TTS61M(2)CL-13M/C Area Scan Camera User Manual

（V0.9　Feb. 11, 2023）

Hefei I-TEK Optoelectronics Co., LTD.

http://www.i-tek.cn/

Revision History

Revision	Date	Description
0.1	2020/07/07	● Initial version
0.3	2020/12/14	● Add color camera information ● Add low resolution mode (mode_27) ● Update product appearance
0.5	2021/04/22	● Update mechanical drawing, the mounting holes remain unchanged relative to the original positions
0.6	2021/12/10	● Modify test picture pattern ● Update the maximum of exposure time ● Update mechanical drawing ● Update strobe output circuit drawing
0.7	2022/01/10	● Update the name of company
0.8	2022/04/25	● Update the logo of company ● Update legends in section 8
0.9	2023/02/11	● Update company address

Manufacturer Information

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Contents

1 Precautions

- **General**

① Do not drop, damage, disassemble the camera.
② Do not let children touch the camera without supervision.
③ Do not use the camera for other purposes than those specified herein.
④ Should there be any problem with the camera, please contact us in time for technical support.

- **Installation and Maintenance**

① Do not install the camera in an environment with direct sunlight, high humidity or heavy dust.
② Keep the camera away from an environment with strong electromagnetic interference.
③ Keep the camera away from heat sources.
④ Be careful not to let the camera soak in liquid, such as water and drinks.
⑤ Clean dust on the surface of the camera as often as possible to avoid dust entering the camera, otherwise it may cause fault to the camera.
⑥ To clean the dust on the camera surface, do not wash with water, wipe it with lint-free cloth.

- **Power Supply**

① +12V±10% voltage and 5.0A current are recommended for the camera.
② Hefei I-TEK Optoelectronics Co., LTD. does not provide power supply with the camera, users may prepare the power supply on their own.

- **Document**

① Hefei I-TEK Optoelectronics Co., LTD. does not warrant that the document is the final version. The document may be updated after product upgrade. Please contact market@i-tek.cn for the latest version, which is provided for the authorized users.

2 Camera Models

Description of camera models:

The models of line scan camera and area scan camera are described as follows:

Cameras of various types:

Line scan camera

PA: Panther (Panther - Industrial line scan camera)

PL: Plasma (Plasma - Industrial line scan camera)

PH: Phoenix (Phoenix - Industrial line scan camera)

TPH: TEC-Phoenix (Thermal Electric Cooling - Phoenix - Industrial line scan camera)

Area scan camera

HS: Hercules (Hercules - CCD industrial area scan camera)

THS: TEC-Hercules (Thermal Electric Cooling - Hercules - CCD industrial area scan camera)

TS: Taurus (Taurus - CMOS industrial area scan camera)

TTS: TEC-Taurus (Thermal Electric Cooling - Taurus CMOS industrial area scan camera)

XS: XStream (XStream - Super high speed camera)

Interface specification:

GV: GigEVision

CL: CameraLink

CXP: CoaXPress

U30: USB3.0

Color form:

M: Monochrome C: Color

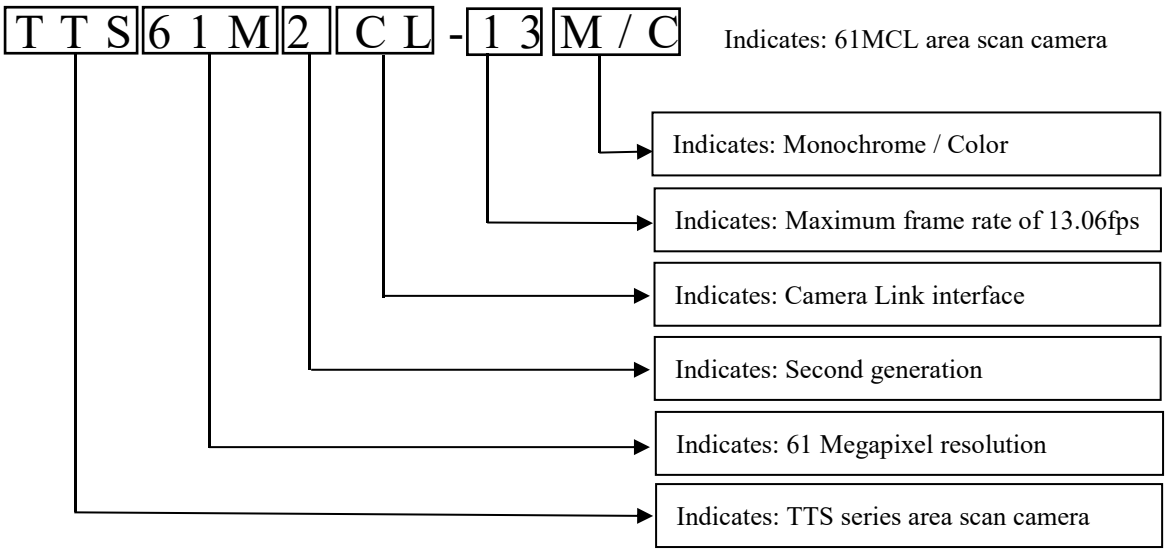
F: Full Color T: TDI (time delay integration)

Line rate or frame rate:

Line scan camera: Maximum line rate, e.g. 30kHz

Area scan camera: Maximum frame rate, e.g. 4000fps

e.g.



3 Product Appearance

TTS61MCL：

TTS61M2CL：

Fig. 1 Product Appearance

Note:

① The camera provides eight M4 threaded holes on the four sides for fixing of the device.

② Please refer to the chapter “Mechanical Dimensions and Interfaces” below for the detailed camera dimensions.

4 Product Specifications

The TTS61M(2)Cl-13M/C Camera is the latest model in the industry-proven TTS series, a 61 megapixel resolution CMOS Camera with Camera Link interface. The camera is based on the latest CMOS image sensor technology from SONY Semiconductor Solutions and delivers a frame rate output of up to 13.06 fps at full resolution.

The camera uses electronic refrigeration technology to reduce the operating temperature of the CMOS image sensor to 20 degrees below the ambient temperature, which greatly improves the noise and sensitivity performance under low light. It is an ideal choice for demanding customer applications, such as FPD, PCB and semiconductor detection.

4.1 Main Features

- Up to 61 Megapixel CMOS Imaging Sensor
- High Data Accuracy, 8/10/12-bit Pixel Format
- Rich Exposure Control Modes
- Defect Pixel Correction
- Standard Camera Link Interface
- Camera Link Output Mode: 4Tap/8 Tap/10 Tap
- LVDS (RS-644) Serial Communication by Camera Link Interface
- Thermal Electric Cooling - about 20 degrees below ambient temperature
- Strobe Output
- Gain/Offset Control
- Test Image
- Temperature Monitor
- LUT
- Flat Field Correction
- Dark Image Correction (It was finished when it left the factory)
- Field Upgrade Onsite

4.2 Camera Specifications

Table 1 TTS61M(2)CL-13M/C Product Specifications

Model	TTS61MCL-13M/C	TTS61M2CL-13M/C
Product Description	61 mega-pixel industrial area scan camera	
Resolution	9568 x6380	
Pixel Size	3.76μm x 3.76μm	
Sensor Type	Rolling shutter CMOS	
Image Type	Monochrome/Color	
Sensor Size	43.24mm (diagonal)	
Dynamic Range	≥75.8dB	
SNR	46.5dB	
Data Rate	830MB/s	

Lens Mount	Nikon F Mount	
Max. Frame Rate	13.06fps	
Trigger Mode	Free-Run, External Pulse, External PWM	
External Trigger	2.5V ~ 12 V Logic level input, Optically isolated	
External Trigger Channel	Camera Link CC1 input / External signal	
Strobe Output	3.3V Logic level Output, Optically isolated	
Exposure Control	Timed, Pulse Width Control	
Exposure Time	120μs ~60s (Step: 4tap/60μs; 8tap/30μs; 10tap/23.75μs)	
Data Format	8/10/12 bit	
Operating Temperature	0~50℃	
Data Interface	Camera Link	
Power Supply	DC12V±10%　5.0A	
Power Consumption	50.0W	
Mechanical	111mm x 111mm x 104.5mm (without lens adapter)	111mm x 111mm x 103mm (without lens adapter)
Pixel Clock	83MHz	
Cooling Method	Thermal electric cooling with a fan	
Cooling Performance	About 20℃ below ambient temperature	
Weight	1848.4g	1824.4g

4.3 Camera Block Diagram

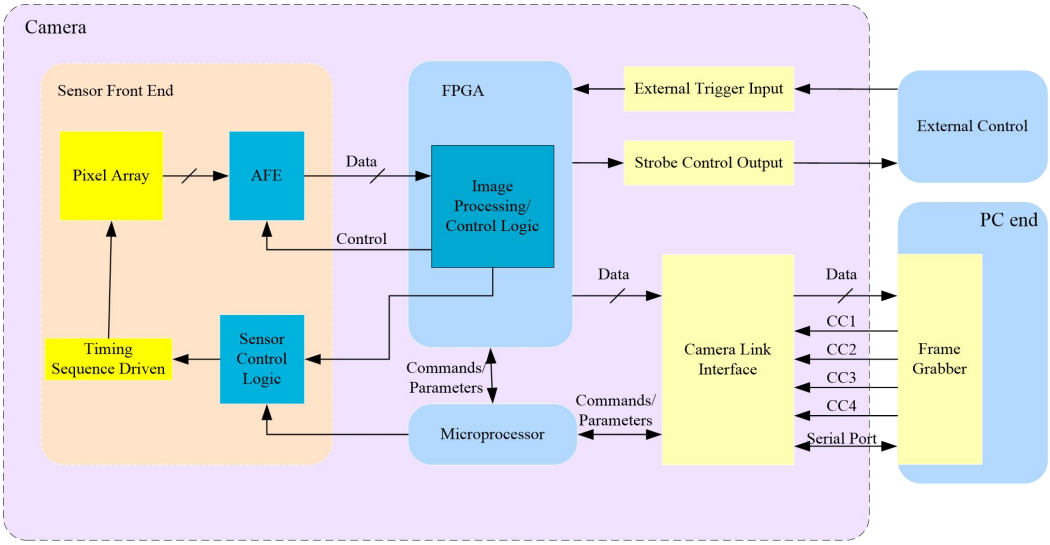
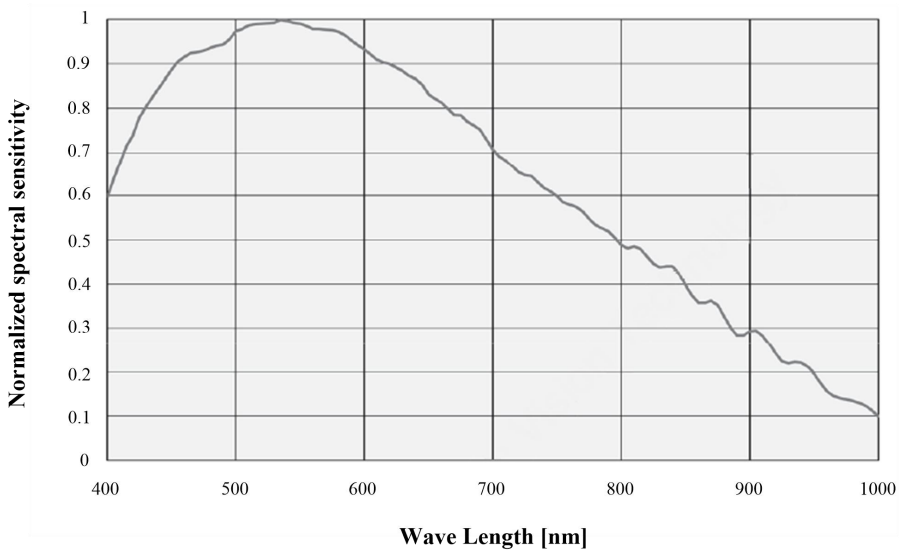


Fig. 2 Internal Implementation Structure of Camera

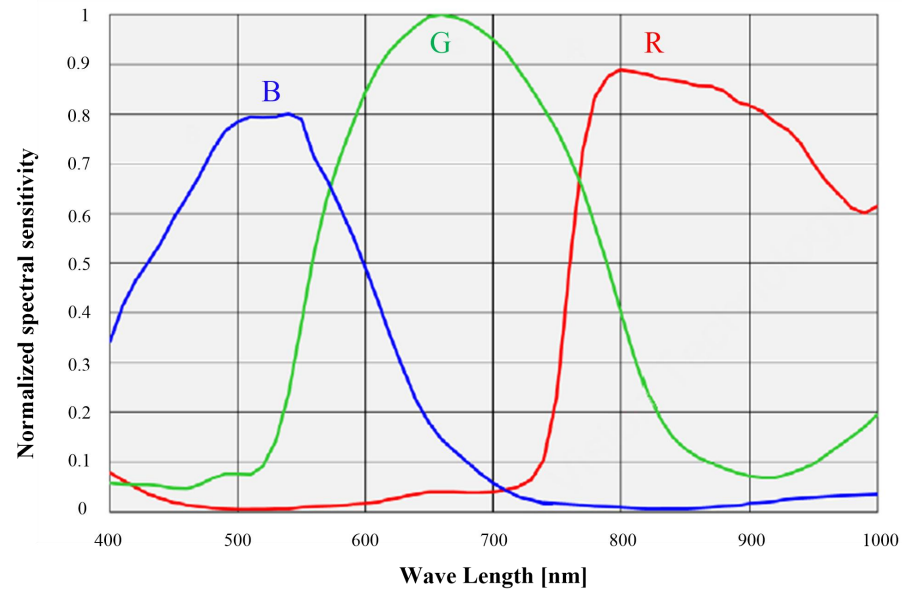
TTS61M(2)CL-13M/C is designed based on 61 megapixel area scan image sensor. The pixel array is sampled uniformly by the progressive scan control system, and the sampled data is converted from analog front-end to digital signal. The digital signal is processed by FPGA and microprocessor, and then transmitted to the frame grabber through Camera Link interface. The camera can also receive external trigger signals for acquisition by CC1 channel of Camera Link or independent IO port of camera.

4.4 Spectral Response

The following figure shows the spectral response of the monochrome and color camera.



(a) Monochrome Camera



(b) Color Camera

Fig. 3 Spectral Response of Camera

4.5 Camera Bayer Pattern

TTS61M(2)CL-13C camera supports color mode, Bayer pattern is shown in Figure 4 (HR is horizontal resolution, VR is vertical resolution).

