Horizon J3 Tuning Tool User Guide

v1.1

2020-03

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Revision History

The revision history lists the major changes that have occurred between versions of each document. The following table lists the technical content of each document update.

Version	Revision Date	Description
1.0	2020-3-24	Draft
1.1	2020-3-26	Update description

Table of Content

1 Control tool instructions

1.1 Control tool function

Control tool is a graphical tool for tuning ISP parameters during ISP tuning, as shown in Figure 1. With the help of this tool, tuning personnel can view ISP status information and adjust parameters of isp modules.

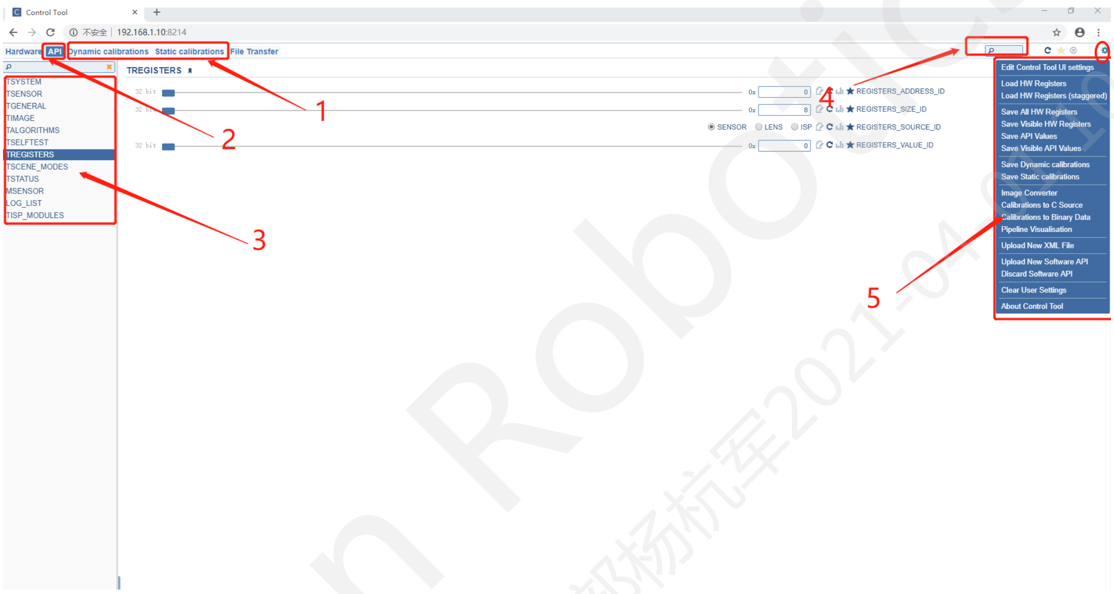


Figure 1: Control tool interface.

There are many modules in Figure 1, such as calibration, API and so on. The descriptions of each module are shown in Table 1.

#	Name	Description	Remark
1	calibration information	dynamic/static	tuning related parameters
2	api page		
3	api related options	There are several sub items, see tuning guide for instructions	
4	Feature search options	Quickly find the location of related function items	
5	State control options	Auxiliary function, eg. convert the json file to the *.c file for compilation	

Table 1: Control tool interface function description

1.2 Control tool operating instructions

1. Make sure J3 is connected to PC.

2. Log into J3 using serial port (or SSH) and start control tool server

Start command: ./act-server --http-port=8214 --fw-acc=stream --fw-channel=chardev --fw-dev=/dev/ac_isp --hw-acc=stream --hw-buf-size=1024 --hw-channel=devmem --hw-dev=/dev/mem --hw-mem-offset=0xb3000000 --hw-mem-size=0x400000

The parameter description is shown in Table 2. The parameters to be configured are firmware and hardware. Firmware uses chardev to interact data with the driver and hardware uses devmem to read and write ISP register parameters.

#	Parameter Name	Parameter	Description
1	--http-port	8214	Network port number
firmware			
2	--fw-channel	chardev	Connect to the driver through chardev
3	--fw-dev	/dev/ac_isp	Device name
4	--hw-buf-size	1024	Buffer size
5	--fw-acc (firmware access type)	stream	Use stream via /dev/ac_isp
hardware			
6	--hw-channel	devmem	Use devmem to get register information
7	--hw-dev	/dev/mem	Device name
8	--fw-acc (hardware access type)	stream	hardware access type
9	--hw-mem-offset	0xb3000000	Offset address
10	--hw-mem-size	0x400000	Parameter length

