

PN-CL Series Line Scan Camera User Manual

(V0.8 Mar. 20, 2025)



Hefei I-TEK Optoelectronics Co., Ltd.

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



Revision History

Revision	Date	Description
0.1	2023/01/18	● Initial version
0.2	2023/03/10	● Add camera information
0.3	2023/05/04	● Add camera information ● Update parameter list
0.4	2023/06/08	● Add information of PN4KCL-30KN4 camera
0.5	2023/08/23	● Update camera control chapter ● Update camera configure chapter ● Update product appearance of PN4KCL camera
0.6	2024/11/29	● Update spectral response curve
0.7	2025/03/03	● Update the maximum line rate of the camera
0.8	2025/03/20	● Update physical and structural diagrams



Manufacturer Information

Hefei I-TEK Optoelectronics Co., LTD.

Tel.: +86-551-65318597

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

Revision History	2
Manufacturer Information	3
Contents	4
1 Precautions	6
2 Camera Models	7
3 Product Appearance	9
4 Product Specifications	11
4.1 Main Features	11
4.2 Camera Specifications	11
4.3 Camera Structure	18
4.4 Pixel Arrangements	19
4.5 Spectral Response	21
4.6 Environmental Requirements	23
4.7 RoHS Certification	23
5 Mechanical Dimensions and Interfaces	24
5.1 Mechanical Dimensions	24
5.2 Camera Interface	26
5.2.1 Camera Status Indicator	26
5.2.2 Power Interface	27
5.2.3 Data Interface	27
6 Camera Features	36
6.1 Trigger Mode	36
6.1.1 Free-Run Mode	36
6.1.2 External Pulse Mode	36
6.1.3 External PWM Mode	37
6.2 Camera Scanning Direction	38
6.3 Horizontal Binning	39
6.4 Spatial Correction	40
6.5 Parallax Correction	40
6.6 Time Delay Integration	41
6.7 White Balance	42
6.8 Test Image	42
6.9 Data Format	43
6.10 Gain and Offset	43
6.11 LUT	44
6.12 Flat Field Correction	45
6.13 Camera Temperature	49
6.14 Load/Save Configuration	49
7 Camera Control	50
7.1 Serial Port Parameters	50
7.2 Command Format	50
7.3 Command List	51



8	Camera Configure	56
8.1	Device Control Category	56
8.2	Image Format Control Category	57
8.3	Acquisition Control Category	59
8.4	Analog Control Category	60
8.5	IO Control Category	60
8.6	Image Correction Category	61
8.7	Digital Control Category	62
8.8	Lookup Table Category	64
8.9	Flat Field Correction Category	64
8.10	User Set Control Category	65
9	FAQ	67
10	After Sales and Warranty Policy	68



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 of PN4KCL-30KN4 camera is $+12V \pm 10\%$, and the current must be 0.5A. The recommended voltage of other camera is $+12 \sim 24V (\pm 10\%)$, and the current must be 1.0A.
- 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)

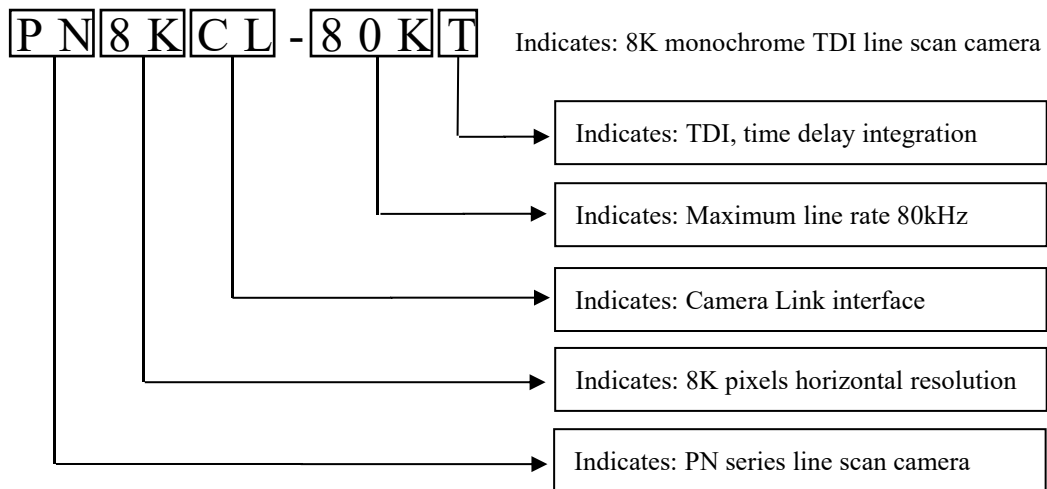


S	SWIR (Short Wave Infrared)
W	MWIR (Middle Wave Infrared)
L	LWIR (Long Wave Infrared)