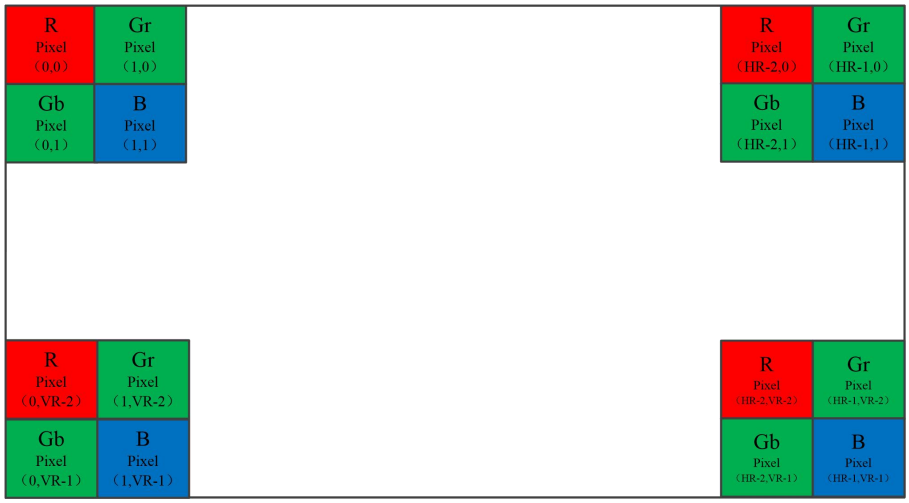


Fig. 4 Camera Bayer Pattern

4.6 Low Resolution Mode

TTS61M(2)CL-13M/C supports low resolution mode. The conversion between normal mode 0C and low resolution mode 27 is as follows:

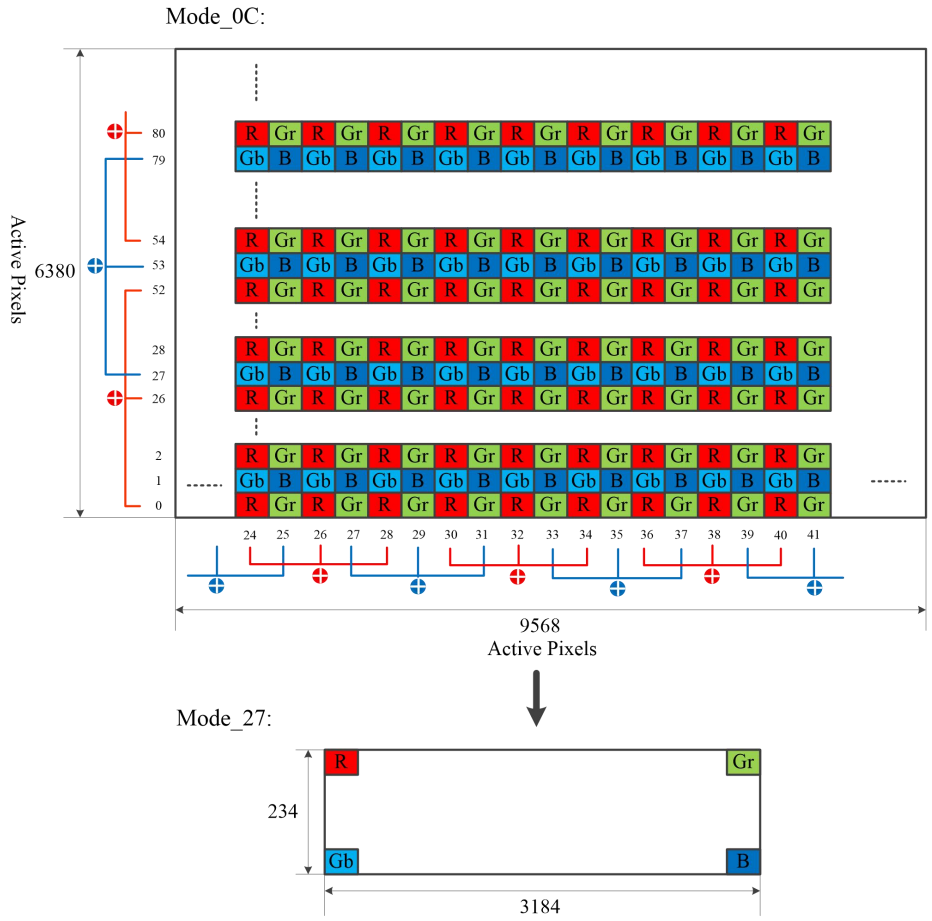


Fig. 5 Low Resolution Mode

In the vertical direction, one pixel is sampled in every 27 rows, and every 3 rows of images are averaged. Red channel pixels and blue channel pixels are sampled in an interval of one row, so the vertical resolution is 1/27 of the original.

In the horizontal direction, weighted average is carried out for every 3 columns of pixels with a weight of 1:2:1, so the horizontal resolution becomes 1/3 of the original.

4.7 Environmental Requirements

(1) Operating temperature: 0℃~50℃, humidity: 10% ~ 90%; Storage temperature: -20℃~75℃.
(2) The sensor in the camera has dustproof sealing setting, which can effectively prevent dust from entering the sensor surface. If the lens cap is open, dust may enter. Therefore, tighten the lens cap when the camera is not in use.

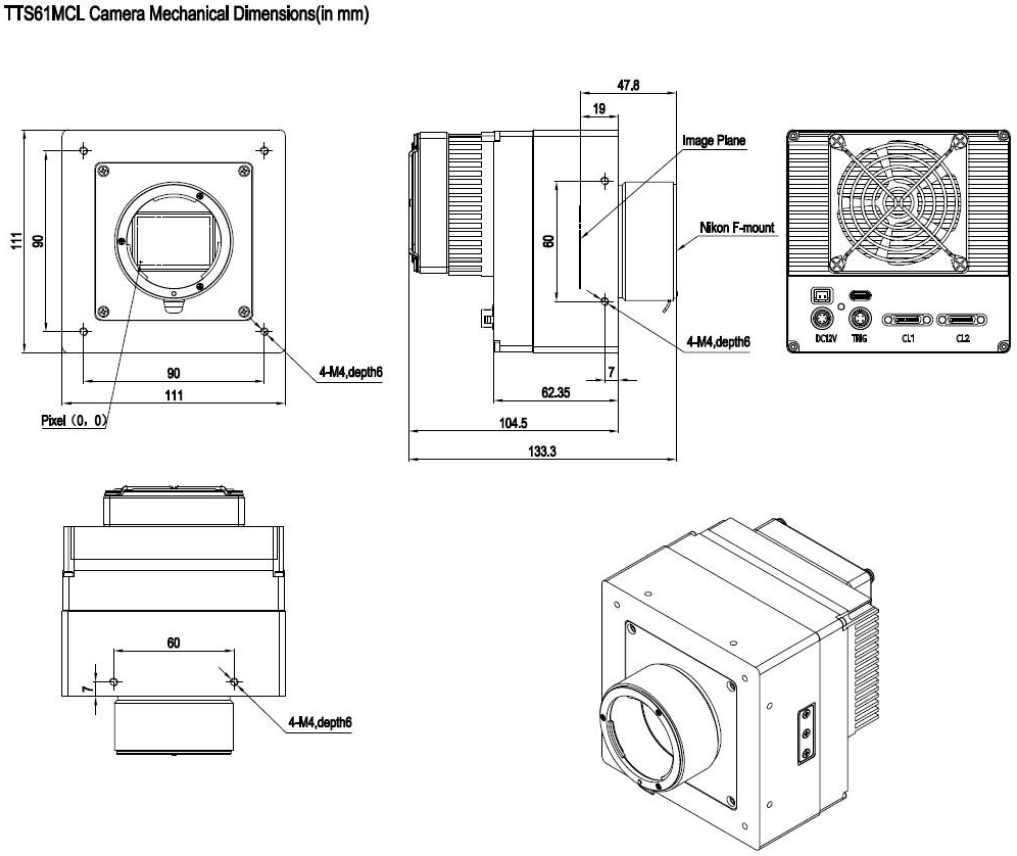
4.8 RoHS Certification

All camera components (including electronic components, PCB, and shell) are RoHS standard.

5 Mechanical Dimensions and Interfaces

5.1 Mechanical Dimensions

TTS61MCL：



TTS61M2CL：

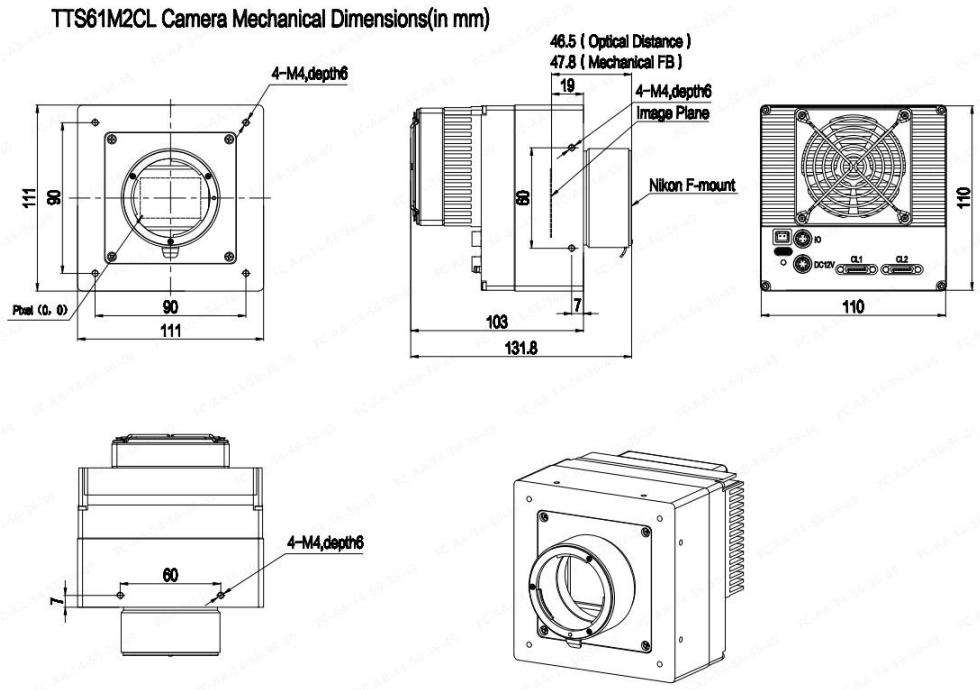


Fig. 6 TTS61M(2)CL Camera Mechanical Dimensions

5.2 Camera Interface

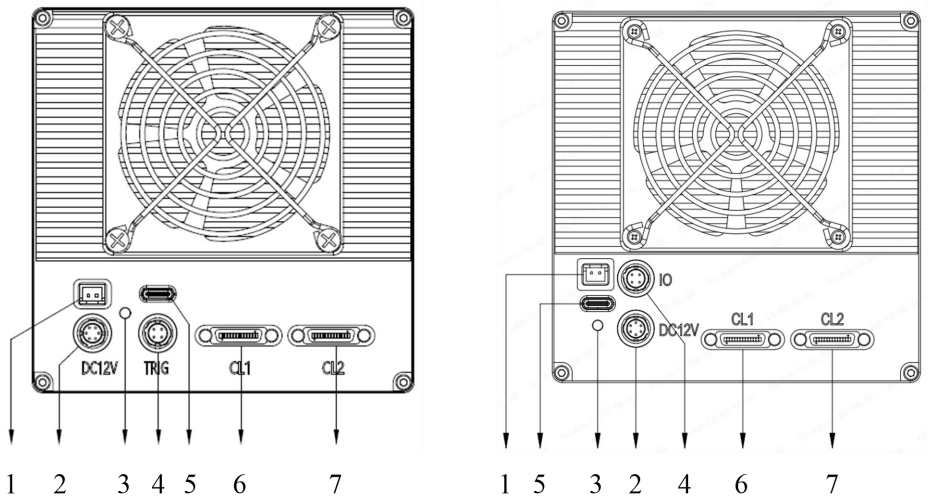


Fig. 7 External Interfaces of Camera

(1) Fan Power Socket
(2) 6-pin 12V Power Input Interface
(3) Camera Status Indicator
(4) 4-pin Control I/O Interface (Trigger Input and Strobe Output)
(5) Type-C
(6) Camera Link Connector 1(Base)
(7) Camera Link Connector 1(Medium/Full/Full+)

5.2.1 Camera Status Indicator

The camera status indicator is used to indicate the real-time status of the camera, as shown in the table below:

Table 2 Camera Status Indicators

LED Status Indicators	Camera Status
Solid Green	Normal
Blinking Green	No trigger input within three seconds in external trigger mode
Solid Red	Processor is starting
Blinking Red	Camera fatal error (need contact technical support)
Solid Yellow	Camera is initializing or executing command

5.2.2 Power Input Interface

The power input interface e is a 6-pin connector with the model:
Hirose HR10A-7R-6PB (Male).

Corresponding connector on the power cable model:

Hirose HR10A-7P-6S (Female).

