PR-CL Series Line Scan Camera User Manual

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Hefei I-TEK Optoelectronics Co., Ltd.

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

Revision History

Revision	Date	Description
0.1	2022/12/05	● Initial version
0.2	2023/02/22	● Add camera information ● Update company address
0.3	2023/05/04	● Add camera information ● Update parameter list
0.4	2023/06/08	● Add information of PR16KCL-17KC camera
0.5	2025/04/08	● Update LUT function to support models

Manufacturer Information

Hefei I-TEK Optoelectronics Co., LTD.

Tel.: +86-0551-65318597

Email: market@i-tek.cn

Website: www.i-tek.cn

Address: 3F, Building #J2, Phase II, Zhong'an Chuanggu Technology Park, Wangjiang West Road, High-tech Industry Development Zone, Hefei, Anhui

Zip Code: 230088

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 If there is 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. Please use a soft object dipped in a small amount of 70% alcohol to wipe it off.

- **Power Supply**

① The recommended voltage is +12~24V (±10%), and the current must be 2.0A.
② Hefei I-TEK Optoelectronics Co., LTD. does not provide external power supply. Users need to connect power supply by themselves.

- **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

- **Camera Product Model**

Abbreviation	Name	Description
Line Scan Camera:		
PA	Panther	Panther (Single line industrial line scan camera)
PL	Plasma	Plasma (Multi-line industrial line scan camera)
PH	Phoenix	Phoenix (TDI industrial line scan camera)
TPH	TEC-Phoenix	TEC-Phoenix (TEC-TDI industrial line scan camera)
PN	Pneuma	Pneuma (Basic industrial line scan camera)
PR	Prometheus	Prometheus (High resolution industrial line scan camera)
PU	PupMaya	PupMaya (High width industrial line scan camera)
PT	Ptepare	Ptepare (Special custom industrial line scan camera)
PM	Prism	Prism line scan camera
Area Scan Camera:		
TM	Taurus-Prism	Prism area scan camera
HS	Hercules	Hercules (CCD industrial area scan camera)
TS	Taurus	Taurus (CMOS industrial area scan camera)
THS	TEC-Hercules	TEC-Hercules (CCD TEC industrial area scan camera)
TTS	TEC-Taurus	TEC-Taurus (CMOS industrial area scan camera)
XS	XStream	XStream (Super high speed camera)

- **Interface Specification**

Abbreviation	Interface Type
GV	GigE Vision
CL	Camera Link
CXP/CXP10/CXP12	CoaXPress
U30	USB3.0
XGV	10 GigE Vision
PCIe	PCI-Express
SFP	Small Form Pluggable

- **Color Form**

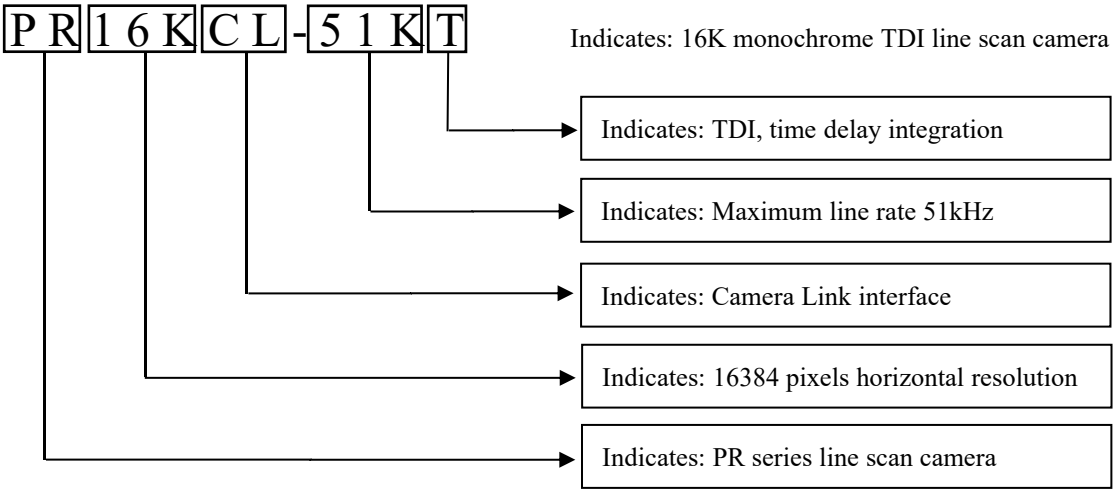
Abbreviation	Image Mode
M	Monochrome
C	Color
F	Full Color
T	Monochrome TDI (Time Delay Integration)
X	Time Division Camera
U	UV (Ultraviolet)
N	NIR (Near Infrared)

S	SWIR (Short Wave Infrared)
W	MWIR (Middle Wave Infrared)
L	LWIR (Long Wave Infrared)

- **Line Rate or Frame Rate**

Camera Type	Description
Line Scan Camera	Maximum line rate, e.g. 30kHz
Area Scan Camera	Maximum frame rate, e.g. 4000fps

e.g.



3 Product Appearance

Fig.1 Product Appearance

Note:

① The front and the side of the camera provide threaded holes for mounting camera.

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

4 Product Specifications

PR-CL series camera is designed for high-speed line scan applications in industrial automation inspection and is developed and manufactured by Hefei I-TEK Optoelectronics Co., LTD.. The camera integrates international leading high-speed linear array image sensor, large-scale field programmable logic gate array parallel processor, and outputs data through Camera Link interface. It also has features of high speed, high sensitivity and low noise.

4.1 Main Features

- Global Shutter CMOS Sensor
- Line Resolution 16384 Pixels
- Maximum Line Rate 51kHz
- High Sensitivity and Low Noise
- Rich Exposure Control Modes (External Trigger, Free-Run)
- Minimum Exposure Time: 3μs Exposure Time Step: 0.0125μs
- Data Format: 8/10bit
- User-configurable Scanning Direction
- Binning
- Flat Field Correction
- Spatial Correction
- Parallax Correction
- Digital Gain / Analog Gain / Offset Control
- White Balance
- LUT
- Real-time Temperature Monitoring

4.2 Camera Specifications

Table 1 PR16KCL-17KC Product Specifications

Model	PR16KCL-17KC
Product Description	16K color line scan camera
Resolution	16384 x 3
Pixel Size	5μm x 5μm
Sensor Type	Global shutter CMOS
Image Type	Color
Sensor Size	81.92mm
Dynamic Range	≥ 62.8dB
SNR	40.2dB
Data Rate	835MB/s
Analog Gain	X1/X2
Digital Gain	0.01~8
Digital Offset	-1023~1023

Lens Mount	M90 x 1
Max Line Rate	17.0kHz@3Tap, 10.2kHz@2Tap
Trigger Mode	Free Run, External Pulse, External PWM
Trigger Signal	Camera Link CC1
Exposure Control	External PWM, Timed
Exposure Time	2.2μs ~ 63997μs (step: 0.01μs)
Data Format	8/10bit
Operation Temperature	0~55°C
Data Interface	Camera Link
Power Supply	DC12~24V (±10%) 2.0A
Power Consumption	11.6W
Mechanical	99mm x 99mm x 73mm
Weight	831.1g

Table 2 PR16KCL-17KC2 Product Specifications

Model	**PR16KCL-17KC2**
Product Description	16K color TDI line scan camera
Resolution	16384 x 6
Pixel Size	5μm x 5μm
Sensor Type	Global shutter CMOS
Image Type	Color
Sensor Size	81.92mm
Dynamic Range	≥ 64.8dB
SNR	43.8dB
Data Rate	835MB/s
Analog Gain	X1/X2
Digital Gain	0.01~8
Digital Offset	-1023~1023
Lens Mount	M90 x 1
Max Line Rate	17.0kHz@8bit, 10.2kHz@10bit
Trigger Mode	Free Run, External Pulse, External PWM
Trigger Signal	Camera Link CC1
Exposure Control	External PWM, Timed
Exposure Time	3μs ~ 63997μs (step: 0.0125μs)
Data Format	8/10bit
Operation Temperature	0~55°C
Data Interface	Camera Link
Power Supply	DC12~24V (±10%) 2.0A

Power Consumption	12.0W
Mechanical	99mm x 99mm x 73mm
Weight	831.1g

Table 3 PR16KCL-51KT Product Specifications

Model	**PR16KCL-51KT**
Product Description	16K monochrome TDI line scan camera
Resolution	16384 x 2
Pixel Size	5μm x 5μm
Sensor Type	Global shutter CMOS
Image Type	Monochrome
Sensor Size	81.92mm
Dynamic Range	≥ 64.8dB
SNR	43.8dB
Data Rate	830MB/s
Analog Gain	X1/X2/X4
Digital Gain	0.01~8
Digital Offset	-1023~1023
Black Level	0~1023
Lens Mount	M90 x 1
Max Line Rate	51.0kHz@8bit, 40.8kHz@10bit
Trigger Mode	Free Run, External Pulse, External PWM
Trigger Signal	Camera Link CC1
Exposure Control	External PWM, Timed
Exposure Time	3μs ~ 63997μs (step: 0.0125μs)
Data Format	8/10bit
Operation Temperature	0~55°C
Data Interface	Camera Link
Power Supply	DC12~24V (±10%) 2.0A
Power Consumption	12.0W
Mechanical	99mm x 99mm x 73mm
Weight	831.1g

Table 4 PR16KCL-51KT4 Product Specifications

Model	**PR16KCL-51KT4**
Product Description	16K monochrome TDI line scan camera
Resolution	16384 x 4
Pixel Size	5μm x 5μm
Sensor Type	Global shutter CMOS

Image Type	Monochrome
Sensor Size	81.92mm
Dynamic Range	≥ 64.8dB
SNR	43.8dB
Data Rate	830MB/s
Analog Gain	X1/X2/X4
Digital Gain	0.01~8
Digital Offset	-1023~1023
Black Level	0~1023
Lens Mount	M90 x 1
Max Line Rate	51.0kHz@8bit, 40.8kHz@10bit
Trigger Mode	Free Run, External Pulse, External PWM
Trigger Signal	Camera Link CC1
Exposure Control	External PWM, Timed
Exposure Time	3μs ~ 63997μs (step: 0.0125μs)
Data Format	8/10bit
Operation Temperature	0~55°C
Data Interface	Camera Link
Power Supply	DC12~24V (±10%) 2.0A
Power Consumption	12.7W
Mechanical	99mm x 99mm x 73mm
Weight	831.1g

4.3 Camera Block Diagram

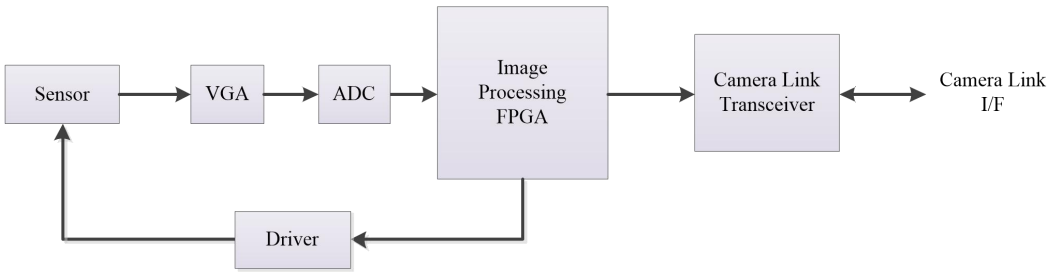


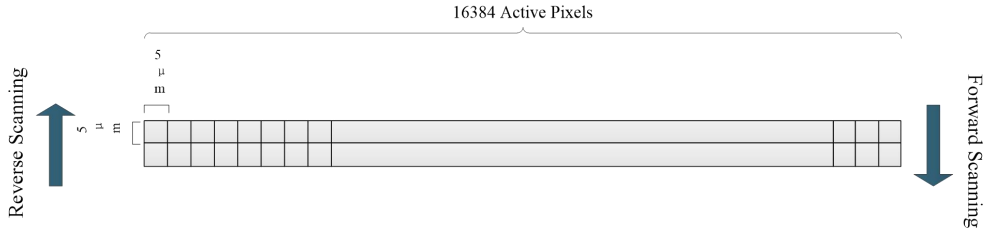
Fig.2 Internal Implementation Structure of Camera

PR-CL series camera is designed based on high-speed line scan image sensor. The pixel array is uniformly sampled and maintained by global shutter control system, and converted from analog front end to digital signal. After relevant algorithm processing by FPGA, it is transmitted to PC frame grabber through Camera Link interface. The camera can accept external signal trigger acquisition, and the source is CC1 signal from Camera Link interface.

