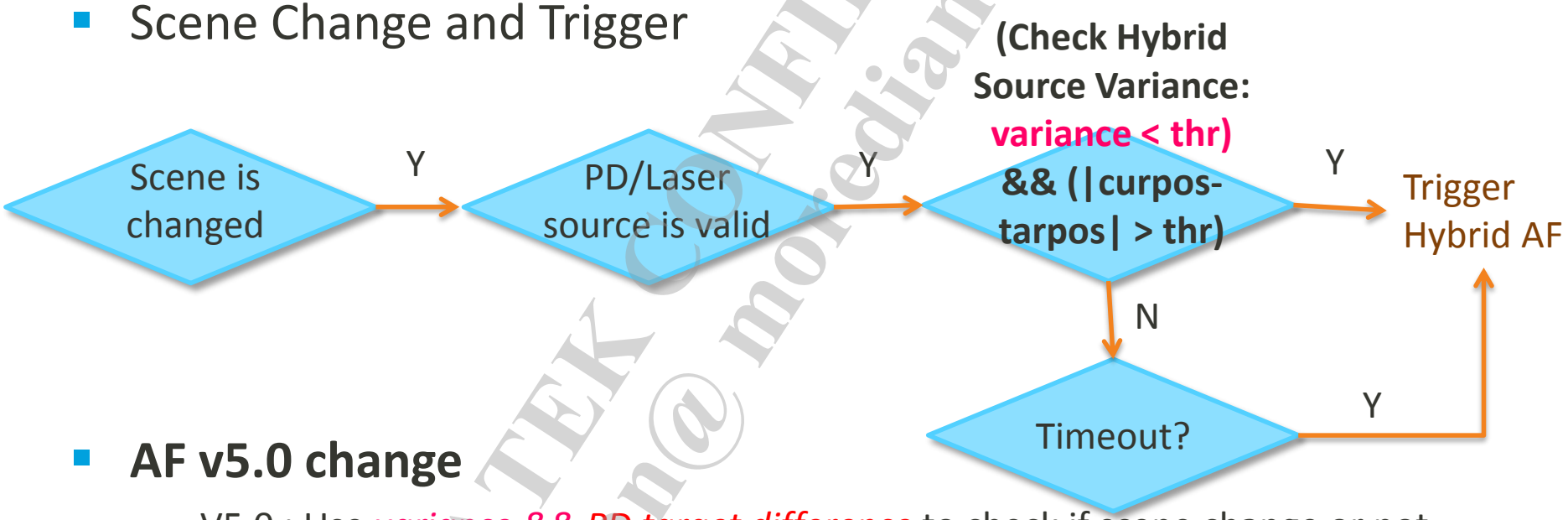
Hybrid scene change

- In this state, scene change detection is the same to CDAF except hybrid scene change.
- Scene Change and Trigger



- **AF v5.0 change**
  - V5.0 : Use *variance && PD target difference* to check if scene change or not
  - V4.0 : Use *PD target difference*

PD target difference

```
150, //[29] pd_trigger_threshold_inf
150, //[30] pd_trigger_threshold_mac
```

Timeout:

```
7, //[23] trigger_sensitivity_caf
-1, //[24] trigger_sensitivity_taf
```

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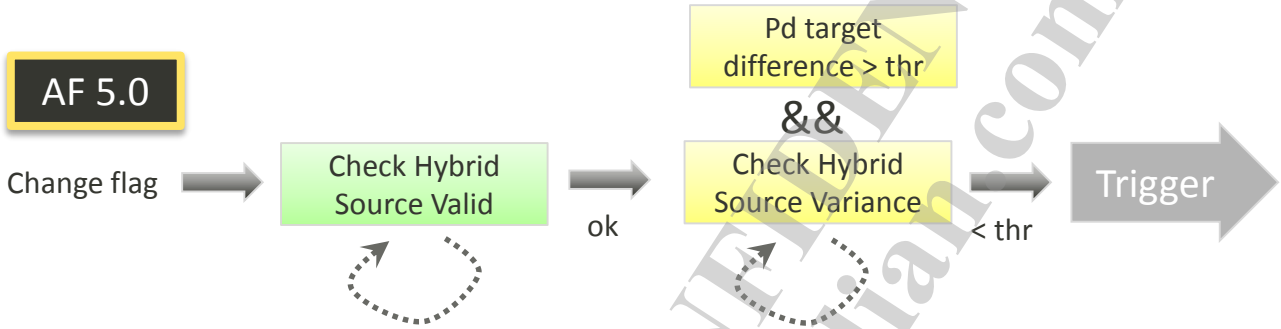
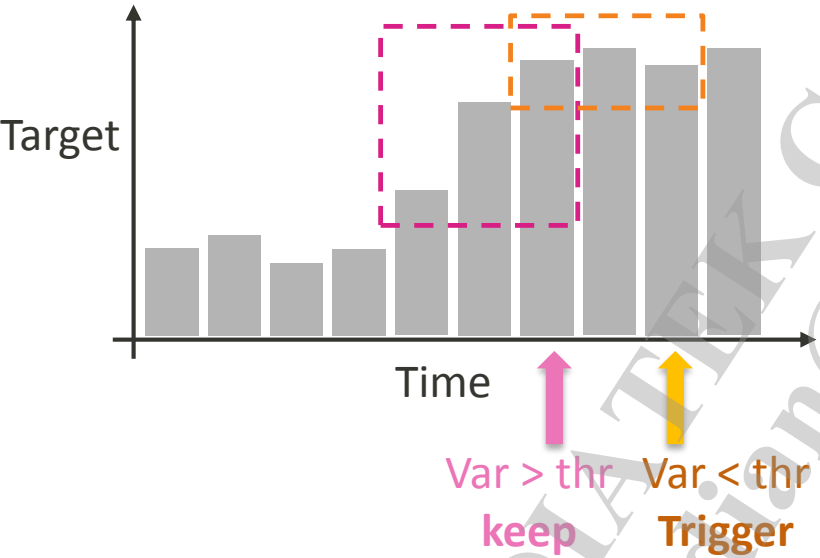
Hybrid scene change





- **Check Hybrid Source Variance**
  1. Check last para@[44] frame target and get calculate variance
  2. AF trigger condition : check if variance is smaller than para@[45] (threshold) for last para@[44] frames.

[44] pd_trigger_variance_frame	Trigger variance check frame number
[45] pd_trigger_variance	Variance under this value will give trigger signal

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Hybrid AF – Hybrid scene change

Name	Description	Default Value	Note
[21] pd_scene_enable	set 1 to let PD target change as scene change.	0	0 or 1
[22] pd_change_frame	increased this value to improve PDAF trigger stability ; decreased to improve sensitivity.	10	>0
[23] pd_change_thr	increased this value to improve PDAF trigger stability ; decreased toimprove sensitivity.	90 (DAC)	>=0
[24] pd_stable_frame	pd_stable_frame	10	>0
[25] pd_stable_thr	pd_stable_thr	90 (DAC)	>0
[26] pd_valid_confidence_chg	set what's confidence level data will use for PD scene change.	70	0~100
[27] pd_valid_confidence_stb	set what's confidence level data will use for PD scene stable.	70	0~100
[44] pd_trigger_variance_frame	Trigger variance check frame number	3	
[45] pd_trigger_variance	Variance under this value will give trigger signal	100	

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Log

- The log can be enabled via the following command.
  - adb shell setprop debug.af.enable 1
- Example log

```
AfAlgoC : [HB] DafIO in PD: mode 2 p1Num 0 dac 597 conf 85 PD value -643 isUpdate 1(1) dynamic 2, sub-win 0(PD)0(FV)
AfAlgoC : HBTrackS3 m 2 scene 0->0, trig 0, chg(0 0000 0000) stb(1 1111 1011), var 0(100) confThr 50, cnt 0(7), pd diff 6(24) pd stb conv 1
AfAlgoC : [HB] DafIO in PD: mode 2 p1Num 0 dac 597 conf 85 PD value -643 isUpdate 0(0) dynamic 2, sub-win 0(PD)0(FV)
AfAlgoC : HBTrackS3 m 2 scene 0->0, trig 0, chg(0 0000 0000) stb(1 1111 1011), var 0(100) confThr 50, cnt 0(7), pd diff 6(24) pd stb conv 1
AfAlgoC : [HB] DafIO in PD: mode 2 p1Num 0 dac 594 conf 61 PD value -395 isUpdate 1(1) dynamic 2, sub-win 0(PD)0(FV)
AfAlgoC : HBTrackS3 m 2 scene 0->0, trig 0, chg(0 0000 0000) stb(1 1110 1011), var 4(100) confThr 50, cnt 0(7), pd diff 3(24) pd stb conv 1
AfAlgoC : [HB] DafIO in PD: mode 2 p1Num 0 dac 594 conf 61 PD value -395 isUpdate 0(0) dynamic 2, sub-win 0(PD)0(FV)
AfAlgoC : HBTrackS3 m 2 scene 0->0, trig 0, chg(1 0000 0000) stb(0 1110 1011), var 4(100) confThr 50, cnt 0(7), pd diff 3(24) pd stb conv 1
AfAlgoC : [HB] DafIO in PD: mode 2 p1Num 0 dac 594 conf 51 PD value -369 isUpdate 1(1) dynamic 2, sub-win 0(PD)0(FV)
AfAlgoC : HBTrackS3 m 2 scene 0->0, trig 0, chg(1 0000 0000) stb(0 0110 1011), var 0(100) confThr 50, cnt 0(7), pd diff 3(24) pd stb conv 1
AfAlgoC : [HB] DafIO in PD: mode 2 p1Num 0 dac 593 conf 53 PD value -311 isUpdate 1(1) dynamic 2, sub-win 0(PD)0(FV)
AfAlgoC : HBTrackS3 m 2 scene 1->0, trig 0, chg(0 0000 0110) stb(1 0111 1011), var 0(100) confThr 50, cnt 2(7), pd diff 2(24) pd stb conv 1
AfAlgoC : [HB] DafIO in PD: mode 2 p1Num 0 dac 593 conf 53 PD value -311 isUpdate 0(0) dynamic 2, sub-win 0(PD)0(FV)
AfAlgoC : HBTrackS3 m 2 scene 1->0, trig 0, chg(0 0000 0110) stb(1 0111 1011), var 0(100) confThr 50, cnt 3(7), pd diff 2(24) pd stb conv 1
AfAlgoC : [HB] DafIO in PD: mode 2 p1Num 0 dac 586 conf 62 PD value 424 isUpdate 1(1) dynamic 2, sub-win 0(PD)0(FV)
AfAlgoC : [HB] DafIO in PD: mode 2 p1Num 0 dac 692 conf 46 PD value -11800 isUpdate 1(1) dynamic 2, sub-win 0(PD)0(FV)
AfAlgoC : HBTrackS3 m 2 scene 1->0, trig 0, chg(1 0001 1110) stb(0 0110 0011), var -2(100) conf Thr 50, cnt 2(7), pd diff 127(24) pd stb conv 0
AfAlgoC : [HB] DafIO in PD: mode 2 p1Num 0 dac 692 conf 46 PD value -11800 isUpdate 0(0) dy 2, sub-win 0(PD)0(FV)
AfAlgoC : HBTrackS3 m 2 scene 1->0, trig 0, chg(1 0001 1110) stb(0 0110 0011), var -2(100) confTh 2(7), pd diff 127(24) pd stb conv 0
AfAlgoC : [HB] DafIO in PD: mode 2 p1Num 0 dac 702 conf 46 PD value -12702 isUpdate 0(0) dynamic in 0(PD)0(FV)
AfAlgoC : HBTrackS3 m 2 scene 1->0, trig 0, chg(1 0001 1110) stb(0 0111 1111), var -2(100) confThr 50. pd stb conv 0
```

-2 : pd conf is low

Var current value(thr: [45] pd_trigger_variance)

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MID-LOW CONFIDENCE HANDLING

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New item

- Weighted PD Target
- Adjust Speed by Defocus and Confidence
- Fit Peak Protection