- **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

PN4KCL camera:



PN8KCL-33KC/PN16KCL-50KT camera (new version):



PN8KCL/PN16KCL camera (old version):



Fig.1 Product Appearance



Note:

- ① The front and the sides of camera provides threaded holes for mounting and fixing.
- ② Please refer to “Mechanical Dimensions and Interfaces” below for detailed camera dimensions.



4 Product Specifications

PN-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
- 4096 / 8192 / 16384 Pixels Line Resolution
- Maximum Line Rate 180kHz
- High Sensitivity and Low Noise
- Rich Exposure Control Modes (External Trigger, Free-Run)
- Data Format: 8/10bit
- User-Configurable Scanning Direction
- Binning
- Flat Field Correction
- Spatial Correction
- Parallax Correction
- Analog Gain / Digital Gain / Offset Control
- White Balance
- Real-time Temperature Monitoring

4.2 Camera Specifications

Table 1 PN4KCL-30KN4 Product Specifications

Model	PN4KCL-30KN4
Product Description	4K near infrared line scan camera
Resolution	4096 x 4
Pixel Size	7um x 7um
Sensor Type	Global shutter CMOS
Image Type	Monochrome
Sensor Size	28.67mm
Dynamic Range	≥ 65.6dB
SNR	49.4dB
Lens Mount	M42
Max Line Rate	30.0kHz@8/10bit
Trigger Mode	Free Run, External Pulse, External PWM
Trigger Signal	Camera Link CC1
Analog Gain	X1/X2/X3/X4/X5/X6/X7/X8
Black Level	0~1023



Digital Gain	0.01~8
Digital Offset	-1023~1023
Exposure Control	External PWM, Timed
Exposure Time	10.5us~63997us (step: 0.01us)
Data Format	8/10bit
Operation Temperature	0~55°C
Data Interface	Camera Link
Data Rate	153MB/s
Power Supply	DC 12V±10% 0.5A
Power Consumption	3.7W
Mechanical	60mm x 60mm x 37.42mm

Table 2 PN4KCL-46KC Product Specifications

Model	PN4KCL-46KC
Product Description	4K color line scan camera
Resolution	4096 x 3
Pixel Size	7um x 7um
Sensor Type	Global shutter CMOS
Image Type	Color
Sensor Size	28.67mm
Dynamic Range	≥ 61.9dB
SNR	43.5dB
Lens Mount	M42
Max Line Rate	20.5kHz@1Tap, 41.0kHz@2Tap, 67.9kHz@3Tap
Trigger Mode	Free Run, External Pulse, External PWM
Trigger Signal	Camera Link CC1
Analog Gain	X1/X2/X3/X4/X5/X6/X7/X8
Black Level	0~1023
Digital Gain	0.01~8
Digital Offset	-1023~1023
Exposure Control	External PWM, Timed
Exposure Time	4.5us~63997us (step: 0.01us)
Data Format	RGB@8/10bit
Operation Temperature	0~55°C
Data Interface	Camera Link
Data Rate	587MB/s
Power Supply	DC 12~24V (±10%) 1.0A
Power Consumption	3.8W



Mechanical	60mm x 60mm x 37.42mm
------------	-----------------------

Table 3 PN4KCL-180KM Product Specifications

Model	PN4KCL-180KM
Product Description	4K monochrome line scan camera
Resolution	4096 x 1
Pixel Size	7um x 7um
Sensor Type	Global shutter CMOS
Image Type	Monochrome
Sensor Size	28.67mm
Dynamic Range	≥ 63.6dB
SNR	44.0dB
Lens Mount	M42
Max Line Rate	38.4kHz@2Tap, 76.8kHz@4Tap, 145.6kHz@8Tap, 178.6kHz@10Tap
Trigger Mode	Free Run, External Pulse, External PWM
Trigger Signal	Camera Link CC1
Analog Gain	X1/X2/X3/X4/X5/X6/X7/X8
Black Level	0~1023
Digital Gain	0.01~8
Digital Offset	-1023~1023
Exposure Control	External PWM, Timed
Exposure Time	2us~63997us (step: 0.01us)
Data Format	8/10bit
Operation Temperature	0~55°C
Data Interface	Camera Link
Data Rate	785MB/s
Power Supply	DC 12~24V (±10%) 1.0A
Power Consumption	4.6W
Mechanical	60mm x 60mm x 37.42mm