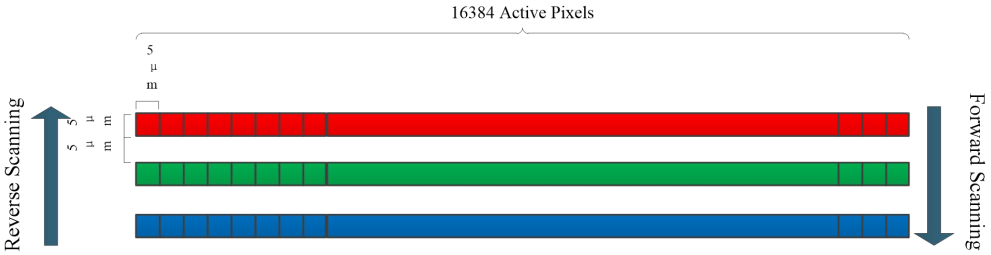
The camera has embedded image processing algorithms including flat field correction and flip, which are realized in real time in FPGA.

4.4 Pixel Arrangements

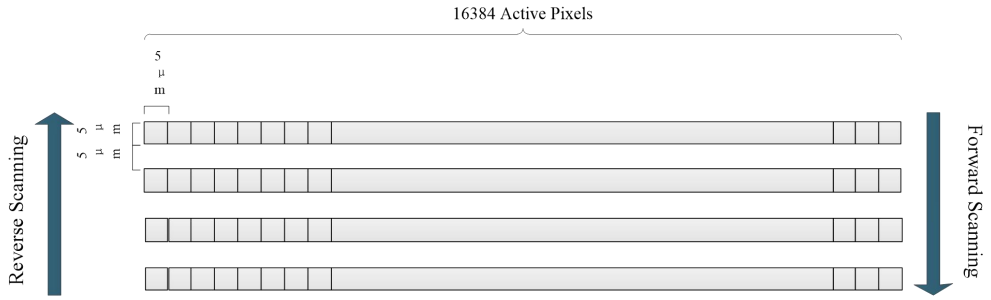
Different types of PR-CL series camera has different line counts. Depending on line counts, pixels of camera are arranged in different ways. Here introduces pixel arrangements of multi-line cameras, as shown in the figure below.



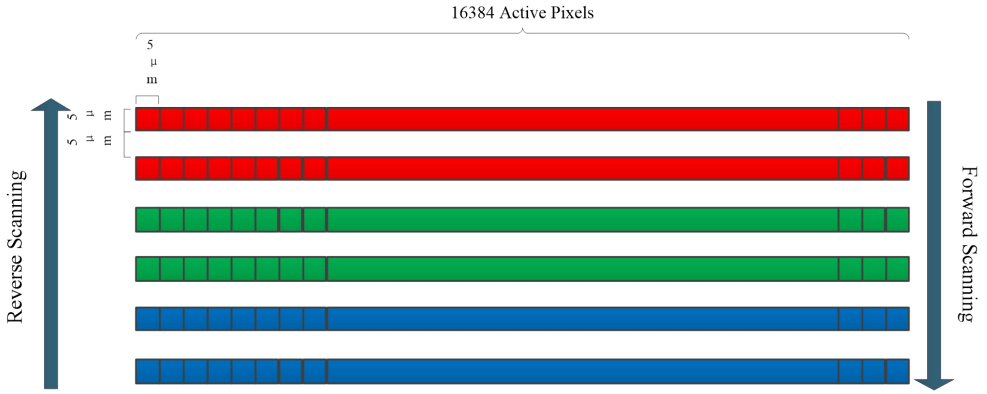
(a) 16K Double-Line Monochrome



(b) 16K Triple-Line Color



(c) 16K Four-Line Monochrome



(d) 16K Six-Line Color

Fig.3 Pixel Arrangements

4.5 Spectral Response

The following is spectral response curve of PR-CL series camera.

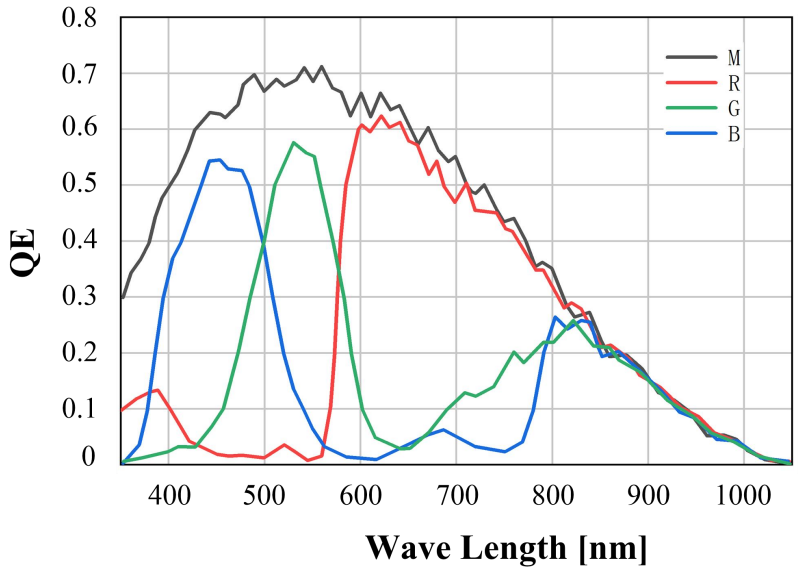


Fig.4 Spectral Response Curve of Camera

4.6 Environmental Requirements

(1) Operating temperature: 0℃~55℃, humidity: 10% ~ 80%; Storage temperature: -20℃~75℃.

(2) The sensor in the camera has dust proof sealing setting, which can effectively prevent dust from entering sensor surface. If lens cap is open, dust may enter. Therefore, tighten the lens cap when the camera is not in use.

4.7 RoHS Certification

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

5 Mechanical Dimensions and Interfaces

5.1 Mechanical Dimensions

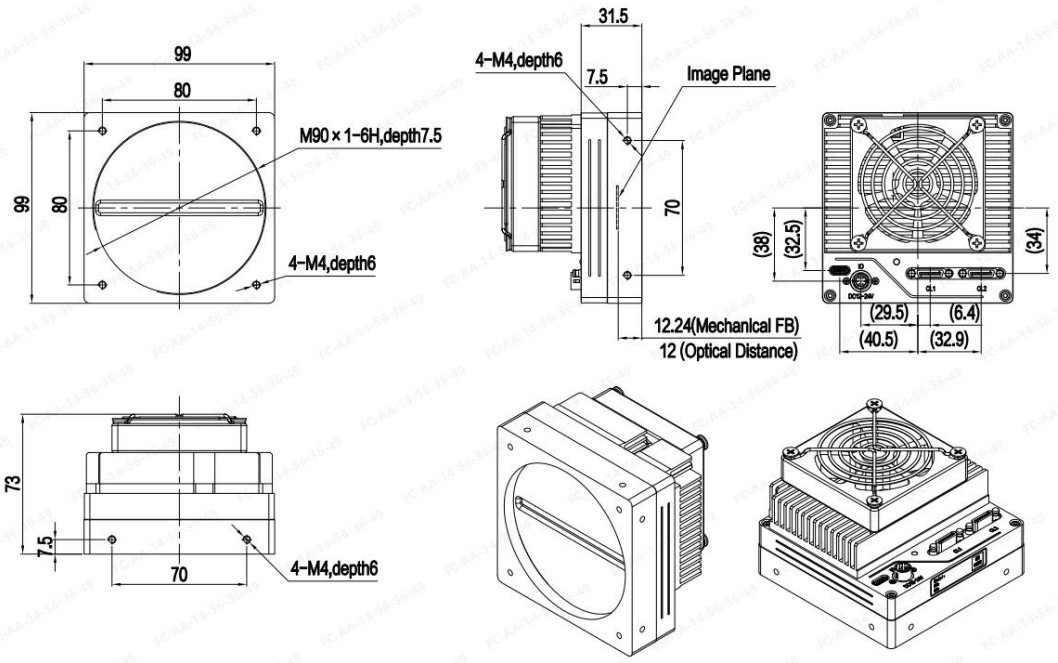


Fig.5 Camera Mechanical Dimensions

5.2 Camera Interface

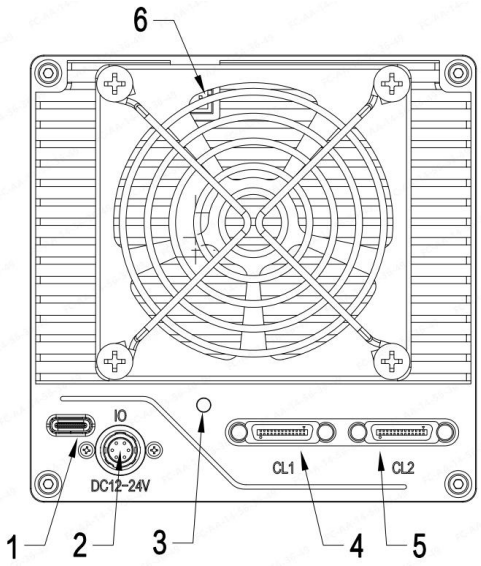


Fig.6 External Interfaces of Camera

（1）Type-C Interface
（2）6-pin Power Input
（3）Camera Status Indicator
（4）Camera Link Interface 1(Base)
（5）Camera Link Interface 2 (Medium / Full / Full+)

（6）Fan Power Interface

5.2.1 Camera Status Indicator

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

Table 5 Camera Status Indicator

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 Interface

The power input interface 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:

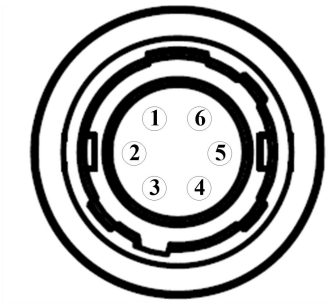


Fig.7 Pin Assignments for Power Interface

Table 6 Power Interface Pin Definition

Signal	Pin	Signal	Pin
VCC	1	Reserved	4
VCC	2	GND	5
Reserved	3	GND	6

5.2.3 Data Interface

PR-CL series camera uses Mini Camera Link connector as data output interface. Mini Camera Link connector is an industry standard interface. The signal definition is as follows:

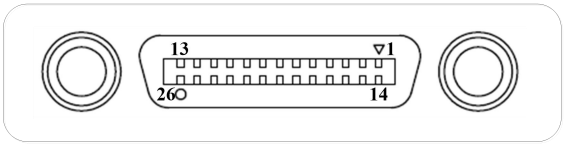


Fig. 8 Mini Camera Link Connector

Table 7 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 8 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/Full/Full+ interface (CL2) must be correctly connected to their respective interfaces on the Frame Grabber according to the instructions on the back of the camera.