Table 2: Control tool server start parameter description

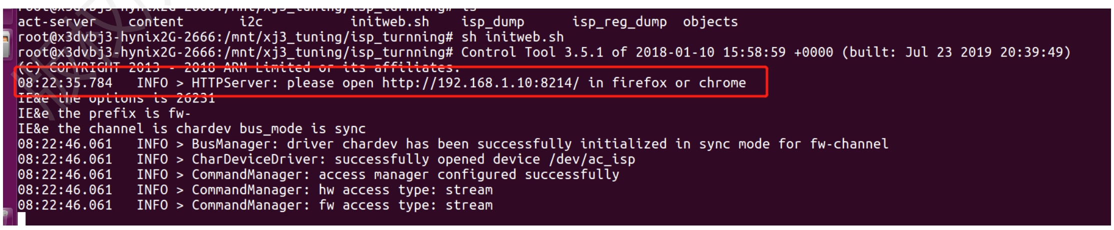


Figure 2: Control tool server started successfully

3. Use the Firefox (or Chrome) browser to access the address.

note:

(1) J3 IP address: 192.168.1.10, port number: 8214, then visit http://192.168.1.10:8214/. See log for the access address.

(2) The initial login needs to load the " IV009-HW-Control.xml" document to build the hardware page's information, and load the " command.json" to build the api page. This file will be published with the tool.

2 Hobot player instructions

2.1 Hobot player function

Hobot player is used as an auxiliary debugging tool for isp-tuning to view image effects, as shown in Figure 3. Table 2 describes each component in Figure 1.

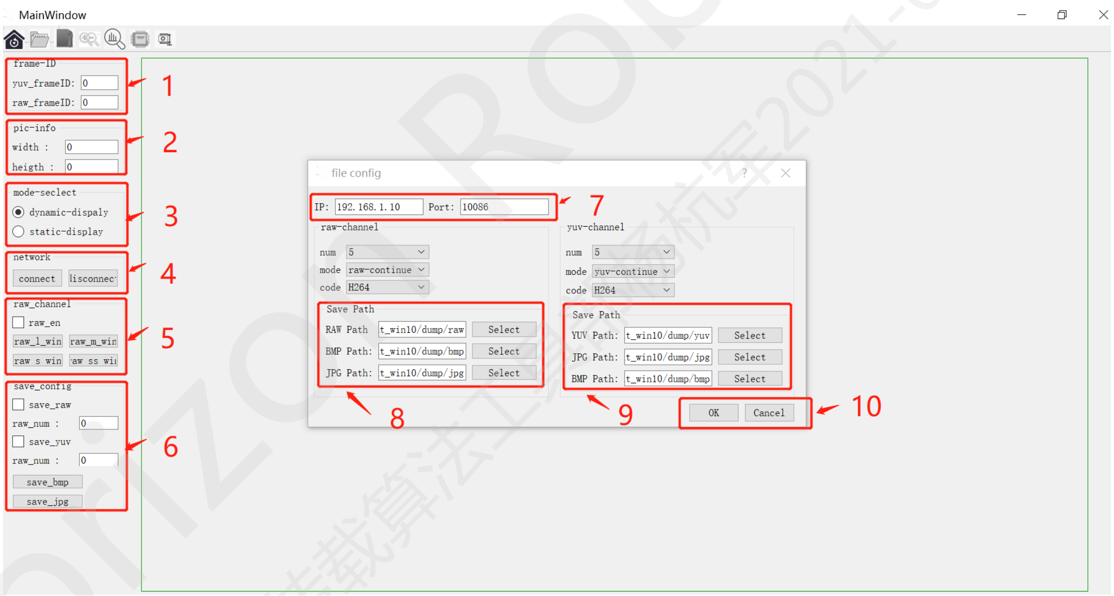


Figure 3: Hobot player interface

#	Function	Description
1	Display frame-id of images	This ID is the hardware number, 0-65536 cycles
2	Display size information of images	Actual size information of images
3	Switch between Network Transmission and Static Display	
4	Network connection/disconnection	

5	Open the raw display interface	Up to dol4
6	Image storage configuration	Store multiple consecutive frames of images
7	Configure network and port number	J3 device network IP and connection port number
8	Configure the storage path of RAW graph	
9	Configure the storage path of YUV graph	
10	Confirm configuration	

Table 3: Hobot player function list

Hobotplayer software includes images network transmission display function and static image auxiliary analysis function. The specifications of network transmission display function are shown in Table 4.

note: yuv and video cannot be supported simultaneously. Raw image dumps can only be used when offline.

Function	Description	Note
Raw	Support raw 8/10/12/14/16	Offline mode
YUV	Support nv12	Online/offline mode
video	Support h264/h265/jepg	Online/offline mode

Table 4: Hobot player network transmission display specifications

The following table describes static image auxiliary analysis function, including image storage, RGB statistics display, grid, zoom, and other functions.