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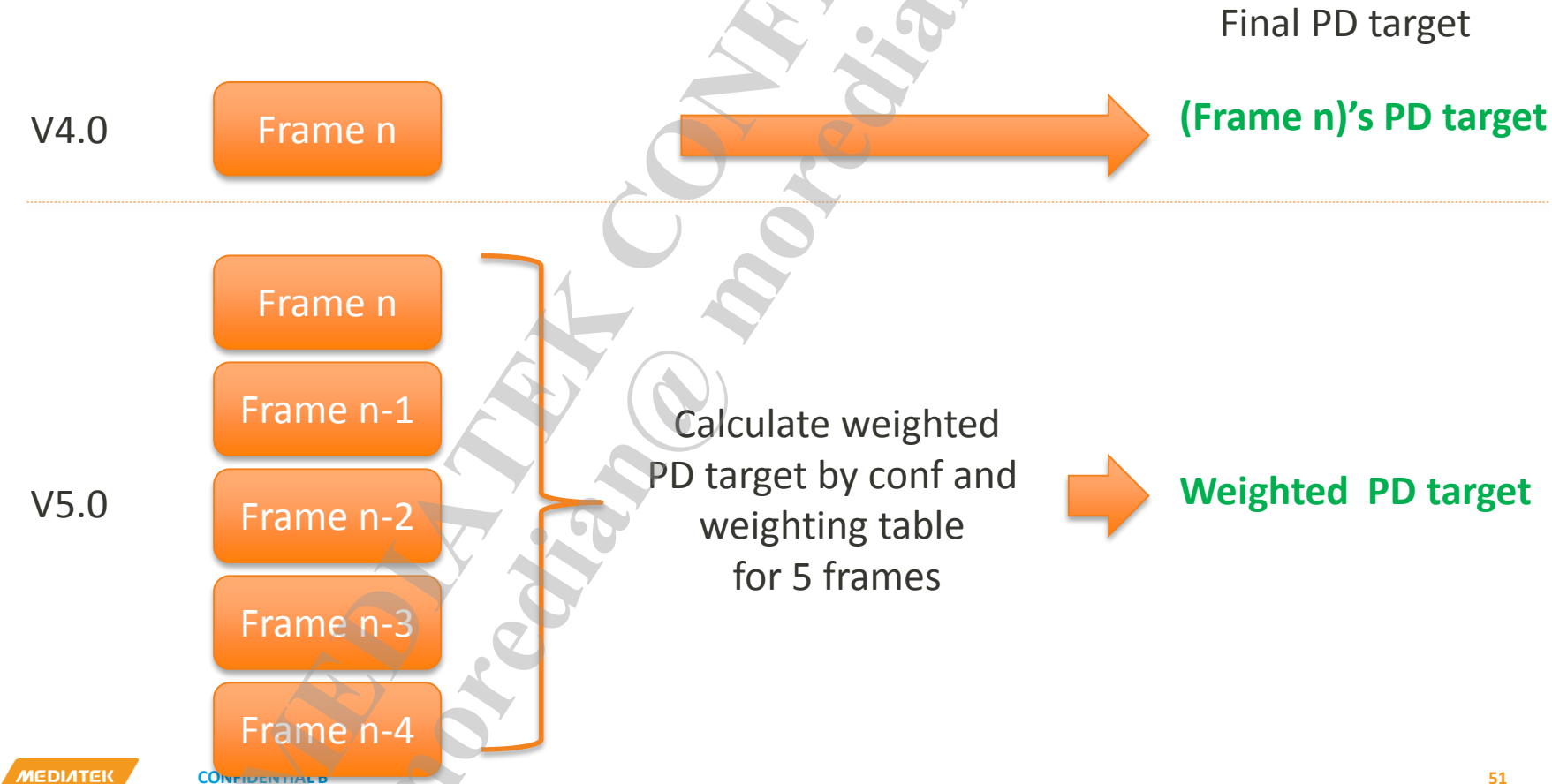
Weighted PD Target

- Purpose
  - Apply weighted PD target by smooth frames



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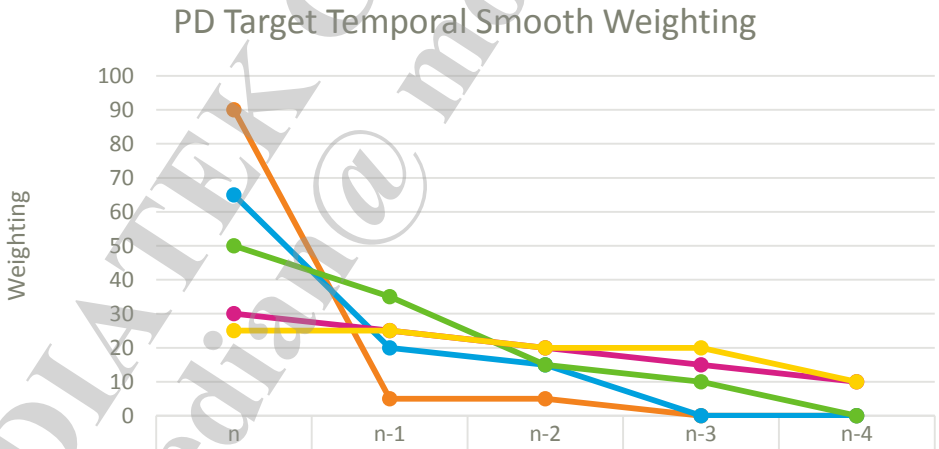
Weighted PD Target

- Weighted PD target calculation
  - Final weighting = **temporal weight** x confidence weight

Set value by parameter

By past 5 frame's confidence

  - Final PD target : tarPos * final weighting for 5 frames



	n	n-1	n-2	n-3	n-4
100~80	90	5	5	0	0
79~60	65	20	15	0	0
59~40	50	35	15	10	0
39~20	30	25	20	15	10
19~0	25	25	20	20	10

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Weighted PD Target

- Weight table setting by parameter
  - Set a temporal smooth weight table for past 5 frame at each confidence level region.
  - The default value is the higher confidence the lower smooth weighting.

i4PDAFCoefs	[46]	[47]	[48]	[49]	[50]
Confidence	100~80	79~60	59~40	39~20	19~0
Default	1	1	2	2	3
Ex: no smooth	1	1	1	1	1
Ex: smooth all	5	5	5	5	5

Table :
50 30 20 0 0

This table is fixed. Only selection by parameter

	N	N-1	N-2	N-3	N-4
1	100	0	0	0	0
2	70	20	10	0	0
3	50	30	20	0	0
4	40	30	20	10	0
5	25	25	20	20	10

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PDAF – Weighted PD target

Name	Description	Default Value	Note
[46] pd_temp_smooth_conf_80_100	select a temporal smooth weighting table for each confidence level	1	1~5
[47] pd_temp_smooth_conf_60_79	select a temporal smooth weighting table for each confidence level	1	1~5
[48] pd_temp_smooth_conf_40_59	select a temporal smooth weighting table for each confidence level	2	1~5
[49] pd_temp_smooth_conf_20_49	select a temporal smooth weighting table for each confidence level	2	1~5
[50] pd_temp_smooth_conf_0_19	select a temporal smooth weighting table for each confidence level	3	1~5

```
        n,   n-1,  n-2, n-3, n-4
    +------------------------
(1)| 100,   0,    0,   0,   0, //temporal smooth lv1
(2)| 70,    20,   10,  0,   0, //temporal smooth lv2
(3)| 50,    30,   20,  0,   0, //temporal smooth lv3
(4)| 40,    30,   20,  10,  0, //temporal smooth lv4
(5)| 25,    25,   20,  20,  10, //temporal smooth lv5
```

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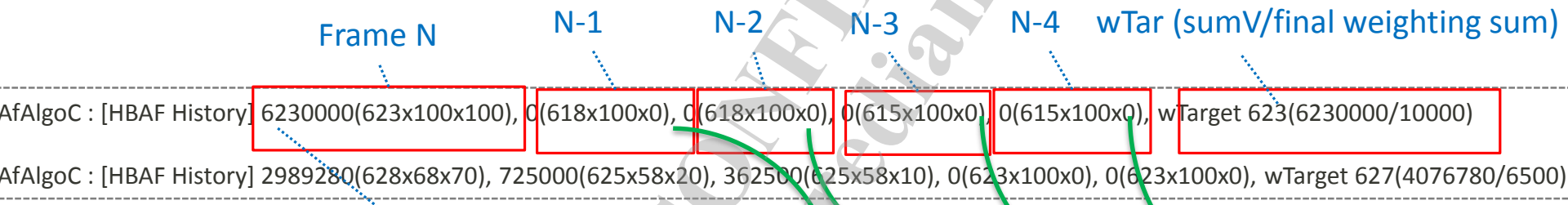
Log

- The log can be enabled via the following command.
  - adb shell setprop debug.af.enable 1
- Example log



Target 623 x confidence 100 x conf weighting 100

	N	N-1	N-2	N-3	N-4
1	100	0	0	0	0
2	70	20	10	0	0
3	50	30	20	0	0
4	40	30	20	10	0
5	25	25	20	20	10

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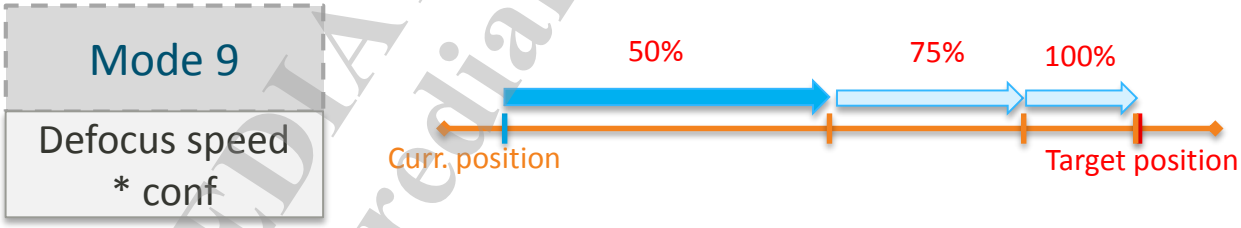
Adjust Speed by Defocus and Confidence

- Purpose
  - Move large step when far away form target ; move quick when close to target
  - Original Mode1-Mode8 (see next 3 pages)
  - Add new moving mode – Mode 9
- Concept (Mode 9)
  - Final moving speed = defocus speed x confidence



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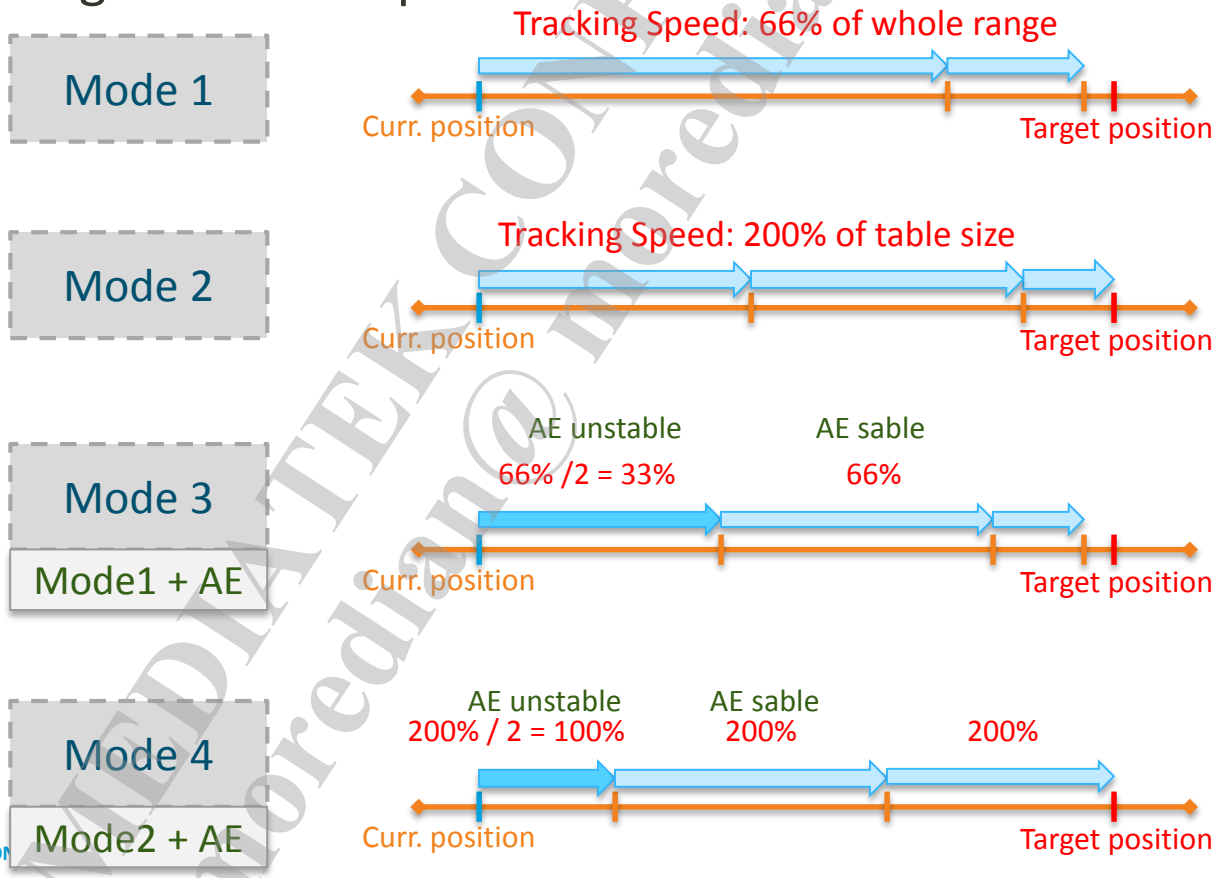
Moving mode

- **Target moving and contrast-based fine search (middle Confidence)**
  - Moving mode and speed