The power input interface on the back of the camera is shown as follows:

Fig. 8 Pin Assignments for Power Input Interface

Table 3 Pin Configurations for Power Input Interface

Signal	Pin	Signal	Pin
+12 V	1	GND	4
+12 V	2	GND	5
+12 V	3	GND	6

5.2.3 Camera Link Connector

TTS61M(2)CL-13M/C uses Mini Camera Link connector as its data interface. Mini Camera Link connector complies with the industry standard, shown as follows:

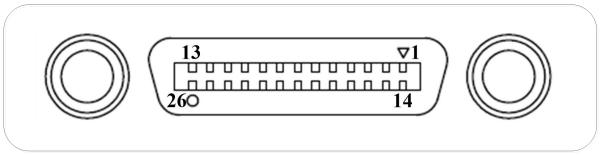


Fig. 9 Mini Camera Link Connector

Table 4 Pin Assignments for Mini Camera Link Connector 1

PAIR List	Pin	Signal Name	Type	Description
PAIR 0	1	Ground	Ground	Cable Shield
	14	Ground	Ground	Cable Shield
PAIR 1	2	X0-	LVDS-Out	Camera Link Transmitter
	15	X0+	LVDS-Out	Camera Link Transmitter
PAIR 2	3	X1-	LVDS-Out	Camera Link Transmitter
	16	X1+	LVDS-Out	Camera Link Transmitter
PAIR 3	4	X2-	LVDS-Out	Camera Link Transmitter
	17	X2+	LVDS-Out	Camera Link Transmitter
PAIR 4	5	XCLK-	LVDS-Out	Camera Link Transmitter
	18	XCLK+	LVDS-Out	Camera Link Transmitter
PAIR 5	6	X3-	LVDS-Out	Camera Link Transmitter
	19	X3+	LVDS-Out	Camera Link Transmitter
PAIR 6	7	UART_RX+	LVDS-In	Serial Data Receiver
	20	UART_RX-	LVDS-In	Serial Data Receiver
PAIR 7	8	UART_TX-	LVDS-Out	Serial Data Transmitter
	21	UART_TX+	LVDS-Out	Serial Data Transmitter
PAIR 8	9	CC1-	LVDS-In	Software External Trigger
	22	CC1+	LVDS-In	Software External Trigger
PAIR 9	10	CC2+	LVDS-In	Software External Trigger
	23	CC2-	LVDS-In	Software External Trigger
PAIR 10	11	CC3-	LVDS-In	Software External Trigger
	24	CC3+	LVDS-In	Software External Trigger
PAIR 11	12	CC4+	LVDS-In	Software External Trigger
	25	CC4-	LVDS-In	Software External Trigger
PAIR 12	13	Ground	Ground	Cable Shield
	26	Ground	Ground	Cable Shield

Table 5 Pin Assignments for Mini Camera Link Connector 2

PAIR List	Pin	Signal Name	Type	Description
PAIR 0	1	Ground	Ground	Cable Shield
	14	Ground	Ground	Cable Shield
PAIR 1	2	Y0-	LVDS-Out	Camera Link Transmitter
	15	Y0+	LVDS-Out	Camera Link Transmitter
PAIR 2	3	Y1-	LVDS-Out	Camera Link Transmitter
	16	Y1+	LVDS-Out	Camera Link Transmitter
PAIR 3	4	Y2-	LVDS-Out	Camera Link Transmitter
	17	Y2+	LVDS-Out	Camera Link Transmitter
PAIR 4	5	YCLK-	LVDS-Out	Camera Link Transmitter
	18	YCLK+	LVDS-Out	Camera Link Clock Tx
PAIR 5	6	Y3-	LVDS-Out	Camera Link Channel Tx
	19	Y3+	LVDS-Out	Camera Link Channel Tx
PAIR 6	7	-	Not Used	Connected with 100 ohm
	20	-	Not Used	
PAIR 7	8	Z0-	LVDS-Out	Camera Link Transmitter
	21	Z0+	LVDS-Out	Camera Link Transmitter
PAIR 8	9	Z1-	LVDS- Out	Camera Link Transmitter
	22	Z1+	LVDS- Out	Camera Link Transmitter
PAIR 9	10	Z2-	LVDS- Out	Camera Link Transmitter
	23	Z2+	LVDS- Out	Camera Link Transmitter
PAIR 10	11	ZCLK-	LVDS- Out	Camera Link Transmitter
	24	ZCLK+	LVDS- Out	Camera Link Clock Tx
PAIR 11	12	Z3-	LVDS- Out	Camera Link Channel Tx
	25	Z3+	LVDS- Out	Camera Link Channel Tx
PAIR 12	13	Ground	Ground	Cable Shield
	26	Ground	Ground	Cable Shield

Note: The Base interface (CL1) and the Medium interface (CL2) must be correctly connected to their respective interfaces on the frame grabber according to the instructions on the back of the camera.

TTS61M(2)CL-13M/C supports the following output modes: 4tap@8/10/12bit, 8tap@8/10bit, and 10tap@8bit. The mapping between signals and ports in each output mode is shown in the following table.

Table 6 Port Assignments(4tap @ 8/10bit/12bit)

	8bit	10bit	12bit
	4tap/8bit	4tap/10bit	4tap/12bit
Port A0	A0	A0	A0
Port A1	A1	A1	A1
Port A2	A2	A2	A2
Port A3	A3	A3	A3
Port A4	A4	A4	A4
Port A5	A5	A5	A5
Port A6	A6	A6	A6
Port A7	A7	A7	A7
Port B0	B0	A8	A8
Port B1	B1	A9	A9
Port B2	B2	-	A10
Port B3	B3	-	A11
Port B4	B4	B8	B8
Port B5	B5	B9	B9
Port B6	B6	-	B10
Port B7	B7	-	B11
Port C0	C0	B0	B0
Port C1	C1	B1	B1
Port C2	C2	B2	B2
Port C3	C3	B3	B3
Port C4	C4	B4	B4
Port C5	C5	B5	B5
Port C6	C6	B6	B6
Port C7	C7	B7	B7

	8bit	10bit	12bit
	4tap/8bit	4tap/10bit	4tap/12bit
Port D0	D0	D0	D0
Port D1	D1	D1	D1
Port D2	D2	D2	D2
Port D3	D3	D3	D3
Port D4	D4	D4	D4
Port D5	D5	D5	D5
Port D6	D6	D6	D6
Port D7	D7	D7	D7
Port E0	-	C0	C0
Port E1	-	C1	C1
Port E2	-	C2	C2
Port E3	-	C3	C3
Port E4	-	C4	C4
Port E5	-	C5	C5
Port E6	-	C6	C6
Port E7	-	C7	C7
Port F0	-	C8	C8
Port F1	-	C9	C9
Port F2	-	-	C10
Port F3	-	-	C11
Port F4	-	D8	D8
Port F5	-	D9	D9
Port F6	-	-	D10
Port F7	-	-	D11

Table 7 Port Assignments(8tap @ 8/10bit)

	8bit	10bit
	8tap/8bit	8tap/10bit
Port A0	A0	A2
Port A1	A1	A3
Port A2	A2	A4
Port A3	A3	A5
Port A4	A4	A6
Port A5	A5	A7
Port A6	A6	A8
Port A7	A7	A9
Port B0	B0	B2
Port B1	B1	B3
Port B2	B2	B4
Port B3	B3	B5
Port B4	B4	B6
Port B5	B5	B7
Port B6	B6	B8
Port B7	B7	B9
Port C0	C0	C2
Port C1	C1	C3
Port C2	C2	C4
Port C3	C3	C5
Port C4	C4	C6
Port C5	C5	C7
Port C6	C6	C8
Port C7	C7	C9
Port D0	D0	D2
Port D1	D1	D3
Port D2	D2	D4
Port D3	D3	D5
Port D4	D4	D6
Port D5	D5	D7
Port D6	D6	D8
Port D7	D7	D9
Port E0	E0	E2
Port E1	E1	E3
Port E2	E2	E4
Port E3	E3	E5
Port E4	E4	E6
Port E5	E5	E7
Port E6	E6	E8
Port E7	E7	E9

	8bit	10bit
	8tap/8bit	8tap/10bit
Port F0	F0	F2
Port F1	F1	F3
Port F2	F2	F4
Port F3	F3	F5
Port F4	F4	F6
Port F5	F5	F7
Port F6	F6	F8
Port F7	F7	F9
Port G0	G0	G2
Port G1	G1	G3
Port G2	G2	G4
Port G3	G3	G5
Port G4	G4	G6
Port G5	G5	G7
Port G6	G6	G8
Port G7	G7	G9
Port H0	H0	H2
Port H1	H1	H3
Port H2	H2	H4
Port H3	H3	H5
Port H4	H4	H6
Port H5	H5	H7
Port H6	H6	H8
Port H7	H7	H9
Port I0	-	A0
Port I1	-	A1
Port I2	-	B0
Port I3	-	B1
Port I4	-	C0
Port I5	-	C1
Port I6	-	D0
Port I7	-	D1
Port J0	-	E0
Port J1	-	E1
Port J2	-	F0
Port J3	-	F1
Port J4	-	G0
Port J5	-	G1
Port J6	-	H0
Port J7	-	H1

Table 8 Port Assignments(10tap @ 8bit)

	8bit
	10tap/8bit
Port A0	A0
Port A1	A1
Port A2	A2
Port A3	A3
Port A4	A4
Port A5	A5
Port A6	A6
Port A7	A7
Port B0	B0
Port B1	B1
Port B2	B2
Port B3	B3
Port B4	B4
Port B5	B5
Port B6	B6
Port B7	B7
Port C0	C0
Port C1	C1
Port C2	C2
Port C3	C3
Port C4	C4
Port C5	C5
Port C6	C6
Port C7	C7
Port D0	D0
Port D1	D1
Port D2	D2
Port D3	D3
Port D4	D4
Port D5	D5
Port D6	D6
Port D7	D7
Port E0	E0
Port E1	E1
Port E2	E2
Port E3	E3
Port E4	E4
Port E5	E5
Port E6	E6
Port E7	E7

	8bit
	10tap/8bit
Port F0	F0
Port F1	F1
Port F2	F2
Port F3	F3
Port F4	F4
Port F5	F5
Port F6	F6
Port F7	F7
Port G0	G0
Port G1	G1
Port G2	G2
Port G3	G3
Port G4	G4
Port G5	G5
Port G6	G6
Port G7	G7
Port H0	H0
Port H1	H1
Port H2	H2
Port H3	H3
Port H4	H4
Port H5	H5
Port H6	H6
Port H7	H7
Port I0	I0
Port I1	I1
Port I2	I2
Port I3	I3
Port I4	I4
Port I5	I5
Port I6	I6
Port I7	I7
Port J0	J0
Port J1	J1
Port J2	J2
Port J3	J3
Port J4	J4
Port J5	J5
Port J6	J6
Port J7	J7

5.2.4 Control I/O Interface

The control I/O interface adopts a 4-pin connector with the model:
Hirose HR10A-7R-4PB (Male).

Corresponding connector on the cable model:
Hirose HR10A-7P-4S (Female).

The control I/O receptacle on the back of the camera is shown as follows:

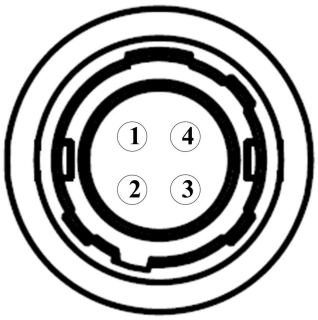


Fig. 10 Pin Assignments for Control I/O Interface

Table 9 Pin Configurations for Control I/O Interface

Signal	Pin	Signal	Pin
Trigger In +	1	GND	3
Trigger In -	2	Strobe Out	4

The following figure shows trigger signal input circuit of the 4-pin connector. Transmitted trigger signal is applied to the internal circuit through a photo coupler. The minimum trigger width that can be recognized by the camera is 1μs. If transmitted trigger signal is less than 1μs, camera will ignore trigger signal. Trigger input voltage range is 2.5V~12V, an external trigger circuit example is shown below.

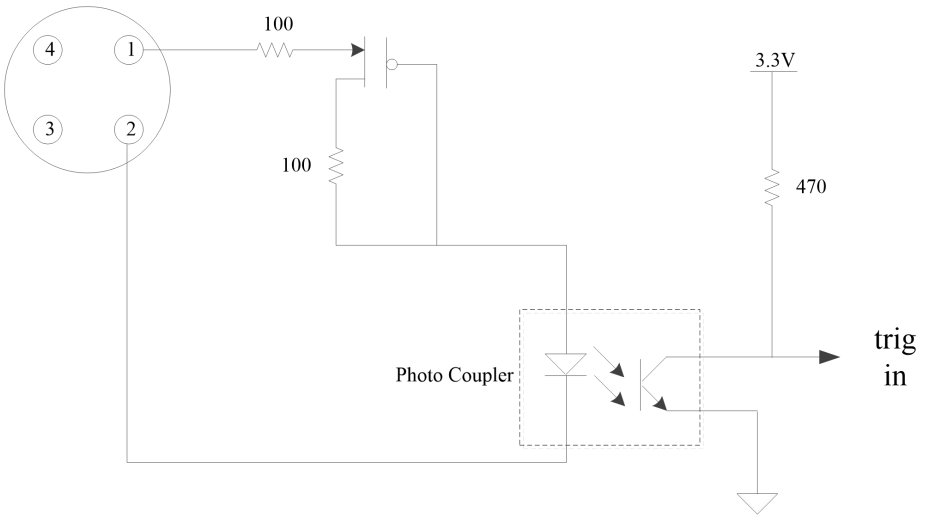


Fig. 11 Trigger Input Schematic

The strobe output signal comes out through 3.3V output level of TTL Driver IC. A pulse width of signal is synchronized with an exposure (shutter) signal of the camera.

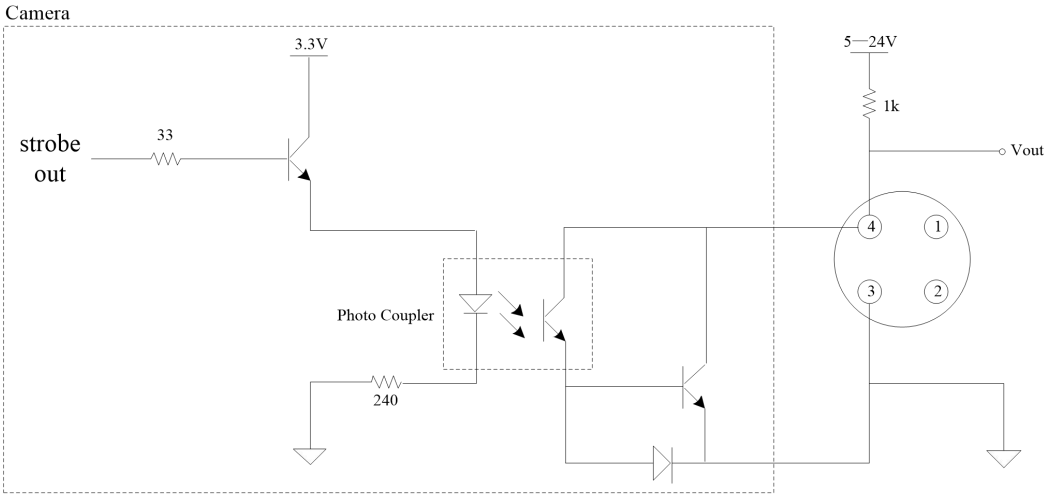


Fig. 12 Strobe Output Schematic

6 Camera Features

This chapter introduces the internal characteristics of TTS61M(2)CL-13M/C camera in detail.

6.1 Trigger Mode

TTS61M(2)CL-13M/C camera supports three trigger modes: Free-Run mode, External Pulse mode and External PWM mode.

6.1.1 Free-Run Mode

In the Free-Run mode, the camera generates the relevant control sequence internally according to the frame period and exposure time parameters configured by users and outputs the image.

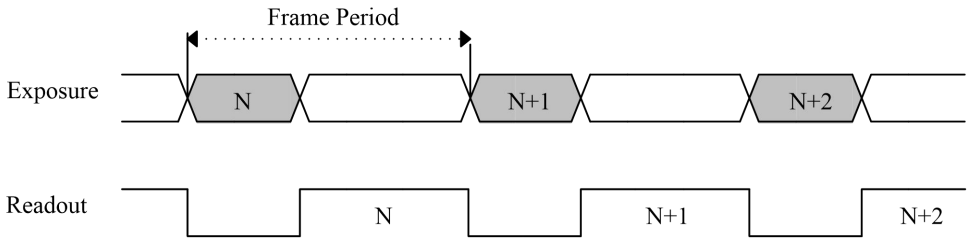


Fig. 13 Free-Run Mode

In order to achieve normal image output, TTS61M(2)CL-13M/C camera limits the range of frame period and exposure time. In Free-Run mode, users can configure the exposure time range from 120μs to 60s; The minimum frame period should be greater than both the exposure time and the reading time of a frame of data. For different Tap modes, the read time of one frame of camera data is shown in the following table:

Table 10 Readout Time of One Frame in Different Tap Modes

Tap mode	4Tap@8/10/12 bit	8Tap@8/10 bit	10Tap@8bit
Readout time of one frame	194ms	97ms	77ms

The frame period and exposure time instructions are sent to the camera through the serial port of Camera Link, and the detailed instructions are in Section 7.