Function	Description	Note
Hardware frame number of images	The frame number is hardware frame number, 0-65535 cycles	Valid during network transmission
Size information of images	Width/height information	
Save a certain number of raw images	The saved raw image is in mipi-raw format	Valid during network transmission
Save a certain number of yuv images	The saved yuv image is in nv12 format	Valid during network transmission
Convert raw/yuv to bmp/jepg	This conversion is a third-party library, not hardware	
Display local	Specify image information before use,	Valid during static

raw/yuv/bmp/jepg image	otherwise an error will be prompted Support raw8/10/12/14/16 Support nv12	display
Add grid to image/zoom	Zoom in/out on a fixed scale Zoom in/out via “Ctrl + mouse wheel” Drag with the right mouse button Display/set grid	Valid during static display
Display RGB channel statistics		Valid during static display
Image effect adjustment	Support gamma/awb/ob/gain Support clip (RGB channel information)	Valid during static display
Convert mipi-raw to arm-raw		Valid during static display

Table 5: Hobot player auxiliary debugging function

2.2 Hobot player instructions

2.2.1 Hobot player network transmission

Online mode: support yuv/video. In the online mode, the vio application needs to configure the data path as sensor-sif-isp-ldc-ipu-ddr mode, and the YUV image information is obtained from the IPU.

Offline mode: support raw/yuv (or video). In offline mode, the vio application needs to configure the data path as sensor-sif-ddr-sif-isp-ldc-ipu-ddr mode. Raw image information is obtained from the SIF and YUV image information is obtained from the IPU.

Steps:

1. Connect the J3 to the PC through the network.
2. Log into the J3 system with serial port (or SSH) and start the Hobot player server
3. Open the Hobot player on the PC, configure the network information, click Connect to establish the connection, and then view the image information.

2.2.2 Hobot player static image

Before opening local images, you need to switch to the static display mode and configure the basic information of images, which includes image type, size, etc. The configuration information is shown in Figure 4, among which module 1 shows the graphic information including the selection of raw/yuv/bmp/jepg and the characteristics and image sizes in various modes. The characteristics of the RGB three channels are shown in Figure 5. You can also adjust the image effect as shown in Figure 6 and modify the gamma/awb/ob/clip information.