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Moving mode

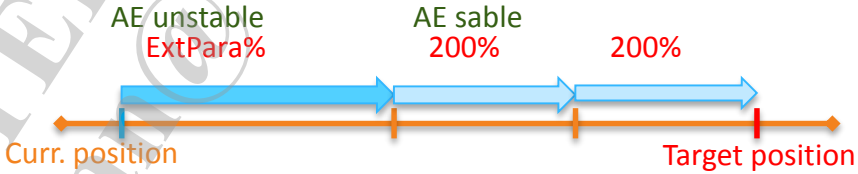
– Moving mode and speed

Mode 7

加速
+Moe1+AE

Mode 8

加速
+Mode2+AE



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Moving mode

SpeedMode	description	movSize	movSpeed
1	Speed% step	|tarPos-curPos|	ori_speed
2	tableSize*speed	TableSize	ori_speed
3 Mode1 + AE	When AE unstable	|tarPos-curPos|	ori_speed/deltaBV
4 Mode2 + AE	When AE unstable	TableSize	ori_speed/deltaBV
7 Speed up+Mode1+AE	When AE unstable	|tarPos-curPos|	ExtPara
8 Speed up+Mode2+AE	When AE unstable	TableSize	ExtPara

SpeedMode [para]: Speed mode for moving to infinity
ori_speed [para] : moving to infinity speed
ExtPara [para] : Extend param for moving to inf
deltaBV: come from AFinput

```
8,    //[11] pd_move_mode_inf
150,  //[12] pd_move_speed_inf
8,    //[13] pd_move_mode_mac
150,  //[14] pd_move_speed_mac
75,   //[15] pd_move_ext_inf
75,   //[16] pd_move_ext_mac
```

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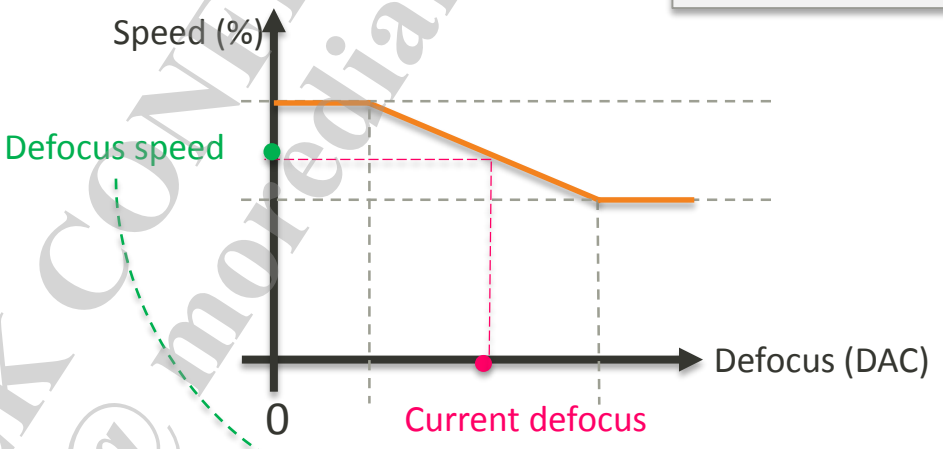
Adjust Speed by Defocus and Confidence

- Speed calculation

Mode 9
Defocus speed * conf



Get defocus speed by right curve

Calculate final speed by conf weighting

$$Final\ Speed = \frac{(100 - W) \times speed\ by\ defocus + W \times PD\ confidence}{100}$$

W : weighting , set by parameter

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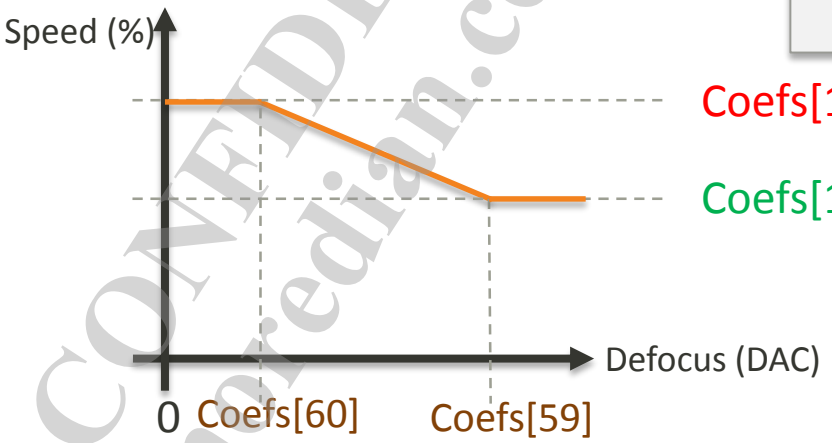
Adjust Speed by Defocus and Confidence

Mode 9

Defocus speed * conf

- Speed calculation



Get defocus speed by right curve

Calculate final speed by conf weighting

i4PDAFCoefs	Description	Default
[11]	Set moving speed mode 9 to enable. (inf direction)	9
[12]	speed for long defocus size (inf direction)	40
[13]	Set moving speed mode 9 to enable. (mac direction)	9
[14]	speed for long defocus size (mac direction)	40
[15]	speed for short defocus size (inf direction)	100
[16]	speed for short defocus size (mac direction)	100
[59]	Long defocus threshold (% of af table size)	50
[60]	short defocus threshold (% of af table size)	5

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Adjust Speed by Defocus and Confidence

- Speed calculation

Mode 9
Defocus speed * conf

Get defocus speed by right curve

Calculate final speed by conf weighting

Let confidence weighting = W

$$Final\ Speed = \frac{(100 - W) \times speed\ by\ defocus + W \times PD\ confidence}{100}$$

i4PDAFCoefs	Description
[61] pd_move_speed_conf_weighting	Confidence weighting (1~100)

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Adjust Speed by Defocus and Confidence

Name	Description	Default Value	Note
[11] pd_move_mode_inf	Set moving speed mode 9 to enable. (inf direction)	9	
[12] pd_move_speed_inf	speed for long defocus size (inf direction)	40	
[13] pd_move_mode_mac	Set moving speed mode 9 to enable. (mac direction)	9	
[14] pd_move_speed_mac	speed for long defocus size (mac direction)	40	
[15] pd_move_ext_inf	speed for short defocus size (inf direction)	100	
[16] pd_move_ext_mac	speed for short defocus size (mac direction)	100	
[59] pd_move_ext2	Long defocus threshold (% of af table size)	50	
[60] pd_move_ext3	short defocus threshold (% of af table size)	5	
[61] pd_move_speed_conf_weighting	Confidence weighting (1~100)	40	

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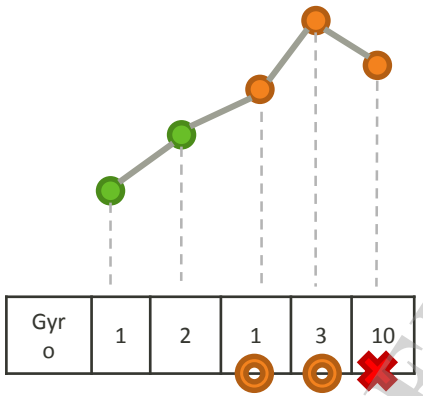
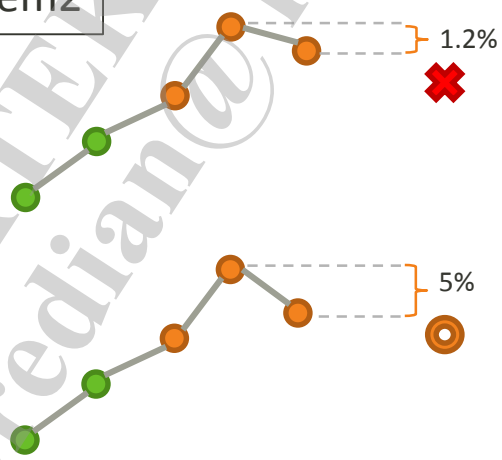
Fit Peak Protection

- Purpose
  - Check each condition when peak found, if not satisfy check item, keep finesearch
- Check item
  - Item1 : Gyro < threshold
  - Item2 : FV is not flat when mid-low confidence
  - Item3 : Position after adaptive damping compensation is normal (must be increase or decrease)

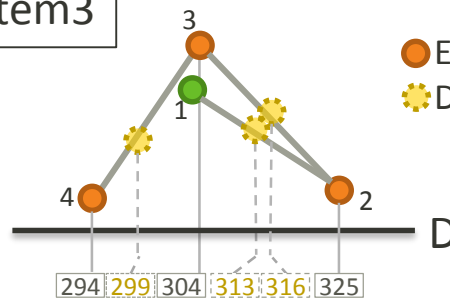
Item1



Item2



Item3



Expected fit pos. : 325 -> 304 -> 294

Damping fit pos. : 313 -> 316 -> 299

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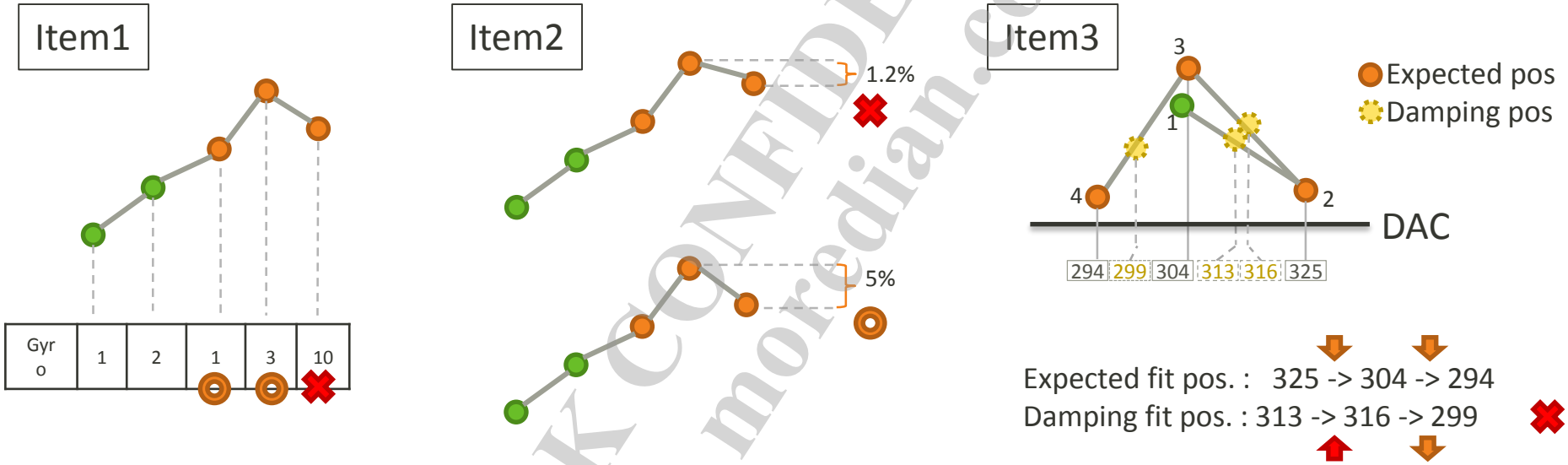
Fit Peak Protection

- Parameter



	i4HybridAFCoefs	Description	Default
Item2	[49] flat fv	FV protection ratio (0~100 %)	2
Item1	[64] gyro stable	Gyro stable protection	10
	[68] mid-low confidence	Mid-Low confidence threshold	50

FV protection function[49] active when confidence < mid-low confidence threshold[68]

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Hybrid AF - Fit Peak Protection

Name	Description	Default Value	Note
[49] flat fv	FV protection ratio (0~100 %)	2	
[64] gyro stable	Gyro stable protection	10	
[68] mid-low confidence	Mid-Low confidence threshold	50	