The corresponding relationship between signals and ports in each output mode is shown in the following table:

Table 9 Port Assignments (2tap @ 8/10bit)

	8bit	10bit
	2tap/8bit	2tap/10bit
Port A0	A0	A0
Port A1	A1	A1
Port A2	A2	A2
Port A3	A3	A3
Port A4	A4	A4
Port A5	A5	A5
Port A6	A6	A6
Port A7	A7	A7
Port B0	B0	A8
Port B1	B1	A9
Port B2	B2	-
Port B3	B3	-
Port B4	B4	B8
Port B5	B5	B9
Port B6	B6	-
Port B7	B7	-
Port C0	-	B0
Port C1	-	B1
Port C2	-	B2
Port C3	-	B3
Port C4	-	B4
Port C5	-	B5
Port C6	-	B6
Port C7	-	B7

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

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

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

Table 11 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 12 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

6 Camera Features

This chapter introduces the main features of PR-CL series camera.

6.1 Trigger Mode

PR-CL series camera supports three trigger modes: Free-Run, External Pulse and External PWM.

6.1.1 Free-Run Mode

In Free-Run control mode, camera's internal logic automatically generates camera control timing, so that the camera can produce normal image output without external trigger signal.

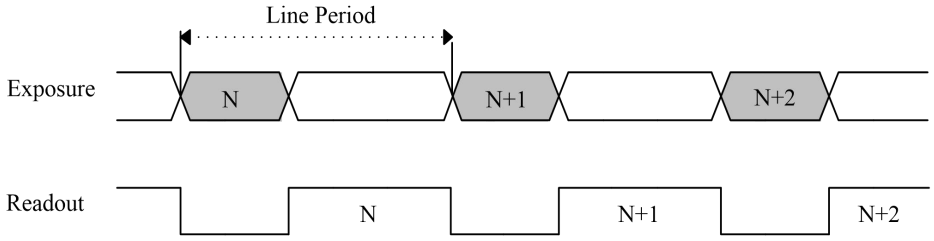


Fig. 9 Free-Run Mode

In Free-Run mode, both exposure time and line period can be set through commands. It should be noted that line period should be not less than the readout time of one line, and should be greater than the sum of the exposure time and the minimum exposure interval. The camera operation timing is shown in the figure above.

6.1.2 External Pulse Mode

In External Pulse mode, camera starts exposure on the rising edge of external trigger signal, and exposure time is configured by writing registers. At this time, frame rate is determined by interval between the rising edges of external trigger pulse.

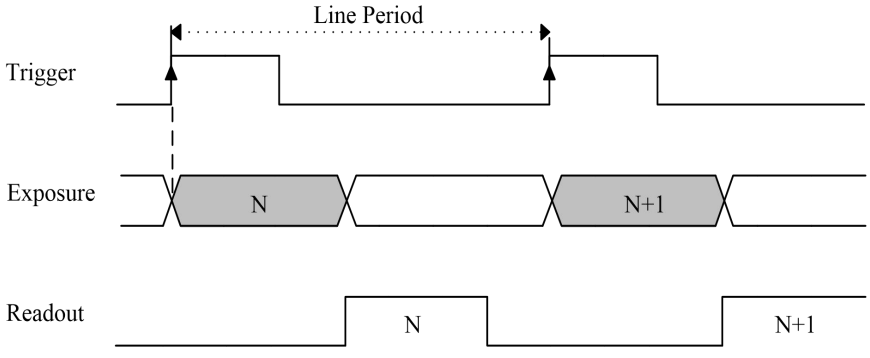


Fig. 10 External Pulse Trigger Mode

In order to obtain a higher frame rate, a new trigger pulse can be initiated to start the next exposure when the camera is reading current frame. Since the reading phase of the previous and next frames

must not conflict with each other, the external trigger with a frame period of less than one-frame readout time will be automatically ignored by the camera, which is shown in the figure below.

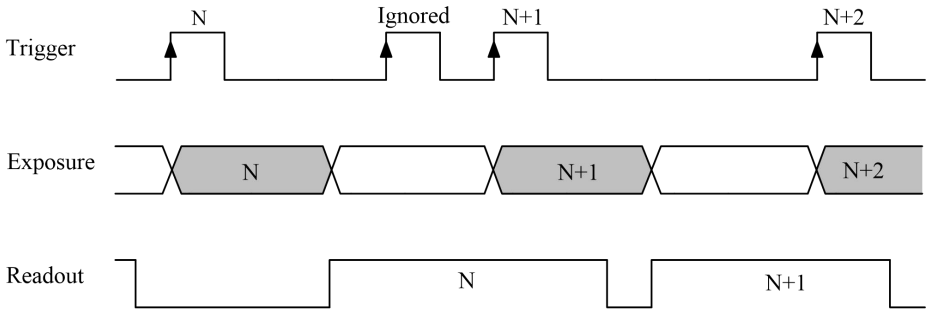


Fig. 11 External Trigger Interval is Too Short

6.1.3 External PWM Mode

In this mode, exposure starts on the rising edge of external trigger, and ends on the falling edge, so the exposure time is equal to the high-level duration of the external trigger, and the frame period is equal to the pulse interval.

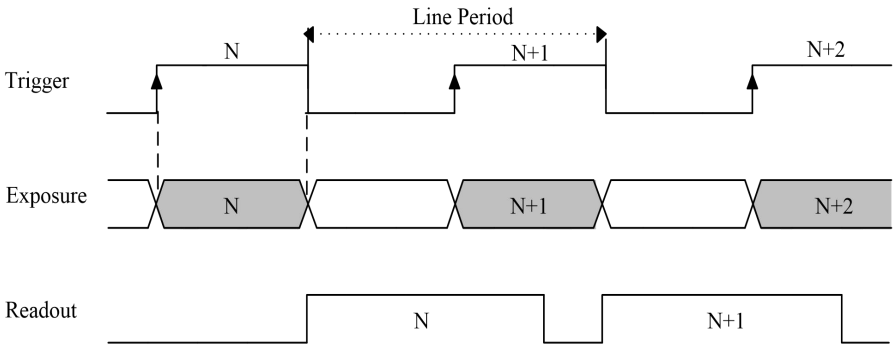


Fig. 12 External PWM Trigger Mode

In this mode, external trigger high level should ensure a time greater than the minimum exposure time. For pulses lower than this width, camera will treat them as the minimum exposure time.

In this mode, exposure interval must meet the minimum exposure time, so it should last more than the minimum exposure time between falling edge of this external trigger and rising edge of the next external trigger.

If external trigger interval is too short, it will lead to a conflict between readout time of two frames before and after camera. The pulse which does not meet requirements will be ignored inside camera, so that camera can maintain normal operation, as shown in the figure below. The interval between adjacent falling edges should be greater than readout time of each frame.

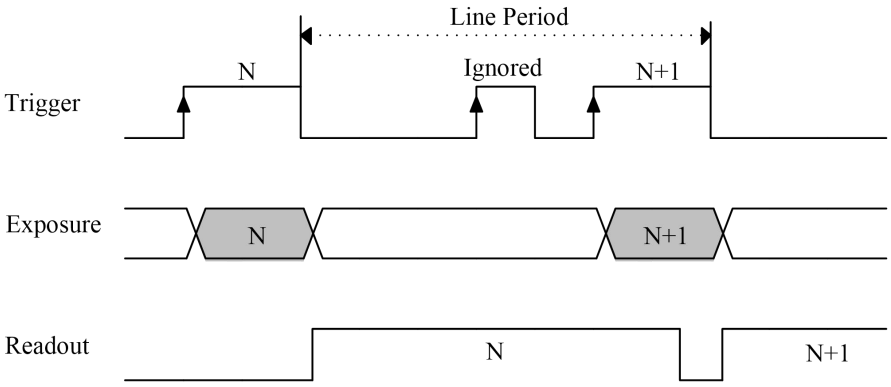


Fig. 13 External Trigger Interval is Too Short

6.2 Camera Scanning Direction

The scanning direction of PR-CL series camera is divided into horizontal scanning direction and vertical scanning direction, as shown in the figure below:

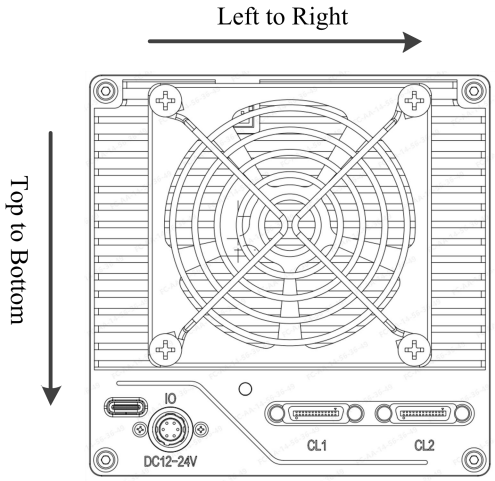
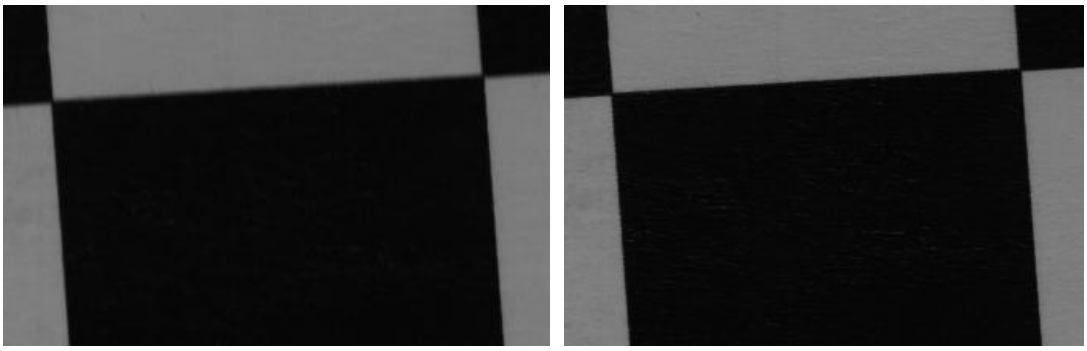


Fig.14 Camera Scanning Direction

The horizontal scanning direction can be left to right or right to left.

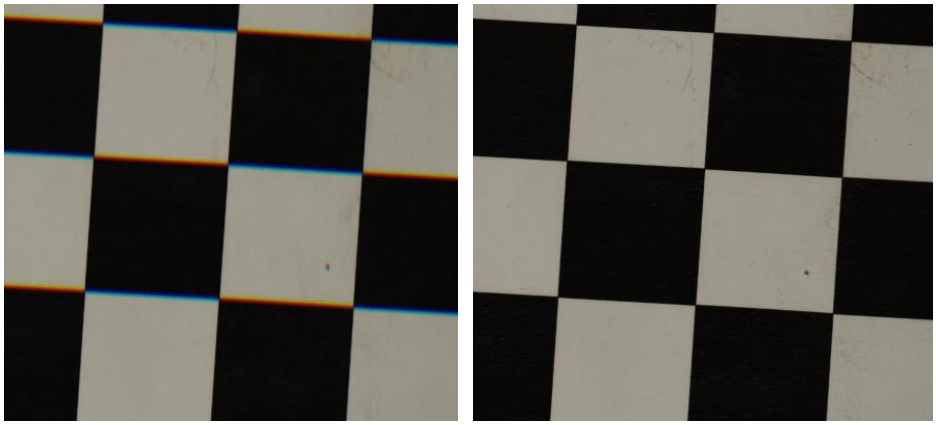
The vertical direction supports the output of images from top to bottom or bottom to top. The direction can be controlled internally by camera or externally by CC3 signal.