Figure 4: Hobot player Image

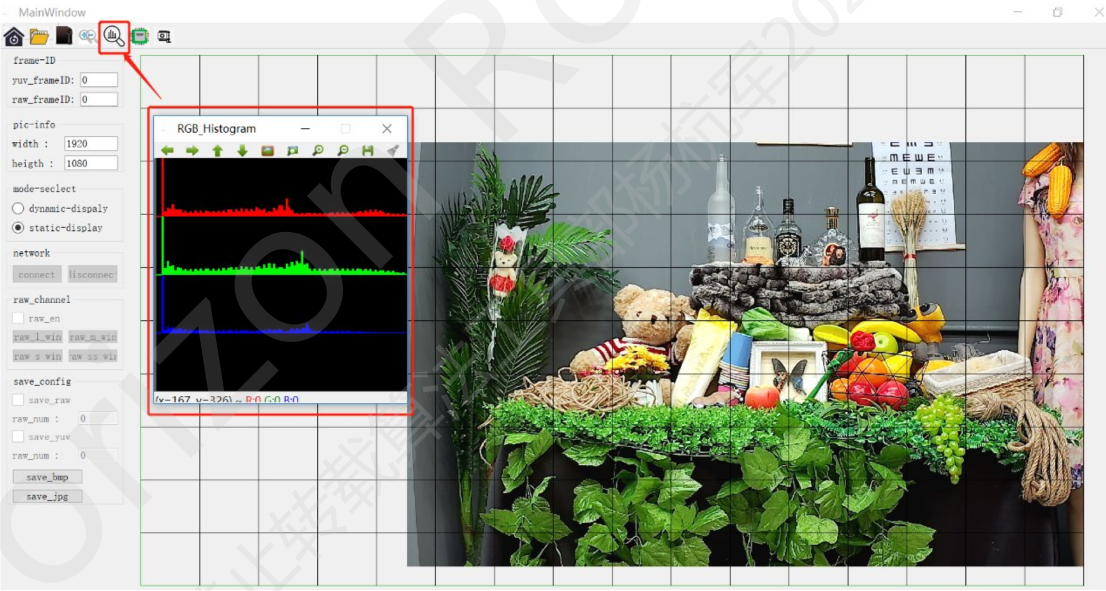


Figure 5: Hobot player rgb statistics

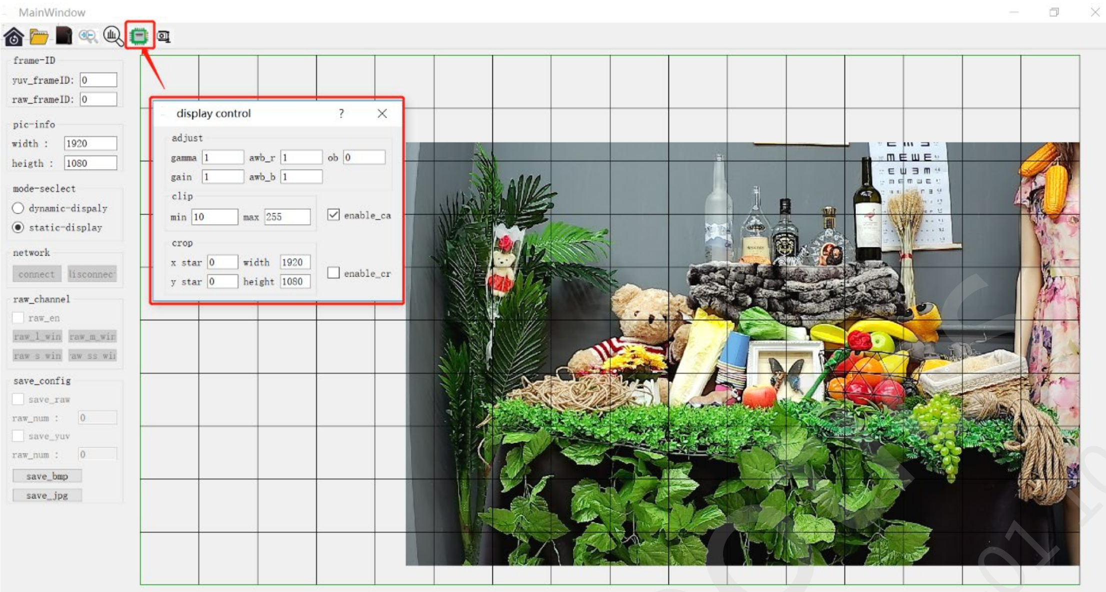


Figure 6: Hobot player image effect adjustment

3 Calibration tool instructions

3.1 Calibration tool-Installation

3.1.1 Installation procedure

1. Run the executable file " ISP_Calibration_Tool_Install”.

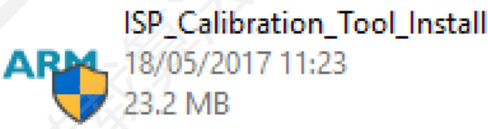


Figure 7: Executable file.

2. After the dialog as shown in figure 8 appears, and then click Next.

Figure 8: First installation window

3. On the following window, browse and select an installation folder.

To add a desktop shortcut, tick the Add a shortcut to the desktop checkbox.

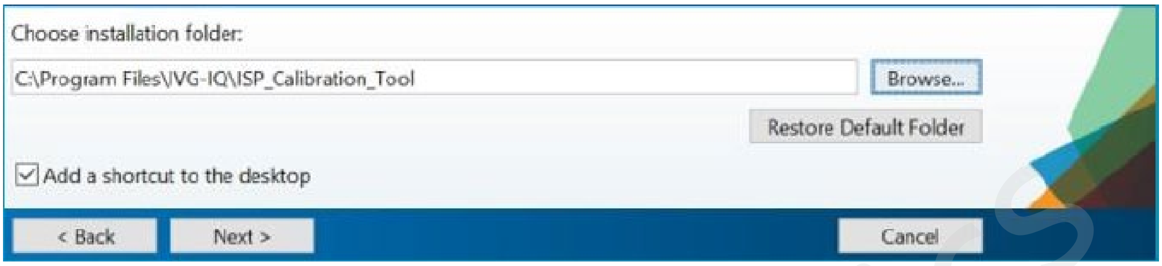


Figure 9: Second installation window

4. During the installation, the software will check whether the latest MATLAB Runtime(R2015b) has been installed. If installed, a confirmation window that shows the status will appear, and then click Next to continue with step 6. If not, the window as shown in figure 10 appears, select the installation folder, and then click Next.

