CONFIDENTIAL B

Basic Tuning Flow – AE Calibration

Outline

- Single Cam Calibration
  - Introduction
  - Pline
  - Fixed Flare Calibration (optional)
  - BV Offset Calibration
- Dual Cam Calibration
  - Bayer + Bayer or Wide + Tele
  - Bayer + Mono
- Appendix

SINGLE CAM CALIBRATION

INTRODUCTION

AE Pline table – Introduction

Introduction of AE Pline Table

a) Image brightness is defined by **Shutter, ISO, Aperture** and **BV**

b) Purpose of AE Pline Table is to find Shutter and ISO value by defined BV

c) Purpose of different AE Pline Table is to fit various scenes

ex

- **Sport Mode** :While objects moving rapidly, if ambient brightness is reduced, no longer exposure time, but increase ISO first
  (When the object moves, long exposure time will lead to blur)

- **Candle Mode** : While objects are static, when the ambient brightness is reduced, increasing exposure time first, then consider increasing ISO
  (There are no blur problems to static objects with long exposure time, so that increase exposure time can be consider to avoiding noise problem.)

AE Pline table – Introduction

Introduction of AE Pline Table

Sport Mode

ISO → small Shutter → short	ISO → going up Shutter → keep 1/30	ISO → big Shutter → long

When brightness going to dark, keep short shutter time first.

Candle Mode

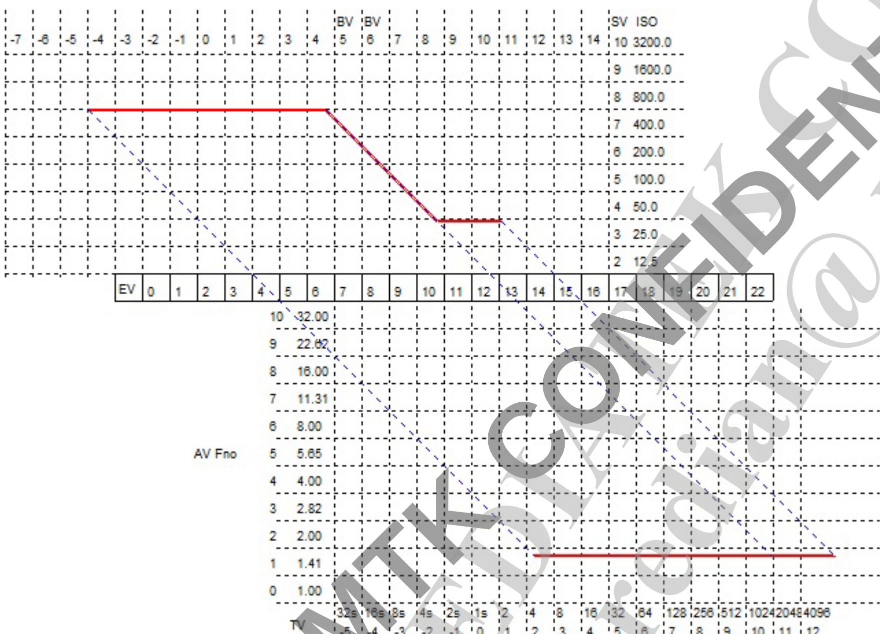
ISO → small Shutter → short	ISO → keep small Shutter → 1/10~1/5	ISO → big Shutter → long

When brightness going to dark, keep small ISO value first.

AE Pline Table
CCT mapping to Pline file

- Parameter file
  - Camera_AE_PlineTable_XXXX.h

CCT



Pline table

```
{91,1296,1040, 0, 0, 0},  //TV = 13.42(7 lines)  AV=1.70  SV=4.04  BV=11.08
{104,1184,1056, 0, 0, 0},  //TV = 13.23(8 lines)  AV=1.70  SV=3.93  BV=11.00
{104,1232,1080, 0, 0, 0},  //TV = 13.23(8 lines)  AV=1.70  SV=4.02  BV=10.91
{117,1232,1048, 0, 0, 0},  //TV = 13.06(9 lines)  AV=1.70  SV=3.98  BV=10.78
{130,1184,1048, 0, 0, 0},  //TV = 12.91(10 lines)  AV=1.70  SV=3.92  BV=10.68
{130,1232,1064, 0, 0, 0},  //TV = 12.91(10 lines)  AV=1.70  SV=4.00  BV=10.61
{143,1232,1080, 0, 0, 0},  //TV = 12.77(11 lines)  AV=1.70  SV=4.02  BV=10.45
{156,1184,1064, 0, 0, 0},  //TV = 12.65(12 lines)  AV=1.70  SV=3.94  BV=10.40
{169,1184,1056, 0, 0, 0},  //TV = 12.53(13 lines)  AV=1.70  SV=3.93  BV=10.29
{182,1184,1056, 0, 0, 0},  //TV = 12.42(14 lines)  AV=1.70  SV=3.93  BV=10.19
{195,1184,1064, 0, 0, 0},  //TV = 12.32(15 lines)  AV=1.70  SV=3.94  BV=10.08
{208,1184,1048, 0, 0, 0},  //TV = 12.23(16 lines)  AV=1.70  SV=3.92  BV=10.01
{221,1184,1056, 0, 0, 0},  //TV = 12.14(17 lines)  AV=1.70  SV=3.93  BV=9.91
{234,1232,1032, 0, 0, 0},  //TV = 12.06(18 lines)  AV=1.70  SV=3.96  BV=9.80
{247,1232,1040, 0, 0, 0},  //TV = 11.98(19 lines)  AV=1.70  SV=3.97  BV=9.71
{273,1184,1048, 0, 0, 0},  //TV = 11.84(21 lines)  AV=1.70  SV=3.92  BV=9.61
{286,1232,1040, 0, 0, 0},  //TV = 11.77(22 lines)  AV=1.70  SV=3.97  BV=9.50
{312,1184,1056, 0, 0, 0},  //TV = 11.65(24 lines)  AV=1.70  SV=3.93  BV=9.41
{338,1184,1048, 0, 0, 0},  //TV = 11.53(26 lines)  AV=1.70  SV=3.92  BV=9.31
{364,1184,1048, 0, 0, 0},  //TV = 11.42(28 lines)  AV=1.70  SV=3.92  BV=9.20
{390,1184,1048, 0, 0, 0},  //TV = 11.32(30 lines)  AV=1.70  SV=3.92  BV=9.10
{416,1184,1048, 0, 0, 0},  //TV = 11.23(32 lines)  AV=1.70  SV=3.92  BV=9.01
{442,1184,1056, 0, 0, 0},  //TV = 11.14(34 lines)  AV=1.70  SV=3.93  BV=8.91
{481,1184,1048, 0, 0, 0},  //TV = 11.02(37 lines)  AV=1.70  SV=3.92  BV=8.80
{493,1232,1040, 0, 0, 0},  //TV = 10.99(37 lines)  AV=1.70  SV=3.97  BV=8.71
{493,1344,1024, 0, 0, 0},  //TV = 10.99(37 lines)  AV=1.70  SV=4.07  BV=8.61
```

AE Pline – Parameter structure

File: camera_AE_PLineTable_XXX.h

Pline tables are classified by scenario, light frequency

Describe the Pline information

```
#include <custom/aaa/AEPlinetable.h>
static strEvPline sPreviewPLineTable_60Hz =
{
};

static strEvPline sPreviewPLineTable_50Hz =
{
};

static strAETable g_AE_PreviewAutoTable =
{
};

static strEvPline sCapturePLineTable_60Hz =
{
};

static strEvPline sCapturePLineTable_50Hz =
{
};

static strAETable g_AE_CaptureAutoTable =
{
};

static strEvPline sVideoPLineTable_60Hz =
{
};

static strEvPline sVideoPLineTable_50Hz =
{
};

static strAETable g_AE_VideoAutoTable =
{
};
```

```
static strEvPline sPreviewPLineTable_60Hz =
{
    {91,1312,1024, 0, 0, 0},  //TV = 13.42(8 lines)  AV=2.00  SV=5.36  BV=10.07
    {103,1216,1032, 0, 0, 0},  //TV = 13.25(9 lines)  AV=2.00  SV=5.26  BV=9.99
    {103,1296,1024, 0, 0, 0},  //TV = 13.25(9 lines)  AV=2.00  SV=5.34  BV=9.91
    {114,1248,1024, 0, 0, 0},  //TV = 13.10(10 lines)  AV=2.00  SV=5.29  BV=9.81
    {125,1248,1024, 0, 0, 0},  //TV = 12.97(11 lines)  AV=2.00  SV=5.29  BV=9.68
    {137,1200,1032, 0, 0, 0},  //TV = 12.83(12 lines)  AV=2.00  SV=5.24  BV=9.59
    {148,1184,1032, 0, 0, 0},  //TV = 12.72(13 lines)  AV=2.00  SV=5.22  BV=9.50
    {159,1200,1024, 0, 0, 0},  //TV = 12.62(14 lines)  AV=2.00  SV=5.23  BV=9.39
    {171,1200,1024, 0, 0, 0},  //TV = 12.51(15 lines)  AV=2.00  SV=5.23  BV=9.28
    {182,1216,1024, 0, 0, 0},  //TV = 12.42(16 lines)  AV=2.00  SV=5.25  BV=9.18
    {193,1232,1024, 0, 0, 0},  //TV = 12.34(17 lines)  AV=2.00  SV=5.27  BV=9.07
    {205,1200,1032, 0, 0, 0},  //TV = 12.25(18 lines)  AV=2.00  SV=5.24  BV=9.01
    {216,1216,1032, 0, 0, 0},  //TV = 12.18(19 lines)  AV=2.00  SV=5.26  BV=8.92
    {239,1184,1032, 0, 0, 0},  //TV = 12.03(21 lines)  AV=2.00  SV=5.22  BV=8.81
};
```

ISP gain : (1x: 1024)

Sensor gain : (1x: 1024)

Exposure time : us

```
static strAETable g_AE_PreviewAutoTable =
{
    AETABLE_RPEVIEW_AUTO,     //eAETableID
    147,     //u4TotalIndex
    20,     //u4StrobeTrigerBV
    101,     //i4MaxBV
    -45,     //i4MinBV
    90,     //i4EffectiveMaxBV
    -50,     //i4EffectiveMinBV
    LIB3A_AE_ISO_SPEED_AUTO, //ISO SPEED
    sPreviewPLineTable_60Hz,
    sPreviewPLineTable_50Hz,
    NULL,
};
```

How many index set of sPreviewPlineTable

BV that triggers flash

BV ranged covered by this Pline

Not used now

AE Pline – Parameter structure

CCT P-line Table

Mapping Table | Table Detail

AE Table Detail

AE Table : AETABLE_PREVIEW_AUTO

No.	MinExp	MaxExp	MinGain	MaxGain
1	10000	30	1195	1195
2	30	30	1195	12288
3	30	24	12288	12288
4	24	24	12288	46080
5	24	15	46080	46080
6				
7				

CCT refers P-line info. from here

```
static strAEPLineNumInfo g_strAEPreviewAutoPLineInfo =
{
    AETABLE_RPEVIEW_AUTO,   P-line ID
    90,
    -50,                    Not used now
    {
        {1,10000,30,1195,1195},
        {2,30,30,1195,12288},
        {3,30,24,12288,12288},
        {4,24,24,12288,46080},
        {5,24,15,46080,46080},
        {6,0,0,0,0},
        {7,0,0,0,0},
        {8,0,0,0,0},
        {9,0,0,0,0},
        {10,0,0,0,0},
        {11,0,0,0,0},
        {12,0,0,0,0},
        {13,0,0,0,0},
        {14,0,0,0,0},
        {15,0,0,0,0},
    }
};

static strAEPLineNumInfo g_strAECaptureAutoPLineInfo =
{
};

static strAEPLineNumInfo g_strAEVideoAutoPLineInfo =
{
};

static strAEPLineNumInfo g_strAEVideo1AutoPLineInfo =
```

P-line Table for CCT use

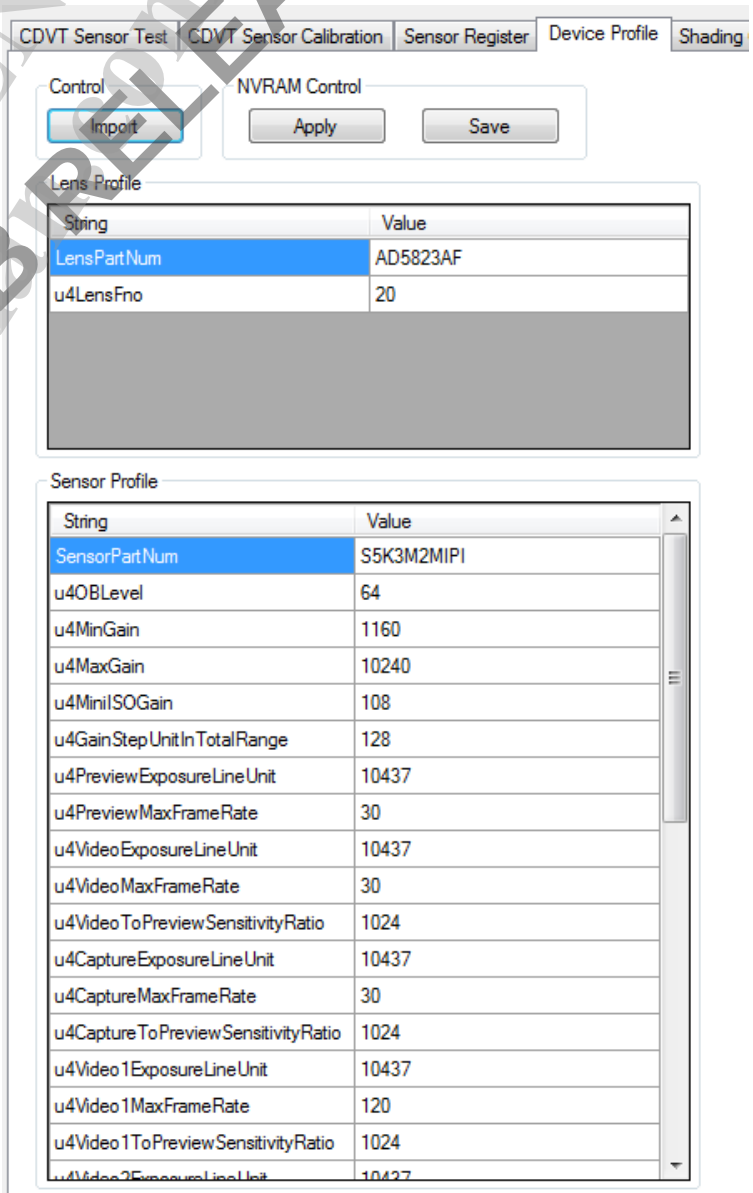
BV Offset

- BV Offset
  - AE always calculates BV, means environment brightness, by AE Pline index and image brightness. The calculated BV is used for AE and AWB Algo.
  - The calculated BV values from different modules often have difference. To make sure the BV values of different modules are on the same level, it's necessary to calculate BV offset
  - LV = BV + 5 (ISO = 100)