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Face af improvement

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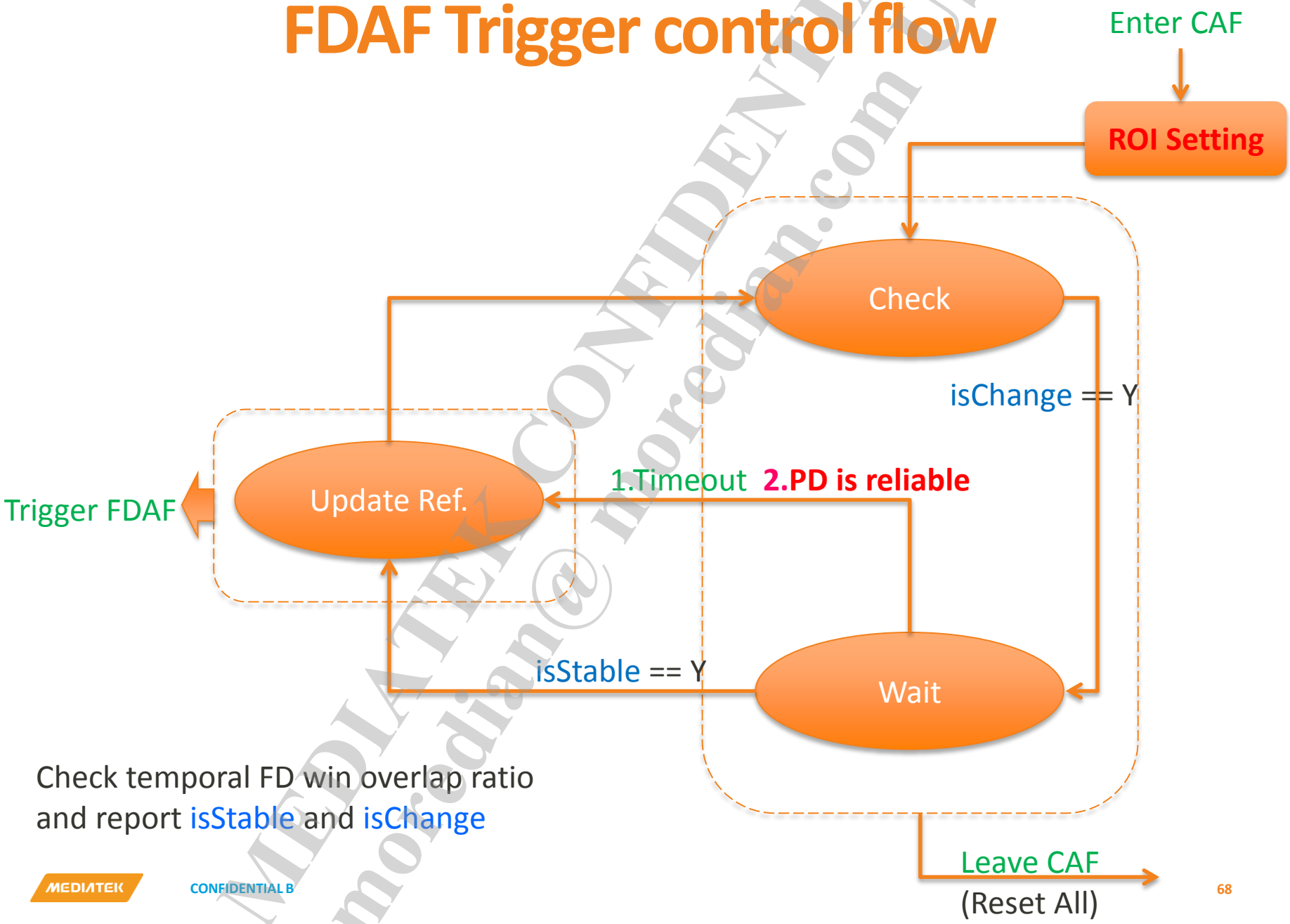
FDAF Trigger control flow



Check temporal FD win overlap ratio
and report isStable and isChange

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Face AF v5.0 – ROI setting

– Accuracy

Face type	Ratio (of TG)	ROI (v5.0 new)	ROI (v4.0)
Small	<= 10%	**LM extension**	FD or FD extract
Normal	> 10%	Finer LM selection	FD or FD extract

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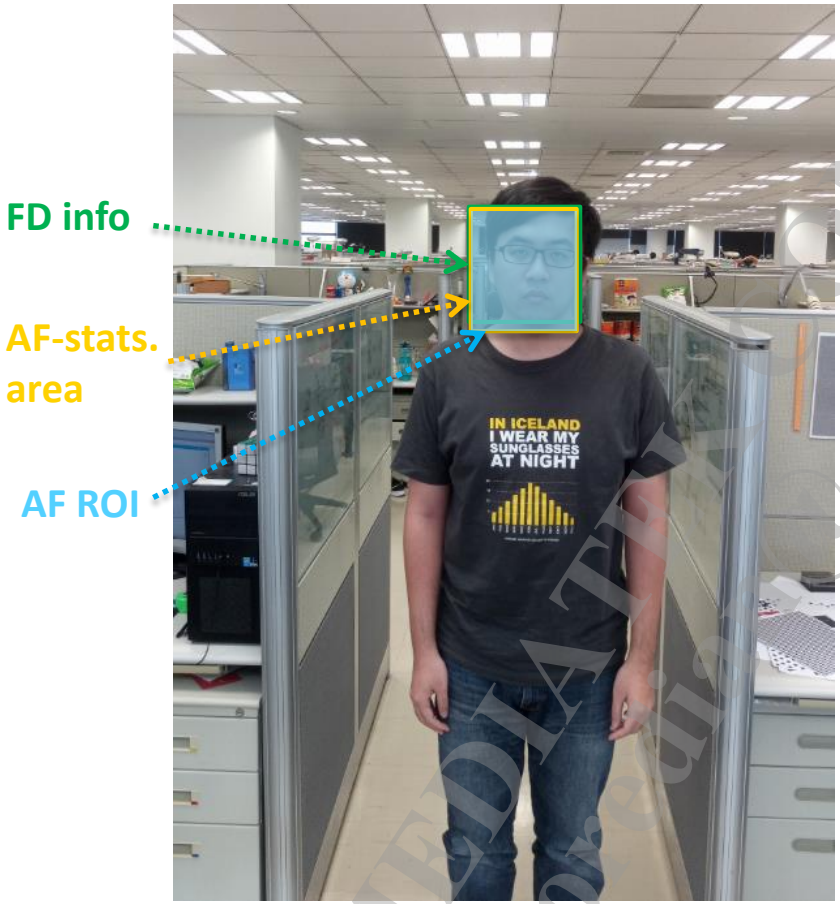
LM extension

FaceAF v4.0 [@6763]

FD info

AF-stats. area

AF ROI

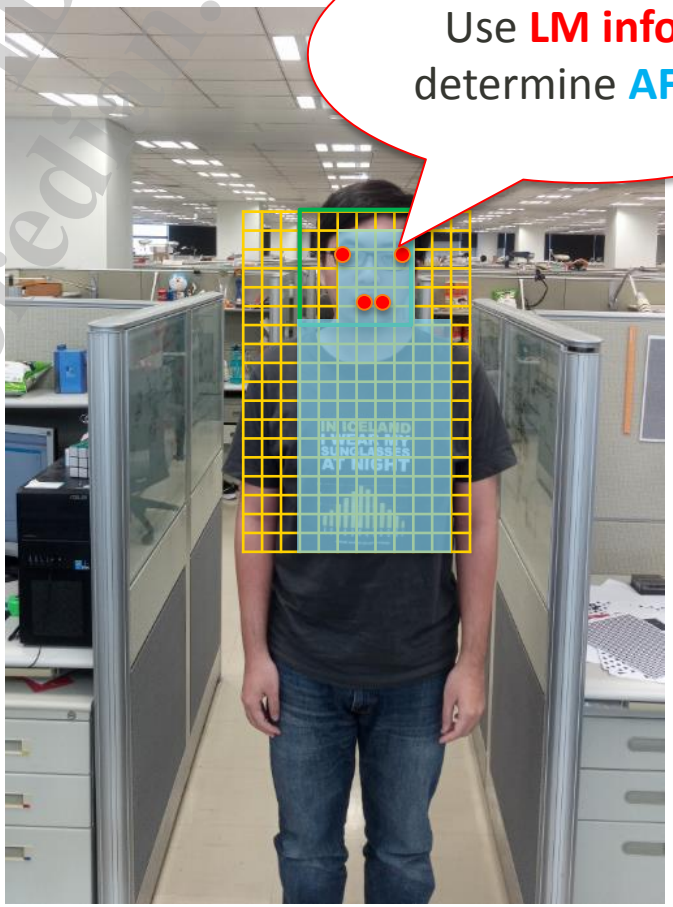


FaceAF v5.0 [@6771]

FD info + LM info

AF-stats. area

AF ROI



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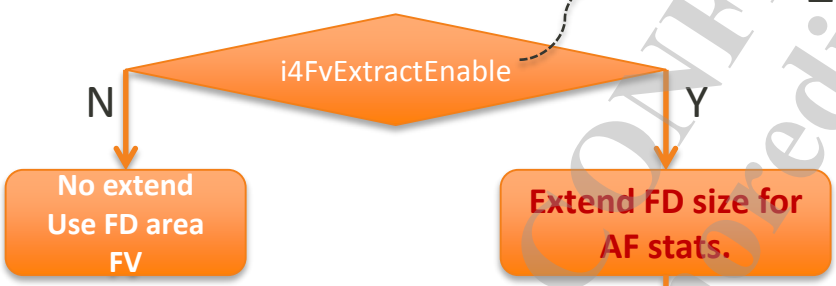
LM extension

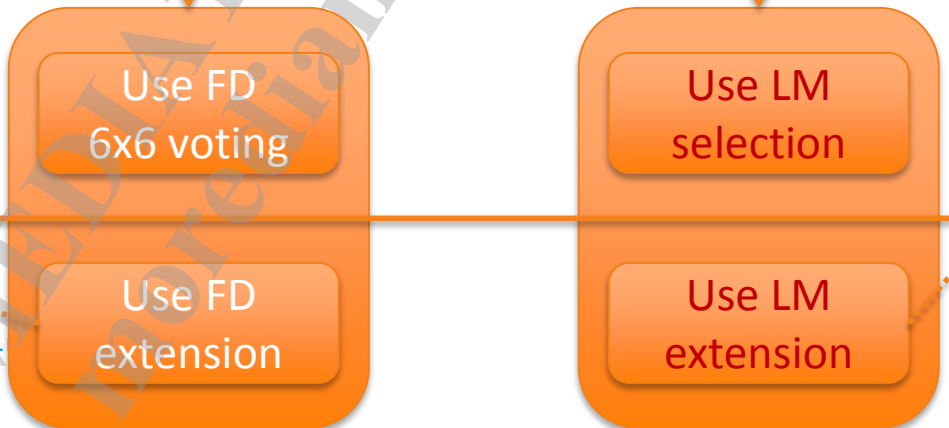
Face type	Ratio (of TG)	ROI (v5.0 new)	ROI (v4.0)
Small	<= 10%	**LM extension**	FD or FD extract
Normal	> 10%	Finer LM selection	FD or FD extract

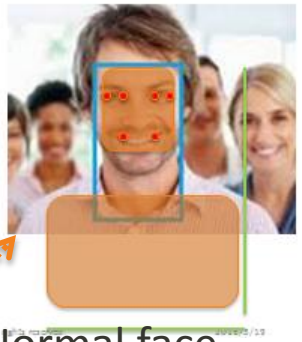
Para: [7] face small face ratio

Para:face_fv_extract_enable



Para:[6] face adv ext mode





Normal face

Small face

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Face AF v5.0 – FDAF Trigger

Parameter Name	Description
[1] face_af_tracking_enable	Enable pd tracking for FaceAF (0:CAF, 1:PDAF, 2:TrackingAF)

- Smoothness
  - V4.0 – Need to wait for stable and then trigger FDAF
  - V5.0 – Trigger FDAF if PD is reliable
  - Fast trigger with smoothness approval by PD
- Face AF tracking
  - Enable : i4PDAFCoefs[1] set to 2
  - Once enable, it can work without other tuning.

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TUNING PARAMETER DESCRIPTION

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Face AF - NVRAM

Name	Description	Default Value	Note
fd_win_percent	no-used		
fd_size_diff	no-used		
fd_detect_cnt	no-used		
fd_none_cnt	no-used		
face_fv_extract_enable	faceAF fv metering	1	
face_fv_extract_thr	voting threshold	50	

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FDAF — Overview

Name	Description	Default Value	Note
[0] face_af_enable	Enable FaceAF v5.0	2	0~2
[1] face_af_tracking_enable	Enable pd tracking for FaceAF (0:CAF, 1:PDAF, 2:TrackingAF)	2	0~2
[2] face_reliable_weight	Add more detect cnt for reliable FD result (MTK FD only)	1	1~3
[3] face_detect_num	Face detected cnt > face_detect_num and stable, FD status = 1	3	3~20
[4] face_none_num	Face not detected cnt > face_none_num and stable, FD status = 0	3	3~20
[5] face_no_input_num	Face no input cnt > face_no_input_num, FD status = 0	30	3~20
[6] face adv ext mode	LM-faceAF(+2) , small face handling(+1)	3	0~15
[7] face small face ratio	Small face threshold ratio (%) of TG width, ex: default 10%	10	
[8] ~[10]	Keep default	0	

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FDAF — Overview

Name	Description	Default Value	Note
[11] change_mode	FD horizontal movement AF re-trigger	0	0 or 1
[12] change_threshold	FD change when ratio < change_threshold	70 (%)	1~99
[13] change_range	FD change check range, should >= change_num	3	3~20
[14] change_num	FD change check number, should <= change_range	3	3~20
[15] stable_mode	Reserved	0	0
[16] stable_threshold	FD stable when ratio > stable_threshold	80 (%)	1~99
[17] stable_range	FD stable check range, should >= stable_num	5	3~20
[18] stable_num	FD stable check number, should <= stable_range	5	3~20
[19] timeout_num	When FD unstable count > timeout_num, re-trigger AF	30	3~60
[20] ~ [30]	Reserved	0,0,0,0,0, 0,0,0,0,0,0,	

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CONFIDENTIAL B

PLAF

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CONCEPT INTRODUCTION

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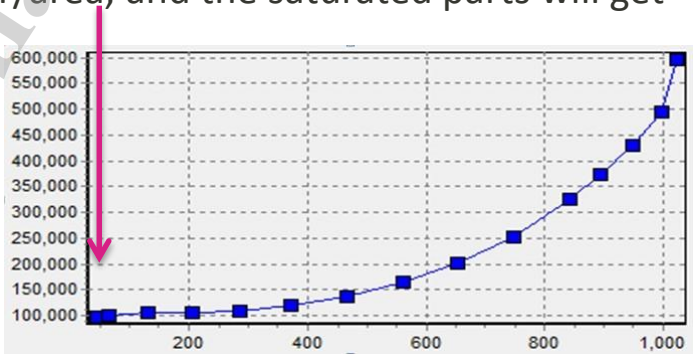
PLAF — Introduction

- Spatial sharpness image filter can generate focus value (FV) for auto focus (AF) to find best focus lens position.
- Since it is effective and simple, it is widely used in camera system.
- However, the point light (PL) scene can confuse it, and make AF miss-focused.
- PL scenes contain saturated (over-exposure) spots/bar/area, and the saturated parts will get bigger & bigger with image blur.
- It causes FV growing with image blur, and AF fail.