6.1.2 External Pulse Mode

In the External Pulse mode, the camera starts exposure at the rising edge of the external trigger signal, while the exposure time is set by user command (consistent with the Free-Run mode). The frame rate of the camera is determined by the frame period between the rising edges of the external trigger pulse, as shown in the figure below.

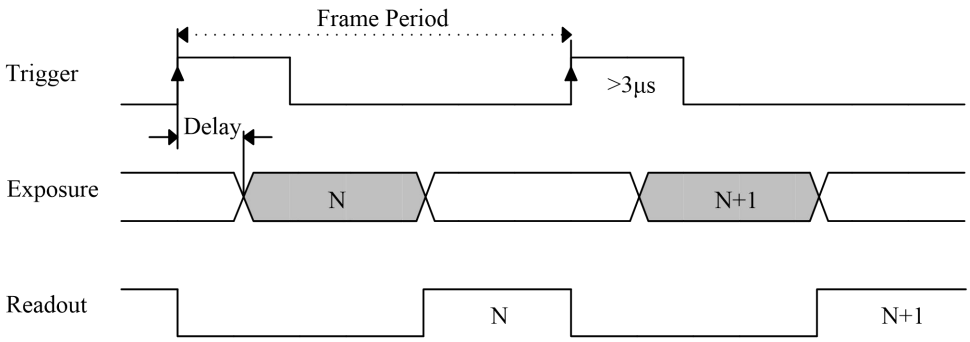


Fig. 14 External Pulse Mode

The external trigger signal can be CC1 signal of Camera Link or external pins from 4-pin control I/O connector, and the input source could be selected by users. To ensure that the camera correctly detects each external trigger pulse, the external trigger pulse must have a width greater than 3μs.

To get a higher frame rate, a new trigger pulse can be fired at the same time the camera reads the data after the last frame exposure. In this fast mode, since it is necessary to ensure that the readout stages of two frames do not conflict, the external trigger with an interval less than 1 frame readout time will be automatically ignored by the camera, as shown in the figure below.

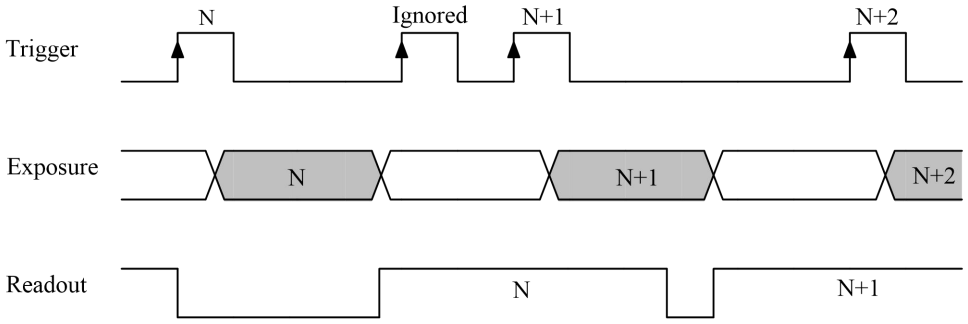


Fig. 15 Frame Period of External Trigger is Too Short

6.1.3 External PWM Mode

In the External PWM mode, the camera exposure starts at the rising edge and ends at the falling edge of the external trigger signal. That is, the actual exposure time is equal to the high level duration of the external trigger, and the frame period is equal to the pulse interval.

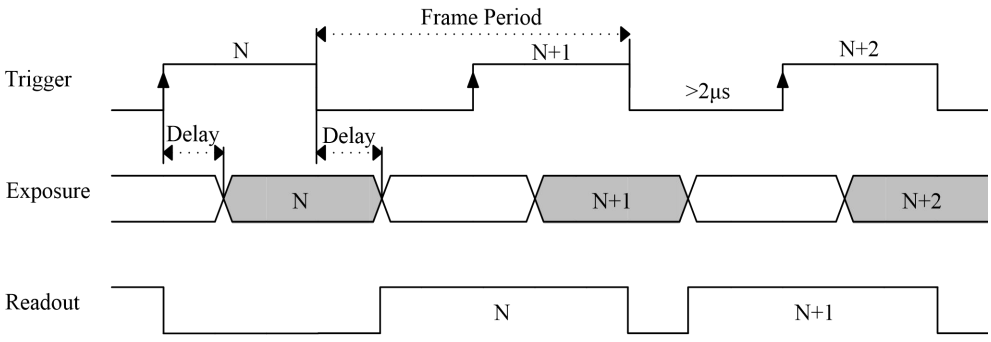


Fig. 16 High Level Trigger Mode

Please note that the minimum exposure time of the camera is 120μs, so the external trigger signal should be wider than 120μs in this mode. In fact, the camera will always process to 95μs exposure time if the pulse width is less than 120μs.

Too short frame period of external trigger will lead to the conflict between the data readout of the previous and current frames of the camera. The pulses that do not meet the requirements will be ignored inside the camera, so that the device can maintain its normal operation. Therefore, in this mode, it should be ensured that the frame period between the falling edges of adjacent external triggers is greater than one-frame readout time.

TTS61M(2)CL-13M/C camera provides rich timing sequence parameter control features for external trigger mode, including external trigger polarity, delay etc. For details, please refer to Section 7 “Camera Configuration” and Section 8 “Camera Configuration Tool”.

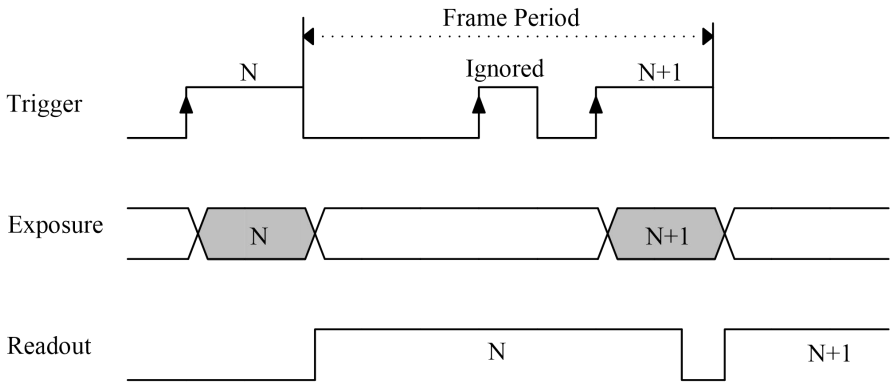


Fig. 17 Frame Period of External Trigger is Too Short

6.2 Region of Interest

ROI feature allows users to specify only a portion of the sensor array output data. Users can obtain data from only a specified part of the sensor array so that the camera can have a higher frame rate. ROI is determined by three parameters, namely the coordinates of the starting point, the number of lines and the number of columns, as shown in the figure below.

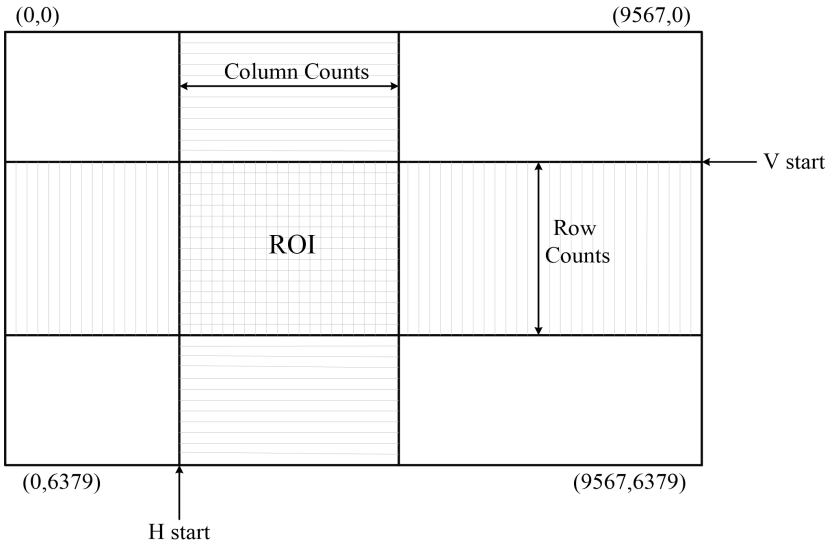


Fig. 18 Region of Interest

Note: The pixel coordinates in the horizontal direction must be a multiple of 16. If not so, it will automatically jump to the closest multiple of 16. The pixel coordinates in the vertical direction must be a multiple of 2. If not so, it will automatically jump to the closest multiple of 2.

Table 11 Maximum Frame Rate Depending on ROI Values

ROI Size H	ROI Size V	4tap	8tap	10tap
9568	6380	5.18fps	10.35fps	13.06fps
8992	6380	5.18fps	10.35fps	13.06fps
8000	6380	5.18fps	10.35fps	13.06fps
6992	6380	5.18fps	10.35fps	13.06fps
6000	6380	5.18fps	10.35fps	13.06fps
4992	6380	5.18fps	10.35fps	13.06fps
4000	6380	5.18fps	10.35fps	13.06fps
2992	6380	5.18fps	10.35fps	13.06fps
2000	6380	5.18fps	10.35fps	13.06fps
992	6380	5.18fps	10.35fps	13.06fps
9568	6000	5.50fps	11.00fps	13.88fps
9568	5000	6.59fps	13.18fps	16.63fps
9568	4000	8.21fps	16.42fps	20.72fps
9568	3000	10.89fps	21.79fps	27.50fps
9568	2000	16.18fps	32.36fps	40.84fps
9568	1000	31.45fps	62.89fps	79.37fps
9568	500	59.52fps	119.05fps	150.24fps

6.3 LUT

The LUT uses a 12-bit input and 12-bit output look-up table to map and convert the values of the original image. Users can use this function to implement gamma correction. The camera has a factory-configured look-up table and also provides two user-configured look-up tables space.

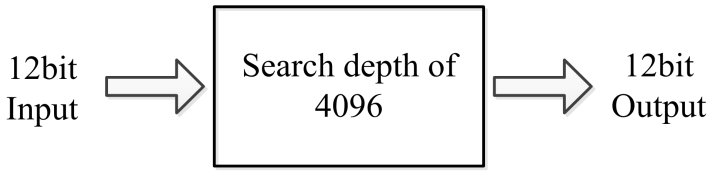


Fig. 19 LUT

The following figure is the LUT mapping curve with Gamma=0.5:

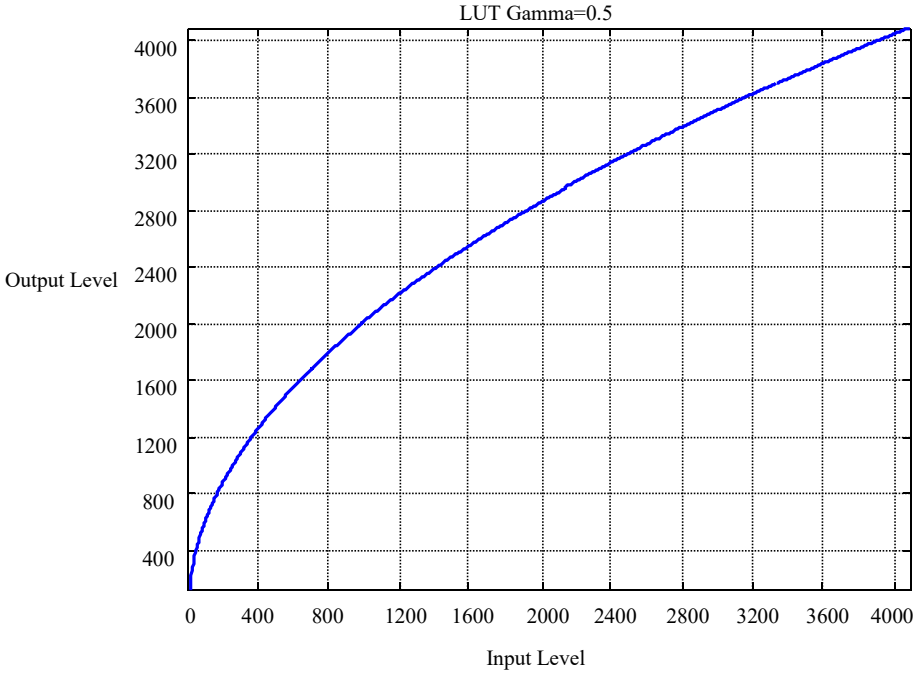


Fig. 20 LUT: Gamma = 0.5

TTS61M(2)CL-13M/C in addition to providing two sets of lookup tables for users to use, also added the hardware Gamma correction function, compared to using the lookup table to write entries one by one, the hardware Gamma correction function can be completed in real time with only one instruction, improving the efficiency of the camera operation.

6.4 Defect Pixel Correction

Due to the defects of the material itself and the issue with the process flow of semiconductor production, there are usually a certain number of pixels in area scan imaging sensors that cannot properly response to the input light, which we call defect pixels. TTS61M(2)CL-13M/C camera provides with defect pixel automatic correction feature. The defect pixel information of the imaging sensor is written into the camera before the camera is delivered out of the factory. Users can control

whether to enable the defect pixel correction, add new defect pixels and read out the current defect pixel list from the camera.

The correction method of defective pixels is based on calculation and output of adjacent valid pixel values in the same line,Black-and-white and color cameras have a slightly different correction method:

For black and white cameras, the defective pixel values are replaced by adjacent pixel values.

For color cameras, the defective pixel values are replaced by the separated pixel values.