Note: For monochrome camera, when camera is set to multi line mode and motion direction does not match, image edge will be blurred. When camera is set to single line mode, sharpness is not affected by scanning direction. For color camera, when vertical scanning direction does not match the direction of the object's movement, it will cause image edge dispersion.



(a) Multi Line Mode and Motion Direction does not Match (b) Multi Line Mode and Motion Direction Matches

Fig.15 Vertical Scanning Direction of Monochrome Camera



(a) Motion Direction does not Match (b) Motion Direction Matches

Fig.16 Vertical Scanning Direction of Color Camera

6.3 Horizontal Binning

PR-CL series camera horizontal binning supports two pixels binning. After normal exposure acquisition, camera sums up values of two adjacent pixels and outputs them as a single pixel value. With binning feature, SNR can be improved by about 1.4 times and the number of effective pixels in a frame can be reduced by half.

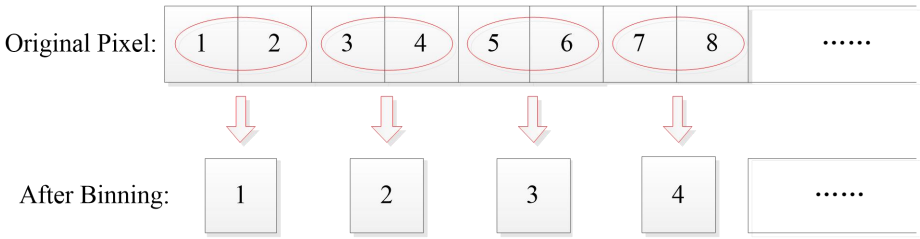
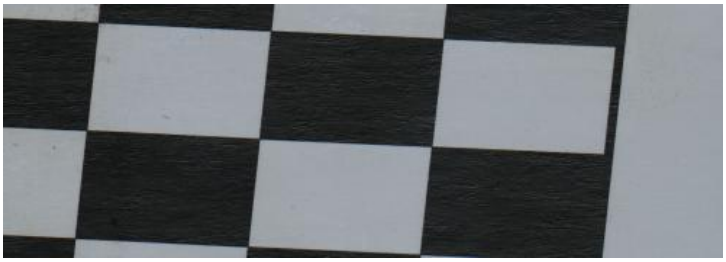


Fig.17 Horizontal Binning_2x1

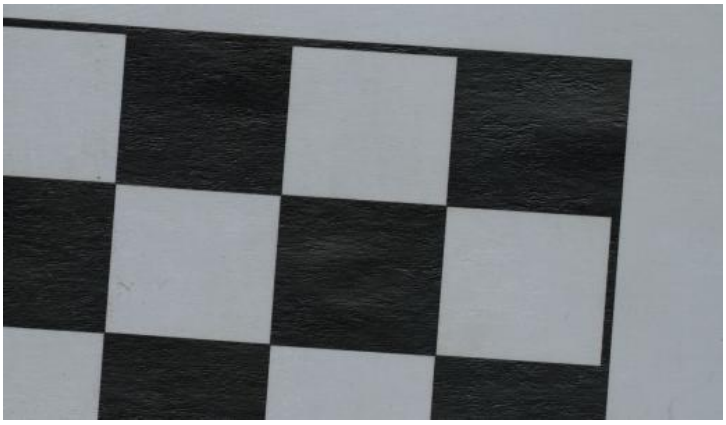
6.4 Spatial Correction

When horizontal and vertical magnification of camera are the same, a square object should remain square after being photographed. However, in actual situation, external trigger signal cannot be completely transformed to the most accurate proportion in most cases, a little error will lead to square being stretched or compressed, object in the same position cannot be superimposed to the same pixel,

and edge transition is shown as artifacts. The spatial correction function compensates camera acquisition speed proportionally according to received line signal, which can ensure that a square object should remain square after being photographed as an image.



(a) Before Spatial Correction

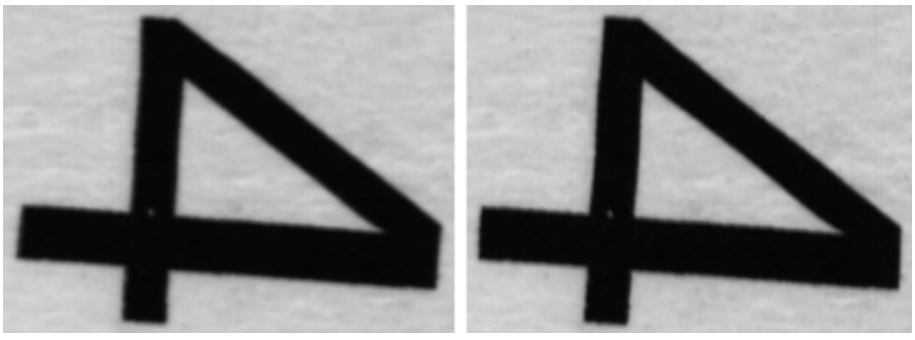


(b) After Spatial Correction

Fig. 18 Spatial Correction Effect

6.5 Parallax Correction

When camera has a large inclination angle with horizontal plane in the direction of object motion, actual optical magnification is different due to the difference of sensor position, which leads to edge blurring at the left and right ends of image. Parallax correction solves the problem of blurred edges by different horizontal stretching so that the left and right ends of image can be aligned.

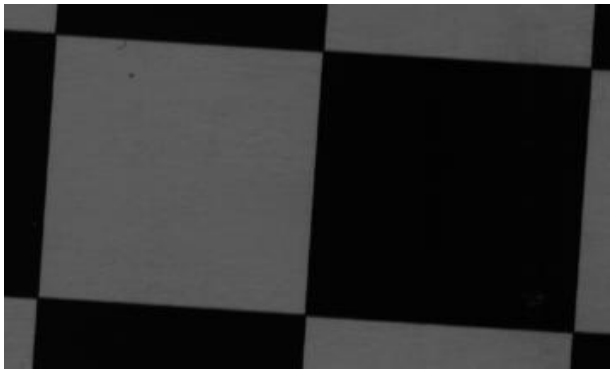


(a) Before Parallax Correction (b) After Parallax Correction

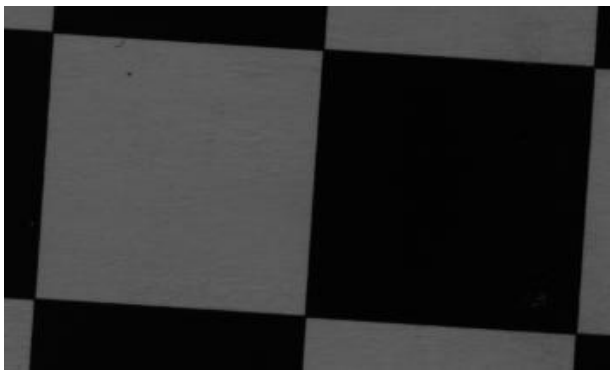
Fig. 19 Parallax Correction Effect

6.6 Time Delay Integration

For camera adopts multi line sensor, two adjacent exposures can make two lines of pixels in the same position, and the response of pixels can be increased by adding their values, while SNR of images can be improved. In order to make two adjacent lines of pixels in the same position, the image length to width ratio should be 1:1, and the vertical scanning direction should be set correctly, otherwise the image edge will be blurred.



(a) Edge Blur



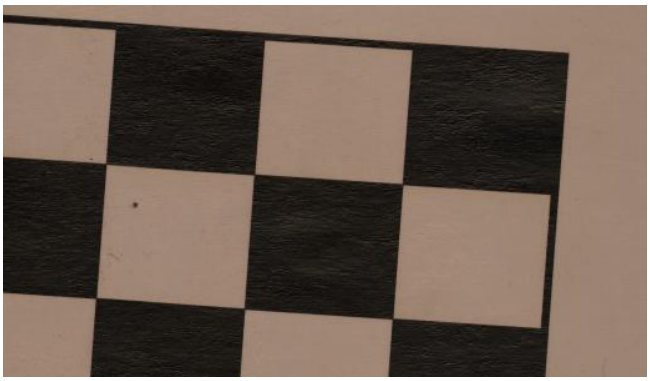
(b) Edge Clear

Fig.20 Time Delay Integration Effect

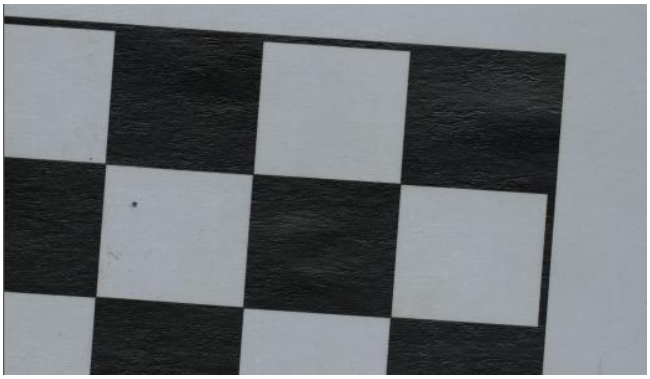
6.7 White Balance

White balance is an important parameter of color industrial camera, which directly affects color effect of reconstructed image. When white balance of industrial camera is not properly set, reconstructed image will appear color deviation phenomenon. Ideally, white objects should remain white after being photographed by color camera. However, due to inconsistent response of light source band and sensor RGB channel, image obtained by shooting white objects is generally not completely white. White balance correction redefines white by adjusting compensation coefficient of each RGB channel. When a change in external lighting or in optics causes a white object not to be white, users need to perform white balance function.

Color camera internally provides white balance function, which balances output values of each channel of sensor. Automatic white balance calculates white balance coefficient by sampling local pixels in sensor, and then adjusts each component of image according to coefficient, so that values of Red, Green and Blue components in output image are consistent.



(a) Before White Balance



(b) After White Balance

Fig.21 White Balance Effect

6.8 Test Image

PR-CL series camera provides two test images. Unlike images acquired from sensor data, test images are pre-edited and stored inside the camera as a fixed style. Test images can be used to test whether the data link works well.

The camera provides the following test images shown in the figure below:

- Vertical test image: Fixed image with gray gradient in horizontal direction.
- Horizontal test image: Scroll image with gray gradient in the vertical direction.

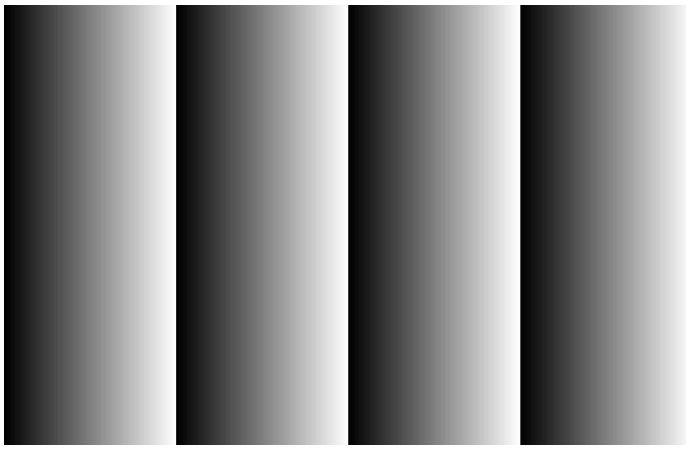


Fig.22 Vertical Test Image

Fig.23 Horizontal Test Image

6.9 Data Format

PR-CL series camera provides 8bit and 10bit pixel data bit widths. If it is 8bit width, it is equivalent to intercept the upper 8 bits of 10bit data.