PLINE GENERATION

AE Pline table – Device Profile

- Device Profile Introduction (MTK provide)
  - Also named device info.
  - It's necessary to make sure every item in Device Profile is correct with driver owner, before Pline generation.
  - Make sure that all items in Device Info. are the same as which in NVRAM. If not, it's necessary to modify the items in NVRAM and push the new .so to the phone, or AE may operate incorrectly.
    - NVRAM file: camera_ae_tuning_para_[Sensor mode]_[Sensor].cpp



AE Pline table – Device Profile

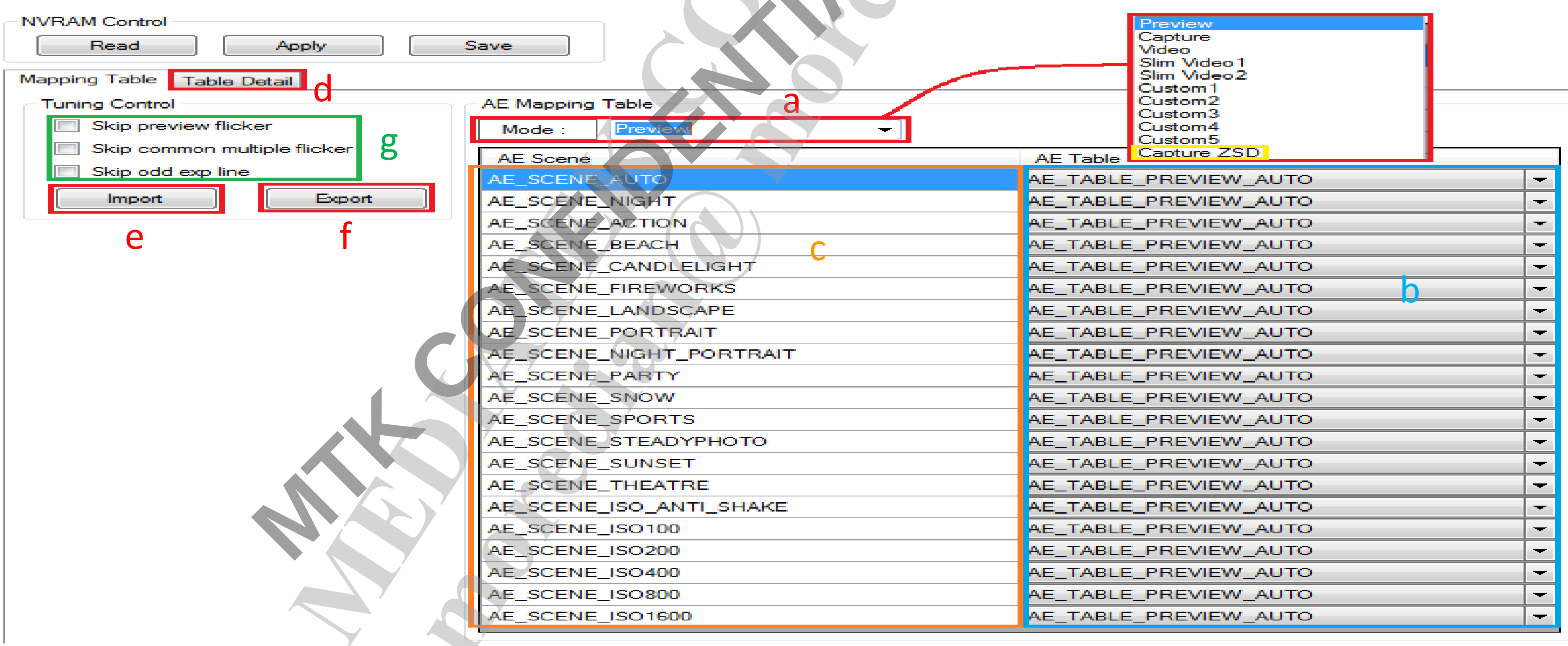
- Device Profile Introduction (MTK provide)
  - u4OBLevel : OB value (useless)
  - u4MinGain : Minimum saturation gain
  - u4MaxGain : Sensor support maximum gain
  - u4MiniISOGain : ISO value when sensor gain is 1024
  - u4GainStepUnitInTotalRange : Sensor gain step based on 1024 (if sensor gain step is 8, x=1024/8=128)
  - u4PreviewExposureLineUnit : Preview line unit in us
  - u4PreviewMaxFrameRate : Preview max frame rate
  - u4VideoExposureLineUnit : Video line unit in us
  - u4VideoMaxFrameRate : Video max frame rate
  - u4VideoToPreviewSensitivityRatio : Video / Preview sensitivity radio
  - u4CaptureExposureLineUnit : Capture line unit in us
  - u4CaptureMaxFrameRate : Capture max frame rate
  - u4CaptureToPreviewSensitivityRatio : Capture / Preview sensitivity radio

AE Pline table – Device Profile

- Device Profile Introduction (MTK provide)
  - Fno : F number*10, ex: f2.2, u2LensFno=22
  - Gain Step : Minimum step unit of sensor gain
  - FixSensorGain : If the sensor gain is nonlinear, use fixsensorgain table.
  - FocusLength : Focus Length*100

AE Pline table – Table Mapping

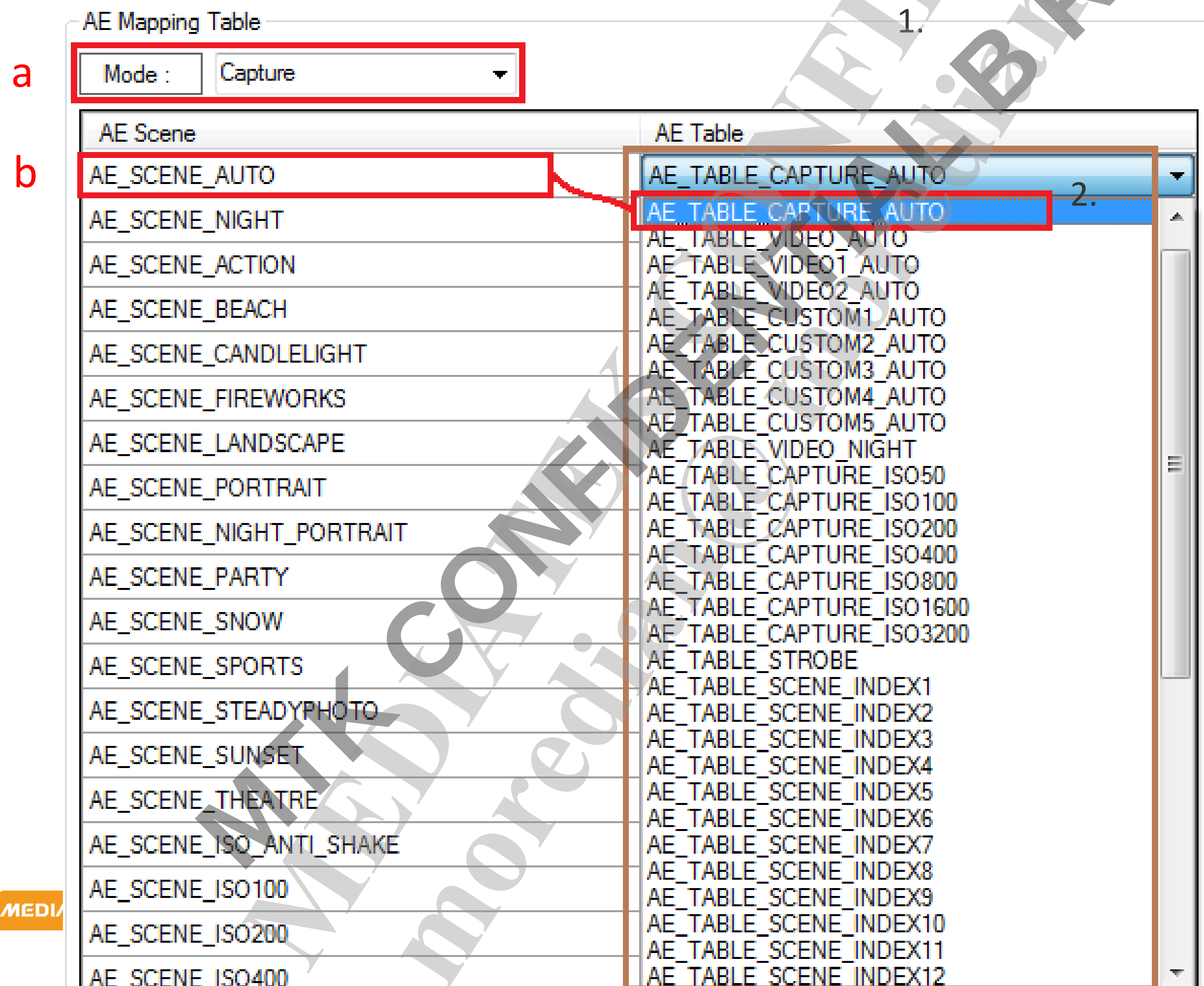
- AE Pline Table main page
  - a) Mode Menu : List of all sensor and selected for tuning.
  - b) AE Table : Current AE scene mapping table.
  - c) AE Scene : List of all AE scene with selected sensor mode.
  - d) Table Detail : For each table detail tuning.
  - e) Import from P-line Info : Import Pline table from csv file.
  - f) Export to P-line Info : Export current Pline table to csv file.
  - g) Flicker skip : Skip options for special demand.



NVRAM Control
Read
Apply
Save
Mapping Table
Table Detail
d
Tuning Control
Skip preview flicker
Skip common multiple flicker
Skip odd exp line
g
Import
Export
e
f
AE Mapping Table
Mode :
Preview
a
Preview
Capture
Video
Slim Video1
Slim Video2
Custom1
Custom2
Custom3
Custom4
Custom5
Capture ZSD
AE Scene
AE Table
AE_SCENE_AUTO
AE_SCENE_NIGHT
AE_SCENE_ACTION
AE_SCENE_BEACH
AE_SCENE_CANDLELIGHT
AE_SCENE_FIREWORKS
AE_SCENE_LANDSCAPE
AE_SCENE_PORTRAIT
AE_SCENE_NIGHT_PORTRAIT
AE_SCENE_PARTY
AE_SCENE_SNOW
AE_SCENE_SPORTS
AE_SCENE_STEADYPHOTO
AE_SCENE_SUNSET
AE_SCENE_THEATRE
AE_SCENE_ISO_ANTI_SHAKE
AE_SCENE_ISO100
AE_SCENE_ISO200
AE_SCENE_ISO400
AE_SCENE_ISO800
AE_SCENE_ISO1600
c
AE_TABLE_PREVIEW_AUTO
b

AE Pline table – Table Mapping

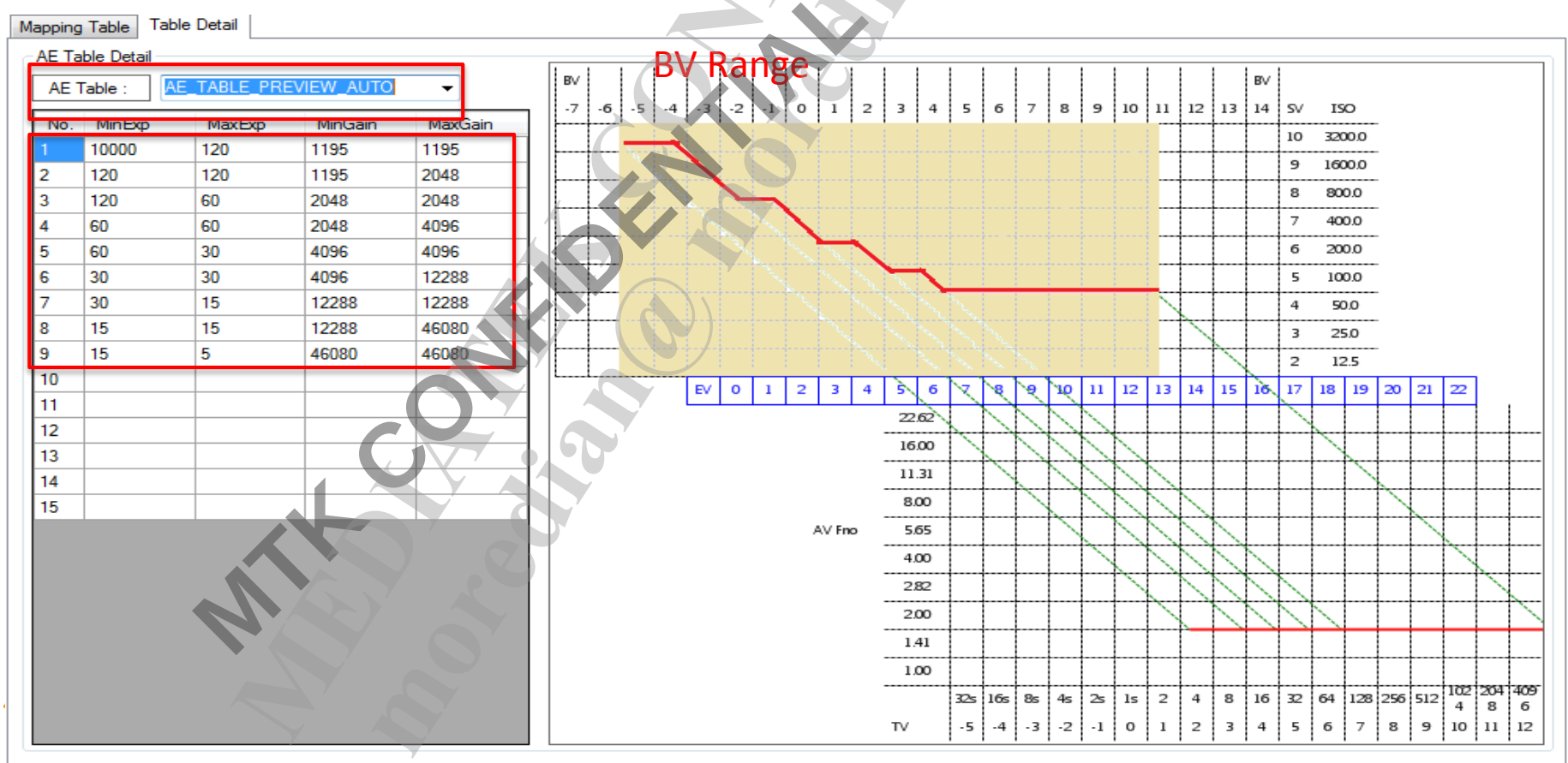
- Update Scene mapping
  a) Select sensor mode you want to update.
  b) Click combo box which is mapping to a scene you want to change. Then select the table name.