Table 4 PN8KCL-33KC Product Specifications

Model	PN8KCL-33KC
Product Description	8K color line scan camera
Resolution	8192 x 3
Pixel Size	7um x 7um
Sensor Type	Global shutter CMOS
Image Type	Color
Sensor Size	57.34mm
Dynamic Range	≥ 65.7dB



SNR	45.0dB
Lens Mount	M72
Max Line Rate	20.3kHz@2Tap, 33.3 kHz@3Tap
Trigger Mode	Free Run, External Pulse, External PWM
Trigger Signal	Camera Link CC1
Analog Gain	X1/X2/X3/X4/X5/X6/X7/X8
Black Level	0~1023
Digital Gain	0.01~8
Digital Offset	-1023~1023
Exposure Control	External PWM, Timed
Exposure Time	3.5us~63997us (step: 0.013us)
Data Format	RGB@8/10bit
Operation Temperature	0~55°C
Data Interface	Camera Link
Data Rate	818MB/s
Power Supply	DC 12~24V ($\pm 10\%$) 1.0A
Power Consumption	6.6W
Mechanical	Old version: 76mm x 76mm x 54.61mm New version: 76mm x 76mm x 43.3mm

Table 5 PN8KCL-33KC2 Product Specifications

Model	PN8KCL-33KC2
Product Description	8K color TDI line scan camera
Resolution	8192 x 6
Pixel Size	7um x 7um
Sensor Type	Global shutter CMOS
Image Type	Color
Sensor Size	57.34mm
Dynamic Range	≥ 65.7 dB
SNR	45.0dB
Lens Mount	M72
Max Line Rate	20.3kHz@2Tap, 33.3 kHz@3Tap
Trigger Mode	Free Run, External Pulse, External PWM
Trigger Signal	Camera Link CC1
Analog Gain	X1/X2/X3/X4/X5/X6/X7/X8
Black Level	0~1023
Digital Gain	0.01~8
Digital Offset	-1023~1023
Exposure Control	External PWM, Timed



Exposure Time	3.5us~63997us (step: 0.013us)
Data Format	RGB@8/10bit
Operation Temperature	0~55°C
Data Interface	Camera Link
Data Rate	818MB/s
Power Supply	DC 12~24V (±10%) 1.0A
Power Consumption	6.8W
Mechanical	76mm x76mm x 54.61mm

Table 6 PN8KCL-50KT4 Product Specifications

Model	PN8KCL-50KT4
Product Description	8K monochrome TDI line scan camera
Resolution	8192 x 4
Pixel Size	7um x 7um
Sensor Type	Global shutter CMOS
Image Type	Monochrome
Sensor Size	57.34mm
Dynamic Range	≥ 65.7dB
SNR	45.0dB
Lens Mount	M72
Max Line Rate	20.4kHz@2Tap, 40.8 kHz@4Tap, 50.0kHz@8/10Tap
Trigger Mode	Free Run, External Pulse, External PWM
Trigger Signal	Camera Link CC1
Analog Gain	X1/X2/X3/X4/X5/X6/X7/X8
Black Level	0~1023
Digital Gain	0.01~8
Digital Offset	-1023~1023
Exposure Control	External PWM, Timed
Exposure Time	3.5us~63997us (step: 0.013us)
Data Format	8/10bit
Operation Temperature	0~55°C
Data Interface	Camera Link
Data Rate	512MB/s
Power Supply	DC 12~24V (±10%) 1.0A
Power Consumption	6.6W
Mechanical	76mm x76mm x 54.61mm

Table 7 PN8KCL-80KT Product Specifications

Model	PN8KCL-80KT
-------	-------------



Product Description	8K monochrome TDI line scan camera
Resolution	8192 x 2
Pixel Size	7um x 7um
Sensor Type	Global shutter CMOS
Image Type	Monochrome
Sensor Size	57.34mm
Dynamic Range	≥ 65.7dB
SNR	45.0dB
Lens Mount	M72
Max Line Rate	20.4kHz@2Tap, 40.8 kHz@4Tap, 50.0kHz@8Tap, 79.4kHz@10Tap
Trigger Mode	Free Run, External Pulse, External PWM
Trigger Signal	Camera Link CC1
Analog Gain	X1/X2/X3/X4/X5/X6/X7/X8
Black Level	0~1023
Digital Gain	0.01~8
Digital Offset	-1023~1023
Exposure Control	External PWM, Timed
Exposure Time	3.5us~63997us (step: 0.013us)
Data Format	8/10bit
Operation Temperature	0~55°C
Data Interface	Camera Link
Data Rate	650MB/s
Power Supply	DC 12~24V (±10%) 1.0A
Power Consumption	7.0W
Mechanical	76mm x76mm x 54.61mm