Fig.24 Data Format

6.10 Camera Link Output Mode

Data of PR-CL series camera outputs from Camera Link interface. The camera supports Base, Medium, Full and Full+ modes. Their tap arrangement are as follows:

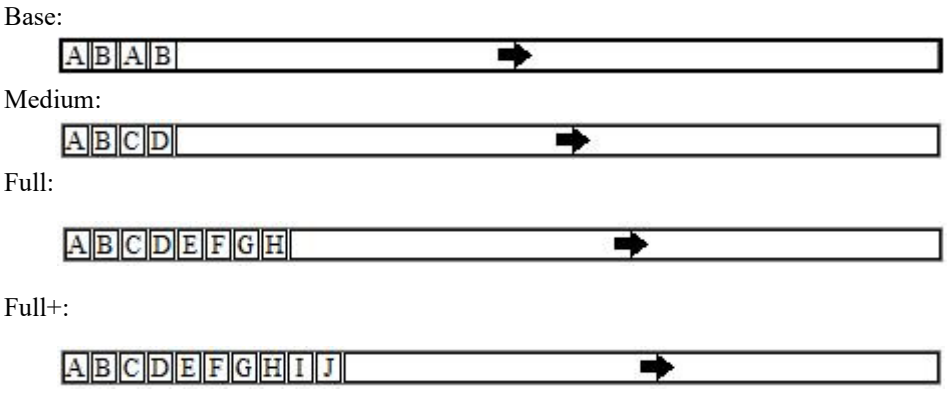


Fig. 25 Camera Link Output Mode

6.11 Gain and Offset

Camera gain is divided into the analog gain and digital gain.

Analog gain acts on analog signal. By increasing analog gain, a stronger response can be generally obtained under weak illumination, thus realizing a higher signal-to-noise ratio.

Digital gain amplifies or reduces data after photoelectric conversion signal passes through AD. It is usually used to increase dynamic range of output image. Digital gain can also be used to adjust brightness of image. Digital offset is often used to adjust overall background brightness of image.

The effect of digital gain can be summarized by the following equation:

Data value (Output) = Data value (digital gain=1 & digital offset=0) * Digital gain value

The effect of digital offset can be summarized by the following equation (Data values less than 0 will be output as 0) :

Data value (Output) = Data value (digital offset=0) + Digital offset value

Digital offset is set for 10 bit of data. If image data is 8bit, actual digital offset is divided by 4.

6.12 LUT

At present, PR16KCL-17KC and PR16KCL-17KC2 support LUT function. LUT uses a look-up table with 10-bit input and 10-bit output to map and convert the values of the original image. Users can use this function to implement gamma correction. The camera has a factory default look-up table and 2 user-configured look-up tables space.

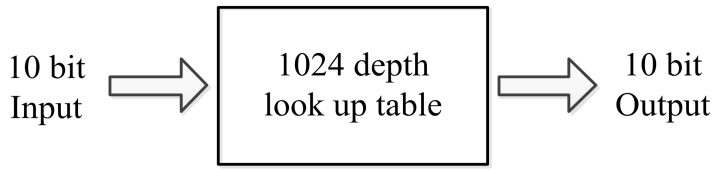


Fig. 26 LUT Structure

The LUT mapping curve for Gamma=0.5 is shown below:

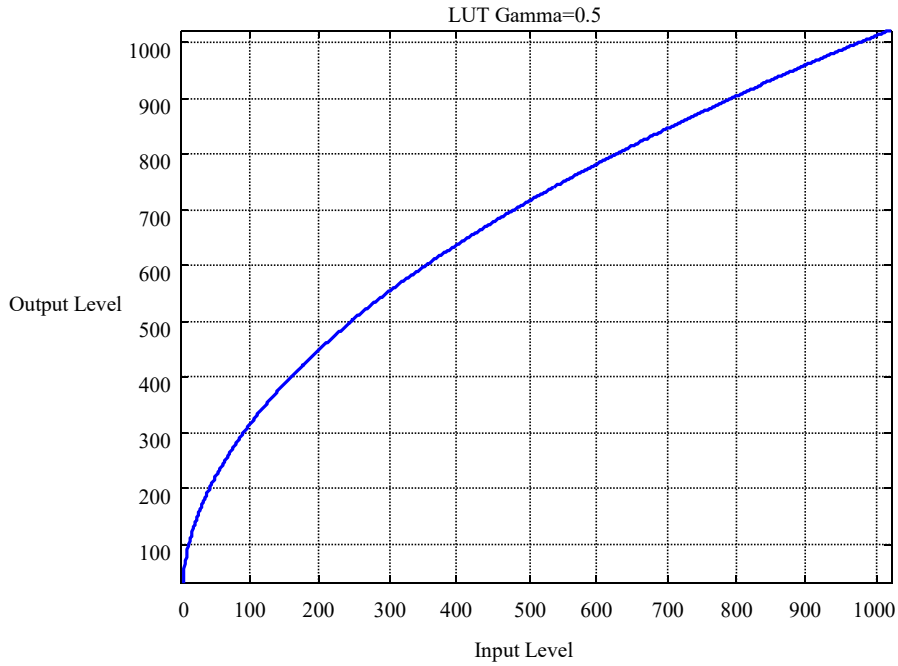


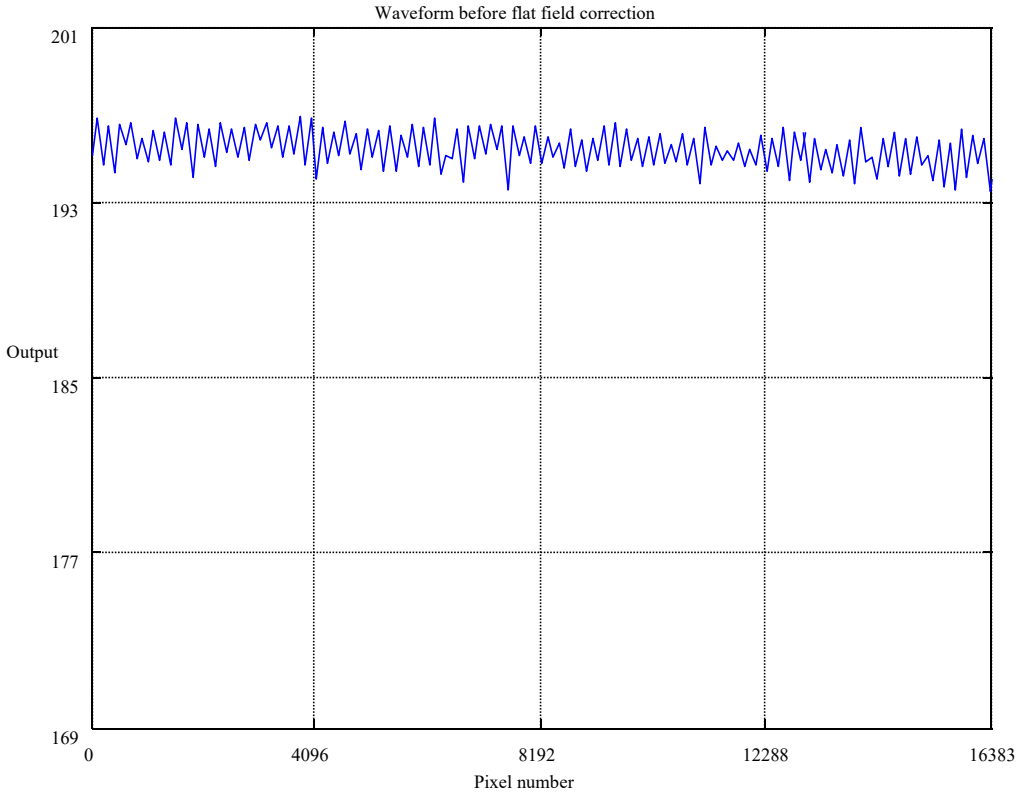
Fig. 27 LUT Gamma = 0.5

6.13 Flat Field Correction

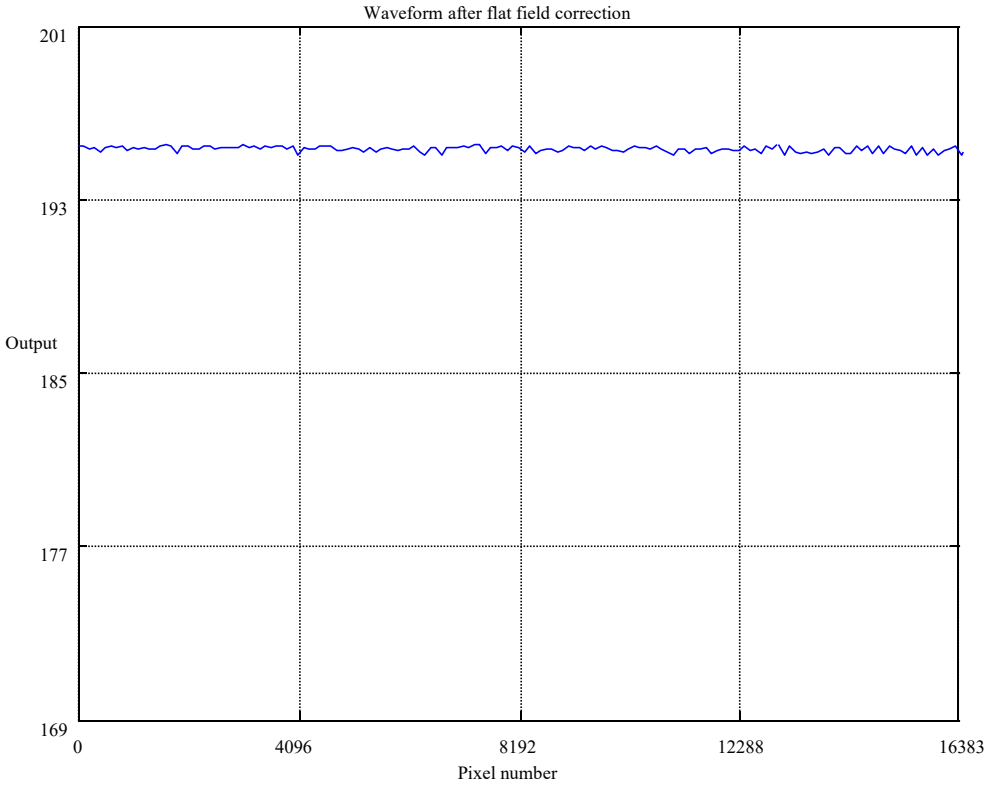
Due to inconsistency of semiconductor technology, response of each pixel of array image sensor is different to some extent, which is reflected in the difference of output data for the same brightness signal. PR-CL series camera internal provides flat field correction function, users can use to achieve flat field effect through the uniform intensity target signal correction parameters.

Ideally, when camera imitates a uniform target, gray value of all pixels in resulting image should theoretically be the same. However, values of each pixel in image often vary considerably. These differences may result from uneven illumination, inconsistent light transmittance between lens center and lens edge, and inconsistent response of camera sensor pixels. The difference of sensor pixel response has been corrected before delivery. In general, it is mainly to correct dark brightness between two sides of image caused by lens. The camera calculates correction parameters of each pixel and stores them in camera for image correction. In some cases, lens and lighting conditions are better and better images can be obtained without flat field correction.

Flat field correction effect is shown in the figure below:



(a) Before Flat Field Correction



(b) After Flat Field Correction

Fig.28 Waveform of Flat Field Correction

6.14 Camera Temperature

PR-CL series camera supports real-time temperature acquisition of camera. Users can read temperature of camera to monitor working status of the sensor.