AE Mapping Table
1.
a
Mode :
Capture
AE Scene
AE Table
b
AE_SCENE_AUTO
AE_SCENE_NIGHT
AE_SCENE_ACTION
AE_SCENE_BEACH
AE_SCENE_CANDLELIGHT
AE_SCENE_FIREWORKS
AE_SCENE_LANDSCAPE
AE_SCENE_PORTRAIT
AE_SCENE_NIGHT_PORTRAIT
AE_SCENE_PARTY
AE_SCENE_SNOW
AE_SCENE_SPORTS
AE_SCENE_STEADYPHOTO
AE_SCENE_SUNSET
AE_SCENE_THEATRE
AE_SCENE_ISO_ANTI_SHAKE
AE_SCENE_ISO100
AE_SCENE_ISO200
AE_SCENE_ISO400
AE_TABLE_CAPTURE_AUTO
2.
AE_TABLE_CAPTURE_AUTO
AE_TABLE_VIDEO_AUTO
AE_TABLE_VIDEO1_AUTO
AE_TABLE_VIDEO2_AUTO
AE_TABLE_CUSTOM1_AUTO
AE_TABLE_CUSTOM2_AUTO
AE_TABLE_CUSTOM3_AUTO
AE_TABLE_CUSTOM4_AUTO
AE_TABLE_CUSTOM5_AUTO
AE_TABLE_VIDEO_NIGHT
AE_TABLE_CAPTURE_ISO50
AE_TABLE_CAPTURE_ISO100
AE_TABLE_CAPTURE_ISO200
AE_TABLE_CAPTURE_ISO400
AE_TABLE_CAPTURE_ISO800
AE_TABLE_CAPTURE_ISO1600
AE_TABLE_CAPTURE_ISO3200
AE_TABLE_STROBE
AE_TABLE_SCENE_INDEX1
AE_TABLE_SCENE_INDEX2
AE_TABLE_SCENE_INDEX3
AE_TABLE_SCENE_INDEX4
AE_TABLE_SCENE_INDEX5
AE_TABLE_SCENE_INDEX6
AE_TABLE_SCENE_INDEX7
AE_TABLE_SCENE_INDEX8
AE_TABLE_SCENE_INDEX9
AE_TABLE_SCENE_INDEX10
AE_TABLE_SCENE_INDEX11
AE_TABLE_SCENE_INDEX12

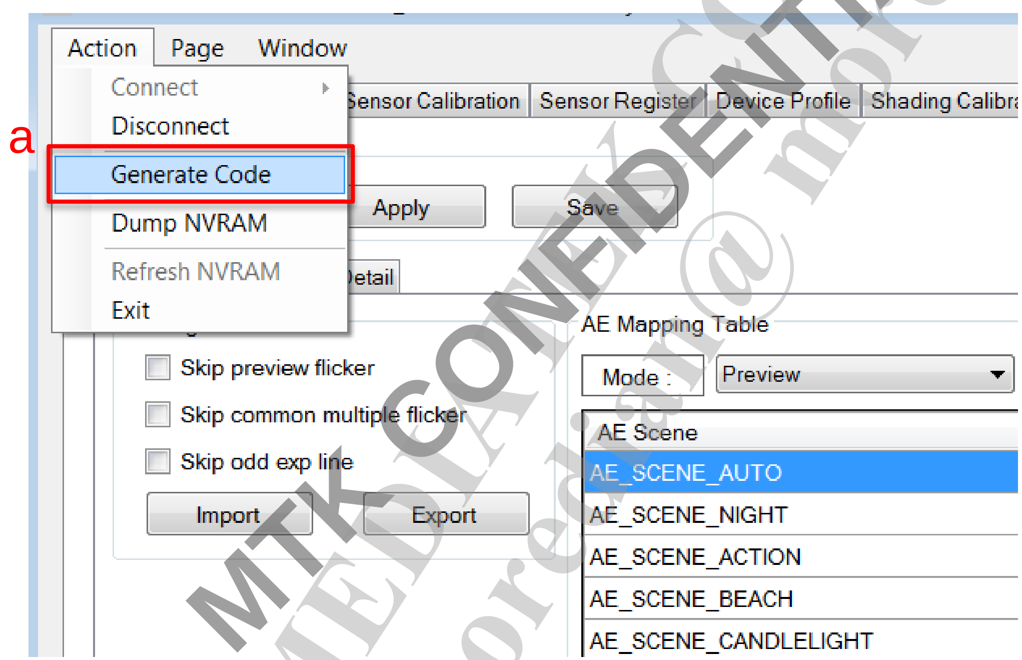
AE Pline table – Table Mapping

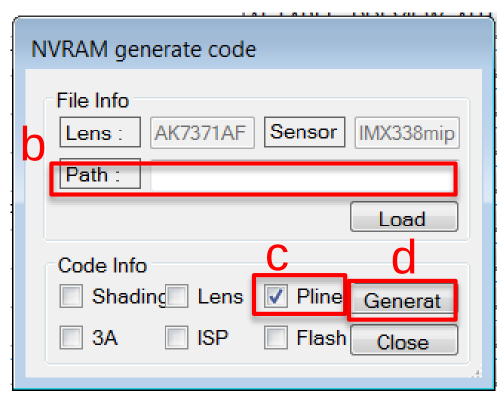
- Update Table detail
  a) Select a table from AE Table. Then right side will show the Pline chart automatically.
  b) Modify the table exposure information and Pline chart also updated after change value.



AE Pline table – Table Mapping

- Generate Pline file
  a) After AE Pline modification, use "Generate Code"
  b) Choose Path to export Pline file
  c) Choose Pline
  d) Click "Generate" to get new Pline file

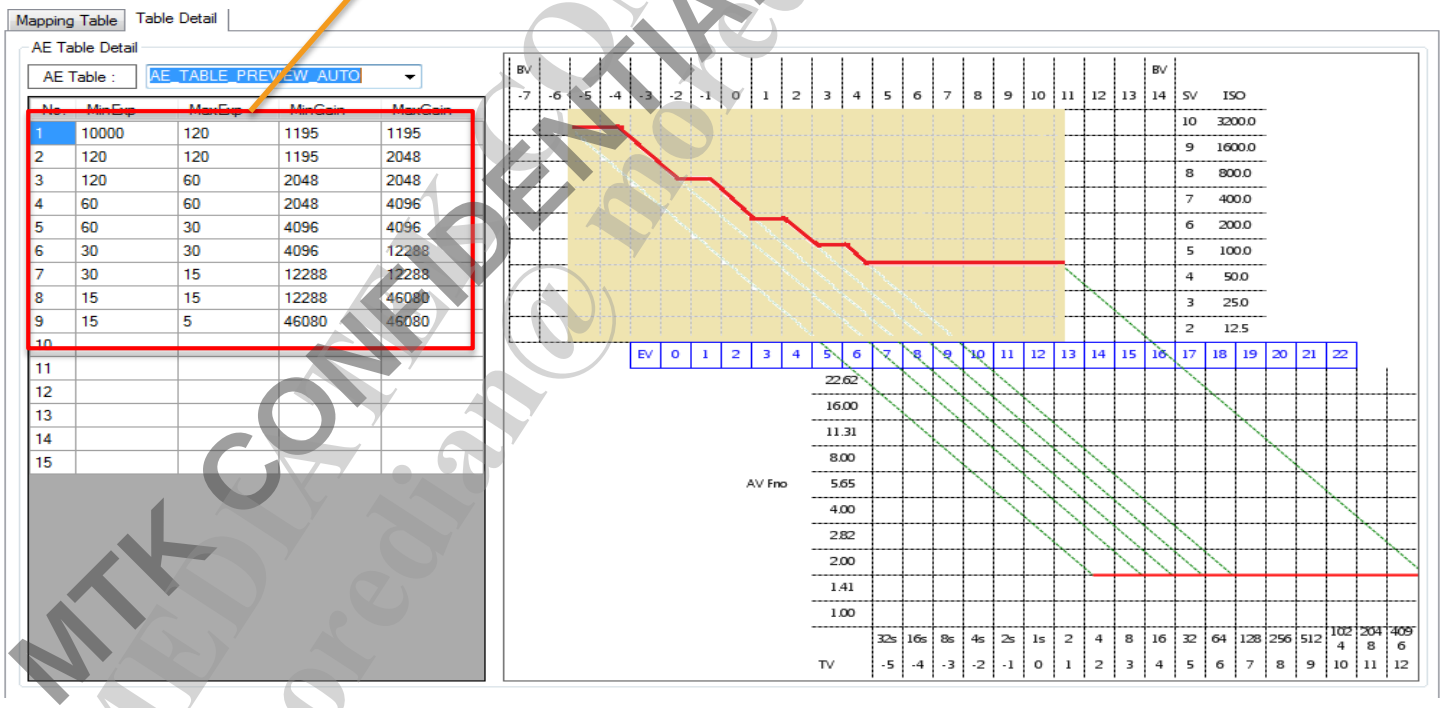




AE Pline table – Table Mapping

- Error message when generating Pline file
  a) If error message occurs, please **check whether exposure information of Pline table is correct**

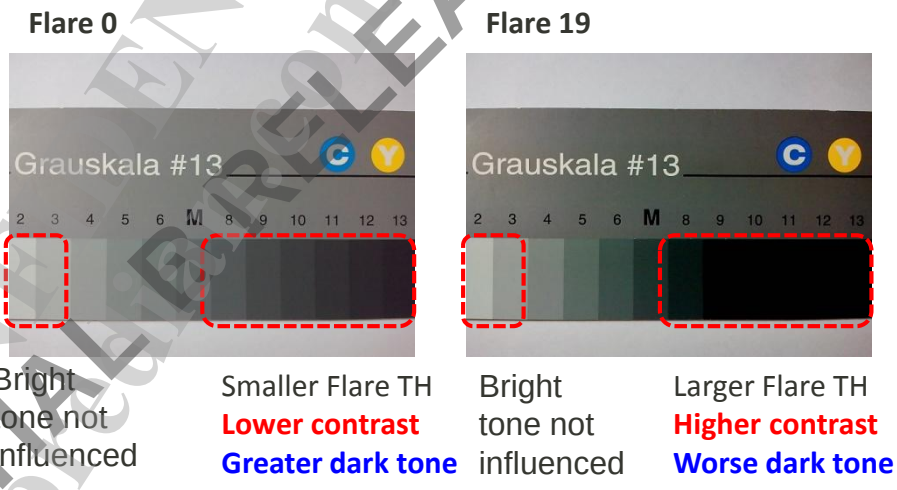
Check whether existing faults.
Ex. Pline table is discontinuous between segments

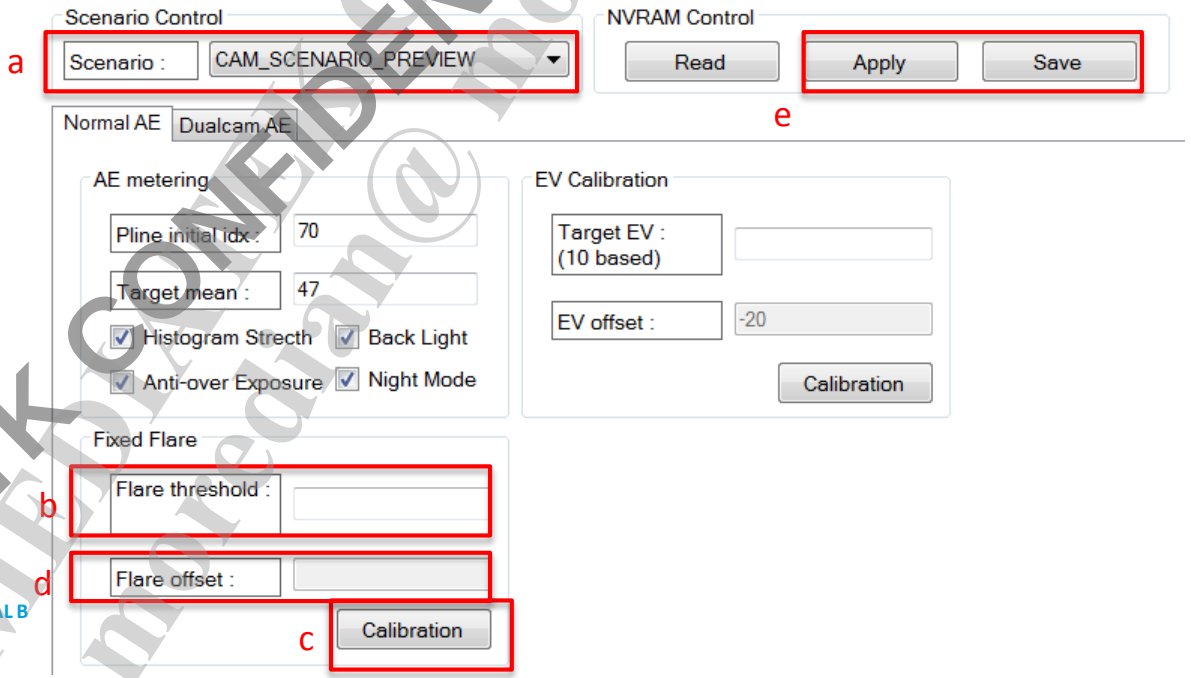


FIXED FLARE CALIBRATION (OPTIONAL)