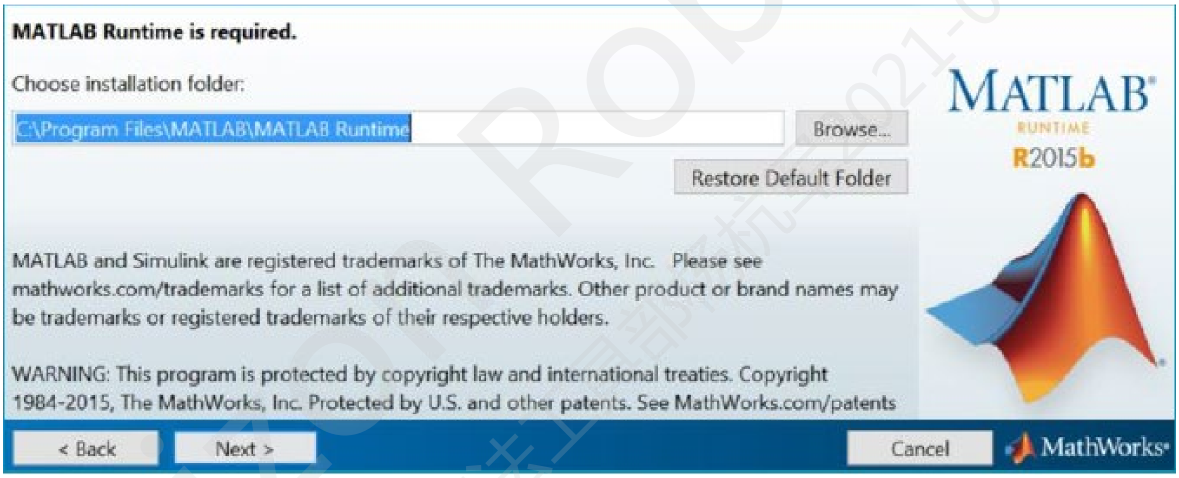


Figure 10: Third installation window.

5, On the license agreement dialog, check yes, and then click Next.

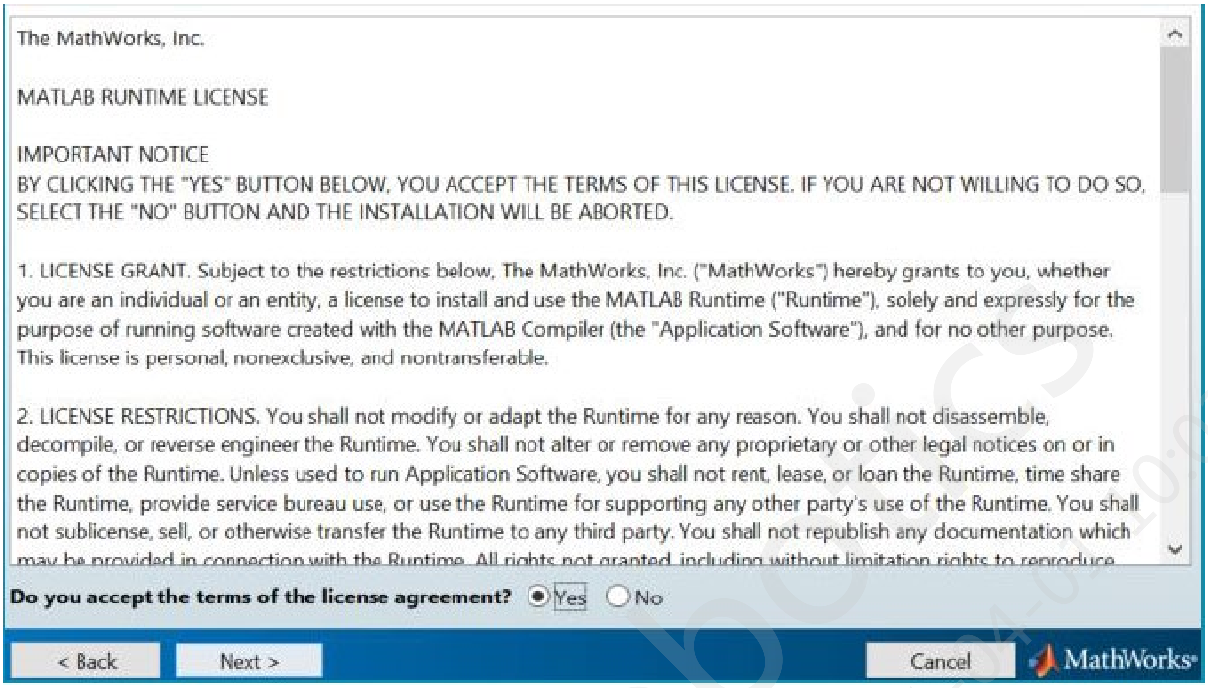


Figure 11: License Agreement window

6. On the following window, click Install to continue the installation.

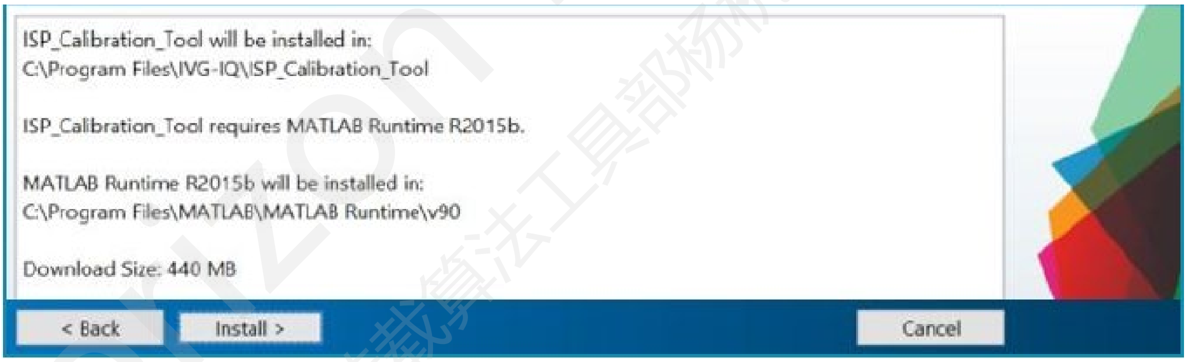


Figure 12: Fourth installation window

7.Wait a moment, click Finish after the installation. The calibration tool completes the installation.