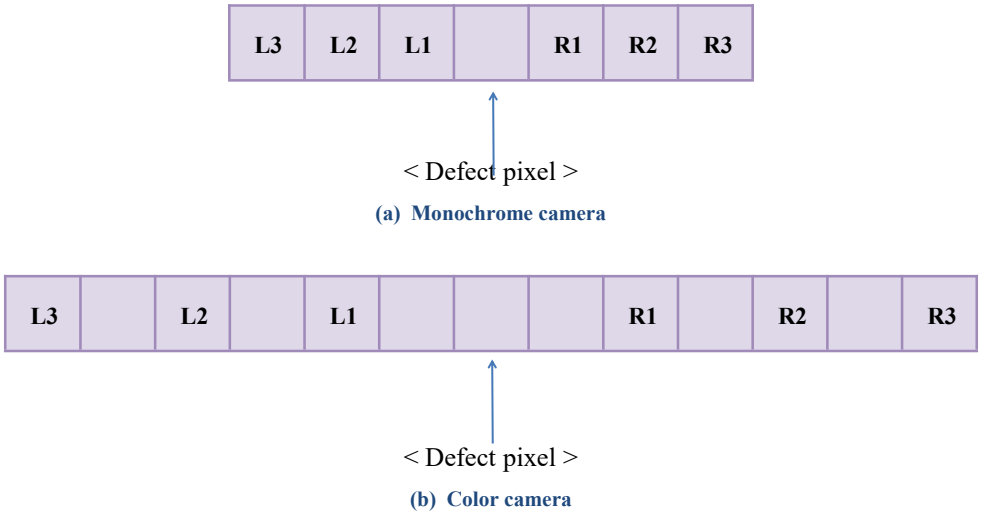


Fig. 21 Defective Pixel Correction Method

In the figure above, the modified value of defective pixels will be calculated according to whether the surrounding pixels are defective pixels, as the rules shown in the following table.

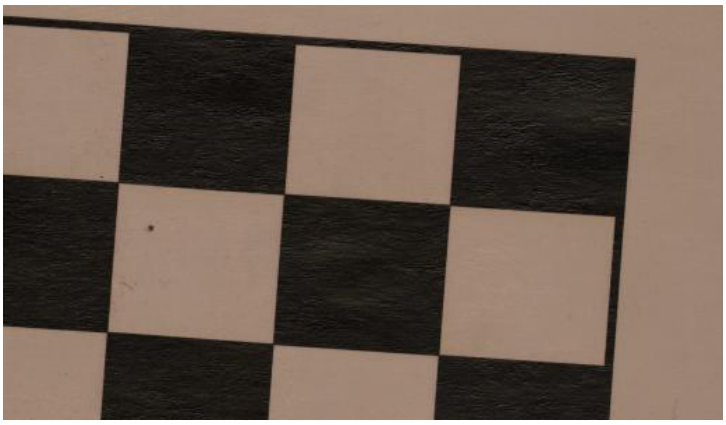
Table 12 Calculation Defect Pixel Correction Value

Adjacent Defect Pixel(s)	Correction value of Current Pixel
None	L1
L1	R1
R1	L1
L1,R1	L2
L1,R1,L2	R2
L1,R1,L2,R2	L3
L1,R1,L2,R2,L3	R3

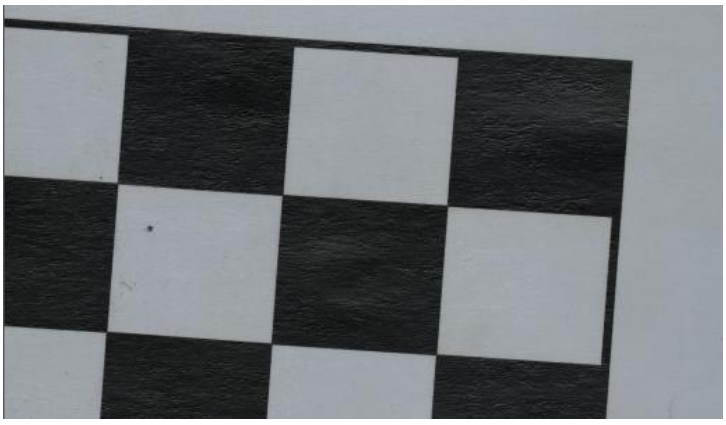
6.5 White Balance

White balance is an important parameter of color industrial camera, which directly affects the color effect of reconstructed image. When the white balance of industrial camera is not properly set, the reconstructed image will appear color deviation phenomenon.

TTS61M(2)CL-13C camera internally provides a white balance function, which balances the output values of each channel of the sensor. Automatic white balance calculates the white balance coefficient by sampling the local pixels in the sensor, and then adjusts each component of the image according to the coefficient, so that the values of the red, green and blue components in the output image are consistent. The renderings are as follows:



(a) Before White Balance



(b) After White Balance

Fig. 22 Effect of White Balance

6.6 Flat Field Correction

Flat field correction is used to improve the image brightness inconsistency caused by external factors such as the vignetting effect of the lens and the inconsistency of illumination. The Flat Field Correction feature can be summarized by the following equation:

$$IC=IR/IF$$

IC: Level value of corrected image
IR: Level value of original image
IF: Level value of Flat Field data

In the actual use conditions, generate a Flat Field data (IF) and enable the Flat Field Correction feature according to the following procedures:

① Flat Field Correction parameters are calculated by the camera command “FFCL=1”. Considering the pixel array size and vignetting effect of area scan camera, Flat Field Correction parameters are calculated by using block data of 64*64 pixels. These Flat Field Correction parameters will be temporarily stored in the camera buffer.

② Enable the Flat Field Correction through the camera command “FFCR=1”. The Flat Field Correction parameters will be processed by bilinear difference algorithm to the original image.

③ Save Flat Field Correction parameters into EEPROM by camera command “Save = 1/2”.

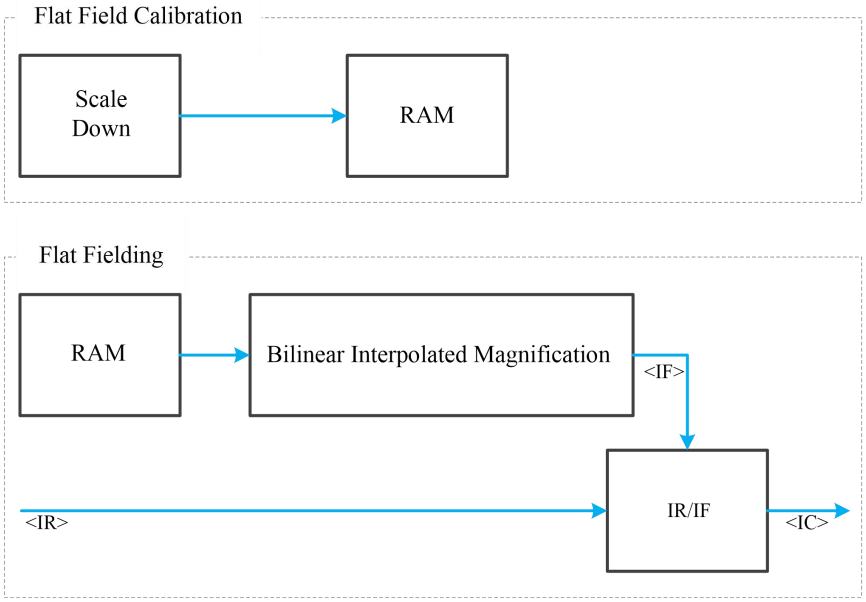


Fig. 23 Generation and Application of Flat Field Data

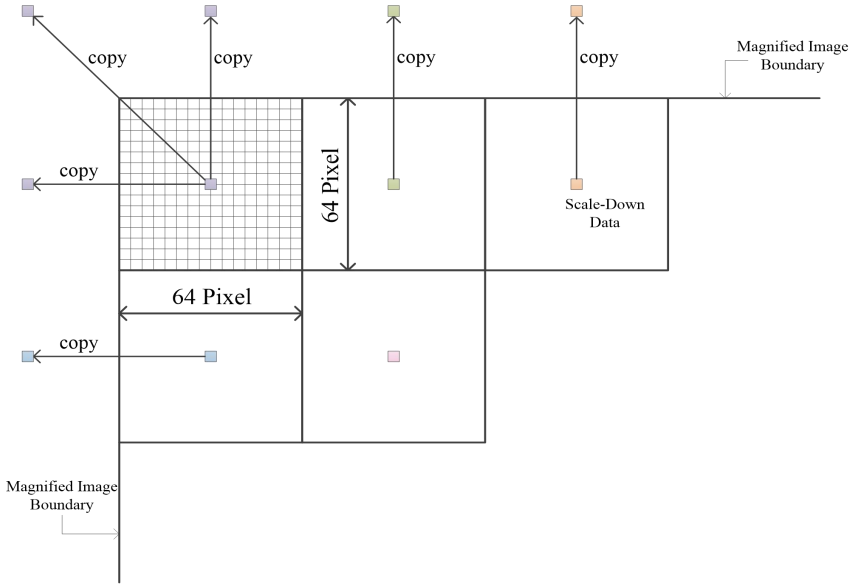


Fig. 24 Bilinear Interpolated Magnification

Precautions for flat field correction:

① It is recommended to set the data mode to correction data and the camera command to “DMOD=1” before calculating flat field.

② Temporarily turn off the ROI function during correction, and carry out flat field correction under full resolution. After the correction is completed, the ROI function can be restarted. Multiple flat field corrections will overwrite the previous correction data.

③ Set the trigger mode of the camera to Free Run before flat field correction, even if the camera works normally in other modes.

6.7 Test Image

The camera provides two test images. Unlike images collected from sensors, test images are fixed style images that are pre-edited and stored inside the camera. The test image can be used to test whether the data link is open.

This camera provides the test image as shown, which users can invoke using the camera command “DMOD=2/DMOD=3/DMOD=4”.

- Test image 1: fixed image with horizontal gray gradient.
- Test image 2: fixed image with vertical gray gradient.
- Test image 3: Fixed image with all pixels of the same gray scale.

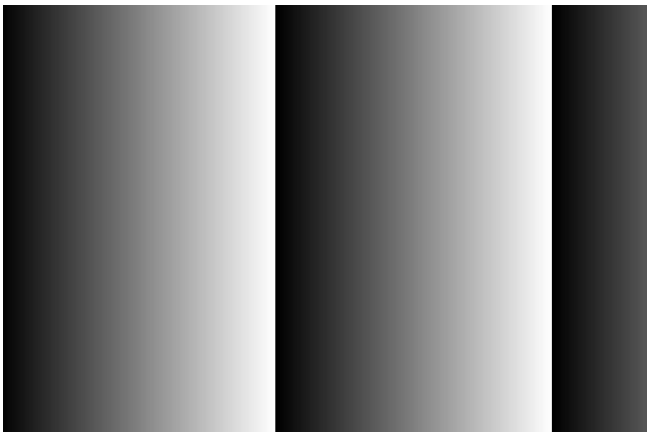


Fig. 25 Test Image 1

Fig. 26 Test Image 2

Fig. 27 Test Image 3

6.8 Strobe

The strobe signal is used to synchronize the external light source with the camera. As a Rolling Shutter type camera, TTS61M(2)CL-13M/C camera requires the camera or the target to stand still during exposure, otherwise smearing may happen. The strobe signal can be used as a basis to judge whether the exposure is over.

6.8.1 Strobe Signal Type

TTS61M(2)CL-13M/C provides two modes of strobe signal: Wide Strobe and Narrow Strobe.

- Wide Strobe: The Strobe signal goes high when the exposure time for the top line of pixels begins and goes low when the exposure time for the bottom line of pixels ends.
- Narrow Strobe: The Strobe signal goes high when the exposure time for the bottom line of pixels begins and goes low when the exposure time for the top line of pixels ends.

The narrow strobe mode is only valid when the exposure time is greater than the readout time. The following figure shows strobe output timing sequence for Wide Strobe mode / Narrow Strobe mode.

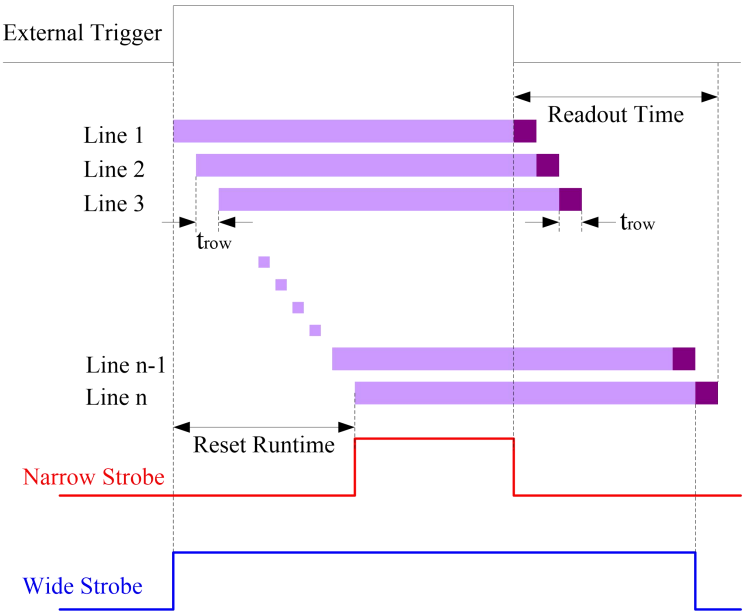


Fig. 28 Strobe Signal (Polarity：High)

6.8.2 Strobe Signal Polarity

TTS61M(2)CL-13M/C camera supports setting of the polarity of strobe output signal. Refer to the command list below for the setting command. Strobe polarity settings comprise high or low.

- High: Specifies that a falling edge of the strobe output signal will be valid.
- Low: Specifies that a rising edge of the strobe output signal will be valid.

6.9 Camera Link Output Mode

The camera data is output through the Camera Link interface and Medium, Full, Full+ modes are supported. Their Tap arrangements are shown as follows:

Medium:

Full:

Full+:

Fig. 29 Camera Link Output Mode

6.10 Data Format

TTS61M(2)CL-13M/C camera processes data in 12bit data format, but provides 8bit, 10bit and 12bit output. When the camera outputs 8bit data, the lowest 4bit data will be deleted. When the camera outputs 10 bits of data, the lowest 2 bits will be deleted.

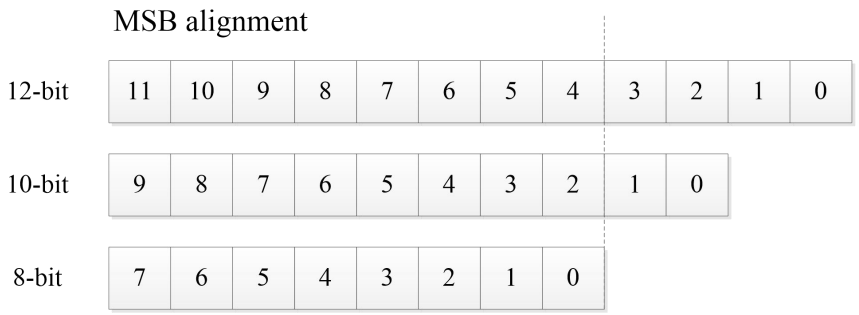


Fig. 30 Data Format

6.11 Gain & Offset

Camera gain is divided into analog gain and digital gain.

Analog gain acts on the analog signal, and usually a stronger response under weak light can be obtained by increasing the analog gain, thus obtaining a higher signal-to-noise ratio. Users can configure the camera analog gain. Similarly, analog offset is generally used to adjust the black level position of the front-end sensor.