The recommended environment temperature range of the camera is 0℃~40℃, and internal working temperature range is 0℃~55℃. If users detect an abnormal temperature (such as over 65℃), it is recommended to stop the camera immediately and contact our technical support.

6.15 Load / Save Configuration

PR-CL series camera supports three working parameter sets, including one factory default parameter set and two user parameter sets. Factory default parameter set can be used in most occasions. Users can also configure parameters based on actual requirements and save in user parameter set for self-loading after power on. The camera will automatically load the last saved parameter set each time.

Due to the correlation between parameters of camera, if camera does not work properly after modifying parameters, users can restore the factory default parameter set, and then reset parameters and save settings.

7 Camera Control

PR-CL series camera supports users to send control commands to the camera through the serial channel of Camera Link interface, and configure the camera working mode.

7.1 Serial Port Parameters

Table 13 Serial Port Parameter

Serial Port Parameter	Value
Baud Rate	115200
Data Bit	8
Parity Bit	N/A
Stop Bit	1
Flow Control	N/A

7.2 Command Format

The commands received by the camera have the following two formats depending on whether the command has parameter:

- **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]

Output: >Ok[CR]

- **Format 2**

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

For example, input: list[CR]

Output: >[MEM][CR]>Ok[CR]

- **Format 3**

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

For example, input: clnk[CR]

Output: >[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 in stead 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 PR-CL series camera is as follows. After connecting the camera through serial port, you can input relevant commands to configure the camera. The introduction of camera commands is as follows.

Table 15 Camera Instruction List

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	
SYNC	SYNC=0/1/2 (Set Command)	Set Synchronization Mode (0/1/2: Free Run/External Pulse/External PWM)	
	SYNC (Get Command)	0	Free Run
		1	External Pulse
		2	External PWM
CLNK	CLNK=0/1/2/3/4/5/6 (Set Command)	Set Camera Link Mode (0 to 6: 2tap@8bit / 4tap@8bit / 8tap@8bit / 10tap@8bit / 2tap@10bit / 4tap@10bit / 8tap@10bit)	
	CLNK (Get Command)	0	2tap@8bit
		1	4tap@8bit
		2	8tap@8bit
		3	10tap@8bit
		4	2tap@10bit
		5	4tap@10bit

		6	8tap@10bit
TPRD	TPRD=[10,64000] (Set Command)	Set Line Period Time in microsecond (10us to 64000us)	
	TPRD (Get Command)	Get the Current Value	
LRPS	LRPS=[15.625,100000] (Set Command)	Set LineRate (15.625000 to 100000.000000)	
	LRPS (Get Command)	Get the Current Value	
TEXP	TEXP=[2.125, 64000] (Set Command)	Set Exposure Time in microsecond (2.125000us to 64000.000000us)	
	TEXP (Get Command)	Get the Current Value	
DMOD	DMOD=0/1/2/3 (Set Command)	Set Data Mode (0/1/2/3: Original/Corrected/Test Pattern1/Test Pattern2)	
	DMOD (Get Command)	0	Original
		1	Corrected
		2	Test Pattern1
		3	Test Pattern2
HDIR	HDIR=0/1 (Set Command)	Set Horizontal Scan Direction (0/1: Left to Right/Right to Left)	
	HDIR (Get Command)	0	Left to Right
		1	Right to Left
BINN	BINN=0/1 (Set Command)	Set Horizontal Binning Mode (0/1: 1x1/2x1)	
	BINN (Get Command)	0	1x1
		1	2x1
SDWM	SDWM=0/1 (Set Command)	Set the scan direction working mode(0/1: Internal Control/External Control)	
	SDWM (Get Command)	0	Internal Control
		1	External Control
SDIT	SDIT=0/1 (Set Command)	Set the scan direction internal control type (0/1: BottomToTop / TopToBottom)	
	SDIT (Get Command)	0	BottomToTop
		1	TopToBottom
SDRV	SDRV=0/1 (Set Command)	Set the scan direction signal polarity (0/1: Original/Reverse)	
	SDRV (Get Command)	0	Original
		1	Reverse
DIGN	DIGN=[0.01,8] (Set Command)	Set Digital Gain (x0.01 to x8)	
	DIGN (Get Command)	Get the Current Value	
DIOS	DIOS=[-1023,1023] (Set Command)	Set Digital Offset (-1023 to 1023)	
	DIOS (Get Command)	Get the Current Value	
FFCL	FFCL=2,0/1	Flat Field Calibration (line(bit0..2 for line1/line2/line3),0/1 (Init/Exec))	
FFCR	FFCR=0/1 (Set Command)	Flat Field Correction (0/1 Disable/Enable)	
	FFCR (Get Command)	0	Disable

		1	Enable
FFCM	FFCM=0/1 (Set Command)	Set Flat Field Calibration Mode (0/1: Disable/Enable Calibration Reference)	
	FFCM (Get Command)	0	Disable Calibration Reference
		1	Enable Calibration Reference
FFCS	FFCS=[0,16384]	Set Flat Field Calibration Start Position (0~16384 Multiples of 16)	
	FFCS	Get the Current Value	
FFCW	FFCW=[16,16384]	Set Flat Field Calibration Width (16~16384 Multiples of 16)	
	FFCW	Get the Current Value	
REFM	REFM=[128,4095]	Set Flat Field Data Reference (128 to 4095)	
	REFM	Get the Current Value	
SROI	SROI=0/1 (Set Command)	Set Region of Interest (0/1: Disable/Enable)	
	SROI (Get Command)	0	Disable
		1	Enable
RICS	RICS=[0,16384] (Set Command)	Set ROI Start Column (0~16384 Multiples of 16)	
	RICS (Get Command)	Get the Current Value	
RICC	RICC=[128,16384] (Set Command)	Set ROI Column Count (128~16384 Multiples of 128)	
	RICC (Get Command)	Get the Current Value	
LSCR	LSCR=0/1 (Set Command)	Set Line Spatial Correction Mode (0/1: Disable/Enable)	
	LSCR (Get Command)	0	Disable
		1	Enable
LSCF	LSCF=[0.5, 2.0] (Set Command)	Set Line Spatial Correction Factor (0.5 to 2.0)	
	LSCF (Get Command)	Get the Current Value	
LDLY	LDLY=[-1.0, 1.0] (Set Command)	Set Line Delay to Correct Chromatic Aberration (-1.0 to 1.0)	
	LDLY (Get Command)	Get the Current Value	
ANGN	ANGN=1/2/4 (Set Command)	Set Analog Gain (1/2: x1/x2)	
	ANGN (Get Command)	Get the Current Value	
		1	x1
		2	x2
		4	x4
DOFF	DOFF=[0,1023] (Set Command)	Set Black Level (0 to 1023)	
	DOFF (Get Command)	Get the Current Value	
HMOD	HMOD=[0,1] (Set Command)	Set high speed mode (0~1)	
	HMOD (Get Command)	Get the Current Value	
BAUD	BAUD=[4800,460800] (Set Command)	Set Camera Link Serial Port Baudrate 4800~460800	
	BAUD (Get Command)	Get the Current Value	

8 Camera Configure

Hefei I-TEK Optoelectronics Co., LTD. has implemented a library IKapC.lib for camera configuration based on Gen< I >Cam standard, which allows users to use all Hefei I-TEK Optoelectronics Co., LTD. cameras based on IKapC.lib without re-writing codes for each camera. For more information about IKapC.lib, please refer to IKapC user manual.

Hefei I-TEK Optoelectronics Co., LTD. provides visual camera feature configuration tool IKapCViewer.exe. The following shows how to configure the supported camera features. For more information about IKapCViewer.exe, please refer to IKapCViewer user manual.

8.1 Basic Information Category

Basic information, such as camera model, serial number and sensor temperature, is grouped into basic information category, and the application can determine the current camera model by obtaining these features. In the following figure, the gray font indicates that it is currently read-only, and the black font indicates that it can be modified by users.

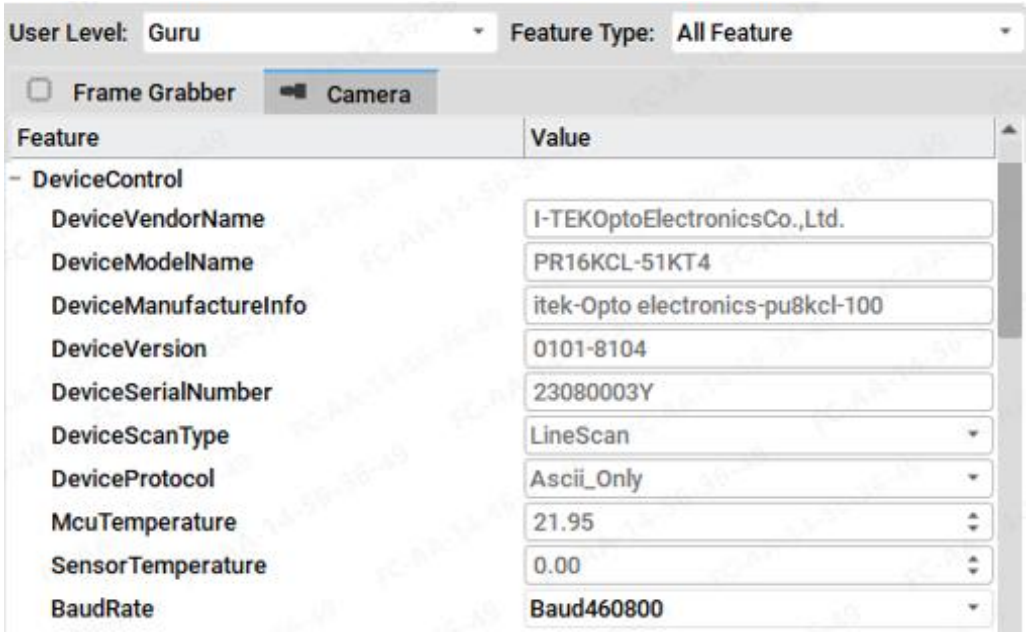


Fig.29 Basic Information Category

The following table describes types of features covered by camera basic information category as well as the specific description and access attributes of features. Different camera versions may support different list of features.

Table 16 Basic Information Category List

Feature Name	Feature Description	Camera Version & Visibility
DeviceVendorName	Vendor name (RO)	0101-8104 Beginner

DeviceModelName	Module name (RO)	0101-8104 Beginner
DeviceManufacturerInfo	Manufacturer information (RO)	0101-8104 Beginner
DeviceVersion	Current camera version (RO)	0101-8104 Beginner
DeviceSerialNumber	Camera serial number (RO)	0101-8104 Beginner
DeviceScanType	Camera scan type (RO)	0101-8104 Beginner
DeviceProtocol	Camera protocol (RO)	0101-8104 Beginner
MCUTemperature	MCU temperature (RO)	0101-8104 Beginner
SensorTemperature	Sensor temperature (RO)	0101-8104 Beginner
DeviceSerialPortBaudRate **Baud9600** **Baud19200** **Baud38400** **Baud57600** **Baud115200** **Baud230400** **Baud460800**	Serial port baud rate Baud9600 Baud19200 Baud38400 Baud57600 Baud115200 Baud230400 Baud460800	0101-8104 Expert

8.2 Image Attribute Category

The type of image output by camera, such as width, height and pixel format are all attributed to image attribute category. Applications can change output image format by modifying these features. In the following figure, the gray font indicates that it is currently read-only, and the black font indicates that it can be modified by users.