Fixed Flare calibration (optional)

- AE calibration page
  a) Select sensor mode
  b) Set Fixed Flare threshold
  c) Click Calibration
  d) Calibrated flare offset is shown
  e) Apply and save to NVRAM

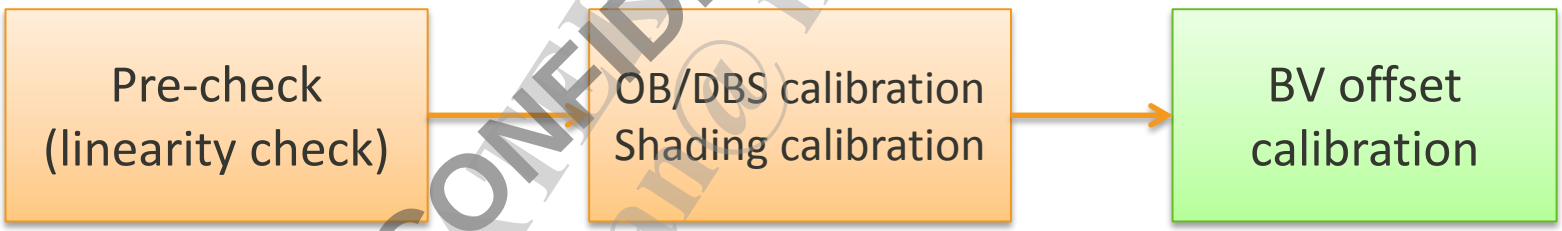




BV OFFSET CALIBRATION

BV Offset Calibration Preparation

- Linearity Check before BV Offset Calibration
- OB/DBS, Shading Calibration before BV Offset Calibration, to make sure correct result



BV Offset Calibration Setup

- Calibration steps:
  - **Step 1**: Lock AF in the macro mode and fixed lsc ra ratio

```
adb shell setprop debug.af_motor.disable 1
adb shell setprop debug.af_motor.positon 1000
adb shell setprop debug.lsc_mgr.ratio 32
```

  - **Step 2**: Disable hs/abl/aor/ns (camera_ae_tuning_para_xxx_xxxxx.cpp)

```
//rHS_Spec
{
    FALSE,//bEnableHistStretch
    ...
},
//rAOE_Spec
{
    FALSE,
//bEnableAntiOverExposure
    ...
},
```

```
//rABL_Spec
{
    FALSE,//bEnableBlackLigh
    ...
},
//rNS_Spec
{
    FALSE, // bEnableNightScene
    ...
},
```

BV Offset Calibration Setup

- Calibration steps:
  - **Step 3**: Set AE target as 47 (camera_ae_tuning_para_xxx_xxxxx.cpp)

```
47,                // u4AETarget
```

  - **Step 4**: Adjust converge ratio (camera_ae_tuning_para_xxx_xxxxx.cpp)

```
//rAEMoveRatio =
{
        ...
        100, //u4B2TEnd
        100,//70,  //u4B2TStart 70
        100,//60,  //u4D2TEnd 60
        100,  //u4D2TStart
},
```

BV Offset Calibration Setup

- Calibration steps:
  - **Step 5**: Disable AEv4p0 (ae_tuning_custm_xxx.cpp)

```
//v4.0
FALSE,          //bAEv4p0MeterEnable;
```

  - **Step 6**: Disable per-frame AE smooth (ae_tuning_custm_xxx.cpp)

```
FALSE,          // Perframe AE smooth option
```

  - **Step 7**: Adjust stable range (ae_tuning_custm_xxx.cpp)

```
static strAEStableThd g_AEStableThd =
{
    0,          // u4InStableThd;  // 0.08EV
    0,          // u4OutStableThd

    TRUE,       // enable ae different mode stable threshold setting
    ...
};
```

BV Offset Calibration Setup

- Calibration steps:
  - **Step 8**: Use CCT to do BV offset calibration. **After calibration, the modified parameters must be set to default!!!.**

BV Offset Environment Setting

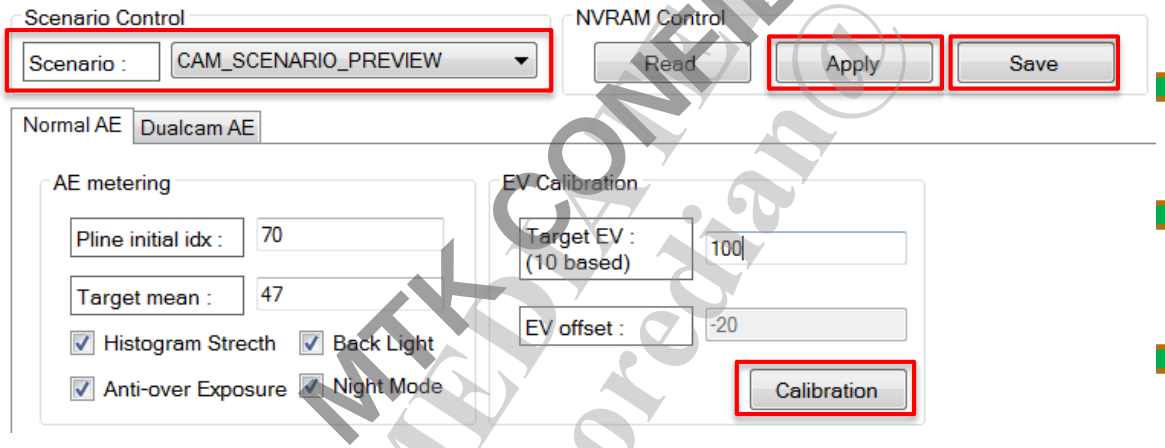
- Tool:
  adb/CCT/Debug Parser

- Light source:
  LSB in dark room

- Environment settings:
  module should put in the center area with min gap.

BV Offset Calibration

- BV offset (AE calibration page, EV Calibration)
  a) Choose sensor mode
  b) Set LSB to LV10
  c) Fill 100 into “Target EV”
  d) Click “Calibration”
  e) Apply to NVRAM
  f) Save to NVRAM



Apply → Save

LSB = LV10， Target LV =100

Click for calibration

BV Offset Calibration Verification

- Check BV offset correctness (AE calibration page)
  a) Set LSB to LV9
  b) Take a picture (JPG)
  c) Use Debug Parser to check AE_TAG_LV (AE page)
  d) AE_TAG_LV = 90 ± 2 → Ok
  e) Repeat a. to d. to check LV5~LV14

AE_TAG_CAP_AET/	1
AE_TAG_LV	91
AE_TAG_EV	91
AE_TAG_REALBV	40
AE_TAG_COMPBV	41
AE_TAG_AE_SCEN	1

DUAL CAM CALIBRATION

Calibration - Preparation

- Before 2A sync calibration, we should finish pre-check (linearity check), shading calibration and OB/DBS calibration.

- 2A sync calibration
  - B+B or W+T : i4BVOffset calibration, gSyncAEInitInfo use the **default** parameters.
  - B+M: gSyncAEInitInfo calibration

B+B OR W+T AE CALIBRATION

Calibration – B+B or W+T AE Calibration

- **The AE calibration of B+B or W+T is the same as single cam AE calibration of BV Offset.**
- If you're familiar with single cam AE calibration of BV Offset, you can do calibration for each cam, like single cam calibration, and skip the following calibration pages. Just refer to verification pages. [link]

Calibration – B+B or W+T AE Calibration

- Tool:
  adb/CCT/Debug Parser

- Brightness:
  LV10

- Light source:
  LSB in dark room

- Environment settings:
  module should put in the center area with min gap.

Calibration – B+B or W+T AE Calibration

- Calibration steps:
  - **Step 1**: Lock AF in the macro mode and fixed lsc ra ratio

```
adb shell setprop debug.af_motor.disable 1
adb shell setprop debug.af_motor.positon 1000
adb shell setprop debug.lsc_mgr.ratio 32
```

  - **Step 2**: Disable hs/abl/aor/ns (camera_ae_tuning_para_xxx_xxxxx.cpp)

```
//rHS_Spec
{
    FALSE,//bEnableHistStretch
    ...
},
//rAOE_Spec
{
    FALSE,
//bEnableAntiOverExposure
    ...
},
```

```
//rABL_Spec
{
    FALSE,//bEnableBlackLigh
    ...
},
//rNS_Spec
{
    FALSE, // bEnableNightScene
    ...
},
```

Calibration – B+B or W+T AE Calibration

- Calibration steps:
  - **Step 3**: Set AE target as 47 (camera_ae_tuning_para_xxx_xxxxx.cpp)

```
47,            // u4AETarget
```

  - **Step 4**: Adjust converge ratio (camera_ae_tuning_para_xxx_xxxxx.cpp)

```
//rAEMoveRatio =
{
        ...
        100, //u4B2TEnd
        100,//70, //u4B2TStart
70
        100,//60, //u4D2TEnd
60
        100, //u4D2TStart
},
```


MEDIATEK

Calibration – B+B or W+T AE Calibration

- Calibration steps:
  - **Step 5**: Disable AEv4p0 (ae_tuning_custm_xxx.cpp)

```
//v4.0
FALSE,          //bAEv4p0MeterEnable;
```

  - **Step 6**: Disable per-frame AE smooth (ae_tuning_custm_xxx.cpp)

```
FALSE,          // Perframe AE smooth option
```

  - **Step 7**: Adjust stable range (ae_tuning_custm_xxx.cpp)

```
static strAEStableThd g_AEStableThd =
{
    0,          // u4InStableThd;  // 0.08EV
    0,          // u4OutStableThd

    TRUE,       // enable ae different mode stable threshold setting
    ...
};
```

Calibration – B+B or W+T AE Calibration

- Calibration steps:
  - **Step 8**: Use the EM mode or CCT to do BV offset calibration. **After calibration, the modified parameters must be set to default!!!.**
  - **Step 9**: Fill the calibration result into parameters.

```
// rCCTConfig
static AE_CCT_CFG_T  g_rCCTConfig =
{
    .
    .
    .
    2,                  // u4TimeLPFStrengthIndex
    {1, 3, 5, 7, 8},    // u4LPFConvergeTable[AE_CCT_STRENGTH_NUM]
    90,                 // u4InDoorEV = 9.0, 10 base
    -6,                 // i4BVOffset delta BV = -2.3
    64,                 // u4PreviewFlareOffset
    64,                 // u4CaptureFlareOffset
    3,                  // u4CaptureFlareThres
```

Calibration – B+B or W+T AE Calibration

- Calibration steps:
  - **Step 10**: gSyncAEInitInfo set to default value.

```
static strSyncAEInitInfo gSyncAEInitInfo =
{
    {0,  0},
    {10, 10},
    // bayer standard RGB to Y 5:9:2
    {3152, 5625, 1250},
    // bayer to mono white
    {10000, 10000, 10000},
    0,
    FALSE,
    SYNC_AE_FOLLOW_MAIN
};
```

目前都採用sub cam follow MAIN cam的方式, 而哪個cam (W or T) 正在preview, 即為MAIN, 只有切換W/T 的那一個frame 會做AE sync, 之後就兩眼free run

Calibration – B+B or W+T AE Verification

- Verification steps:
  - The environment settings are the same as B+B or W+T verification
  - **Step 1**: Lock AF in the macro mode and fixed lsc ra ratio

```
adb shell setprop debug.af_motor.disable 1
adb shell setprop debug.af_motor.positon 1000
adb shell setprop debug.lsc_mgr.ratio 32
```

Calibration – B+B or W+T AE Verification

- Verification steps:
  - **Step 2**: Free-run main camera and get the exposure setting in LSB LV10.
    - (1) Before entering camera, input the following command

      adb shell setprop debug.sync2a.enable 1
    - (2) Check log
      - Exp: exposure Afe: sensor gain Isp: ISP gain

Main camera

N3DSyncAeCore: [N3dAECoreMain] ae_out[**0**] Bv 31 CWV 61 SyncG 1024 Idx 96 **Exp 19999 Afe 2368 Isp 1031** FOff 0 FG 512 ISO 69

N3DSyncAeCore: [N3dAECoreMain] ae_out[**1**] Bv 30 CWV 91 SyncG 1047 Idx 93 **Exp 19999 Afe 1160 Isp** 1047 FOff 0 FG 512 ISO 69

Main2 camera

Calibration – B+B or W+T AE Verification

- Verification steps:
  - **Step 3**: Fix the same exposure setting to main and main2.
    - (1) Before entering camera, input the following command

```
adb shell setprop debug.ae_mgr.enable 1
```

    - (2) After entering camera, input the following command (xxxx: us; yyyy: 1024 base; zzzz: 1024 base)

```
adb shell setprop debug.ae_mgr.shutter xxxx
adb shell setprop debug.ae_mgr.sensorgain yyyy
adb shell setprop debug.ae_mgr.ispgain zzzz
adb shell setprop debug.ae_mgr.preview.update 1
```

Calibration – B+B or W+T AE Verification

- Verification steps:
  - **Step 4**: Use the EM mode to get the processed raw of the main and the main2 sensor
  - **Step 5**: Compare the real difference.
    - Difference between “Raw Center Avg, G” and “Calibrated BV Offset” should be smaller than 0.1 → Pass

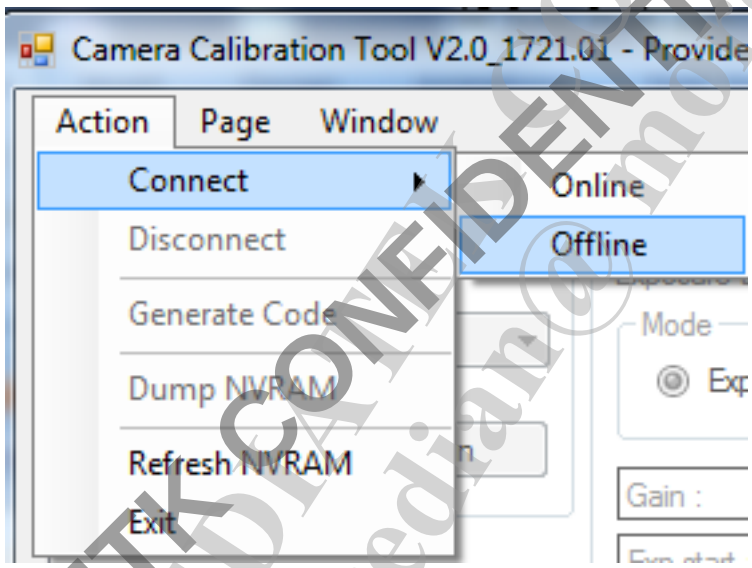
	Main	Main2	Diff EV
Raw Center Avg, G (12 bit)	1084	1561	-0.52611
Calibrated BV Offset	-18	-13	-0.5