The analog gain parameters range from 0 to 96, corresponding to 0 to 18dB. The influence on the camera response curve is shown as follows:

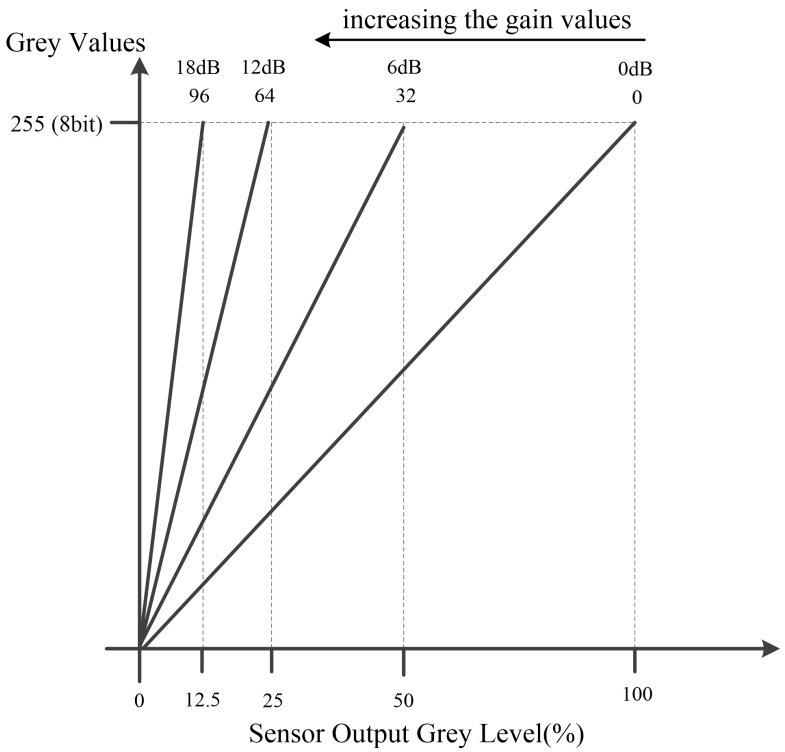


Fig. 31 Analog Gain Effect

Digital gain amplifies or reduces the data after the photoelectric conversion signal passes through AD. It is usually used to increase the dynamic range of the output image or for automatic white balance

operation. Digital gain can also be used to adjust the brightness of the image. Digital offset is often used to adjust the overall background brightness of an image.

Digital gain can be set to 800 levels, whose parameters range from 0.01 to 8.00. The influence of digital gain on output data can be summarized as follows:

Output value = Output value when digital gain is 1 and digital offset is 0 * digital gain parameter

The digital offset can be set to 8191 levels. The digital offset parameter ranges from -4095 to 4095, which is based on the 12bit data format. The effect of digital bias on the output data can be summed up in the following formula (the part of the output value <0 will be output 0) :

Output value = Output value when digital offset is 0 + digital offset parameter

See section 8.3.2 for analog gain and analog offset adjustment. See section 8.3.5 for digital gain and offset Settings.

6.12 Camera Temperature

TTS61M(2)CL-13M/C supports real-time acquisition of camera temperature. Users can read the camera temperature value to monitor the current temperature value of the front-end sensor or make some responses according to the temperature value.

The operating environment temperature of the camera is recommended to be 0°C to 40°C, and the internal operating temperature is recommended to be 0°C to 50°C. If users detect abnormal internal temperature (such as over 60°C), it is recommended to stop the camera immediately to avoid damage caused by faults. Power off and contact our technical support in time.

6.13 Load / Save Configuration

TTS61M(2)CL-13M/C camera supports three sets of working parameters, among which the factory parameter set is not allowed to be modified by users. The parameters have been optimized and can be used in most scenarios. In order to meet the difference of users' specific use environment, the camera also provides two sets of users' working parameters, whose internal parameters can be modified and saved by users. The saved working parameter set will be automatically loaded after the next power-on.

If the camera does not work properly after users modify the saving parameters, they can restore the factory default parameter set and reconfigure the camera based on this parameter set.

Refer to 8.2.1 for the description of loading and saving the camera working parameter set.

7 Camera Configuration

TTS61M(2)CL-13M/C camera supports users to send command to the camera through the serial port channel of Camera Link interface, and configure the camera working mode and related parameters.

7.1 Communication Serial Port Parameters

Table 13 Communication Serial Port Parameters

Serial port parameters	Configuration parameter
Baud rate	115200
Data bit	8
Parity bit	None
Stop bit	1
Stream control	None

7.2 Command Format

The commands received by the camera end are divided into the following two types depending on whether the command carries data:

- **Pure command**

[CMD]=[CR]

- **Data configuration command**

[CMD]=[VAL][CR]

After receiving the command, the camera will return message in three formats:

- **Format 1**

After receiving the general command, the camera will execute the command and return > OK

For example, input: load=0[CR]

Return: >Ok[CR]

- **Format 2**

After receiving the command to read the internal message, the camera will insert the corresponding message before >Ok

For example, input: list[CR]

Return: >[MEM][CR] >Ok[CR]

- **Format 3**

After receiving the command to read the internal message, the camera will insert the corresponding message before >Ok

For example, input: clnk[CR]

Return: [VAL][CR]>Ok[CR]

Note

[CMD] command, 4byte

[VAL] data, no more than 4 decimal digits

[MEM] memory data

[CR] 0x0D, enter

If the input command is in wrong format, an error code will be returned instead of Ok, as shown in the table below:

Table 14 Error Codes Returned upon Failure of Command Execution

Return Code	Description
Ok	Correct
0	Correct, equivalent to Ok
128	Command does not exist.
130	Conflict with other parameters.
131	Parameter value is out of range or does not meet requirements.
132	Command is not allowed to be executed in the current status.
133	Input command syntax error.

7.3 Command List

The list of serial commands supported by TTS61M(2)CL-13M/C camera is as follows. After connecting the camera through serial port, you can input relevant commands to configure the camera.

Table 15 List of Camera Commands

Command	Syntax	Description	
HELP	HELP	Show this information	
LIST	LIST	Show Current Configurations	
LOAD	LOAD=0/1/2	Load Configuration From Flash 0/1/2: Factory/User1/User2	
SAVE	SAVE=1/2	Save Current Configuration To Flash 1/2: User1/User2	
TEMP	TEMP	Get Current Camera Temperature	
FSYN	FSYN=0/1/2 (set command)	Set Frame Sync Mode (0/1/2: Internal Free Run/External Pulse/External PWM)	
	FSYN (get command)	0	Internal Free Run
		1	External Pulse
		2	External PWM
ANOS	ANOS=[0,4095] (set command)	Set Camera Analog Offset (0~4095)	
	ANOS (get command)	Get current value	
ANGN	ANGN=[0,96] (set command)	Set Camera Analog Gain (0~96)	
	ANGN (get command)	Get current value	
CLNK	CLNK=0/1/2/3/4/5 (set command)	Set Camera Link Mode (0/1/2/3/4/5: 4tap@8/10/12bit,8tap@8/10bit,10tap@8bit)	
	CLNK (get command)	0	4tap@8bit
		1	4tap@10bit
		2	4tap@12bit

		3	8tap@8bit
		4	8tap@10bit
		5	10tap@8bit
TEXP	TEXP=[120,60000000] (set command)	Set Exposure Time in microsecond (120us to 60s)	
	TEXP (get command)	Get current value	
DMOD	DMOD=0/1/2/3/4 (set command)	Set Data Mode (0/1/2/3/4: Original/Corrected/Pattern_1/Pattern_2/Pattern_3)	
	DMOD (get command)	0	Original
		1	Corrected
		2	Pattern_1
		3	Pattern_2
		4	Pattern_3
DIGN	DIGN=[0.01,8] (set command)	Set Digital Gain x0.01~x8.0	
	DIGN (get command)	Get current value	
DIOS	DIOS=[-4095,+4095] (set command)	Set Digital Offset (-4095,+4095)	
	DIOS (get command)	Get current value	
SROI	SROI=0/1 (set command)	Set ROI (0/1: Disable/Enable ROI)	
	SROI (get command)	0	Disable ROI
		1	Enable ROI
RICS	RICS=[0, 9552] (set command)	Set ROI Window Start Column Address (0~ 9552) (multiples of 16)	
	RICS (get command)	Get current value	
RICC	RICC=[16, 9568] (set command)	Set ROI Window Column Counts (16~ 9568) (multiples of 16)	
	RICC (get command)	Get current value	
RIRS	RIRS=[0, 6378] (set command)	Set ROI Window Start Row Address (0~ 6378) (multiples of 2)	
	RIRS (get command)	Get current value	
RIRC	RIRC=[2, 6380] (set command)	Set ROI Window Row Count (2~ 6380) (multiples of 2)	
	RIRC (get command)	Get current value	
BPCR	BPCR=0/1 (set command)	Bad Pixel Correction (0/1: Disable/Enable)	
	BPCR (get command)	0	Disable
		1	Enable
BPLT	BPLT	List Bad Pixel Array	
ADBP	ADBP=column,row	Add A New Bad Pixel Into Camera (column,row)	
RMBP	RMBP=column,row	Remove A Bad Pixel From Camera (column,row)	

FFCR	FFCR=0/1 (set command)	Flat Field Correction (0/1: Disable/Enable)	
	FFCR (get command)	0	Disable
		1	Enable
FFCL	FFCL=0/1	Flat Field Correction Calibration (0/1: Init/Calibrate)	
RFFP	RFFP	Readout Flat Field Correction Data	
WFFP	WFFP=addr,data	Write Flat Field Correction Data (addr,data)	
ENLT	ENLT=0/1	Look up Table (0/1 Disable/Enable)	
	ENLT	0	Disable
		1	Enable
SLUT	SLUT=0/1 (set command)	Select Look up Table (0/1)	
	SLUT (get command)	0	Table 0
		1	Table 1
RLUT	RLUT	Readout Current Look up Table	
WLUT	WLUT=addr,data	Write Current Look up Table Data (addr,data)	
GAMA	GAMA=[0.01, 127] (set command)	Set Gamma Correction Parameter Directly (0.01~ 127)	
	GAMA (get command)	Get current value	
FTSC	FTSC=0/1 (set command)	Select Frame Trigger Source (0/1: CC1/IO0)	
	FTSC (get command)	0	CC1
		1	IO0
FTPR	FTPR=0/1 (set command)	Set Trigger Input Polarity (0/1: rising/falling edge)	
	FTPR (get command)	0	rising edge
		1	falling edge
SOTP	SOTP=0/1 (set command)	Set Strobe Output Type (0/1: wide/narrow)	
	SOTP (get command)	0	wide
		1	narrow
SOPR	SOPR=0/1 (set command)	Set Strobe Output Polarity (0/1: high/low)	
	SOPR (get command)	0	high
		1	low
TFTD	TFTD=[0,10000] (set command)	Set Frame Trigger Delay in microsecond (0~10ms)	
	TFTD (get command)	Get current value	
ENVT	ENVT=0/1 (set command)	TEC Cooler Control (0/1: Disable/Enable)	
	ENVT (get command)	0	Disable
		1	Enable
TSET	TSET=[-10,40] (set command)	Set Sensor Temperature (-10~40C)	
	TSET (get command)	Get current value	
BAUD	BAUD=[4800,460800] (set command)	Set Camera Link Serial Port Baudrate (4800~460800bps)	
	BAUD (get command)	Get current value	

Mode	Mode=0/1 (set command)	Set sensor mode (0/1:0C/27)	
	Mode (get command)	0	0C
		1	27
In addition, color camera has more command：			
WBCL	WBCL=0/1	White Balance Calibration (0/1: Init/Calibrate)	
WBCR	WBCR=0/1 (set command)	White Balance Correction (0/1: Disable/Enable)	
	WBCR (get command)	0	Disable
		1	Enable
WBPR	WBPR=[1024,16383] (set command)	White Balance Reference for Red (1024~16383)	
	WBPR (get command)	Get current value	
WBPG	WBPG=[1024,16383] (set command)	White Balance Reference for Green (1024~16383)	
	WBPG (get command)	Get current value	
WBPB	WBPB=[1024,16383] (set command)	White Balance Reference for Blue (1024~16383)	
	WBPB (get command)	Get current value	

8 Camera Configuration Tool

Hefei I-TEK Optoelectronics Co., LTD. has designed IKTool, a special camera configuration software, for users to directly set parameters and configure commands for the camera.

8.1 IKTool Interface

The main window of IKTool comprises the menu bar, camera configuration area and status bar, as shown in the figure below.

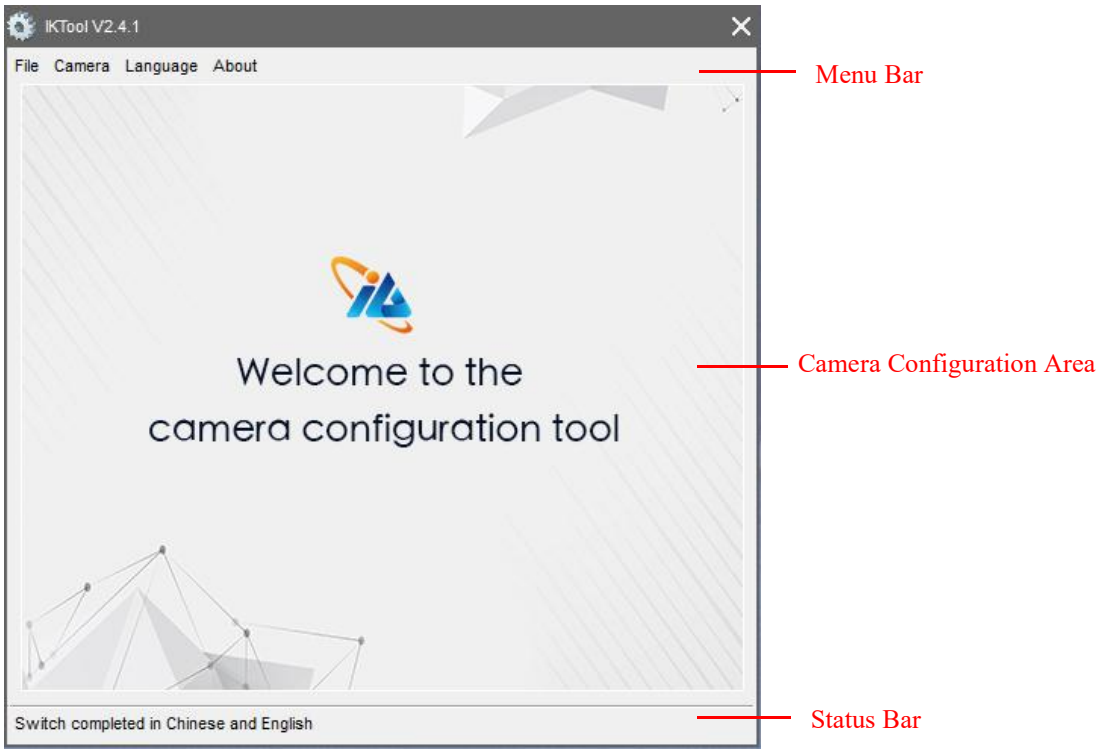


Fig. 32 Graphical Interface

8.2 Menu Bar

IKTool menu bar includes four main menus: “File”, “Camera”, “Language” and “About”, and each main menu contains several sub-menus. Among them, the “File” menu provides camera parameter loading, saving and reading features. The “Camera” menu provides camera probing and control dialog boxes. The “Language” menu provides Chinese and English switching functions. The “About” menu provides information of software and the currently connected camera.