Table 8 PN8KCL-100KM Product Specifications

Model	PN8KCL-100KM
Product Description	8K monochrome line scan camera
Resolution	8192 x 1
Pixel Size	7um x 7um
Sensor Type	Global shutter CMOS
Image Type	Monochrome
Sensor Size	57.34mm
Dynamic Range	≥ 65.7dB
SNR	45.0dB
Lens Mount	M72
Max Line Rate	20.4kHz@2Tap, 40.8 kHz@4Tap, 81.3kHz@8Tap, 100.0kHz@10Tap



Trigger Mode	Free Run, External Pulse, External PWM
Trigger Signal	Camera Link CC1
Analog Gain	X1/X2/X3/X4/X5/X6/X7/X8
Black Level	0~1023
Digital Gain	0.01~8
Digital Offset	-1023~1023
Exposure Control	External PWM, Timed
Exposure Time	3.5us~63997us (step: 0.013us)
Data Format	8/10bit
Operation Temperature	0~55°C
Data Interface	Camera Link
Data Rate	819MB/s
Power Supply	DC 12~24V ($\pm 10\%$) 1.0A
Power Consumption	8.3W
Mechanical	76mm x 76mm x 54.61mm

Table 9 PN16KCL-50KT Product Specifications

Model	PN16KCL-50KT
Product Description	16K monochrome TDI line scan camera
Resolution	16384 x 2
Pixel Size	3.5um x 3.5um
Sensor Type	Global shutter CMOS
Image Type	Monochrome
Sensor Size	57.34mm
Dynamic Range	$\geq 65.7\text{dB}$
SNR	45.0dB
Lens Mount	M72
Max Line Rate	10.2kHz@2Tap, 20.4 kHz@4Tap, 40.8kHz@8Tap, 50.0kHz@10Tap
Trigger Mode	Free Run, External Pulse, External PWM
Trigger Signal	Camera Link CC1
Analog Gain	X1/X2/X3/X4
Black Level	0~1023
Digital Gain	0.01~8
Digital Offset	-1023~1023
Exposure Control	External PWM, Timed
Exposure Time	3.5us~63997us (step: 0.013us)
Data Format	8/10bit
Operation Temperature	0~55°C



Data Interface	Camera Link
Data Rate	819MB/s
Power Supply	DC 12~24V ($\pm 10\%$) 1.0A
Power Consumption	7.4W
Mechanical	Old version: 76mm x 76mm x 54.61mm New version: 76mm x 76mm x 43.3mm

Table 10 PN16KCL-51KM Product Specifications

Model	PN16KCL-51KM
Product Description	16K monochrome line scan camera
Resolution	16384 x 1
Pixel Size	3.5 μ m x 3.5 μ m
Sensor Type	Global shutter CMOS
Image Type	Monochrome
Sensor Size	57.34mm
Dynamic Range	≥ 65.7 dB
SNR	45.0dB
Lens Mount	M72
Max Line Rate	10.2kHz@2Tap, 20.4 kHz@4Tap, 40.8kHz@8Tap, 51.0kHz@10Tap
Trigger Mode	Free Run, External Pulse, External PWM
Trigger Signal	Camera Link CC1
Analog Gain	X1/X2/X3/X4
Black Level	0~1023
Digital Gain	0.01~8
Digital Offset	-1023~1023
Exposure Control	External PWM, Timed
Exposure Time	3.5 μ s~63997 μ s (step: 0.013 μ s)
Data Format	8/10bit
Operation Temperature	0~55°C
Data Interface	Camera Link
Data Rate	836MB/s
Power Supply	DC 12~24V ($\pm 10\%$) 1.0A
Power Consumption	7.1W
Mechanical	76mm x 76mm x 54.61mm

Note: This table is for 0103-8108 version of PN-CL series camera specifications, which may vary slightly from version to version.