PR-CL series camera has a maximum image width of 16384 pixels, which supports ROI and “Binning”. Users can select camera output mode from “Video Mode” drop-down box.

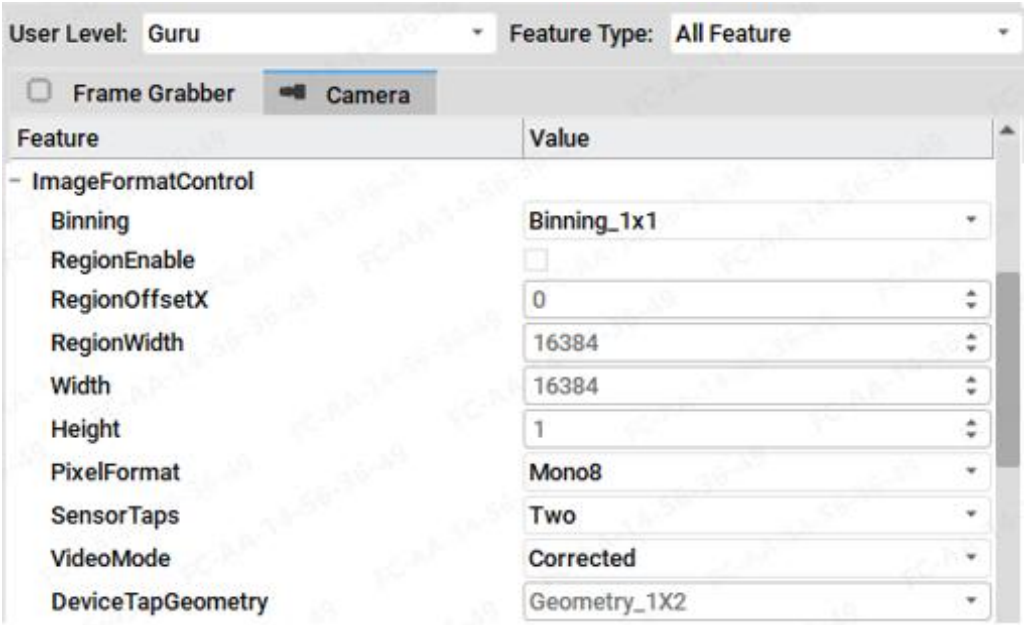


Fig.30 Image Attribute Category

The following table describes types of features covered by camera image attribute category and the specific description and access attributes of features. Different camera versions may support different list of features.

Table 17 Image Attribute Category List

Feature Name	Feature Description	Camera Version & Visibility
Binning **Binning_1x1** **Binning_2x1**	Horizontal binning Binning_1x1 Binning_2x1	0101-8104 Expert
RegionEnable	Enable region of interest	0101-8104 Beginner
RegionOffsetX	ROI horizontal offset value	0101-8104 Beginner
RegionWidth	ROI width	0101-8104 Beginner
Width	Camera output image width (RO)	0101-8104 Beginner
Height	Camera output image height (RO)	0101-8104 Beginner
PixelFormat **Mono8** **Mono10**	Pixel format Mono8 Mono10	0101-8104 Beginner
SensorTaps **Two** **Four** **Eight**	Number of sensor taps 2 4 8	0101-8104 Beginner

Ten	10	
VideoMode **Original** **Corrected** **TestPattern1** **TestPattern2**	Output image type Original Corrected TestPattern1 TestPattern2	0101-8104 Beginner
DeviceTapGeometry	Camera output Tap mode (RO)	0101-8104 Beginner

8.3 Image Acquisition Category

Parameters involved in camera image acquisition, such as line rate, exposure mode and exposure time are summed up in image acquisition category, and the application can change the mode of image acquisition by modifying these features. In the following figure, the gray font indicates that it is currently read-only, and the black font indicates that it can be modified by users.

PR-CL series camera supports three trigger modes, for more details please see Section 6.1. Users can set appropriate exposure mode in “SynchronizationMode”.

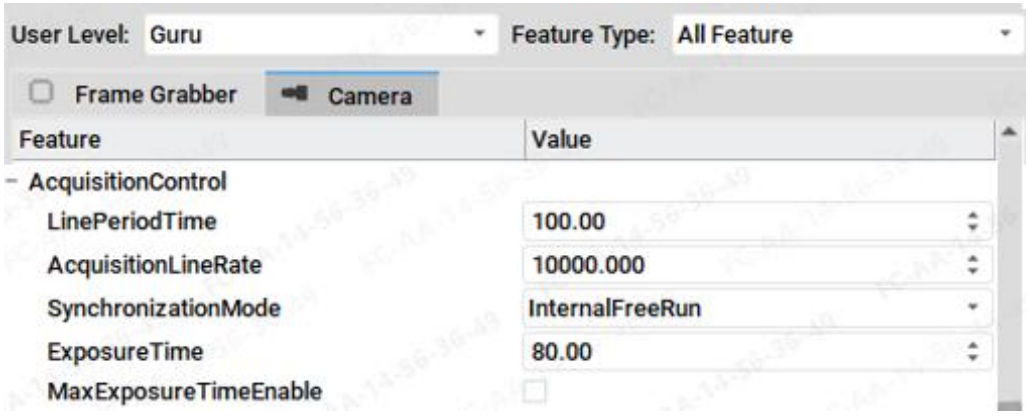


Fig.31 Image Acquisition Category

The following table describes the types of features covered by image acquisition category and the specific description and access attributes of features. Different camera versions may support different list of features.

Table 18 Image Acquisition Category List

Feature Name	Feature Description	Camera Version & Visibility
LinePeriodTime	Line period	0101-8104 Beginner
AcquisitionLineRate	Acquisition line rate	0101-8104 Beginner
SynchronizationMode **Timed**	Exposure control mode Timed	0101-8104 Beginner

TriggerPulse **TriggerWidth**	TriggerPulse TriggerWidth	
ExposureTime	Exposure time	0101-8104 Beginner
MaxExposureTimeEnable	Enable maximum exposure time	0101-8104 Beginner

8.4 IO Control Category

Parameters involved in process of external camera trigger, such as scanning direction and so on are all grouped into IO control category. Application program can modify these features to achieve external IO control. In the following figure, the gray font indicates that it is currently read-only, and the black font indicates that it can be modified by users.

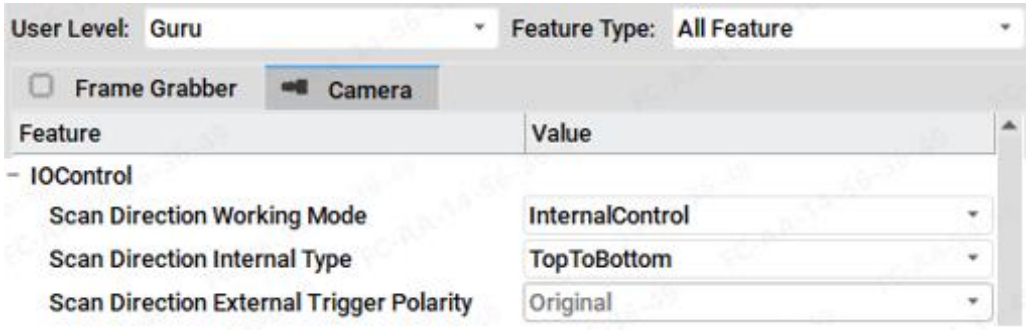


Fig.32 IO Control Category

The following table describes the types of features covered by IO Control Category and the specific description and access attributes of features. Different camera versions may support different list of features.

Table 19 IO Control Category List

Feature Name	Feature Description	Camera Version &Visibility
ScanDirectionWorkingMode **InternalControl** **ExternalControl**	Scan direction working mode InternalControl ExternalControl	0101-8104 Beginner
ScanDirectionInternalType **BottomToTop** **TopToBottom**	Scan direction internal control type BottomToTop TopToBottom	0101-8104 Beginner
ScanDirectionExternalTriggerPolarity **Original** **Reverse**	Scan direction external trigger polarity Original Reverse	0101-8104 Beginner

8.5 Image Correction Category

Correct images according to requirement. Information such as spatial correction, parallax correction and so on are all grouped into this category. Applications can obtain better quality images by

modifying these parameters. In the following figure, the gray font indicates that it is currently read-only, and the black font indicates that it can be modified by users.

PR-CL series camera supports spatial correction and parallax correction to change the quality of image. For detailed descriptions of spatial correction and parallax correction, see section 6.4 and 6.5.

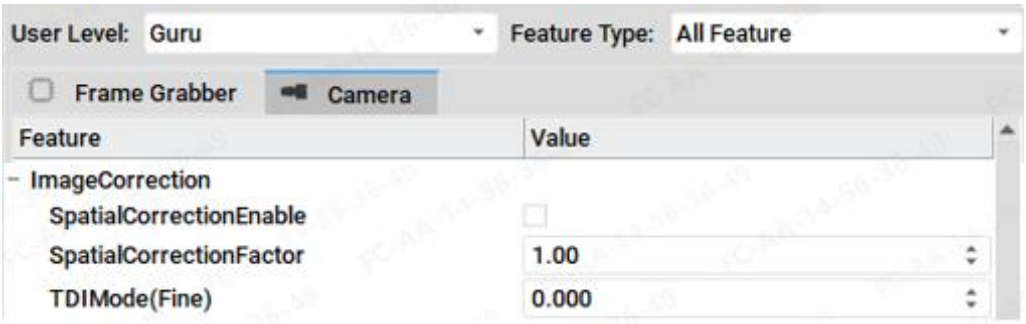


Fig.33 Image Correction Category

The following table describes the types of features covered by image correction category and the specific description and access attributes. Different camera versions may support different list of features.

Table 20 Image Correction Category List

Feature Name	Feature Description	Camera Version & Visibility
SpatialCorrectionEnable	Enable spatial correction	0101-8104 Beginner
SpatialCorrectionFactor	Control spatial correction factor	0101-8104 Beginner
TDIMode (Fine)	TDI mode (fine)	0101-8104 Beginner

8.6 Analog Control Category

Analog gain acts on analog signal, and has a greater impact on SNR. Application can obtain better quality images by modifying these parameters. In the following figure, the gray font indicates that it is currently read-only, and the black font indicates that it can be modified by users.

PR-CL series camera supports analog gain configuration. Generally speaking, the larger analog gain before AD is, the higher image SNR is. Users can set it in “AnalogGain”.

Note: The gain of PR-CL series camera has been optimized for delivery. For non-professional users, it is not recommended to modify these parameters.

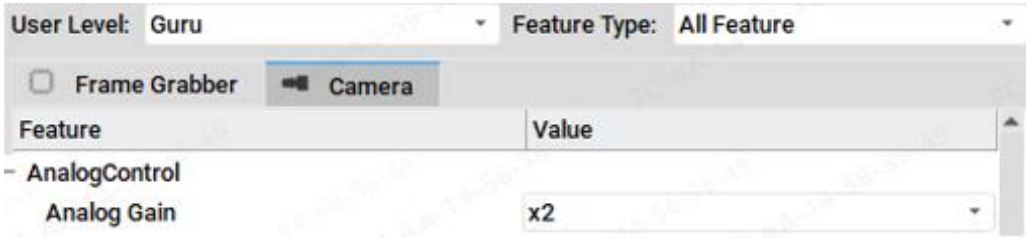


Fig.34 Analog Control Category

The following table describes types of features covered by analog signal control category and specific description and access attributes. Different camera versions may support different list of features.