8.2.1 File

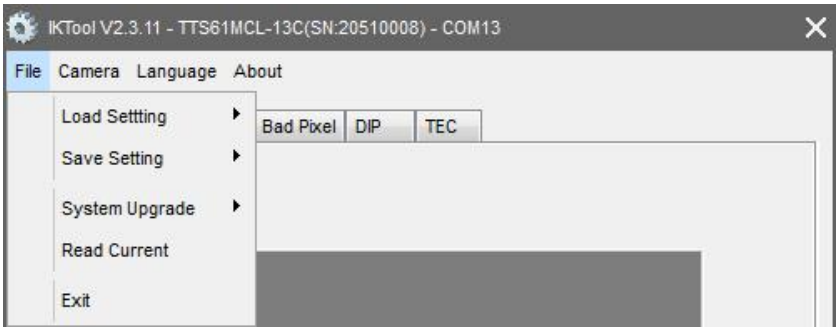


Fig. 33 "File" Menu

- **Load Setting**

Read and load configuration parameters from camera Flash. Users can choose to load factory setting parameters (Factory) or user parameters (including User1 and User2).

- **Save Setting**

Save the current camera configuration parameters to the camera Flash. Be noted that only user parameters (User1 or User2) can be saved.

- **System Upgrade**

Update the system firmware. Users can choose to update the MCU firmware.

- **Read Current**

Read the current configuration parameters of the camera and update the software display.

- **Exit**

Exit IKTool software.

8.2.2 Camera

Fig. 34 "Camera" Menu

- **Camera Scan**

Click this option to pop up the Camera Scan window, which is used to search for the camera connected to the computer, and select the camera to be configured for connection and operation.

Note: After clicking this option, the camera that is already opened will be closed.

The Camera Scan window is shown in the figure below. A list of cameras recognized by the software is shown. Users can select the camera to be configured and click the "OK" button to return. The software will read and display the configuration parameters of the selected camera. Users can also click the Probe button to search the camera again.

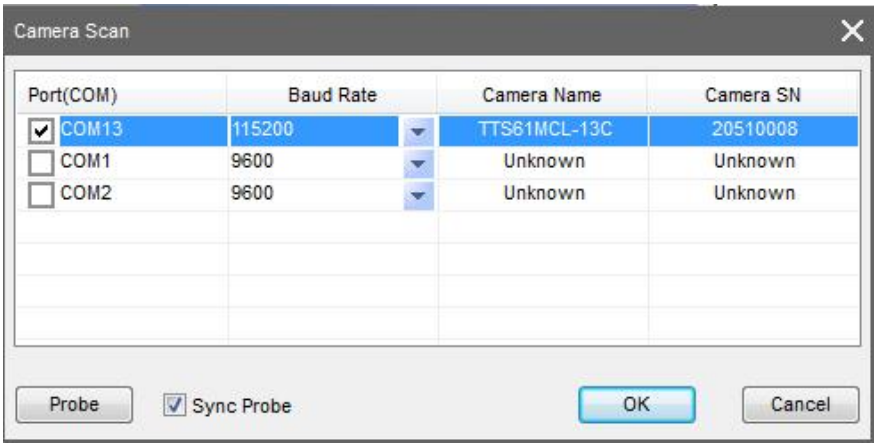


Fig. 35 Camera Scan Window

- **Control Terminal**

Click this option to pop up the Control Terminal window, in which users can manually enter the configuration command to change the parameters or configure the camera, as shown in the figure below. (Refer to 7.3 for configuration commands)

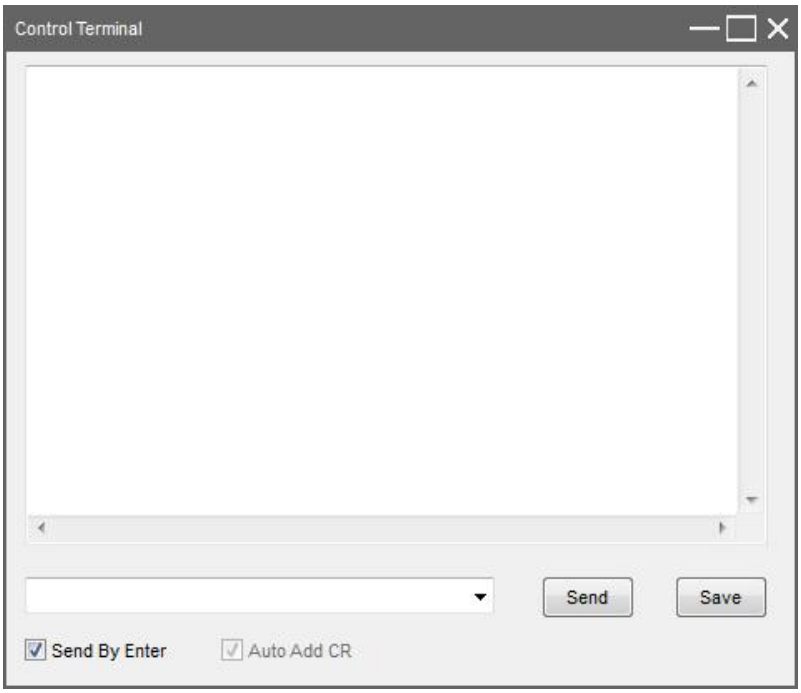


Fig. 36 Control Terminal Window

- **Send By Enter**

Select whether to enable the “Enter” key for sending.

8.2.3 Language

Fig. 37 “Language” Menu

For the convenience of users, IKTool has added Chinese and English switching functions, which solves the language barriers in the use of software.

8.2.4 About

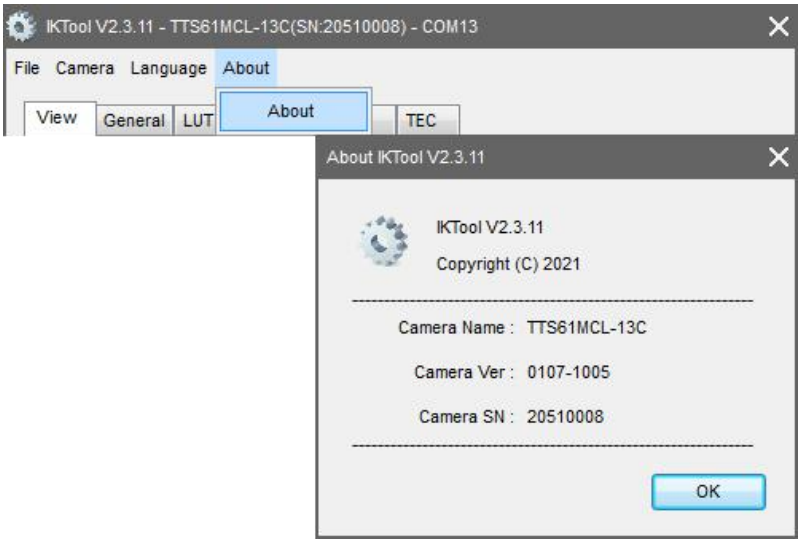


Fig. 38 “About” Menu

- **About**

Display information of software and current connected camera (model, serial number, version, etc.)

8.3 Camera Configuration Area

When the camera is connected, the camera configuration area will display camera related parameters on several pages. The configuration area of TTS61M(2)CL-13M/C camera includes six tabs: “View”, “General”, “LUT”, “Bad Pixel”, “DIP” and “TEC”.

8.3.1 View

The “View” tab allows you to set the general parameters such as ROI, Camera Link mode, serial port baud rate.

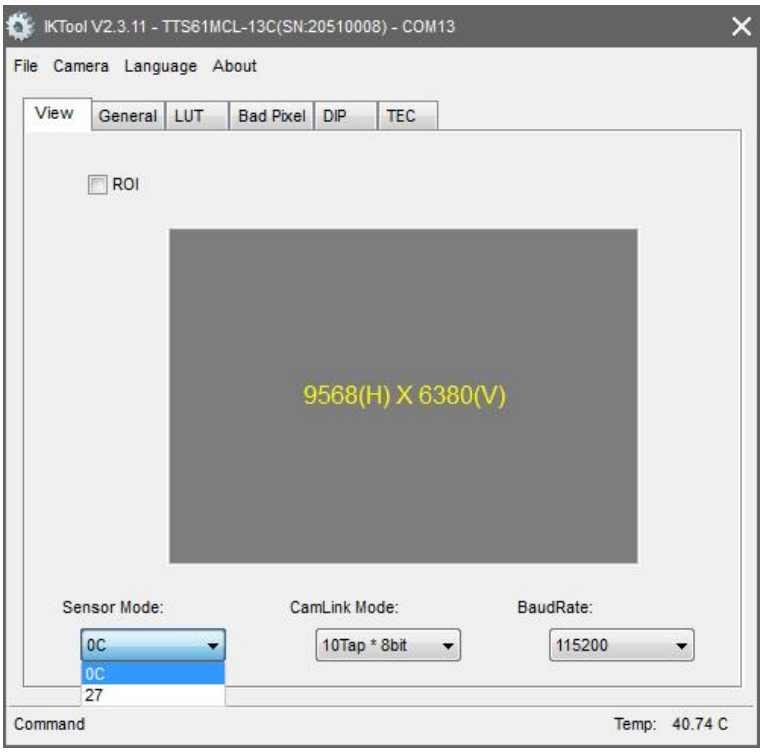


Fig. 39 View

- **ROI**

Users can select whether to enable ROI through the radio button. The interface after ROI is enabled is shown in the figure below. The four input boxes around the rectangle are respectively for the starting coordinates and the number of lines in the horizontal and vertical directions of the output image. Users can configure the parameters to the camera by clicking spin button, or entering pixel coordinates in the box and then pressing the “Enter” key on keyboard. The area confined with the four coordinates will be the area of the final output image.

Note: The pixel coordinates in the horizontal direction must be a multiple of 16. If not so, it will automatically jump to the closest multiple of 16. The pixel coordinates in the vertical direction must be a multiple of 2. If not so, it will automatically jump to the closest multiple of 2.

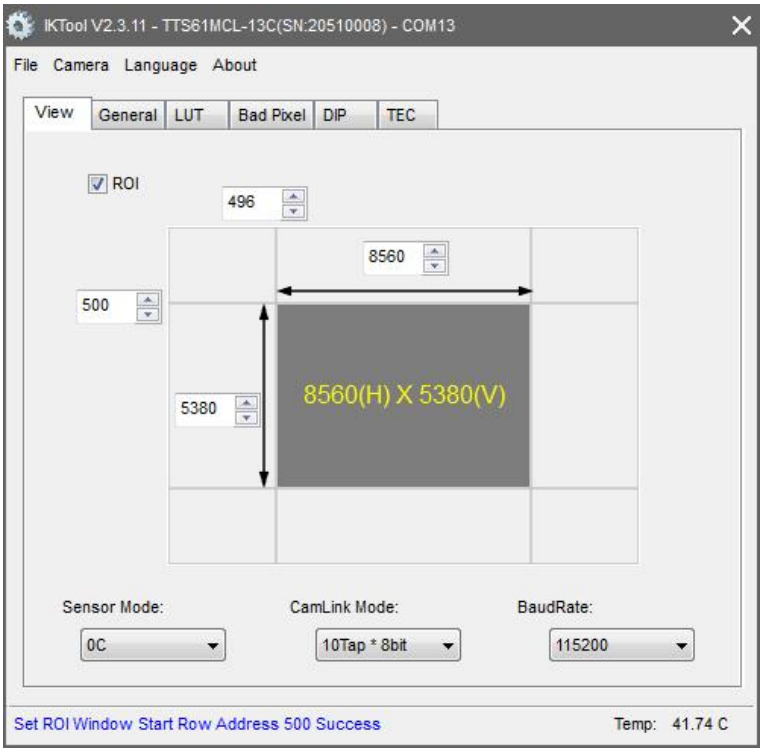


Fig. 40 Enable ROI

- **Sensor Mode**

The user can select the sensor mode from here. There are two options: normal mode 0C and low resolution 27. After switching sensor mode, registers will be changed accordingly and parameter values will be restored to their saved configurations.

- **CamLink Mode**

Users can select TAP specifications and bit output here. TTS61M(2)CL-13M/C camera provides three output pixel formats: 8-bit, 10-bit and 12-bit. Different bit outputs can be selected under the same TAP mode. Refer to "7.3 Command List" for details.

- **Baud Rate**

Users can set baud rate in this drop-down combobox, in the range of 4800bps ~ 460800bps.

8.3.2 General

The "General" tab allows you to set time-related parameters such as exposure, trigger and strobe.

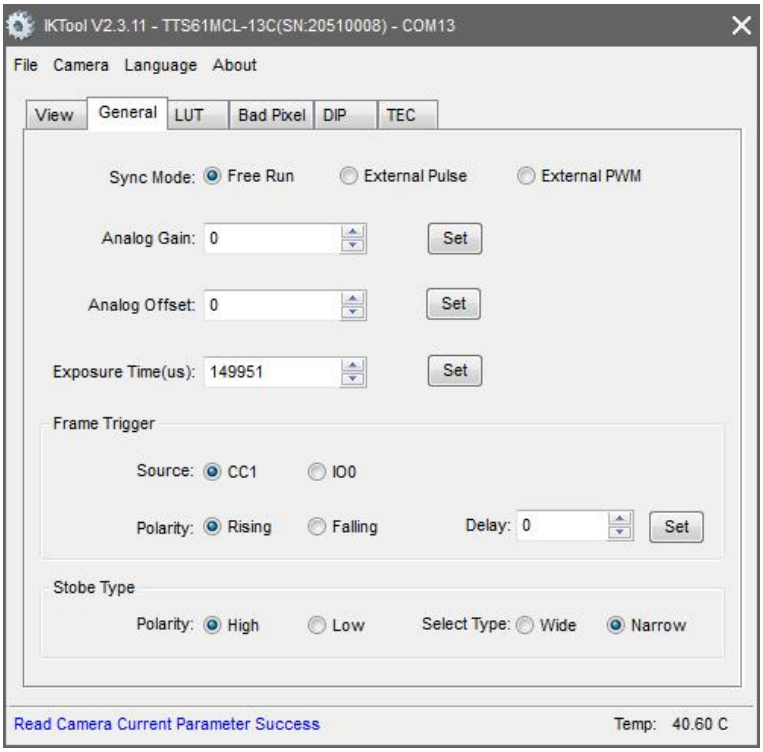


Fig. 41 General

- **Sync Mode**

Select the camera trigger mode. There are three modes for users' option: Free-Run, External Pulse and External PWM.