= Log (main_G/main2_G,2)

B+M AE CALIBRATION

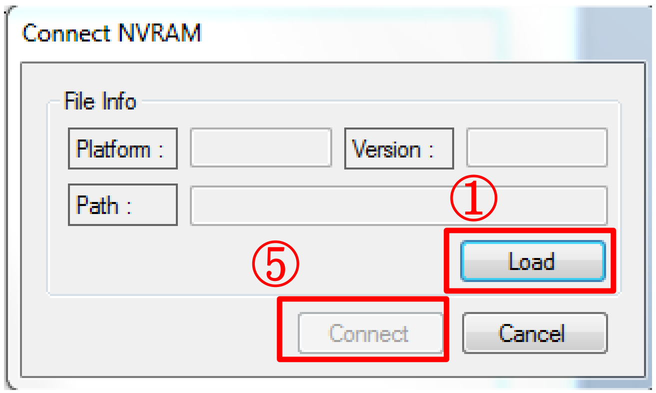
Tuning Tool – CCT Tool

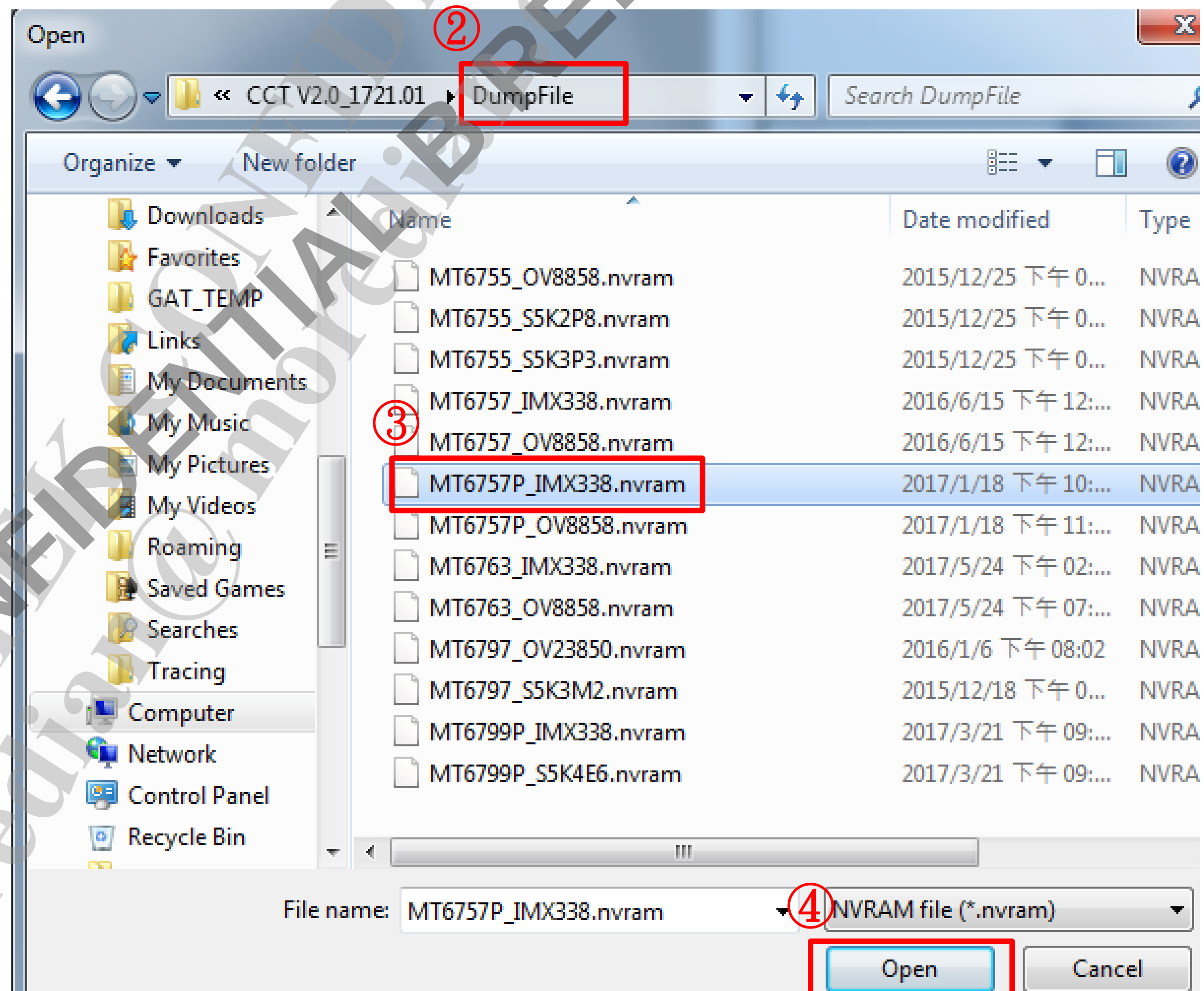
- Dual Cam AE calibration/verify should be processing by CCT using **Offline mode**
- Basic operation of the CCT tool for dual AE calibration/verify
  - (1) Offline connect: Action → Connect →Offline



Tuning Tool – CCT Tool

- Basic operation of the CCT tool for dual AE calibration/verify
  - (2) Load NVRAM

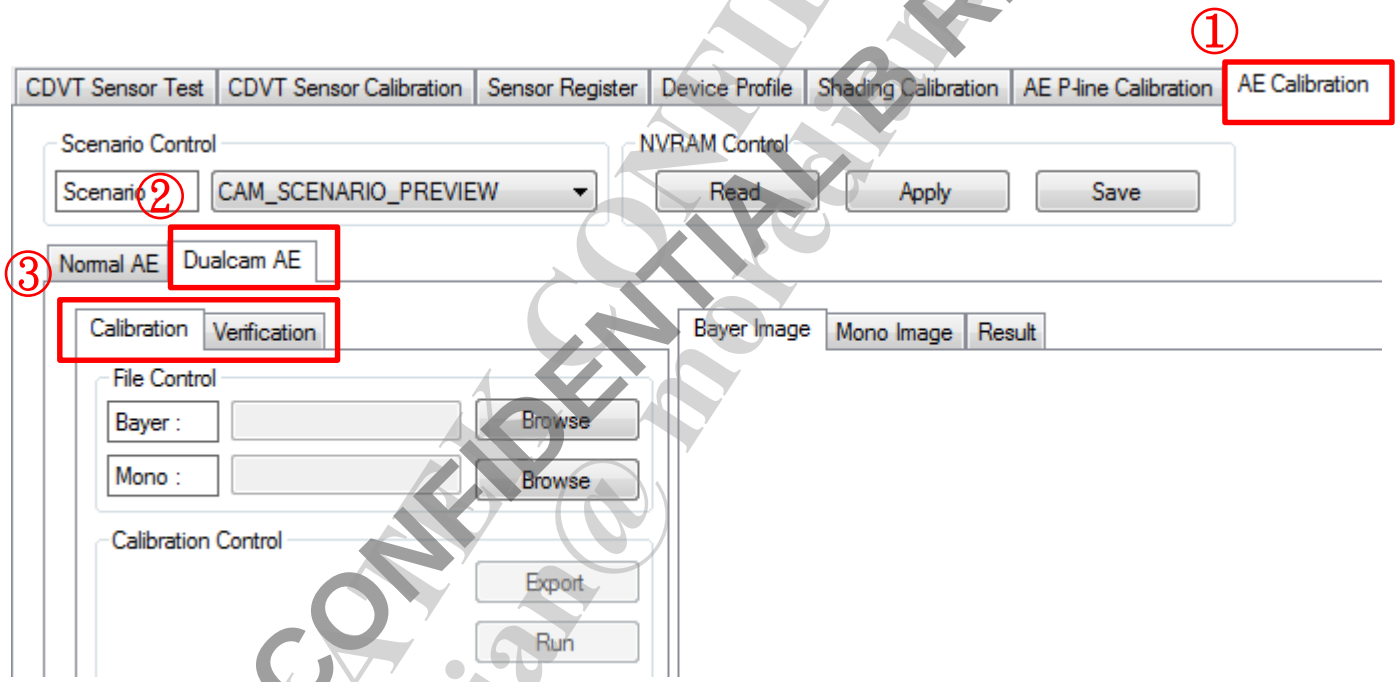




Open
②
« CCT V2.0_1721.01 ▸ DumpFile
Search DumpFile
Organize
New folder
Downloads
Favorites
GAT_TEMP
Links
My Documents
My Music
My Pictures
My Videos
Roaming
Saved Games
Searches
Tracing
Computer
Network
Control Panel
Recycle Bin
Name
Date modified
Type
MT6755_OV8858.nvram
MT6755_S5K2P8.nvram
MT6755_S5K3P3.nvram
MT6757_IMX338.nvram
MT6757_OV8858.nvram
MT6757P_IMX338.nvram
MT6757P_OV8858.nvram
MT6763_IMX338.nvram
MT6763_OV8858.nvram
MT6797_OV23850.nvram
MT6797_S5K3M2.nvram
MT6799P_IMX338.nvram
MT6799P_S5K4E6.nvram
③
File name: MT6757P_IMX338.nvram
④
NVRAM file (*.nvram)
Open
Cancel

Tuning Tool – CCT Tool

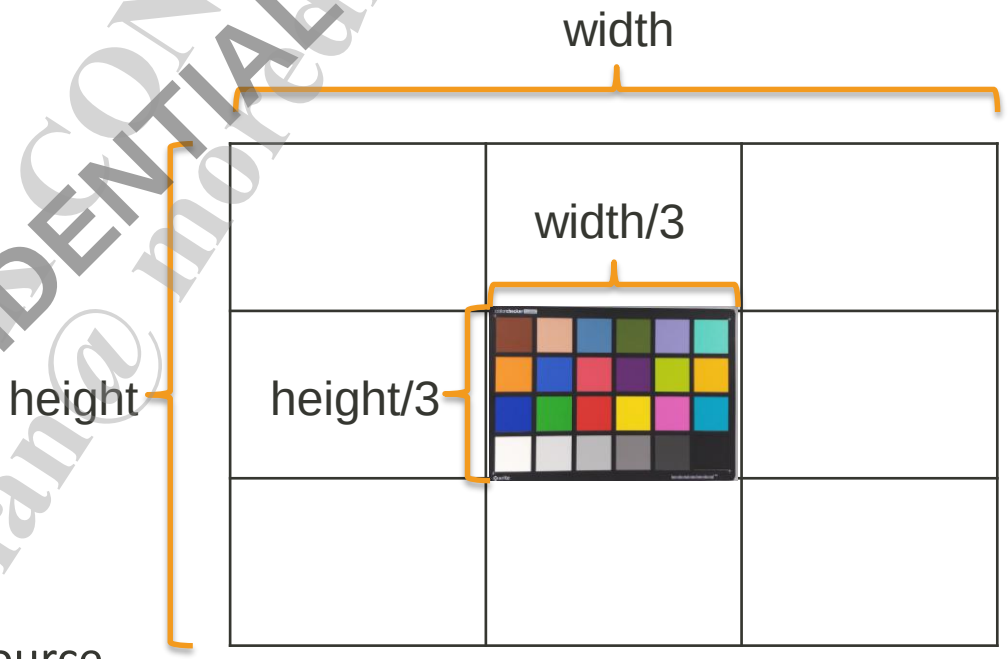
- Basic operation of the CCT tool for dual AE calibration/verify
  - (3) Switch to dual cam AE page



③:
Calibration: B+M AE sync calibration
Verification: Y or G value for the 24 patches calculation and B+M AE sync verification

Calibration – B+M AE calibration

- Chart:
  - Color Checker (24 color chart)
  - Put in the center of image (occupy 1/9 whole image)
- Light Source:
  - D65/CWF/TL84/A/HOR
- Tool:
  - EM mode
  - CCT
  - Adb
  - Debug Parser (DP)
- Total:
  - 10 = 2 sensor x 5 light source