4.3 Camera Structure

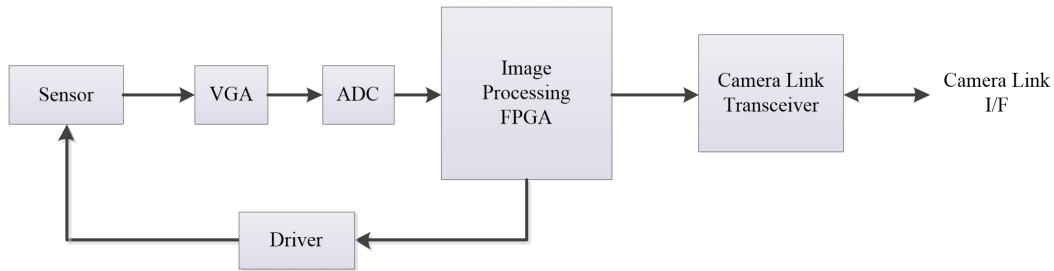


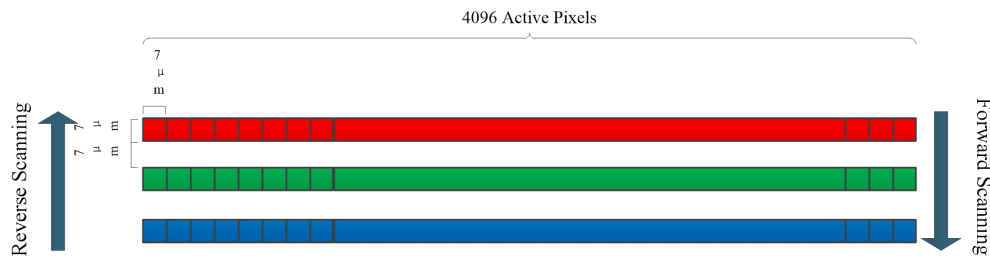
Fig.2 Internal Implementation Structure of Camera

PN-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.

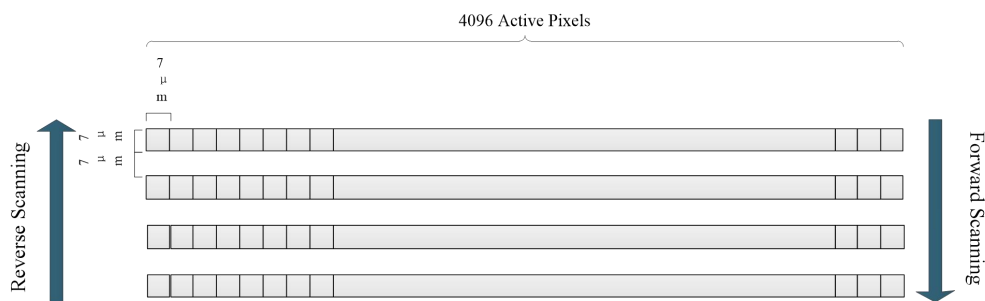
PN-CL series camera can accept external signal trigger acquisition, and the source is CC1 signal from Camera Link interface.