- **Analog Gain**

Set the analog gain in the range of 0 to 96 and the linear value in the range of 0 to 18 dB.

- **Analog Offset**

In setting the analog offset amount, users can set the analog offset amount through the spin button or directly by entering value in the edit box, and then clicking the "Set" button to configure the parameters to the camera.

- **Exposure Time**

Set the exposure time in the range of 120μs to 60s.

The minimum exposure interval for different Tap modes is as follows:

Tap Mode	minimum exposure interval
4tap@8/10/12bit	60μs
8tap@8/10bit	30μs
10tap@8bit	23.75μs

< Frame Trigger >

- **Source**

Select the frame trigger source from three options: IO0/CC1.

- **Polarity**

Select the frame trigger polarity, either rising edge or falling edge.

- **Delay**

Set the amount of delay for the exposure relative to the trigger input. Users can set the delay amount through the spin button or directly by entering value in the edit box, and then clicking the “Set” button to configure the parameters to the camera.

< Strobe Type >

- **Polarity**

Select the strobe signal polarity, either high or low.

- **Select Type**

Select the strobe signal type, either wide or narrow.

Note: The camera needs to work in external trigger mode at this time.

8.3.3 LUT

The “Lookup Table” tab is mainly the user's Look Up Table Settings. The user can read and display the lookup table of the camera or file, store the read lookup table as a CSV file, or write it to the camera, as shown in the figure below.

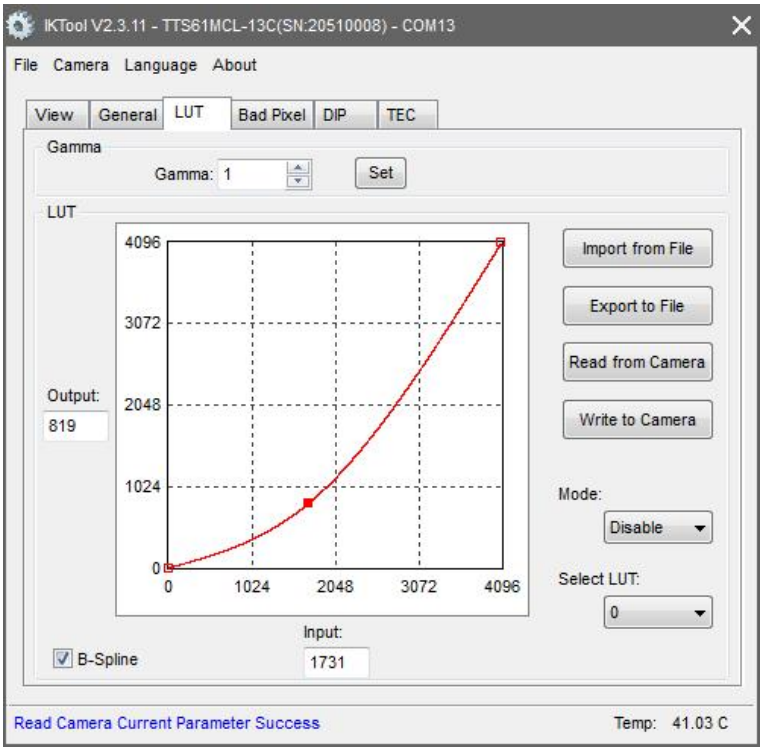


Fig. 42 LUT

- **Gamma**

Writing the Gamma value in the text box and clicking the "Set" button will perform hardware Gamma correction.

< LUT >

- **B-spline**

Select whether to enable B-splines.

- **Import from File**

Load lookup table data file from computer(CSV file).

- **Export to File**

Save the current lookup table to a CSV file.

- **Read from Camera**

Read lookup table data from camera.

- **Write to Camera**

Save the current lookup table data to the camera.

- **Mode**

Select whether lookup table is enabled in the camera.

- **Select LUT**

Select a lookup table. There are two types of tables: 0 and 1.

8.3.4 Bad Pixel

The “Bad Pixel” tab allows users to set the defect pixels. Users can read the defect pixel correction table from the camera or import from file and display it, or change the read or imported defect pixel correction table and store it as a CSV file, or write it into the camera, as shown in the figure below.

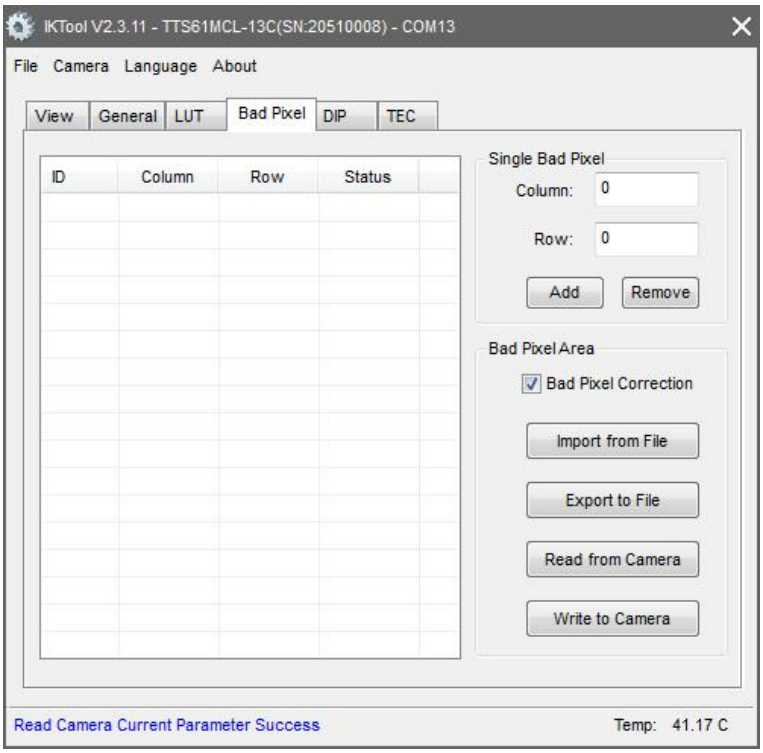


Fig. 43 Bad Pixel

< Single Bad Pixel >

- **Add**

Add defect pixel points. Users enter the abscissa of the defect pixel in the Column box, the ordinate in the Row box, and click the “Add” button, then the camera will take this pixel point as a new defect pixel and add it to the defect pixel table on the left.

- **Remove**

Remove defect pixel points. Users select the coordinates in the defect pixel table on the left, and click the “Remove” button, then the camera will regard this pixel point as a normal one and delete it from the defect pixel table on the left.

< Bad Pixel Area >

- **Bad Pixel Correction**

Select whether to enable defect pixel correction.

- **Import from File**

Import the lookup table file (CSV file) in the computer.

- **Export to File**

Export the current defect pixel table as CSV file.

- **Read from Camera**

Read the defect pixel data from the camera.

- **Write to Camera**

Write the current defect pixel data to the camera.

8.3.5 DIP

The “DIP” tab allows you to set the parameters: flat field correction, data mode, digital gain and offset.

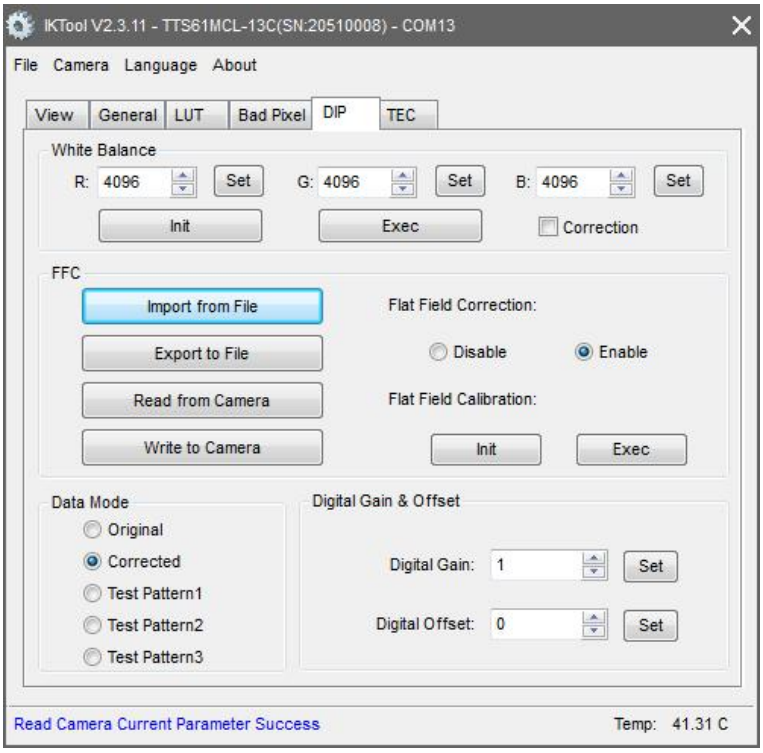


Fig. 44 DIP

< White Balance >(Color camera)

- **R/G/B**

Users can set the values of R, G, and B channels in white balance, ranging from 1024 to 16383.

- **Init**

Initialize white balance data.

- **Exce**

Execute white balance.

- **Correction**

Select whether to enable the white balance function.

< FFC >

- **Import from File**

Load the flat field correction data file in the computer.

- **Export to File**

Save the current flat field correction data to CSV file.

- **Read from Camera**

Read the flat field correction data in the camera.

- **Write to Camera**

Save the current flat field correction data to the camera.

- **Flat Field Correction**

Select whether to enable flat field correction.

- **Flat Field Calibration**

Users can choose to initialize (Init) or calibrate (Calibrate) the flat field correction data.

Note: Flat field correction for low resolution mode Mode_27 is disabled.

< Data Mode>

In selecting the image data mode, you can select the original image, corrected image or test image for output.

< Digital Gain & Offset >

- **Digital Gain**

In setting the digital gain amount, users can set the digital gain amount through the spin button or directly by entering value in the edit box, and then clicking the “Set” button to configure the parameters to the camera.

- **Digital Offset**

In setting the digital offset amount, users can set the digital offset amount through the spin button or directly by entering value in the edit box, and then clicking the “Set” button to configure the parameters to the camera.

8.3.6 TEC

The “TEC” tab allows users to control the target temperature of the CCD imaging sensor, as shown in the figure below.

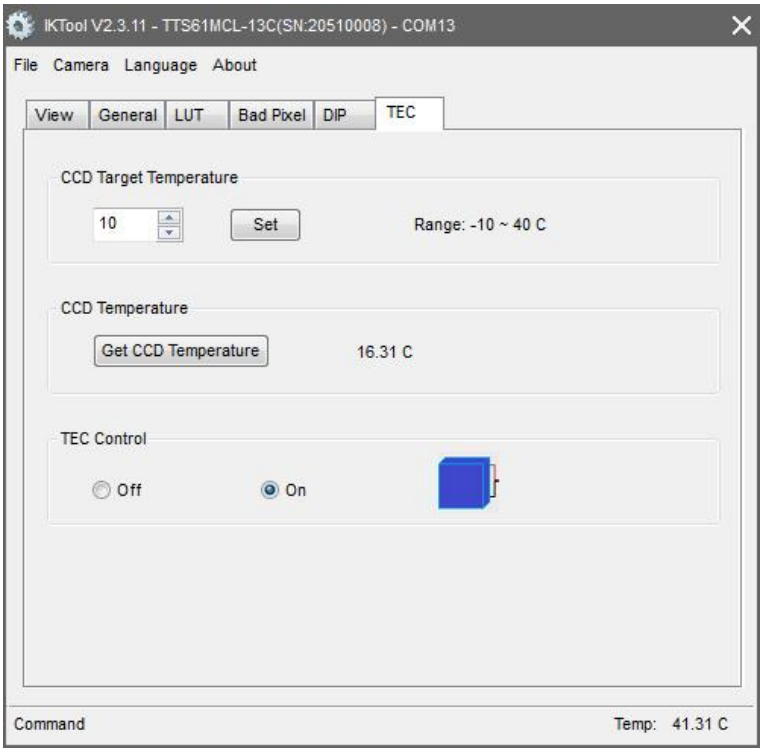


Fig. 45 TEC

- **CCD Target Temperature**

Set the target temperature of CCD imaging sensor.

- **CCD Temperature**

Display the current temperature of CCD imaging sensor.

- **TEC Control**

Turn TEC on or off.

8.4 Status Bar

The status bar of IKTool allows users to display the execution status of the configured camera parameters (lower left corner) and to display the real-time temperature of the camera (lower right corner), as shown in the figure below.

Fig. 46 Status Bar

Note: A "Cancel" button will appear in the status bar during parameter configuration. If a parameter configuration lasts too long, click this button to cancel the operation.

Fig. 47 "Cancel" Button

9 FAQ

- **If the camera cannot be connected to computer,**

① Ensure that the Camera Link interface cable is OK.
② Ensure that Base and Medium configurations of the Camera Link interface are not reversed.
③ Ensure that the serial port channel parameters in the Camera Link interface are set correctly.

- **If the Camera Link interface cannot receive camera clock signal,**

① Ensure that the camera has started properly (i.e. the status indicator should be normally green).
② If a third-party Frame Grabber is used to acquire images, ensure that the Frame Grabber and supporting software are operating properly, which can be checked by restarting the computer.
③ Ensure that Base and Medium configurations of the Camera Link interface are not reversed.
④ Ensure that the Camera Link interface cable is OK.

- **If the camera has no image output in External Pulse mode,**

① Ensure that the external input pulse is normal.
② Ensure that the camera has received the trigger pulse correctly (it can be confirmed by the status indicator display).
③ If the Camera Link interface CC1 signal is used as the trigger input signal, ensure that the Frame Grabber is configured correctly.

- **If temperature of camera casing is abnormal,**

① Ensure that the voltage range of external connected power supply is normal.
② If the case is hot or the camera is smoking, cut off the power immediately and stop using the camera. Contact us for technical support..

- **If images are dark,**

① Ensure that the sensor aperture on the casing is not blocked.
② Ensure that the exposure time is set properly.

- **If the images are not clear,**

① Ensure that the sensor glass is clean.
② Ensure that the camera status indicator is normal.

- **If the camera cannot output images,**

① Check whether the Camera Link interface is normal by the test image.
② Check whether the power supply is normal by the camera indicator status.
③ Check whether the external pulse input is normal in the External Pulse mode by the camera indicator.

If users have any problems during the use of the camera, please contact our technical support in time, we will provide you with the service as soon as possible.