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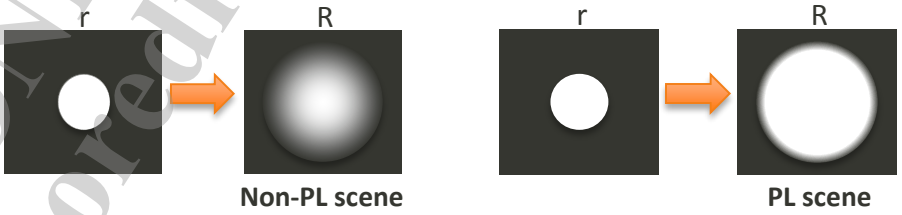
PL detector

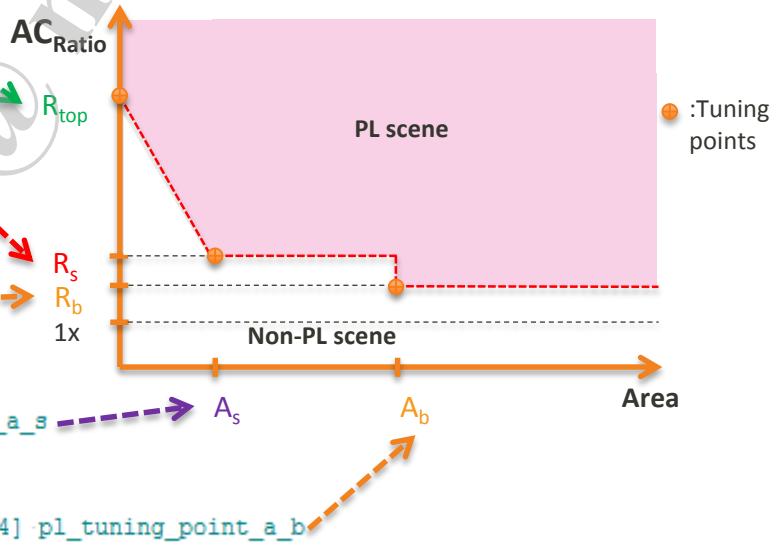
- **Detect PL scene**
  - Check the changes ratio of area when normal AF searching.
    - PL scene should have sufficient area changes ratio.
  - For realization, we use 32-histogram weighted result for area, and get the ratio.

AC_{Ratio} = Area(R) / Area(r)

Area = $Hist_{255}W_{255} + Hist_{248}W_{248}$ …




```
1000,        // [1] pl_tuning_point_r_top
 260,        // [3] pl_tuning_point_r_s
 140,        // [5] pl_tuning_point_r_b
2000000,     // [2] pl_tuning_point_a_s
4500000,     // [4] pl_tuning_point_a_b
```



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PL CAF CASE

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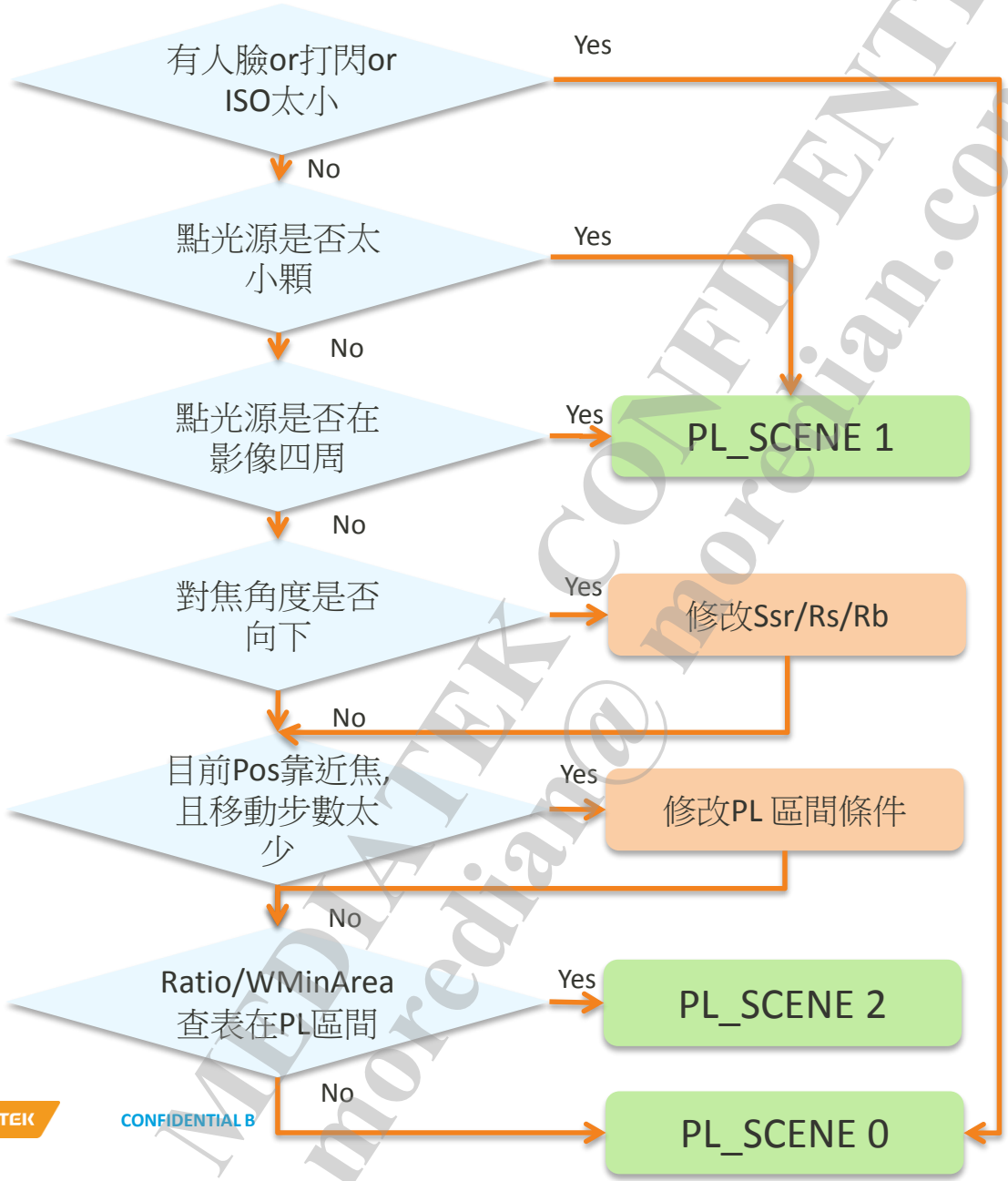
PL detector – CAF Case

SEEK



PL_SCENE 0: Non-PL
PL_SCENE 1: PL abort
PL_SCENE 2: CAF PL
PL_SCENE 3: PDAF PL

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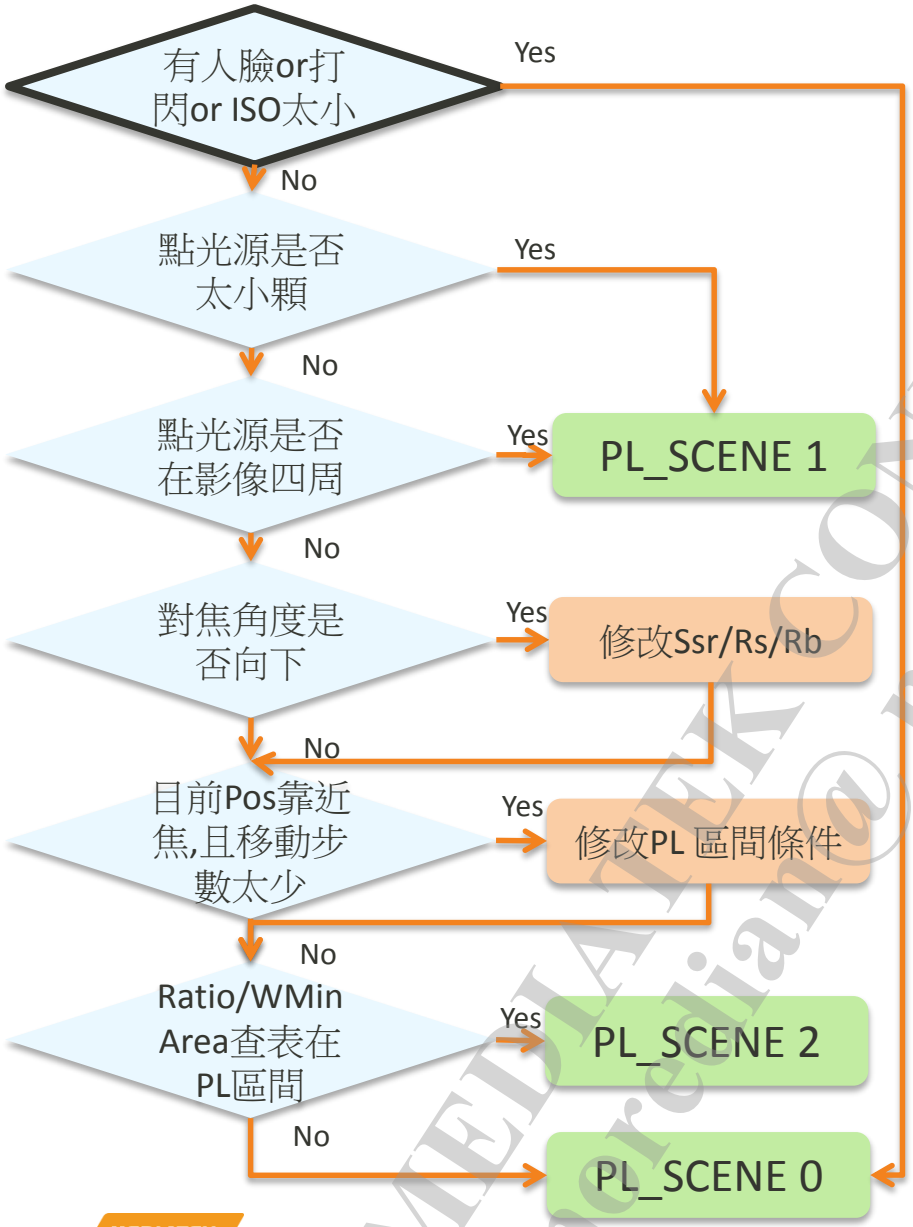
PL detector – CAF Case

SEEK



打閃是否偵測點光源

i4PLAFCoefs[7]

[10]	PLAF will have no effect when flash on.	1

ISO TH調整參數

i4PLAFCoefs[7]

bit[0...3]	ISO threshold for TAF. (x100)	3 (ISO 300)
bit[4...7]	ISO threshold for CAF. (x100)	3 (ISO 300)