Table 21 Analog Control Category List

Feature Name	Feature Description	Camera Version & Visibility
AnalogGain X1 X2	Analog gain X1 X2	0101-8104 Beginner

8.7 Digital Control Category

Parameters involved in digital signal acquisition, such as digital gain and offset, are grouped into digital signal category, and application can modify these features to change digital signal output of the camera. In the following figure, the gray font indicates that it is currently read-only, and the black font indicates that it can be modified by users.

PR-CL series camera supports adjusting digital gain “Gain” and digital offset “Offset” to change the quality of camera output image. See Section 6.11 for detailed description of gain and offset.

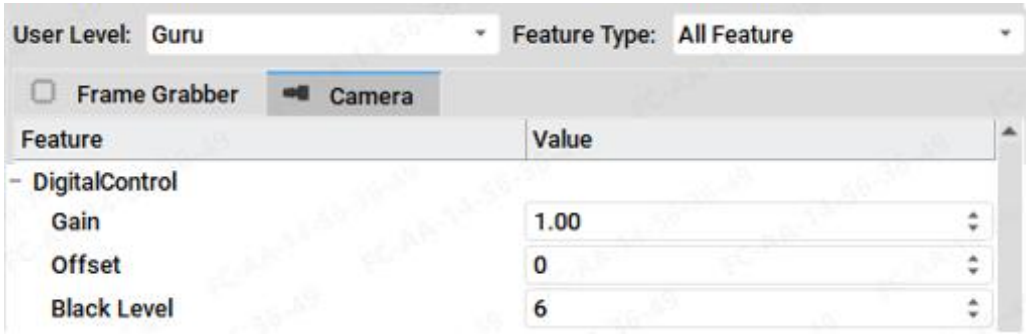


Fig. 35 Digital Control Category

The following table describes the types of features covered by digital signal category and the specific description and access attributes. Different camera versions may support different list of features.

Table 22 Digital Control Category List

Feature Name	Feature Description	Camera Version & Visibility

Gain	Digital gain	0101-8104 Beginner
Offset	Digital offset	0101-8104 Beginner
BlackLevel	Black level	0101-8104 Guru

8.8 Lookup Table Category

Camera lookup table algorithms, such as lookup table parameters, lookup table enable and so on are all grouped into this category. Applications can modify these features to enable or disable lookup table functionality. In the following figure, the gray font indicates that it is currently read-only, and the black font indicates that it can be modified by users.

PR-CL series camera supports 10bit input-10bit output lookup table, which allows users to complete gamma correction. IKapCViewer allows users to enable lookup table function by checking "LUT Enable" check box and modify/access each value of lookup table through "LUT Index". See Section 6.12 for detailed description of lookup table function.

Due to the large number of lookup table entries, users can also read/write lookup table data in batches in IKapCViewer.exe for convenience. For how to read and write lookup table in batches, please refer to IKapCViewer user manual.

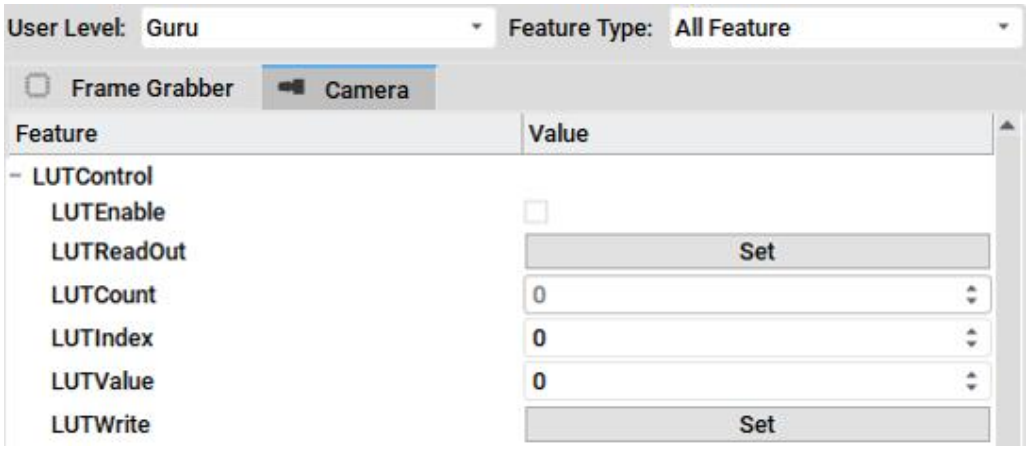


Fig.36 Camera LUT Category

The following table describes the types of features covered by lookup table category and the specific description and access attributes. Different camera versions may support different list of features.

Table 23 LUT Category List

Feature Name	Feature Description	Camera Version & Visibility
LUTEnable	Enable lookup table algorithm	0101-8104 Expert

LUTReadOut	Read lookup table (WO)	0101-8104 Guru
LUTCount	Number of lookup table (RO)	0101-8104 Guru
LUTIndex	Lookup table index	0101-8104 Guru
LUTValue	Lookup table value	0101-8104 Guru
LUTWrite	Write lookup table (WO)	0101-8104 Guru

8.9 Flat Field Correction Category

Parameters involved in camera flat field correction, such as flat field correction enable, are classified into flat field correction category. Applications can modify these features to enable flat field correction features. In the following figure, the gray font indicates that it is currently read-only, and the black font indicates that it can be modified by users.

PR-CL series camera supports flat field correction to change the quality of camera output image. See Section 6.13 for detailed description of flat field correction.

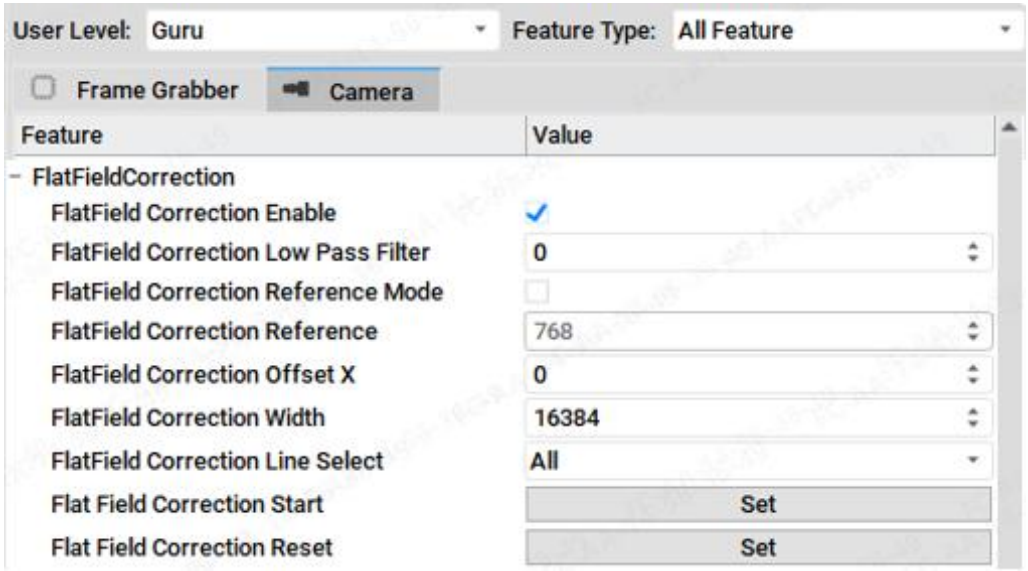


Fig.37 Flat Field Correction Category

The following table describes types of features covered by flat field correction category and specific description and access attributes. Different camera versions may support different list of features.

Table 24 Flat Filed Correction Category List

Feature Name	Feature Description	Camera Version & Visibility
FlatFieldCorrectionEnable	Enable flat field correction	0101-8104

		Expert
FlatFieldCorrectionLowPassFilter	Flat field correction low pass filtering	0101-8104 Expert
FlatFieldCorrectionReferenceMode	Flat field correction reference mode	0101-8104 Expert
FlatFieldCorrectionReference	Flat field correction reference value	0101-8104 Guru
FlatFieldCorrectionOffsetX	Flat field correction horizontal offset	0101-8104 Expert
FlatFieldCorrectionWidth	Flat field correction width	0101-8104 Expert
FlatFieldCorrectionLineSelect All	Flat field correction line selection All	0101-8104 Expert
FlatFieldCorrectionInit	Initialize flat field correction (WO)	0101-8104 Expert
FlatFieldCorrectionExec	Execute flat field correction (WO)	0101-8104 Expert

8.10 User Configuration Category

PR-CL series camera supports saving/loading user configurations. It has a default factory configuration and two sets of user defined configurations. In the following figure, the gray font indicates that it is currently read-only, and the black font indicates that it can be modified by users.

PR-CL series camera can save user configurations as follows:

- Select “User1” in “User Set Selector”.
- Click “User Set Save” button.

All current camera parameters are saved to User1 and enabled after the next power-on.

PR-CL series camera can load user configurations as follows:

- Select “User1” in “User Set Selector”.
- Click “User Set Load” button.

AllUser1 parameters will be imported into the current camera.

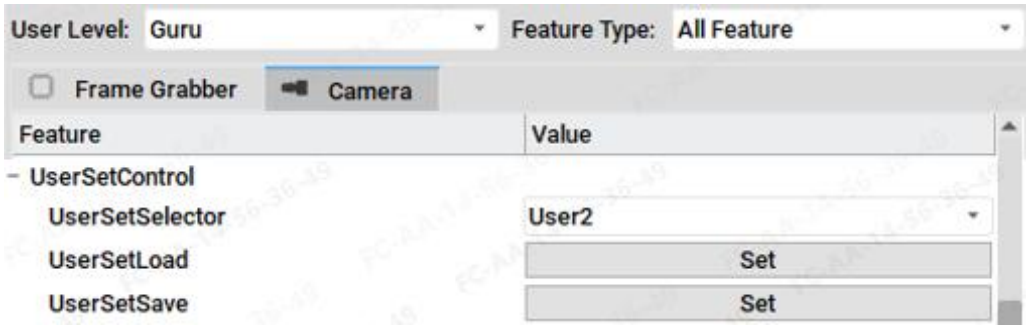


Fig.User Configuration Category

The following table describes the types of features covered by user configuration category and the specific descriptions and access attributes of the features. Different camera versions may support different list of features.

Table 25 User Configuration Category List

Feature Name	Feature Description	Camera Version & Visibility
UserSetSelector **Default** **User1** **User2**	Select user configuration Default User1 User2	0101-8104 Beginner
UserSetLoad	Load camera configuration (WO)	0101-8104 Beginner
UserSetSave	Save camera configuration (WO)	0101-8104 Beginner

9 FAQ

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

① Ensure that Camera Link interface cable is OK

② Ensure that serial port channel parameters of Camera Link interface are correctly set.

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

① Ensure that the camera has been turned on properly (i.e. the status indicator should be normally green).

② If a third-party frame grabber is used to grab images, ensure that frame grabber and supporting software are operating properly, which can be checked by restarting computer.

③ Ensure that the Camera Link interface cable is OK.

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

① Ensure that external input pulse is normal.

② Ensure that the camera has received trigger pulse correctly (it can be confirmed by status indicator display).

③ If Camera Link interface signal is used as trigger input signal, ensure that frame grabber is configured correctly.

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

① Ensure that voltage range of external connected power supply is normal.

② If the casing is hot or the camera emits smoke, immediately cut off power and stop using camera, then contact us for technical support.

- **If images are dark,**

① Ensure that sensor aperture on the casing is not blocked.

② Ensure that exposure time is set properly.

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

① Ensure that sensor glass is clean.

② Ensure that camera status indicator is normal.

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

① Check whether Camera Link interface is normal by the test image.

② Check whether the power supply is normal by camera indicator status.

③ Check whether external trigger input is normal in External Trigger mode by 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.