3.2 ISP calibration tool Home window

3.2.1 Home window

Run the calibration tool, the home window will be shown in figure 13.

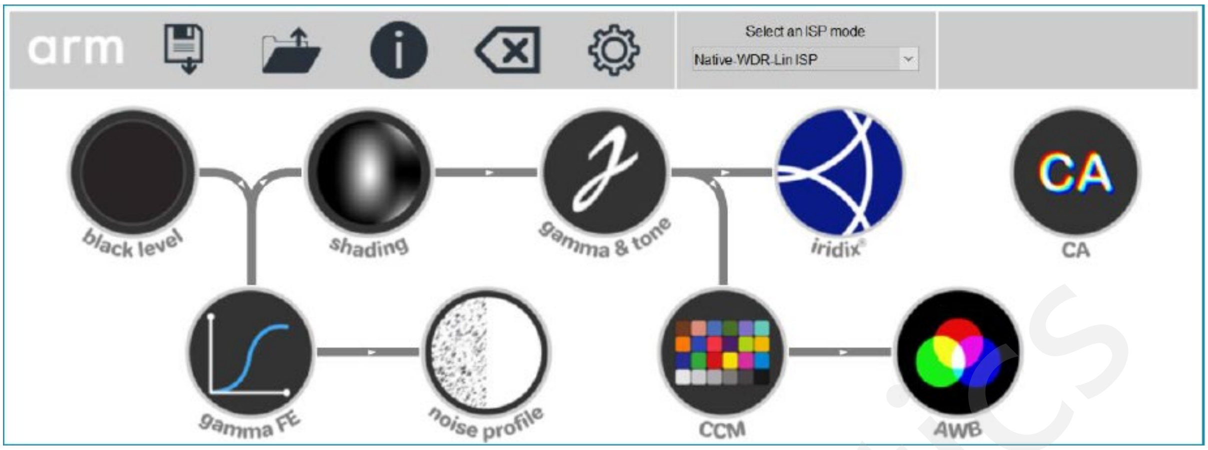
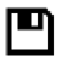
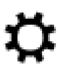


Figure 13: Home window

According to the input image and data, the calibration tool will generate the debugged register value and LUT. The parameters will be saved in static_calibrations.c (or a custom name) file.

3.2.2 Menu buttons

The following table lists the functions of each menu button in the calibration tool.

Icon	Name	Function
	Information panel	Shows current tuning progress (home window only)
	Save / Export	Save module data to global data (module windows) Export global data to file (home window)
	Open	Load a calibration file you have exported previously
	Information	Open the information document (PDF file) for this window
	Clear	Reset tuning data for this window
	Image format	Set the basic sensor properties, such as resolution and bit depth

	Home	Close the module window and return to the home window (module windows only)

Table 6: List of all menu bar buttons in the main window and module windows

3.2.3 Getting started

1. click to open the image format window. Set the image format parameters correctly as described in 3.1.

2. On the main page, select the ISP mode from the Select an ISP mode drop-down list. The ISP modes is the abbreviation of ISP's different modes. It is recommended to perform the calibration in linear mode first. The following table lists the specific mode options. The ISP only supports the modes listed in the table.

Mode name	Description
Linear ISP	ISP receives **linear** data from the sensor. Gamma FE and frame stitch blocks are bypassed.
FS-Lin ISP	ISP receives linear data with alternating exposures from the sensor. Gamma FE is bypassed. Frame stitch block combines alternate exposures into an HDR image.
FS-HDR ISP	ISP receives linear data with alternating exposures from the sensor. Gamma FE converts data into **square root companded.** Frame stitch block combines alternate exposures into an HDR image in square root domain.
Native-WDR-Lin ISP	ISP receives **companded** HDR data (e.g. **piecewise linear**) from the sensor. Gamma FE converts data into linear. Frame stitch block is usually disabled.
Native-WDR ISP	ISP receives companded HDR data (e.g. piecewise linear) from the sensor. Gamma FE converts data into square root companded. Frame stitch block is usually disabled.

The explanation of key words in modes

Linear: Under the condition that sensor errors and black level are ignored, the pixel brightness value is proportional to the illumination. For example, if the number of photons detected by the pixel is increased by 2 times, the pixel brightness value will also be increased by 2 times.

Companded: There is no linear relationship between the pixel brightness value and the illumination, because the sensor will compress the pixel brightness value according to the specified function.