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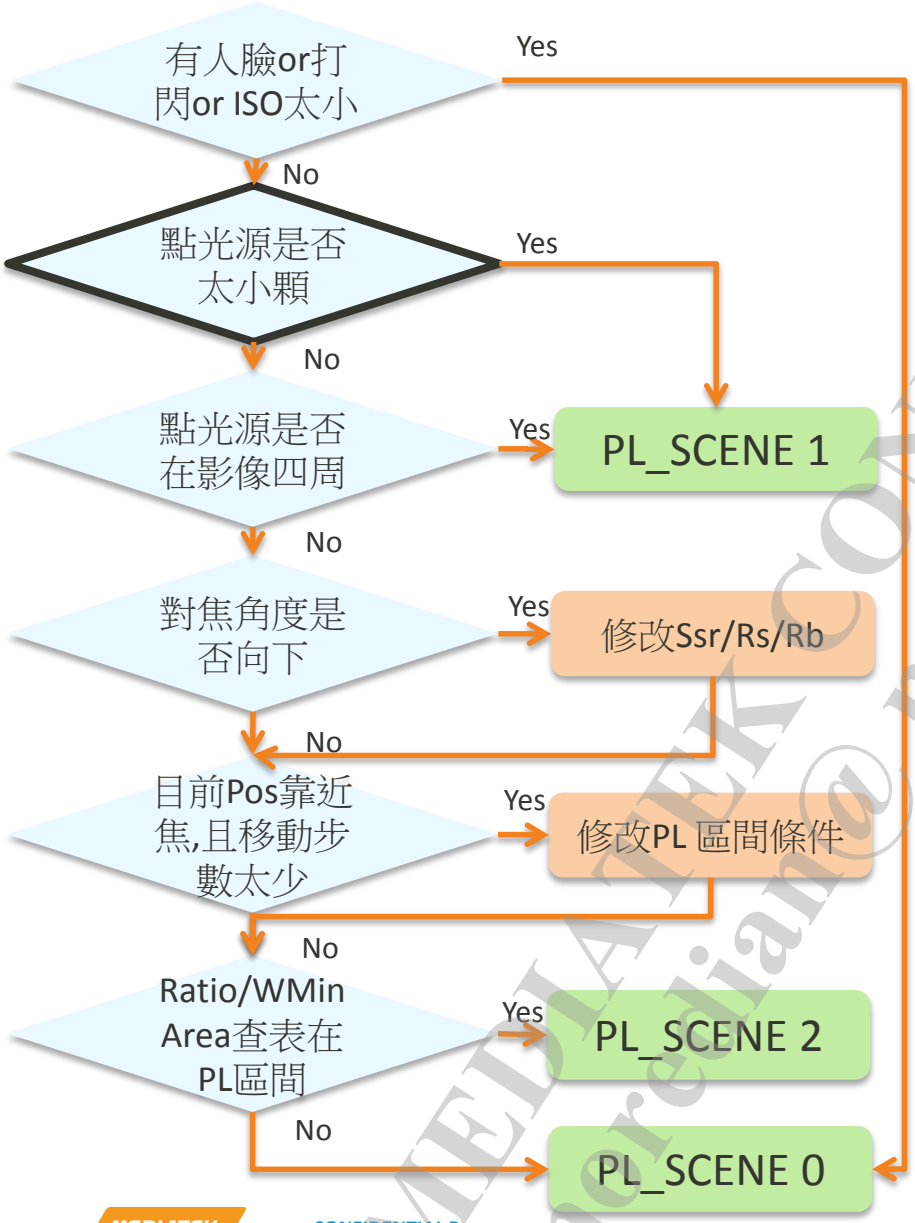
PL detector – CAF Case

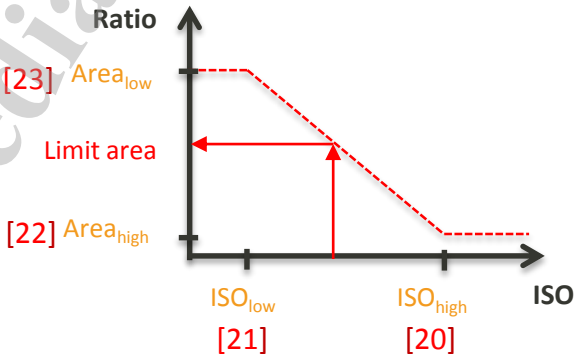
SEEK



如何判斷點光源太小顆

(PL_WMinArea<limitWArea && ISO<PLISOHigh) or
(PL_WMinArea<100 && ISO>PLISOHigh)

如何算limitWArea



i4PLAFCoefs[64]

[20]	PlIsoHigh	**800**
[21]	PlIsoLow	100
[22]	PlAreaHigh	500
[23]	PlAreaLow	1000

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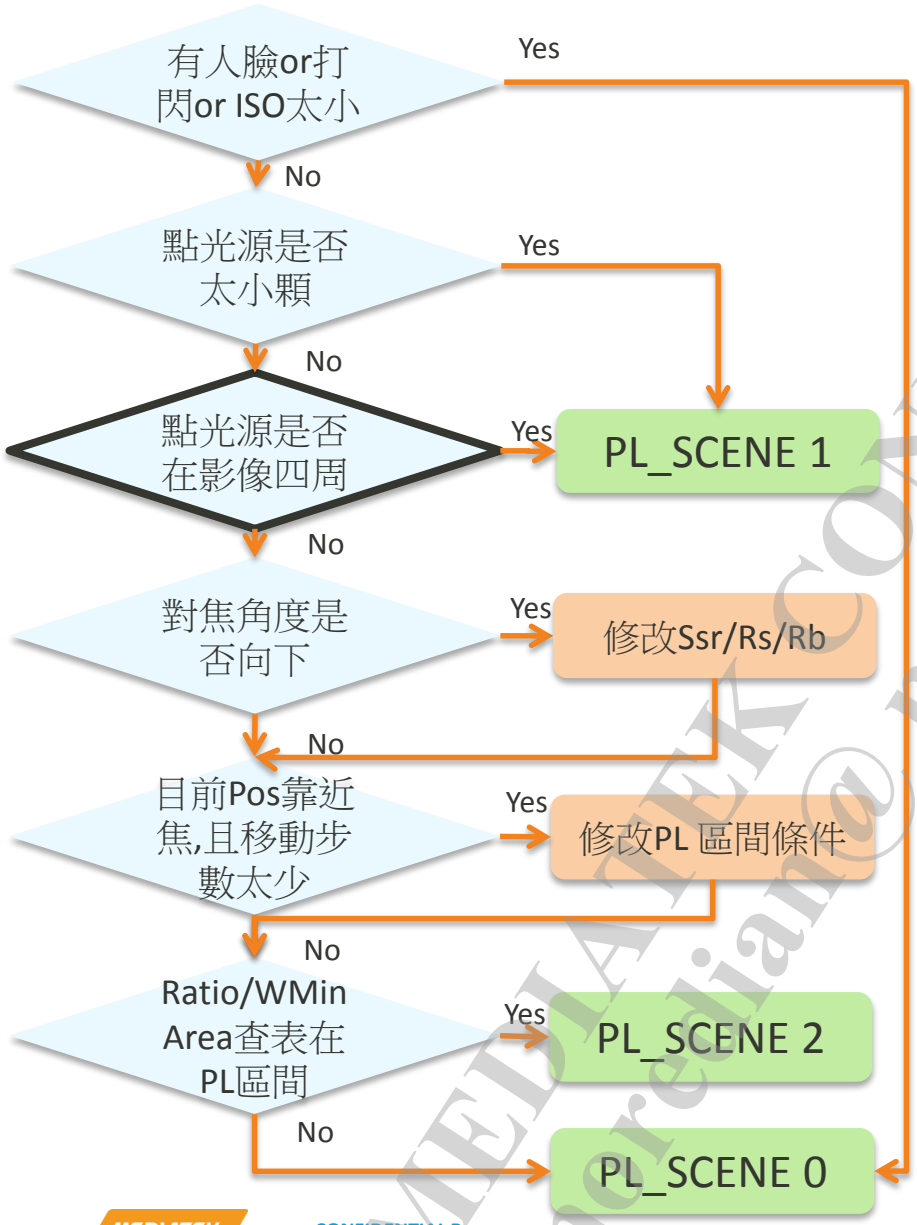
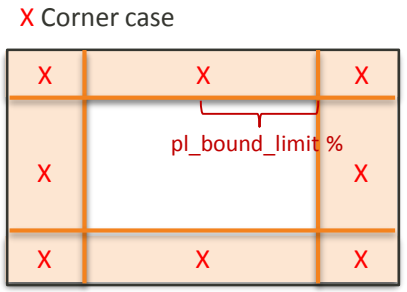
PL detector – CAF Case



如何定義影像四周

中心點(x,y) +- 影像長寬一半的pl_bound_limit %
定義為中間



i4PLAFCoefs[64]

[6]	pl_bound_limit	70

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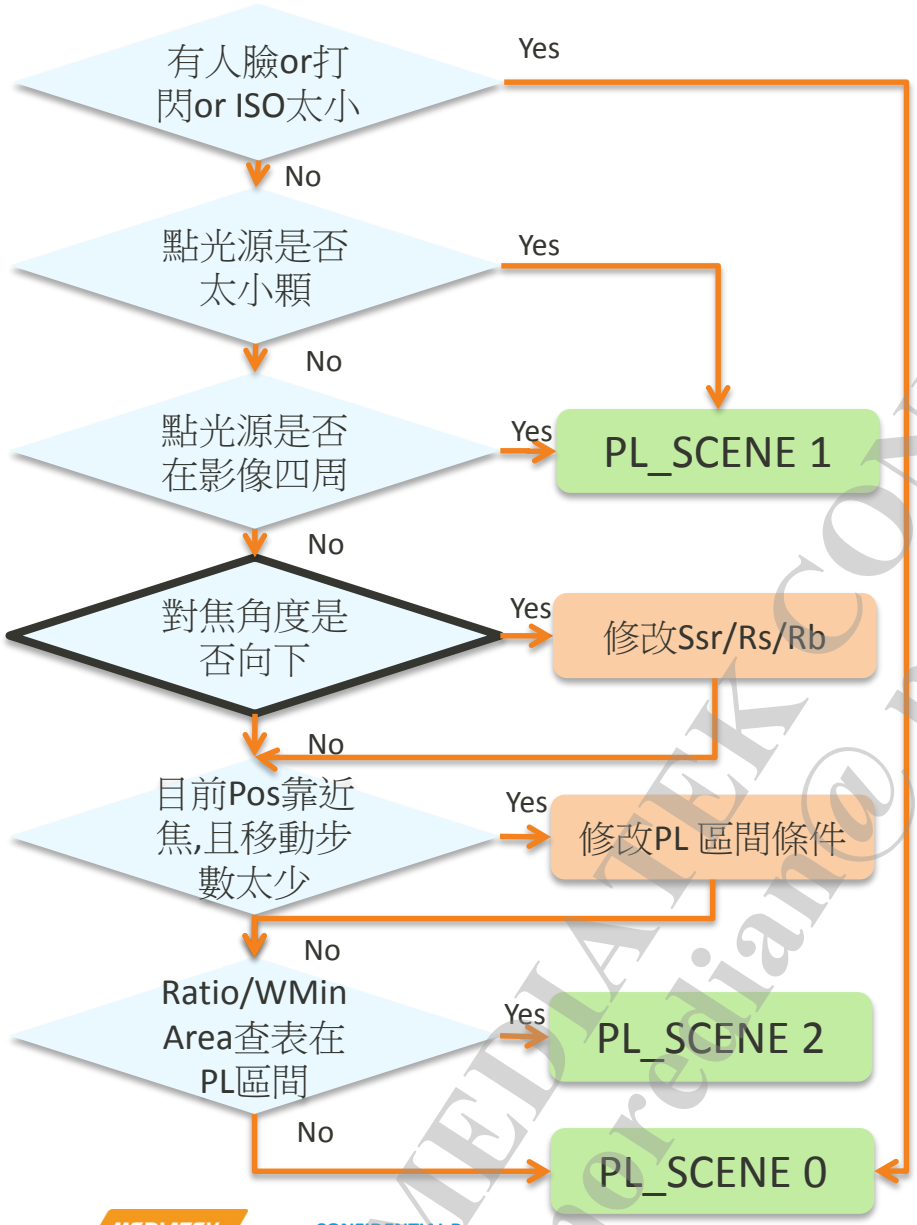
PL detector – CAF Case

SEEK



對焦向下時,first pos 靠近焦,則abort
否則,提高進PL 區的難度 (提高Rs,Rb,Rtop)

Rs = Rs * (10 + PLAF[12…15])/10
Rb= Rb * (10 + PLAF[12…15])/10
Rtop = Rtop * (10 + PLAF[12…15])/10

i4PLAFCoefs[7]

bit[12…15]	If the angle threshold is satisfied, this value determine how many times for raising PL detect line.	3 (1.3x)
bit[16…19]	Camera angle of depression threshold. x(-10)	4 (-40)