Calibration – B+M AE calibration

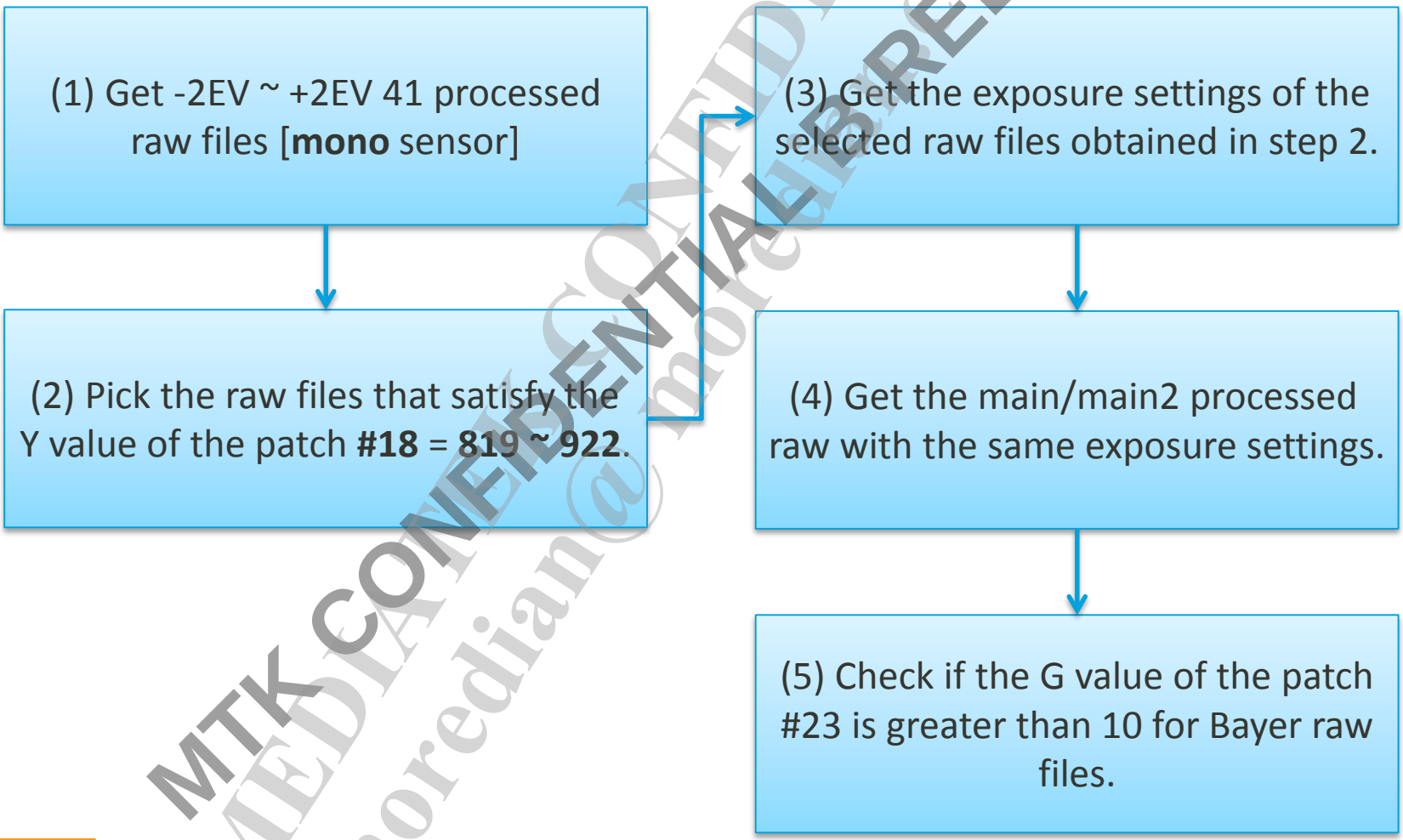
- Exposure:
  - Control exposure gain < 2x (ISO 200)
  - Bayer's exposure is the same with Mono
  - Mono:

    Y value of the patch **#18** around saturation level x (80 %~ 90%) = **819 ~ 922** [10 bit processed raw]
  - Bayer:

    G value of the patch **#23** around **10 or > 10** [10 bit processed raw]

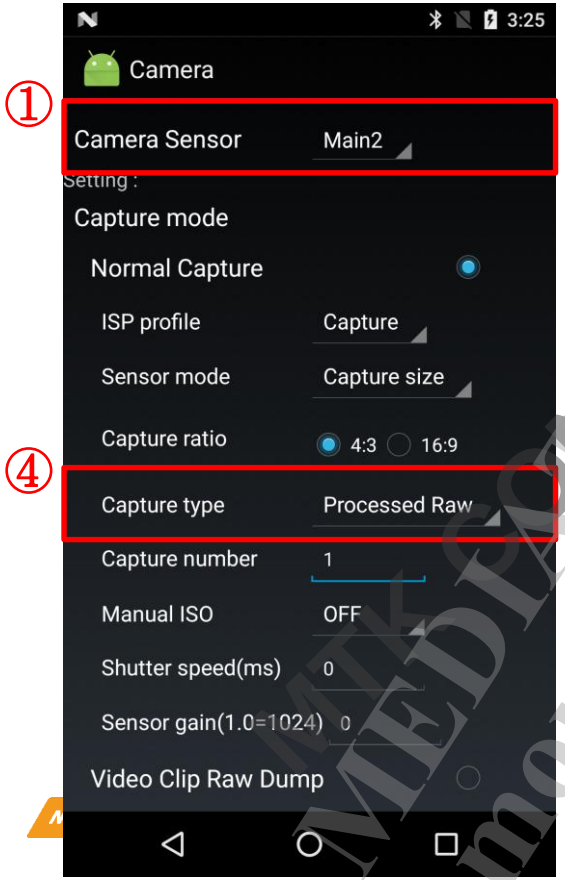
Calibration – B+M AE calibration

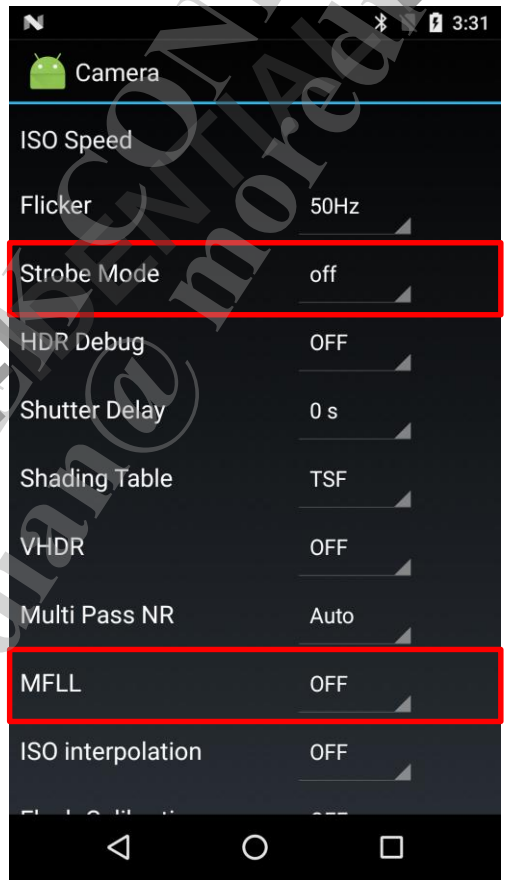
- Data collect steps:

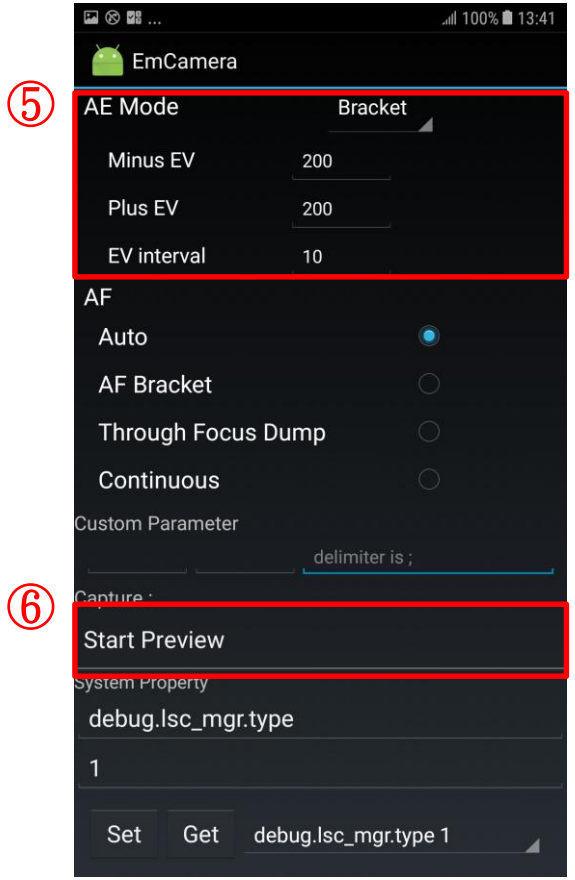


Calibration – B+M AE calibration

- Data collect steps:
  - **Step 1**: Use the EM mode to get **-2EV ~ +2EV, 41** processed raw files of the **mono**(main2) sensor under the **D65/CWF/A/TL84/Hor** light source.



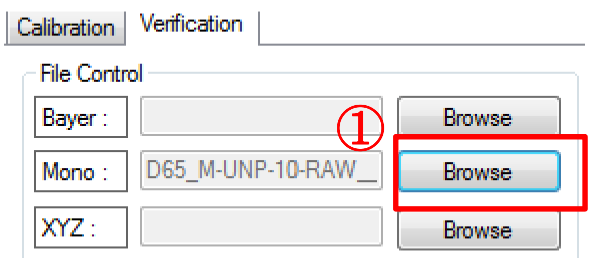


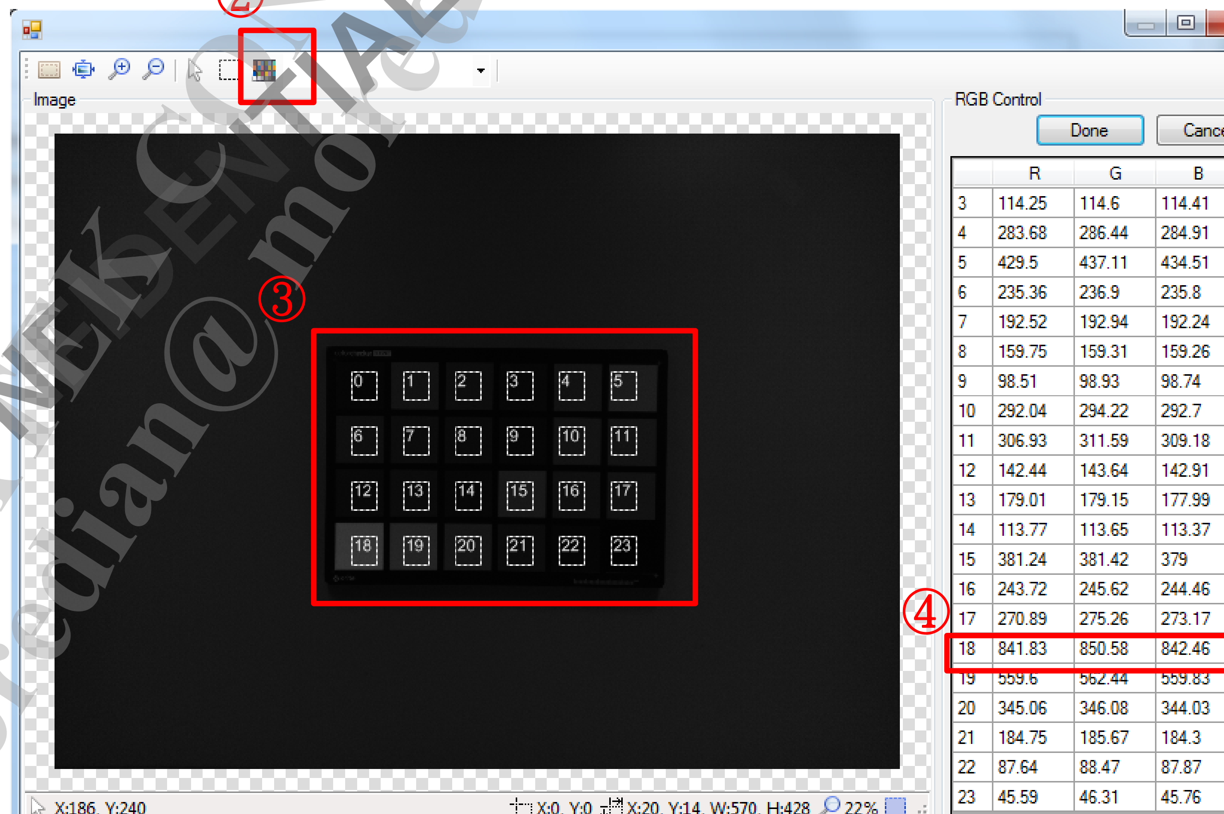


Calibration – B+M AE calibration

- Data collect steps:
  - **<u>Step 2</u>**: Pick the raw files that satisfy the Y value of the patch **#18 = 819 ~ 922**.

    (1) Use the dual AE verification of the CCT tool to get the R/G/B value of the patch #18.





②
Image
③
RGB Control
Done
Cancel
R G B
3 114.25 114.6 114.41
4 283.68 286.44 284.91
5 429.5 437.11 434.51
6 235.36 236.9 235.8
7 192.52 192.94 192.24
8 159.75 159.31 159.26
9 98.51 98.93 98.74
10 292.04 294.22 292.7
11 306.93 311.59 309.18
12 142.44 143.64 142.91
13 179.01 179.15 177.99
14 113.77 113.65 113.37
15 381.24 381.42 379
16 243.72 245.62 244.46
17 270.89 275.26 273.17
④
18 841.83 850.58 842.46
19 559.6 562.44 559.83
20 345.06 346.08 344.03
21 184.75 185.67 184.3
22 87.64 88.47 87.87
23 45.59 46.31 45.76
X:186, Y:240
X:0, Y:0
X:20, Y:14, W:570, H:428
22%

Calibration – B+M AE calibration

- Data collect steps:
  - **Step 2**: Pick the raw files that satisfy the Y value of the patch **#18** = **819 ~ 922**.

    (2) Calculate the Y value and record the EV settings of the selected raw files.

Light source	Y value= (R+G+B)/3	EV settings
D65	819<**845**< 922	-1.0 EV
CWF		+0.6 EV
TL84		..
A		..
Hor		..

Calibration – B+M AE calibration

- Data collect steps:
  - **Step 3**: Get the exposure settings (exposure time/sensor gain/isp gain) of the selected raw files obtained in step 2.

    (1) Use the DP tool to get the EV=0's index and calculate the EV = x's index.

Light source	EV settings	EV=0's index	EV= x's index
D65	-1.0 EV	97	= 97 +(-1.0x10)=87
CWF	+0.6EV	80	= 80 + (0.6x10)=86
TL84	..	..	..
A	..	..	..
Hor	..	..	..

Calibration – B+M AE calibration

- Data collect steps:
  - **Step 3**: Get the exposure settings (exposure time/sensor gain/isp gain) of the selected raw files obtained in step 2.

    (2) Look up the p-line table to get the EV = x's exposure settings.

AE_TAG_PRV_PLINE_ID	23

Scene 5

Light source	EV= x's index	Shutter	Sensor Gain	ISP gain
D65	87	9996	1536	1056
CWF	86	9996	1440	1040
TL84	..	..	..	..
A	..	..	..	..
Hor	..	..	..	..