4.4 Pixel Arrangements

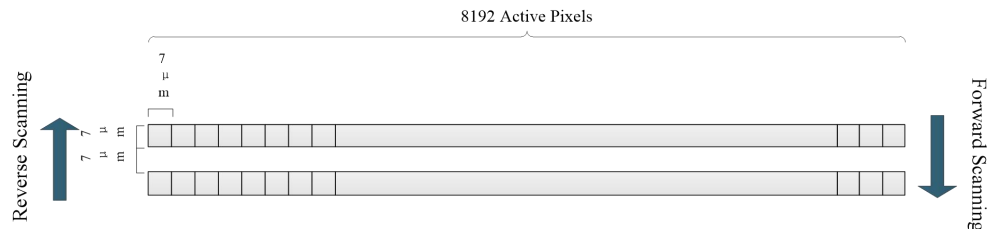
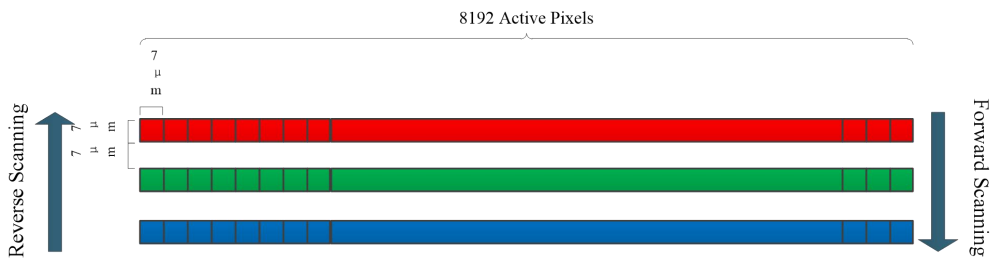
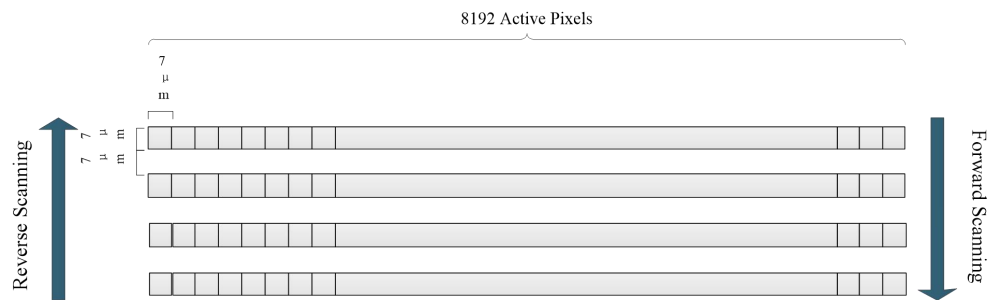
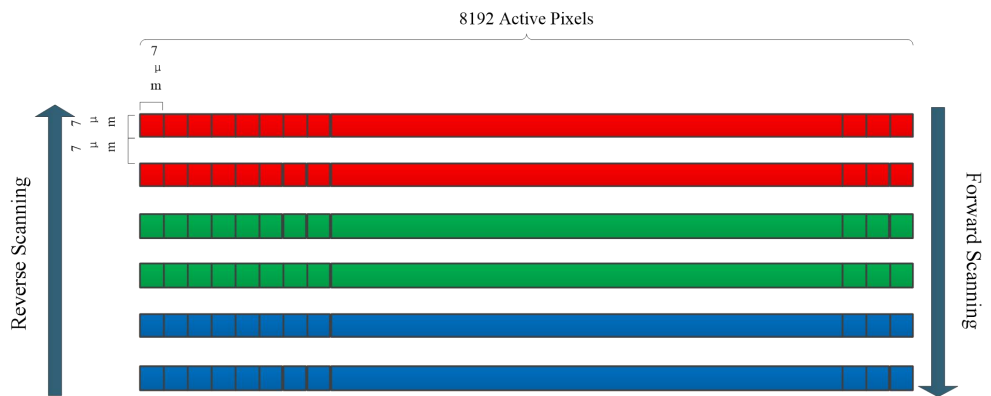
Different types of PN-CL series camera has different line counts. Depending on line counts, pixels of camera are arranged in different ways. Here introduces pixel arrangements of multi-line cameras, as shown in the figure below.