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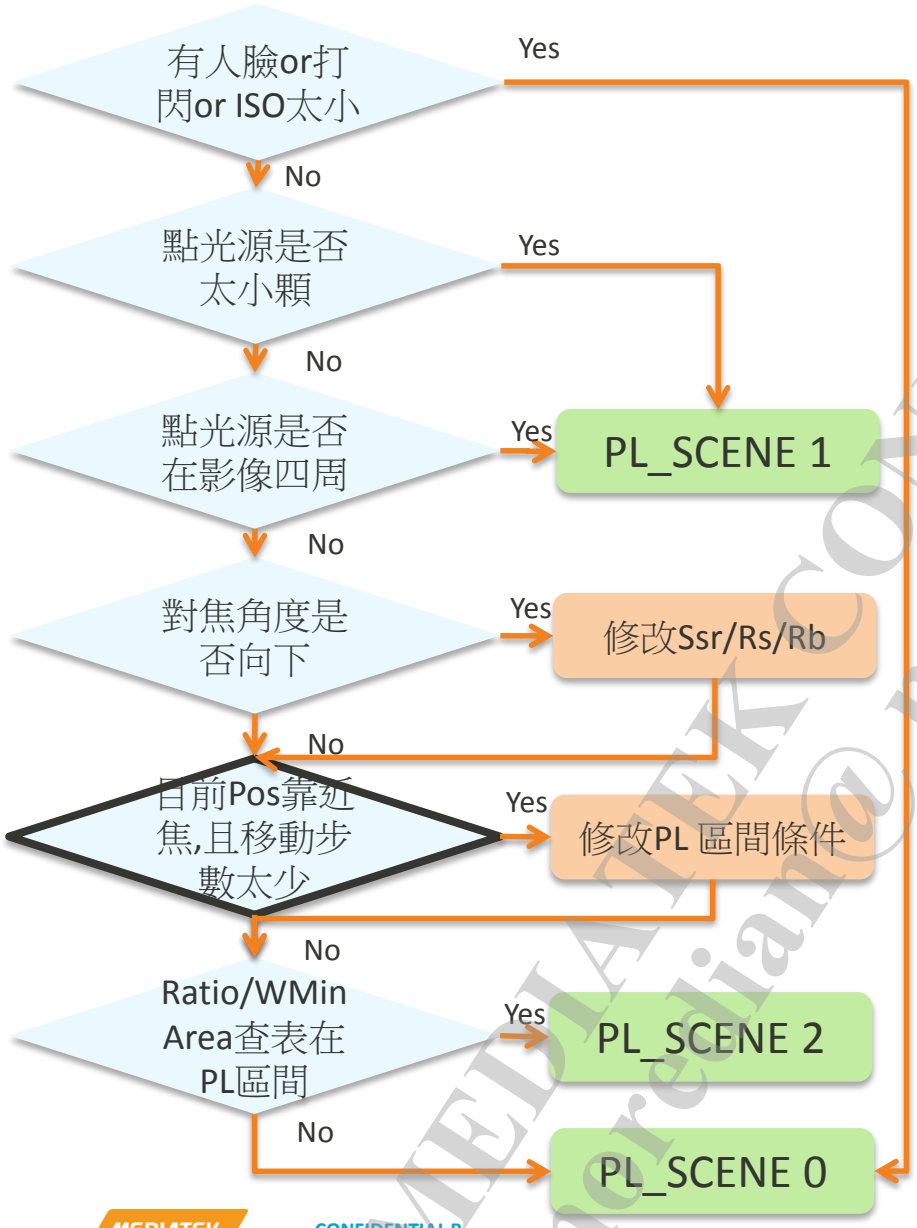
PL detector – CAF Case

SEEK



(Cur_pos > Mid_pos) && (TotInd < PlShotStep)
步數少時,ratio變化可能較小,進PL的條件要變鬆

Mid_pos = 整個AF table *3/4

Rs = Rs * PlShortDca/100
Rb= Rb * PlShortDca/100
Rtop = Rtop * PlShortDca/100
最小不能小於PlShortStepRatio

i4PLAFCoefs[64]

[14]	PlShortStepRatio	**110**
[15]	PlShortStep	4
[16]	PlShortDca	80

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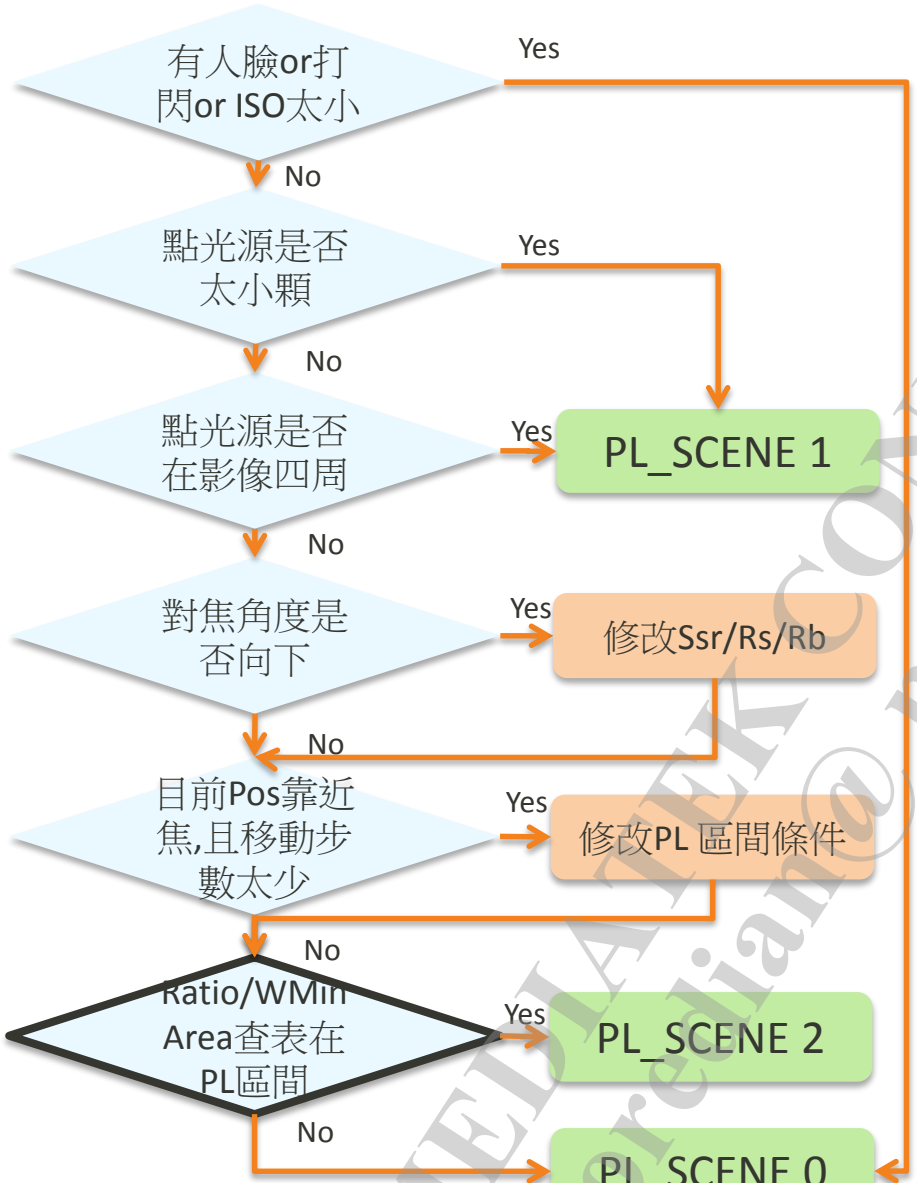
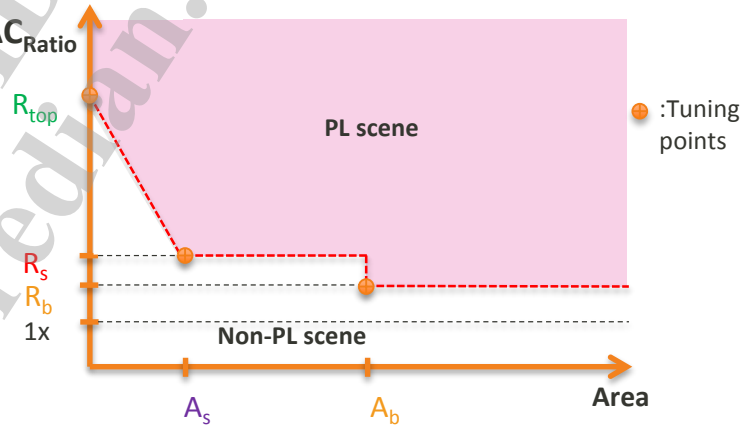


使用Ratio/MinArea查表判定是否為PL景



i4PLAFCoefs[64]

[1]	pl_tuning_point_r_top	2500
[2]	pl_tuning_point_a_s	2000000
[3]	pl_tuning_point_r_s	300
[4]	pl_tuning_point_a_b	8000000
[5]	pl_tuning_point_r_b	140

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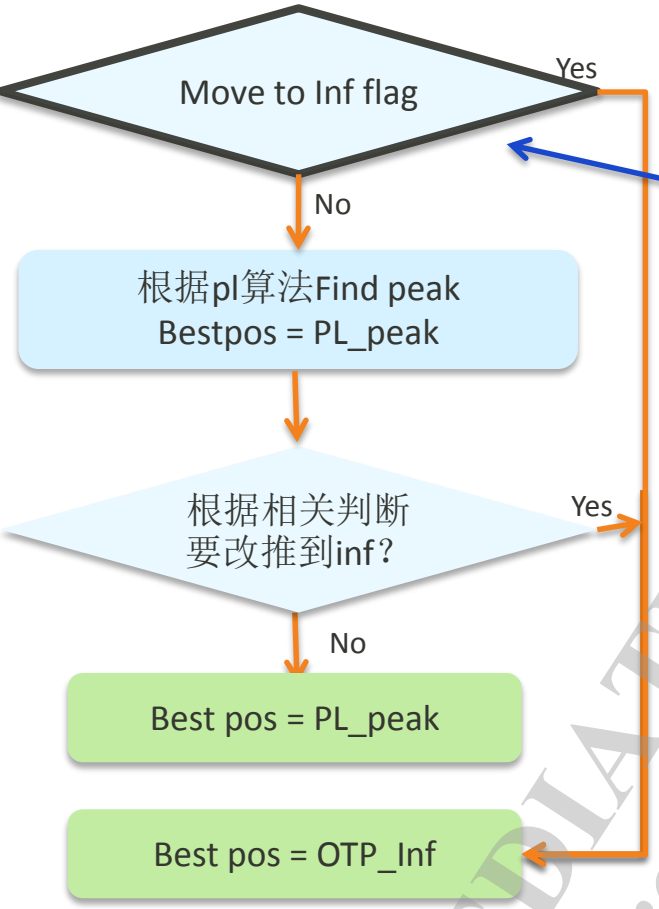
PL Focus – CAF Case



此tuning參數若設1,則偵測到是PL scene,就推OTP_Inf

bit[9]	Move to infinity directly if detect PL.	1

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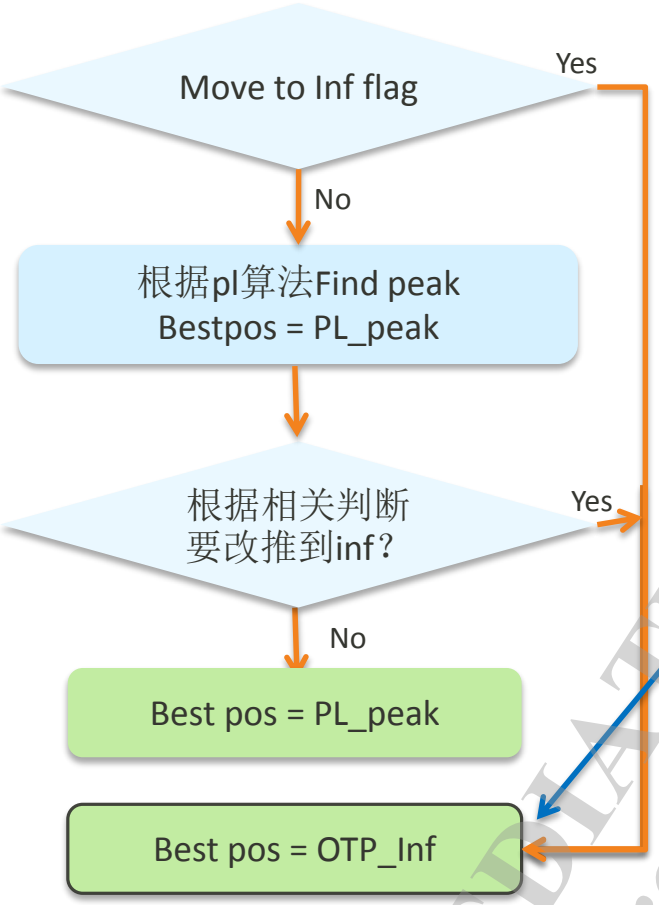
PL Focus – CAF Case



Inf_pos = AF table[1] + pl_temperature_error

(OTP inf可能K歪,所以手動加個shif值)

i4PLAFCoefs[64]