Calibration – B+M AE calibration

- Data collect steps:
  - **Step 4**: Get the main/main2 processed raw with the same exposure settings.
    - (1) Before entering camera, input the following command

      adb shell setprop debug.ae_mgr.enable 1

    - (2) After entering camera, input the following command (xxxx: us; yyyy: 1024 base; zzzz: 1024 base)

```
adb shell setprop debug.ae_mgr.shutter xxxx
adb shell setprop debug.ae_mgr.sensorgain yyyy
adb shell setprop debug.ae_mgr.ispgain zzzz
adb shell setprop debug.ae_mgr.preview.update 1
```

Light source	Shutter	Sensor Gain	ISP gain
D65	9996	1536	1056
CWF	9996	1440	1040
TL84	..	..	..
A	..	..	..
Hor	..	..	..

Calibration – B+M AE calibration

- Data collect steps:
  - **Step 4**: Get the main/main2 processed raw with the same exposure settings.
    - (3) Get processed raw

Calibration – B+M AE calibration

- Data collect steps:
  - **Step 5**: Check if the G value of the patch #23 is greater than 10 for Bayer raw files.
    - If yes => no problem
    - If no => adjust the exposure settings

Calibration – B+M AE calibration

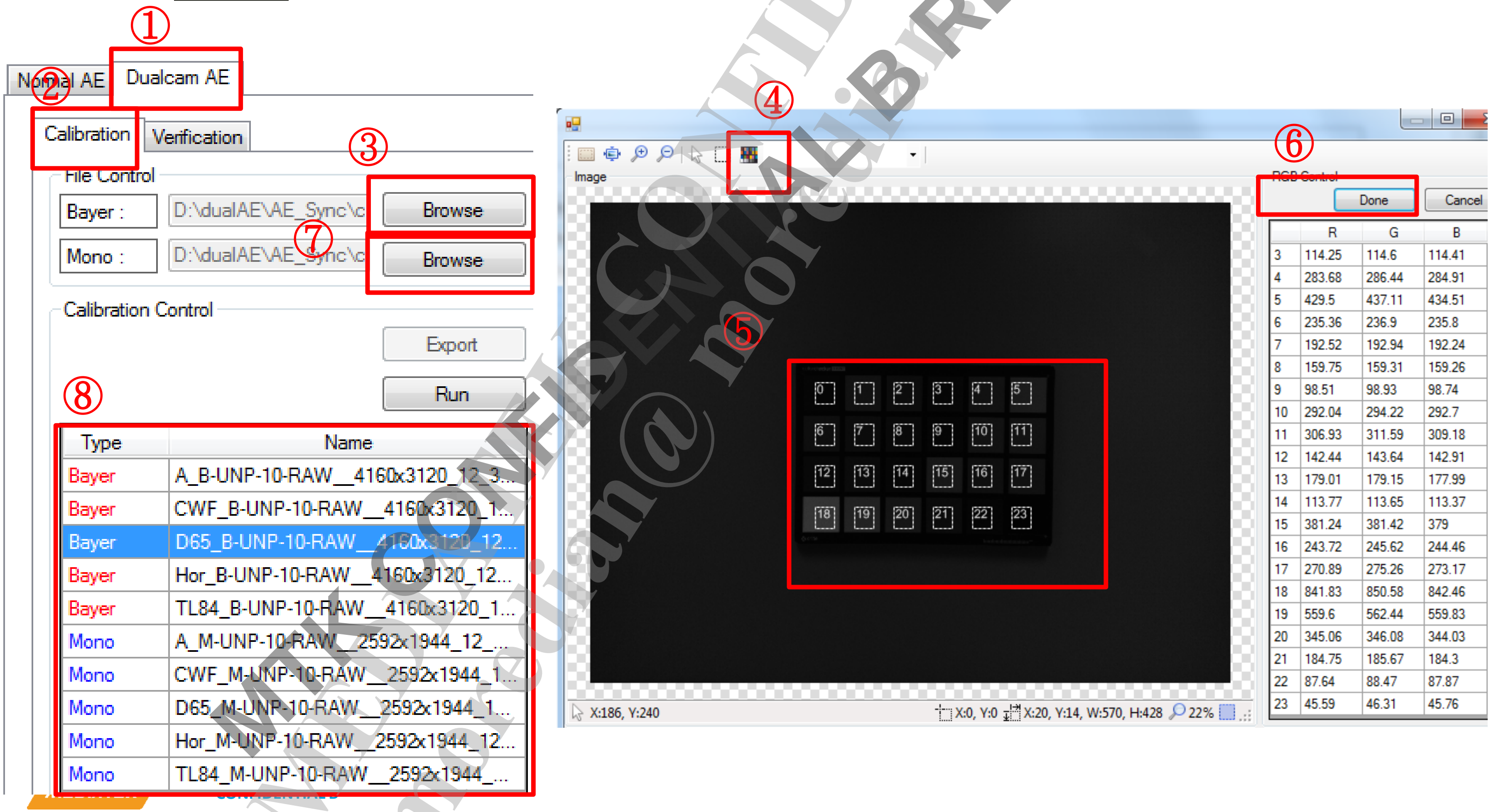
- Calibration steps:
  - **Step 1**: Put the Bayer raw files and the mono raw files in the respective folders and rename these raw files.
    - Naming Rule:
      - Bayer: LightSource_B-UNP-10-RAW__WidthxHeight_12_3
      - Mono: LightSource_M-UNP-10-RAW__WidthxHeigh_12_3

Bayer	Mono
A_B-UNP-10-RAW__4160x3120_12_3.raw	A_M-UNP-10-RAW__2592x1944_12_3.raw
CWF_B-UNP-10-RAW__4160x3120_12_3.raw	CWF_M-UNP-10-RAW__2592x1944_12_3.raw
D65_B-UNP-10-RAW__4160x3120_12_3.raw	D65_M-UNP-10-RAW__2592x1944_12_3.raw
Hor_B-UNP-10-RAW__4160x3120_12_3.raw	Hor_M-UNP-10-RAW__2592x1944_12_3.raw
TL84_B-UNP-10-RAW__4160x3120_12_3.raw	TL84_M-UNP-10-RAW__2592x1944_12_3.raw

5 sets of 1-by-1 raw files

Calibration – B+M AE calibration

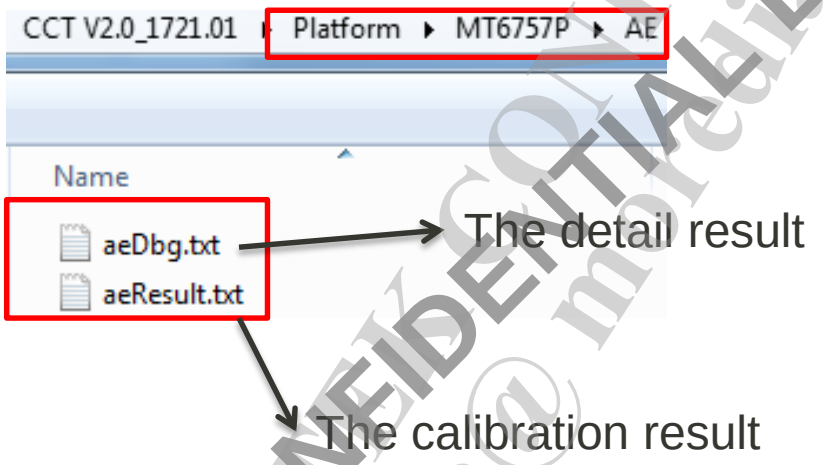
- Calibration steps:
  - **Step 2**: Use the CCT tool to get the calibration data.



①
②
③
④
⑤
⑥
⑦
⑧
Normal AE
Dualcam AE
Calibration
Verification
File Control
Bayer :
D:\dualAE\AE_Sync\c
Browse
Mono :
D:\dualAE\AE_Sync\c
Browse
Calibration Control
Export
Run
Type
Name
Bayer
A_B-UNP-10-RAW__4160x3120_12_3...
Bayer
CWF_B-UNP-10-RAW__4160x3120_1...
Bayer
D65_B-UNP-10-RAW__4160x3120_12...
Bayer
Hor_B-UNP-10-RAW__4160x3120_12...
Bayer
TL84_B-UNP-10-RAW__4160x3120_1...
Mono
A_M-UNP-10-RAW__2592x1944_12_...
Mono
CWF_M-UNP-10-RAW__2592x1944_1...
Mono
D65_M-UNP-10-RAW__2592x1944_1...
Mono
Hor_M-UNP-10-RAW__2592x1944_12...
Mono
TL84_M-UNP-10-RAW__2592x1944_...
Image
X:186, Y:240
X:0, Y:0
X:20, Y:14, W:570, H:428
22%
RGB Control
Done
Cancel
R G B
3 114.25 114.6 114.41
4 283.68 286.44 284.91
5 429.5 437.11 434.51
6 235.36 236.9 235.8
7 192.52 192.94 192.24
8 159.75 159.31 159.26
9 98.51 98.93 98.74
10 292.04 294.22 292.7
11 306.93 311.59 309.18
12 142.44 143.64 142.91
13 179.01 179.15 177.99
14 113.77 113.65 113.37
15 381.24 381.42 379
16 243.72 245.62 244.46
17 270.89 275.26 273.17
18 841.83 850.58 842.46
19 559.6 562.44 559.83
20 345.06 346.08 344.03
21 184.75 185.67 184.3
22 87.64 88.47 87.87
23 45.59 46.31 45.76

Calibration – B+M AE calibration

- Calibration steps:
  - **Step 3**: Check the calibration result.
    - The calibration result will stored in ..\Platform\MT6757P\AE



Calibration – B+M AE calibration

- Calibration steps:
  - **Step 3**: Check the calibration result.
    - aeDbg.txt:

    If fail, please check the raw files if they're exact processed raw with only OB & LSC, and check if exposure value is set normally.

```
[Environment]
BayerPath: D:\dualAE\AE_Sync\calibration_images\BAYER\
MonoPath: D:\dualAE\AE_Sync\calibration_images\MONO\
[Coefficients]
Conversion formula: W = xR + yG + zB
RGB to W coefficients: x:0.887534, y:0.898666, z:1.074054
Raw bit depth: 12
Pass Criterion: |W/RGBtoW|/4096 < 5.00%
==================================
[RawSet 1]
[ColorCell#1]
Bayer: B:25.777613, G:73.244400, R:81.510498
Mono: W:163.730286
RGBtoW :165.852112
Ratio :0.05%
Result:Pass
```

Patch #0

Avg. R/G/B value of the Bayer raw

Avg. W of the mono raw

RGBtoW: conversion R/G/B to W

Check if Ratio < Pass criteria

Calibration – B+M AE calibration

- Calibration steps:
  - **Step 4**: Check the calibration result.
    - aeResult.txt
      - Copy the calibration result(aeResult.txt) to n3d_sync2a_tuning_para.cpp.

```
0.446869
0.452473
0.540781
4468
4524
5407
10
1031
```

```
static strSyncAEInitInfo gSyncAEInitInfo =
{
    {0,  0},
    {3, 3},
    // bayer standard RGB to Y 5:9:2
     {4863, 4170,5650},
    // bayer to mono white
    //{4028, 4281, 5904},
    {10000, 10000, 10000},
    1047,//1033,
    true,
    SYNC_AE_FOLLOW_MAIN
```

Calibration – B+M AE Verification

- Chart:
  - Color Checker (24 color chart)
  - Put in the center of image (occupy 1/9 whole image)
- Light Source:
  - D65/CWF/TL84/A/HOR
- Tool: EM mode/CCT/Adb
- Total:
  - 10 = 2 sensor x 5 light source

Calibration – B+M AE Verification

- Data collect steps:
  - **Step 1**: Camera's stereo mode with enabling sync 2A function and dump the Bayer and the Mono processed raw.

Calibration – B+M AE Verification

- Data collect steps:
  - **Step 2**: If 1 isn't available, record the exposure settings with MTK log, and set the exposure settings manually. And get processed raw from Engineering Mode.

    (1) Get the current exposure settings of the Bayer and the Mono sensor.
    - 1. Before entering camera, input the following command

      adb shell setprop debug.sync2a.enable 1

    - 2. Check log
      - Exp: exposure Afe: sensor gain Isp: ISP gain

Main camera

N3DSyncAeCore: [N3dAECoreMain] ae_out[**0**] Bv 31 CWV 61 SyncG 1024 Idx 96 **Exp 19999 Afe 2368 Isp 1031** FOff 0 FG 512 ISO 69

N3DSyncAeCore: [N3dAECoreMain] ae_out[**1**] Bv 30 CWV 91 SyncG 1047 Idx 93 **Exp 19999 Afe 1160 Isp** 1047 FOff 0 FG 512 ISO 69

Main2 camera

Calibration – B+M AE Verification

- Data collect steps:
  - **Step 2**: If 1 isn't available, record the exposure settings with MTK log, and set the exposure settings manually. And get processed raw from Engineering Mode.

    (2) Set the exposure settings manually and get the Bayer and the processed raw.
    - 1. Before entering camera, input the following command

      ```
      adb shell setprop debug.ae_mgr.enable 1
      ```

    - 2. After entering camera, input the following command (xxxx: us; yyyy: 1024 base; zzzz: 1024 base)

      ```
      adb shell setprop debug.ae_mgr.shutter xxxx
      adb shell setprop debug.ae_mgr.sensorgain yyyy
      adb shell setprop debug.ae_mgr.ispgain zzzz
      adb shell setprop debug.ae_mgr.preview.update 1
      ```

Calibration – B+M AE Verification

- Data collect steps:
  - **Step 2**: If 1 isn't available, record the exposure settings with MTK log, and set the exposure settings manually. And get processed raw from Engineering Mode.

    (2) Set the exposure settings manually and get the Bayer and the processed raw.