Piecewise linear: It is a diffusion-confusion function used in the sensor, which uses inflection point to divide the range of digital pixel values. The slope between each inflection point is constant.

Square root: It is a diffusion-confusion function used in the ISP. By using mathematical square root, the bit depth of the input and output data will be scaled, which acts behind the black level module.

3. First, calibrate the black level, and then follow the sequence indicated by the arrow in the main interface. The arrows show the dependencies between the modules.

4. For example, CCM depends on gamma and tone, so gamma and tone should be calibrated before the CCM. If you change the calibrations of gamma and tone later, you need to recalibrate the CCM and other related modules.

5. The modules without arrow connections are completely independent of other modules. A grayed-out module means that it is not available and a module with a green ring means it has been calibrated.

6. Calibrate each module by clicking the ISP module icon.

Note: The recalibration of modules in the tool will affect "dynamic calibrations"。Before closing the tool, be sure to click the Export (floppy disk) icon in the main window. Otherwise, all progress will be lost.

3.3 Calibration tool – Image format

3.3.1 Image format window

In any window, Click the image format button ( icon), a page as shown in figure 14 will appear.

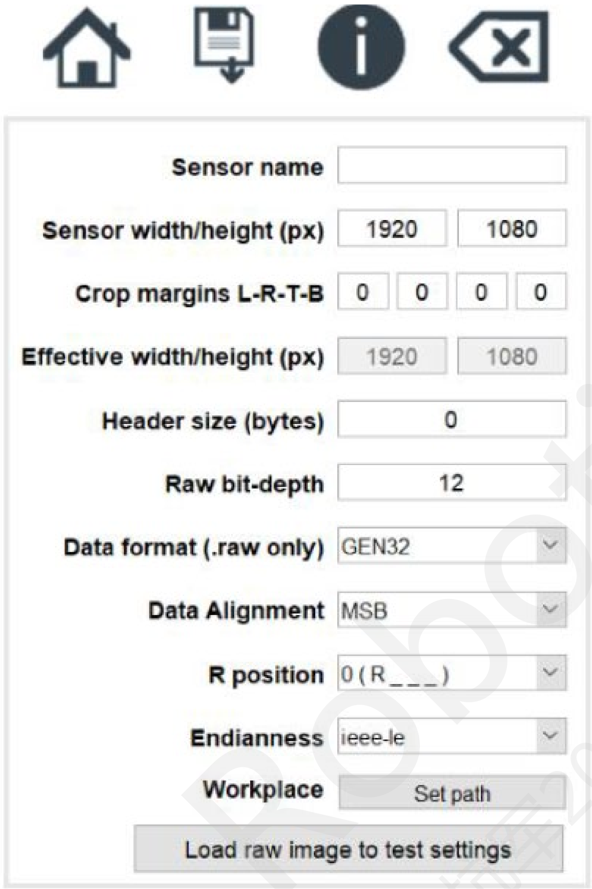


Figure 14: Image format window

3.3.2 Window features

The table 7 lists the specified parameters and their descriptions, which are used to configure the loaded sensor image, so you must set them before debugging any module.

Region	Function
Sensor name	Enter text describing the sensor. This will be used in exported filenames.
Image width	Enter the horizontal resolution of the sensor raw files (in pixels)
Image height	Enter the vertical resolution of the raw files (in pixels)
Header size (bytes)	Enter the length of the raw file header. This is the gap from the start of the file until the first image data and may be 0.
Raw bit-depth	Enter the bit-depth of the sensor (typically 10 or 12)
Data format (.raw only)	Enter the type of data formatting used by the raw files. This does not apply to .rgb, .ppm or .pgm files.
Data alignment	In most data formats, the number of bits used for each pixel is

	more than the sensor bit depth, so the data is aligned to the MSB (most significant bit) or the LSB (least significant bit). Choose this here.
R position	Select the position of the R channel in the file
Endianness	Byte order of data within each 16 or 32-bit word (usually “ieee-le”)
Workplace – Set path	Set the directory for loading & saving data files
Verify settings	Check your settings by loading an image file. Raw images will be converted to color images for display. It is advisable to choose an image with strong colors, to check that “R position” is set correctly.

Table 7: List of all settings and their meanings in the image format GUI

Note: Before using any module in the calibration tool, use the Verify Settings button to check whether the image is correct. If correct, click the Save button.

3.3.3 File types supported

The calibration tool can import raw (Bayer array) images by using standard Netpbm format PPM (extension.ppm) and PGM (extension.pgm).

The calibration tool can perform the demosaic process according to standard JPEG and PNG interpolation methods and generate files with suffix of. rgb. CCM and gamma & tone will use images with suffix of .rgb in only two modules.

3.3.4 Output formats

All supported formats use row precedence, and image data is stored from left to right and then top to bottom.

The table 8 lists the output formats of raw and rgb. The asterisk shows the format supported by the calibration tool. The settings of this format shows in the base mode and plane select columns. The table assumes that the data is written/read in the form of 32-bit words.