[8]	pl_tpl_temperature_error	5

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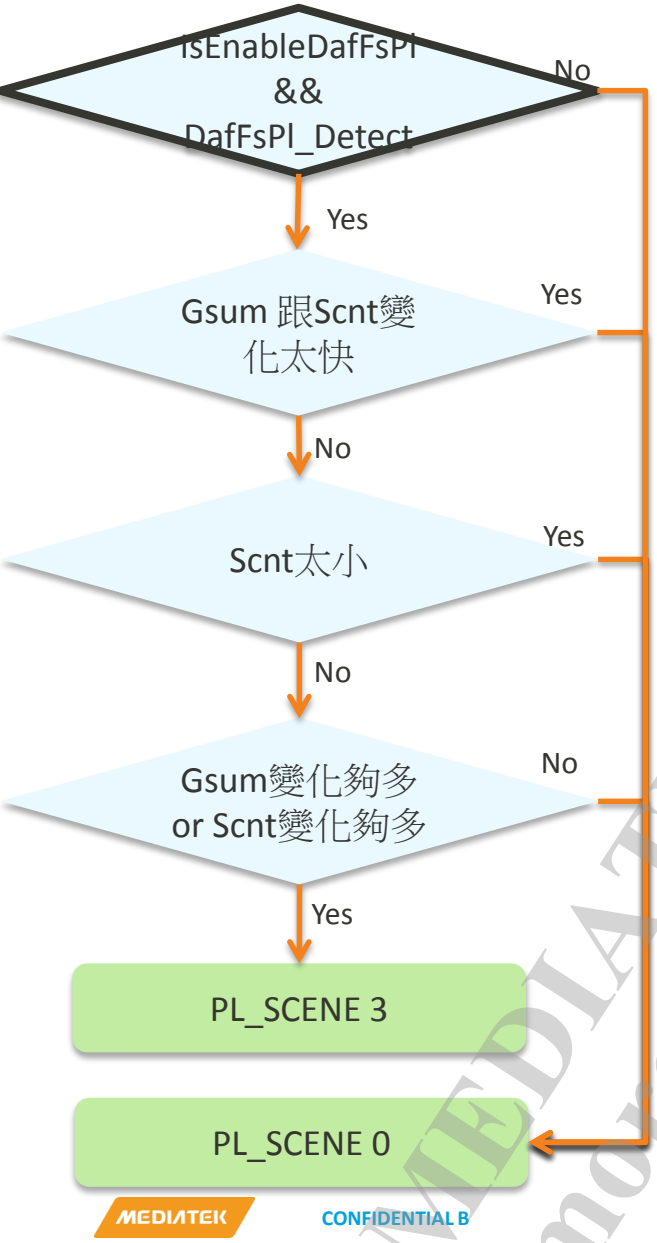
PL detector – PD Case



IsEnableDafFsPl = 沒人臉&& 角度不向下&& pos靠遠焦 && Conf 大於weak && ISO夠大 && 對焦框不在影像邊緣

DafFsPl_Detect = i4HybridAFCoefs [51] (default = 1)

角度tuning參數 i4PLAFCoefs[7]

bit[16...19]	Camera angle of depression threshold. x(-10)	4 (-40)

對焦bound參數 i4PLAFCoefs[64]

[6]	pl_bound_limit	70

ISO參數 i4PLAFCoefs[7]

[0...3]	ISO threshold for TAF. (x100)	3 (ISO 300)
bit[4...7]	ISO threshold for CAF. (x100)	3 (ISO 300)

PL_SCENE 0: Non-PL
PL_SCENE 1: PL abort
PL_SCENE 2: CAF PL
PL_SCENE 3: PDAF PL

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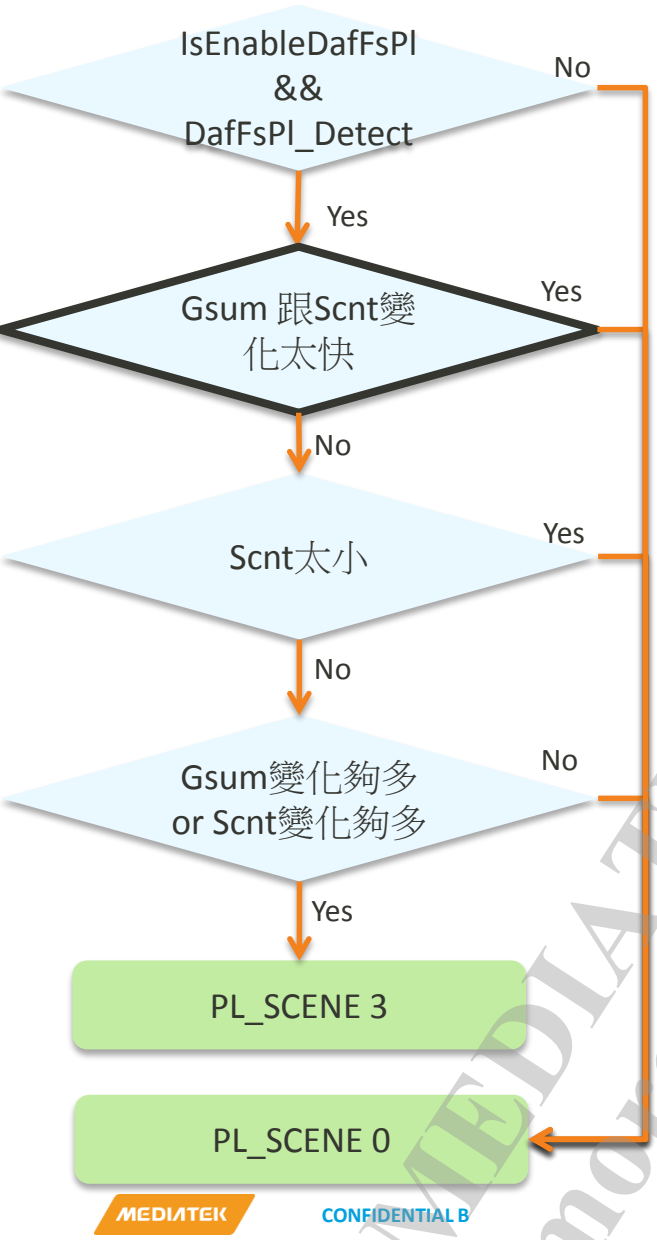
PL detector – PD Case



(Gsum[0]-Gsum[1])/Max_Gsum > abortGsum_TH &&
(Scnt[0]-GScnt[1])/Max_Scnt > abortScnt_TH

i4HybridAFCoefs[128]

[56]	Abnormal Gsum threshold	150
[57]	Abnormal SCnt threshold	150

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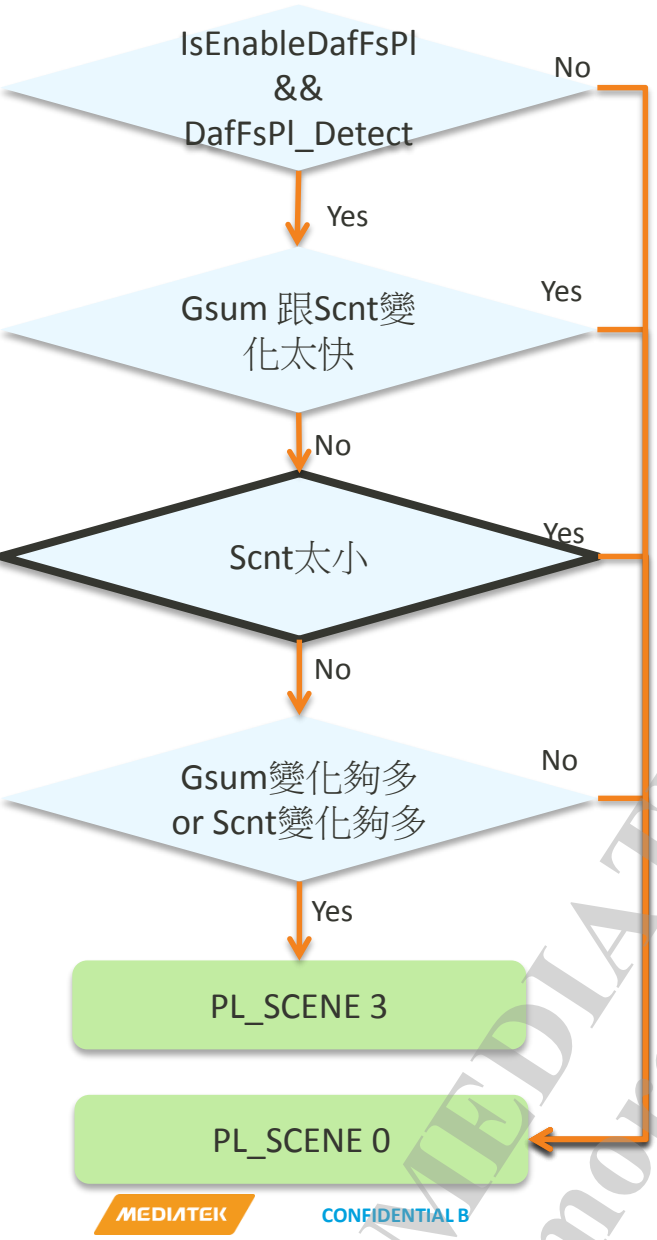
PL detector – PD Case



Pl_MinScnt < Pl_MinScnt_TH

i4HybridAFCoefs[128]

[54]	Fine search PL scnt min threshold	200

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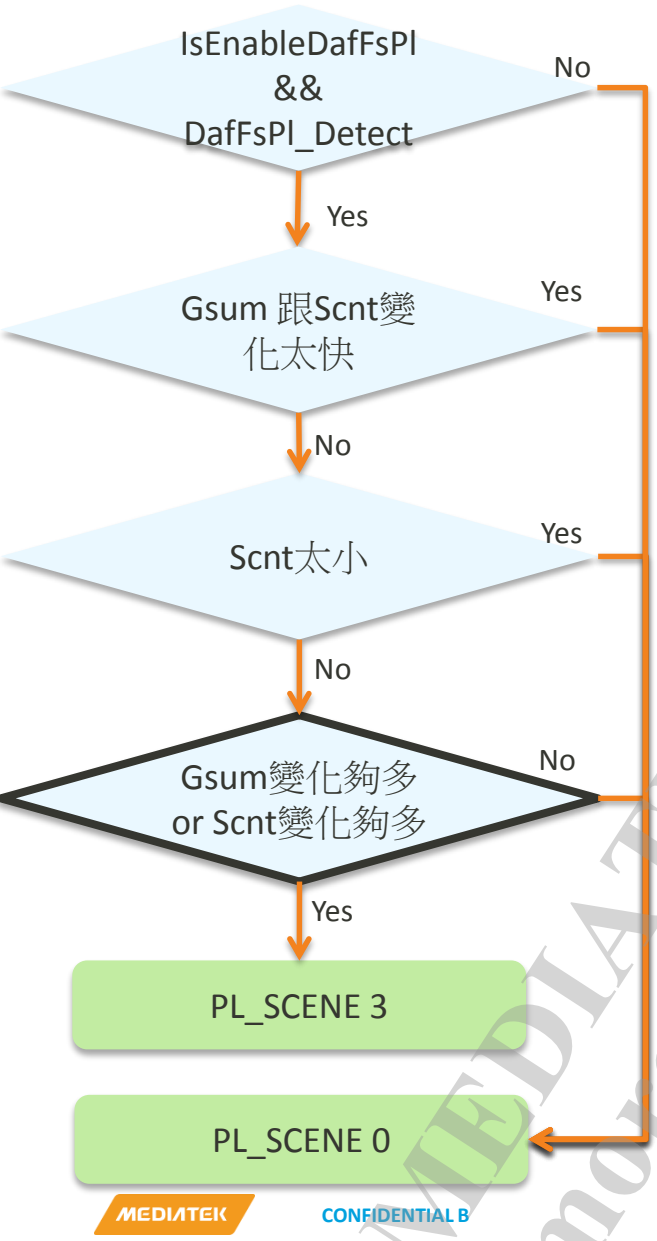

Diff_Gsum/Max_Gsum > Gsum_TH
Diff_Scnt/Max_Scnt > Scnt_TH

i4HybridAFCoefs[128]

[52]	Fine search PL gsum threshold	150
[53]	Fine search PL scnt threshold	200

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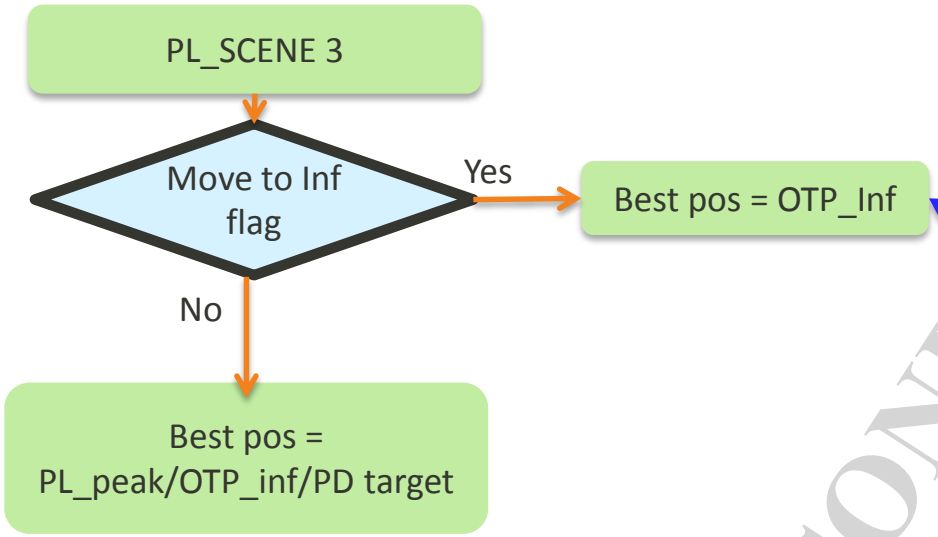
PL Focus – PD Case

DAF_FS



此tuning參數若設1,則偵測到是PL scene,就推OTP_Inf

i4PLAFCoefs[7]

bit[9]	Move to infinity directly if detect PL.	1

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