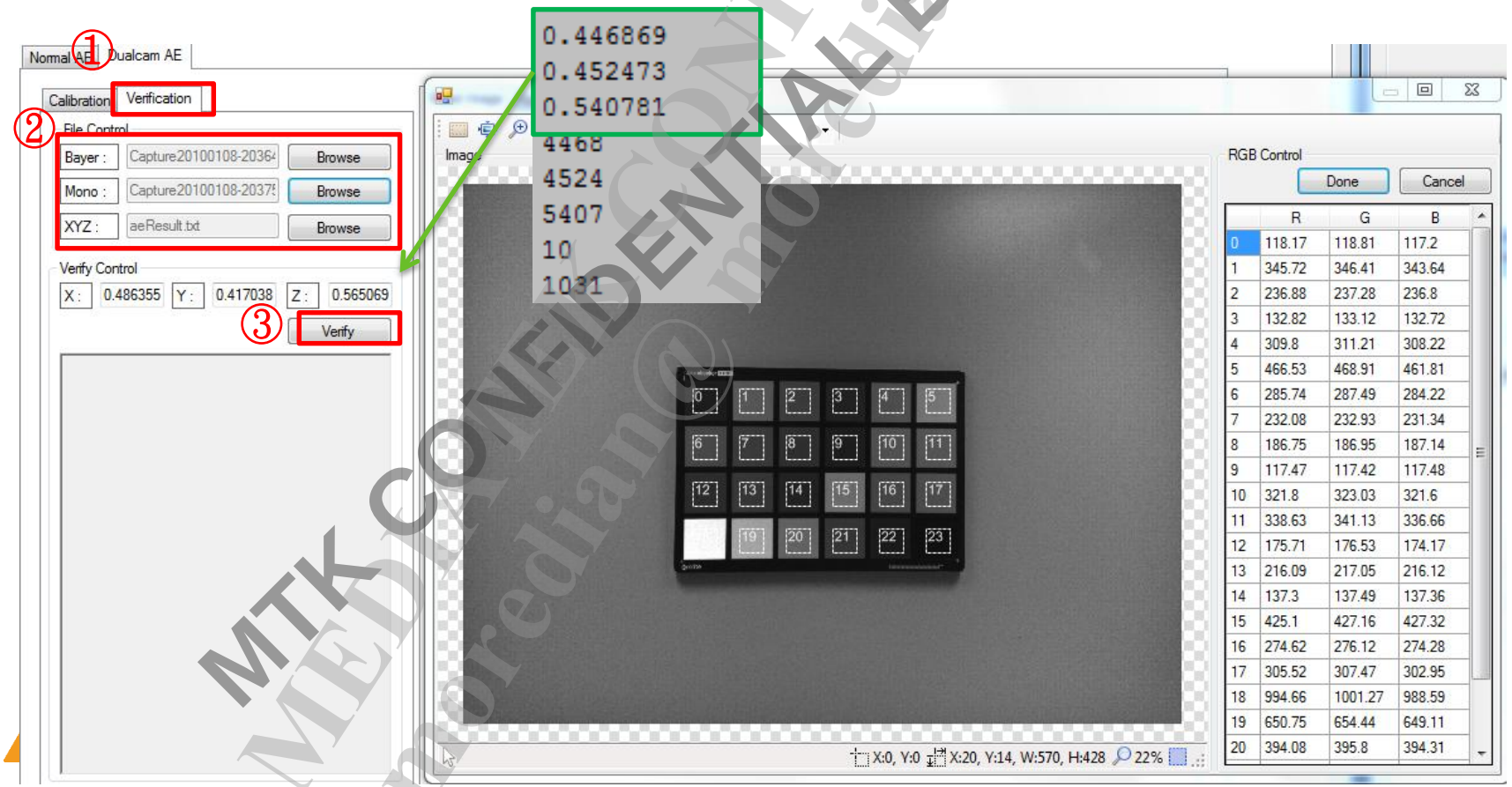
    Note: The exposure settings between the Bayer and the Mono sensor are **different**.

Light source	Bayer Shutter	Bayer Sensor Gain	Bayer ISP gain	Mono Shutter	Mono Sensor Gain	Mono ISP gain
D65	19999	2368	1031	1999	1160	1047
CWF	..	..	..	..	..	..
…						

Calibration – B+M AE Verification

- Verification collect steps:
  - **Step 3**: Use the CCT tool to get the verify result.

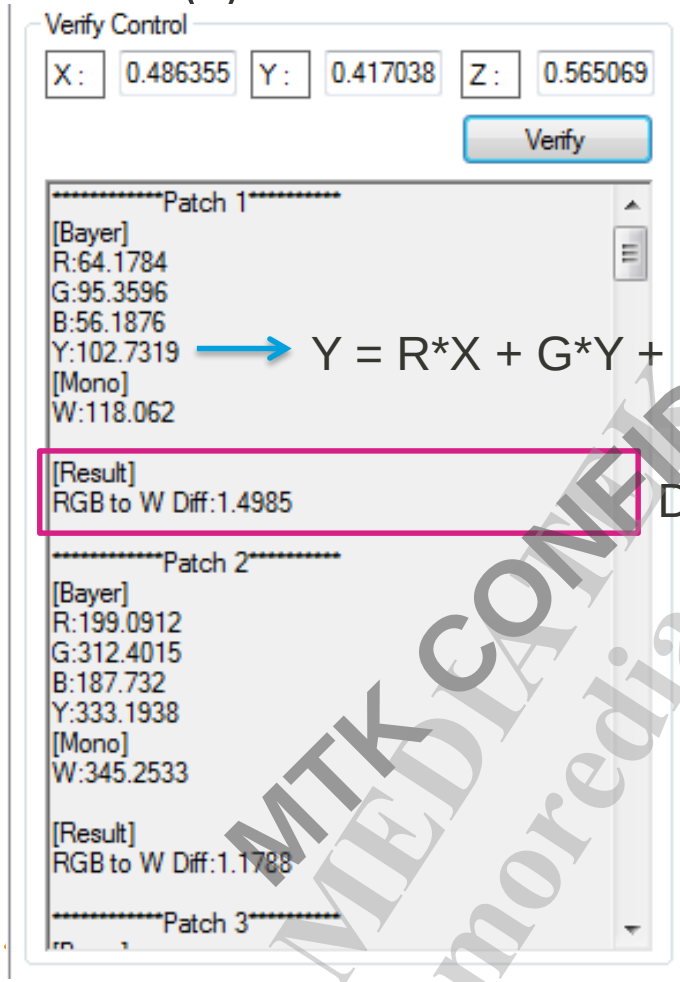
    (1) Load the processed raw and the aeResult.txt.



Calibration – B+M AE Verification

- Verification collect steps:
  - **Step 3**: Use the CCT tool to get the verify result.

    (2) Check if result of all patches < 5.



$Y = R*X + G*Y + B*Z$

Diff. = 100*abs(Y-W)/2^bit depth

APPENDIX

EV Definition

- EV : Exposure Value
  - 代表能夠給出同樣曝光的所有相機光圈快門組合
  - 曝光值同樣也可以表示曝光刻度上的一個級差，1EV對應於兩倍的曝光比例並通常被稱為「一檔」。

高速快門，短暫曝光

慢速快門，長時間曝光

Same Exposure Value

表2. 不同場景下的曝光值(ISO100)

光線條件	EV_{100}
日光	
強烈陽光下的明亮沙灘和雪景（陰影很清晰）[a]	16
強烈陽光下的一般場景（陰影很清晰）[a,b]	15
朦朧日光下的一般場景（陰影柔和）	14
明亮陰天下的一般場景（沒有陰影）	13
非常陰沉的一般場景	12
強烈陽光下四周無遮擋的陰影區	12
戶外，自然光	
彩虹	
晴朗的天空背景	15
多雲的天空背景	14
日落和天際	
日落前一刻	12–14
日落時	12
日落後一刻	9–11
月亮,[c] 緯度 > 40°	
滿月	15
凸月	14
四分之一月	13
月牙	12
月光，月亮在緯度40°以上	
滿月	−3 to −2
凸月	−4
四分之一月	−6
北極光和南極光	
明亮的	−4 to −3
一般的	−6 to −5

APEX (Additive Photographic Exposure System)

- 由美國國家標準協會（ASA）於1960年推出，用於計算單色底片速度
- EV = AV + TV = BV + SV

$$Av = \log_2(f^2)$$

$$Tv = \log_2(1/T)$$

$$Sv = \log_2(0.32 * I)$$

$$Bv = \log_2(\frac{L}{0.3K})$$

f：光圈 f number

T：曝光時間，單位秒

I : ISO speed rating

L: where *L is the luminance in candelas/m^2 and*

K is the reflected light metering constant, usually taken to be 11.4

AE Gen Pline Table

- AV + TV = EV
  - AV　: 光圈值的級數
    一般光圈用Fno.表示. Fno.表示光圈直徑開孔的大小的倒數
    由於面積 = π*半徑, 而光圈每提升一級,代表孔徑縮小一倍, Fno * 1.41,入光量 * ½

Fno.	1	1.41	2	2.82	4	5.65	8	11.3	16	22.6	32
AV	0	1	2	3	4	5	6	7	8	9	10

  - TV　: 快門值的級數
    一般用秒(s)為單位來衡量快門的長短,當快門提升一級,曝光時間 * ½,入光量 * ½

S	32s	16s	8s	4s	2s	1s	1/2s	1/4s	1/8s	1/16s	1/32s	1/64s	1/128s
TV	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7

  - AV + TV　: **光通量的總和**.有多少光通過鏡頭到達Sensor .可視為曝光的供給面
  - EV　: 用來衡量光通量的總和
    EV = Log2(Fno. / 快門時間)
  - 結論　: AV+1 (光圈變小), TV-1(快門加長), EV不變(光通量不變)
    : AV-1 (光圈變大), TV+1(快門縮短), EV不變(光通量不變)

AE Gen Pline Table

- BV + SV
  - BV : 環境亮度的級數. 環境亮度越高,BV越高
  - SV : Sensor感光度的級數. 感光度越高, SV越高

ISO	12.5	25	50	100	200	400	800	1600	3200
SV	2	3	4	5	6	7	8	9	10

  - BV + SV : **光需求的總和**. 固定的環境亮度及感光度之下, 需要多少光通量來讓曝光平衡可視為曝光的需求面

- 曝光公式
  - 當**曝光正確**的前提下(影像亮度到達Target) , AV+TV = EV = BV+SV

AV + TV = EV = BV + SV

曝光的供給面　　曝光的需求面

換句話說, 當滿足AV+TV = BV +SV
(**曝光的供給=曝光的需求**)
此時曝光是正確的(成像亮度正常)

Tuning Files - P-Line

- P-Line:
  - ..\custom**[ProjectName]**\hal\imgsensor\ver2**[SensorName]**_mipi_mono\camera_AE_PLineTable_**[SensorName]**mipimono.h
  - ..\custom**[ProjectName]**\hal\imgsensor\ver2**[SensorName]**_mimipi_raw\camera_AE_PLineTable_**[SensorName]**mipiraw.h

```
static strAETable g_AE_SceneTable11 =
{
    AETABLE_SCENE_INDEX11,     //eAETableID
    167, //u4TotalIndex
    20, //i4StrobeTrigerBV
    123, //i4MaxBV
    -44, //i4MinBV
    0, //i4EffectiveMaxBV
    0, //i4EffectiveMinBV
    LIB3A_AE_ISO_SPEED_AUTO, //ISO SPEED
    sAEScene11PLineTable_60Hz,
    sAEScene11PLineTable_50Hz,
    NULL,
};
```

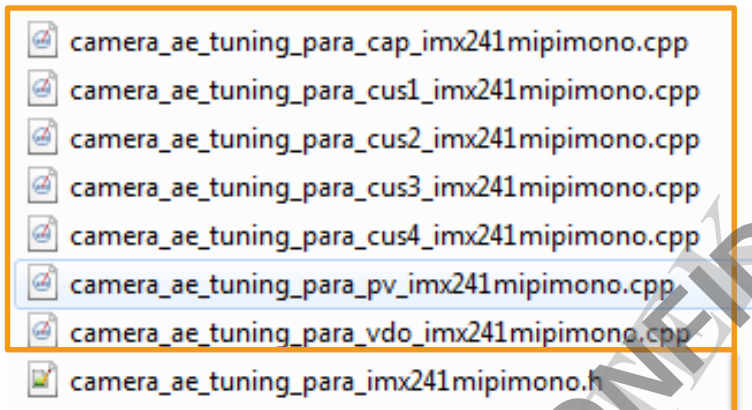
Sensor ID:
1: main camera
2: Sub camera
4: main2 camera

```
ae_mgr : [getCurrentPlineTable()] i4SensorDev:1 PreId:29 CapId:29 Strobe:18
ae_mgr : [getCurrentPlineTable()] i4SensorDev:4 PreId:29 CapId:29 Strobe:18
```

P-line Index

Tuning Files - AE Sync

- Bayer + Bayer or Wide + Tele:
  - i4BVOffset
    - ..\custom**[ProjectName]**\hal\imgsensor\ver2**[SensorName]**_mipi_mono\AE_Tuning_Para\camera_ae_tuning_para_**[Scenerio]**_**[SensorName]**mipimono.cpp




```
// rCCTConfig
static AE_CCT_CFG_T  g_rCCTConfig =
{
    .
    .
    .
    2,                  // u4TimeLPFStrengthIndex
    {1, 3, 5, 7, 8}, // u4LPFConvergeTable[AE_CCT_STRENGTH_NUM]
    90,                 // u4InDoorEV = 9.0, 10 base
    -6,                // i4BVOffset delta BV = -2.3
    64,                 // u4PreviewFlareOffset
    64,                 // u4CaptureFlareOffset
    3,                  // u4CaptureFlareThres
```

Please use the same i4BVOffset settings for all scenario.

Tuning Files - AE Sync

- Bayer + Mono:
  - gSyncAEInitInfo
    - ..\custom**[ProjectName]**\hal\camera_3a\n3d_sync2a_tuning_param.cpp

```
static strSyncAEInitInfo gSyncAEInitInfo =
{
    {0,  0},
    {10, 10},
    // bayer standard RGB to Y 5:9:2
    {3125, 5625, 1250},
    // bayer to mono white
    //{4028, 4281, 5904},
    {10000, 10000, 10000},
    0,
    false,
    SYNC_AE_FOLLOW_MAIN,
      {   //SYNC_AE_DUAL_CAM_DENOISE_BMDN
        {
        1000,  // EV  0
        1072,   //EV  0.1
        1149,   //EV  0.2
        1231,   //EV  0.3
        1320,   //EV  0.4
        1414,   //EV  0.5
        1516,   //EV  0.6
        1625,   //EV  0.7
        1625,   //EV  0.8
        1625,   //EV  0.9
        1625,   //EV  1
        1625,   //EV  1.1
        1625,   //EV  1.2
        1625,   //EV  1.3
        1625,   //EV  1.4
```