<table>
<tr><th rowspan="3">Base mode</th><th rowspan="3">Plane select</th><th rowspan="3">Colour Format</th><th colspan="32">Packing</th></tr>
<tr><th colspan="32">Bit Number</th></tr>
<tr><th>31</th><th>30</th><th>29</th><th>28</th><th>27</th><th>26</th><th>25</th><th>24</th><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>1</td><td>0</td><td>RGB32
(also used for RGB666)</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td colspan="8">Red (7:0)</td><td colspan="8">Green(7:0)</td><td colspan="8">Blue(7:0)</td></tr>
<tr><td>2*</td><td>0</td><td>A2R10G10B10,
10 bit (30 bit colour)</td><td>0</td><td>0</td><td colspan="10">Red (9:0)</td><td colspan="10">Green(9:0)</td><td colspan="10">Blue(9:0)</td></tr>
<tr><td>3</td><td>0</td><td>RGB 565</td><td colspan="5">Red (4:0)</td><td colspan="6">Green(5:0)</td><td colspan="5">Blue(4:0)</td><td colspan="5">Red (4:0)</td><td colspan="6">Green(5:0)</td><td colspan="5">Blue(4:0)</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">0</td><td rowspan="3">RGB24</td><td colspan="8">Blue1(7:0)</td><td colspan="8">Red 0(7:)</td><td colspan="8">Green0(7:0)</td><td colspan="8">Blue0(7:0)</td></tr>
<tr><td colspan="8">Green2(7:0)</td><td colspan="8">Blue2(7:0)</td><td colspan="8">Red1(7:0)</td><td colspan="8">Green1(7:0)</td></tr>
<tr><td colspan="8">Red3(7:0)</td><td colspan="8">Green3(7:0)</td><td colspan="8">Blue3(7:0)</td><td colspan="8">Red2(7:0)</td></tr>
<tr><td>5*</td><td>0</td><td>GEN32</td><td colspan="6">RAW(11:6)</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td colspan="6">RAW(5:0)</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>-*</td><td>-</td><td>RAW8</td><td colspan="8">RAW0(7:0)</td><td colspan="8">RAW1(7:0)</td><td colspan="8">RAW2(7:0)</td><td colspan="8">RAW3(7:0)</td></tr>
<tr><td>6*</td><td>0</td><td>RAW16 (MSB/12-bit example)</td><td colspan="12">RAW0(11:0)</td><td>0</td><td>0</td><td>0</td><td>0</td><td colspan="12">RAW1(11:0)</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td rowspan="3">7*</td><td rowspan="3">0</td><td rowspan="3">RAW12</td><td colspan="8">RAW2(7:0)</td><td colspan="12">RAW1(11:0)</td><td colspan="12">RAW0(11:0)</td></tr>
<tr><td colspan="4">RAW5(3:0)</td><td colspan="12">RAW4(11:0)</td><td colspan="12">RAW3(11:0)</td><td colspan="4">RAW2(11:8)</td></tr>
<tr><td colspan="12">RAW7(11:0)</td><td colspan="12">RAW6(11:0)</td><td colspan="8">RAW5(11:4)</td></tr>
<tr><td colspan="2">Notes</td><td colspan="33">* Data format supported by Calibration Tool</td></tr>
</table>

Table 8: ARM output formats

RAW8/16/32

This is a general data format. You can use the third-party tools to view its binary format. Each pixel may occupy 1, 2, or 4 bytes, depending on the bit depth of sensor. In RAW16, the data is usually aligned with MSB within 16 bit (as shown in table 3), so set "data alignment" to "MSB".

GEN32

In this format, the pixel data bits are up to 12bit of 32-bit words. The most important part is from 26bit to 31bit of the word. The least significant part is from 10bit to 15bit of the word. The data alignment setting is not valid for the 12bit sensor.

RAW12

In this format, the maximum bit depth is 12bit, which is packed into 12 bytes (three 32bit words) in groups of 8 pixels. The data alignment setting is not valid for the 12bit sensor.

A2R10G10B10

Image files with the extension of .rgb must be in this format. Each pixel is stored in a 32bit word, where the blue channel bits are 0-9, the green channel bits are 10-19, and the red channel bits are 20-29.

As for a raw file with unknown format information, you can first open it in hexadecimal by using a third-party tool, then you will see ASCII code as shown in figure 15, so that you can get its pixel and resolution information.

```
P5
#RAW header
3264 2448 1023
```

Figure 15: RAW image header

In figure 15, the information is as follows:

- set image width 3264
- set image height 2448
- set raw bit depth to 10 (maximum pixel value: 1023)

Other settings are found by trial and error. For example:

- if the image is too bright or too dark, try changing the “Data alignment”.
- if the channels are interchanged, try changing the "R position".