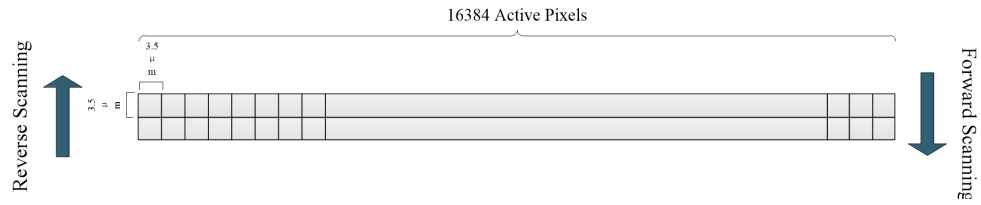


(a) 4K Triple-Line Color



(b) 4K Four-Line Monochrome

**(c) 8K Double-Line Monochrome****(d) 8K Triple-Line Color****(e) 8K Four-Line Monochrome****(f) 8K Six-Line Color**



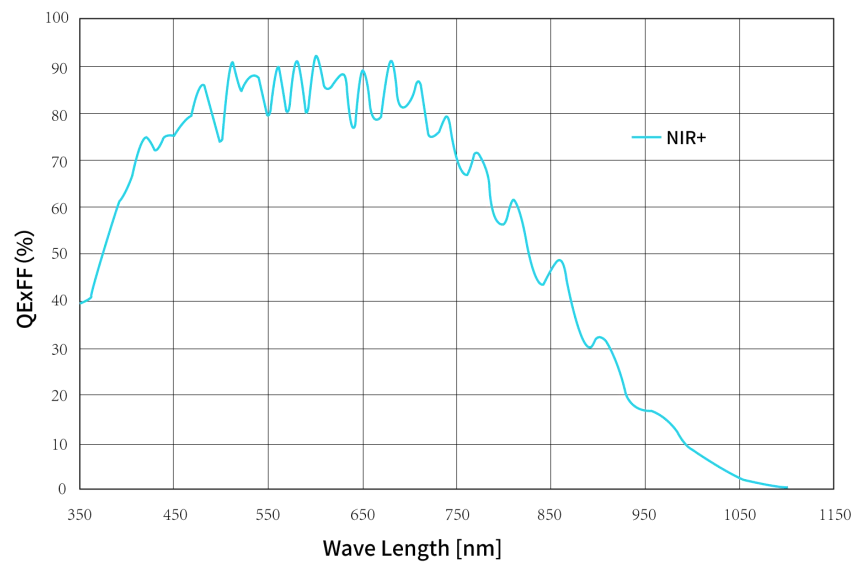
(g) 16K Double-Line Monochrome

Fig.3 Pixel Arrangements

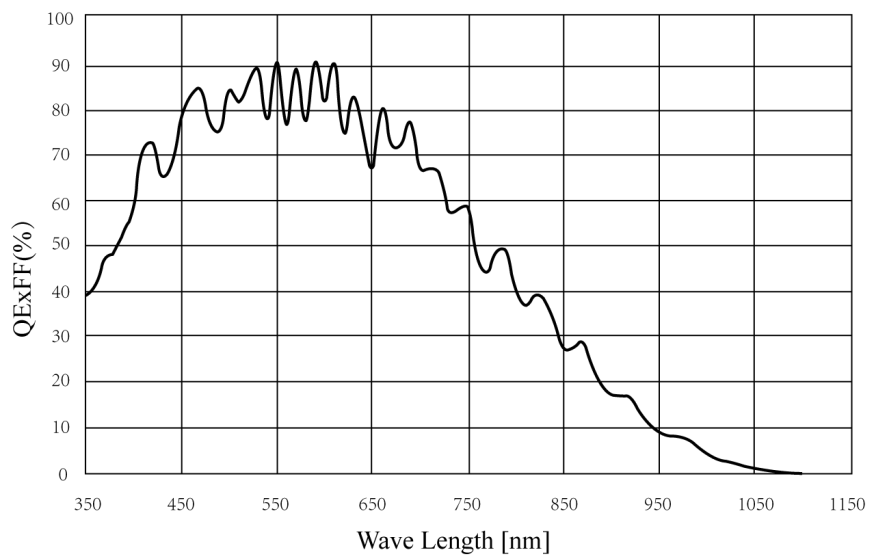
4.5 Spectral Response

The following is spectral response curve of camera.

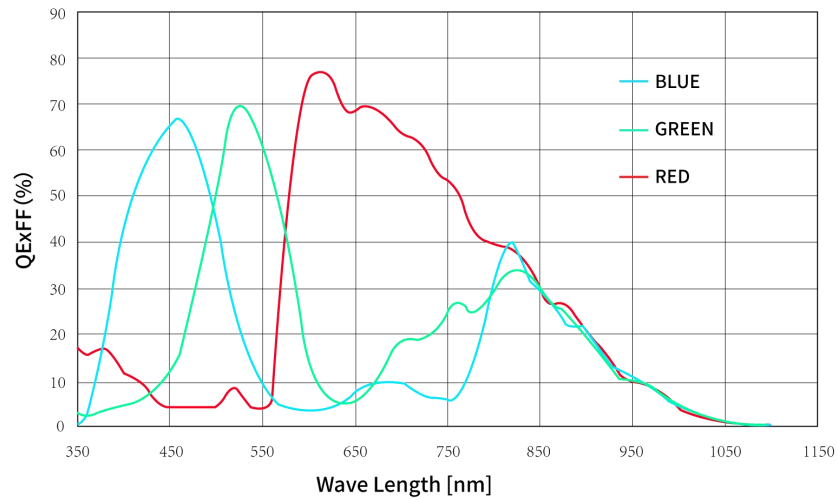
(1) PN4KCL camera:



(a) Near Infrared Camera

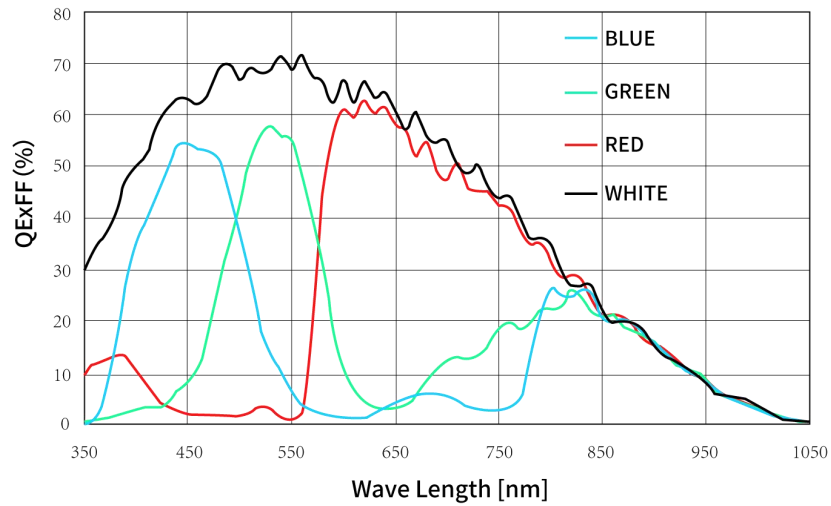


(b) Monochrome Camera



(c) Color Camera

(2) PN8KCL camera:



(3) PN16KCL camera:

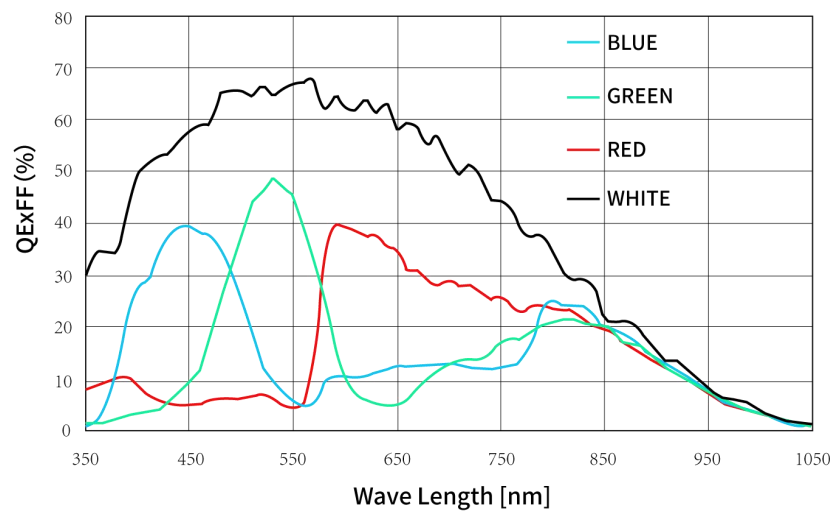


Fig.4 Spectral Response Curve of Camera



4.6 Environmental Requirements

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

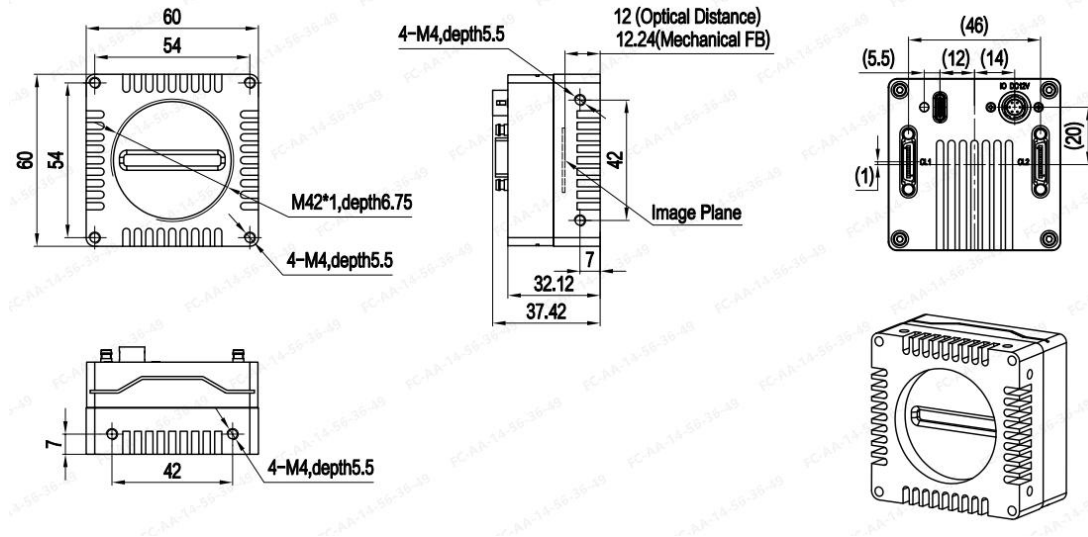
4.7 RoHS Certification

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

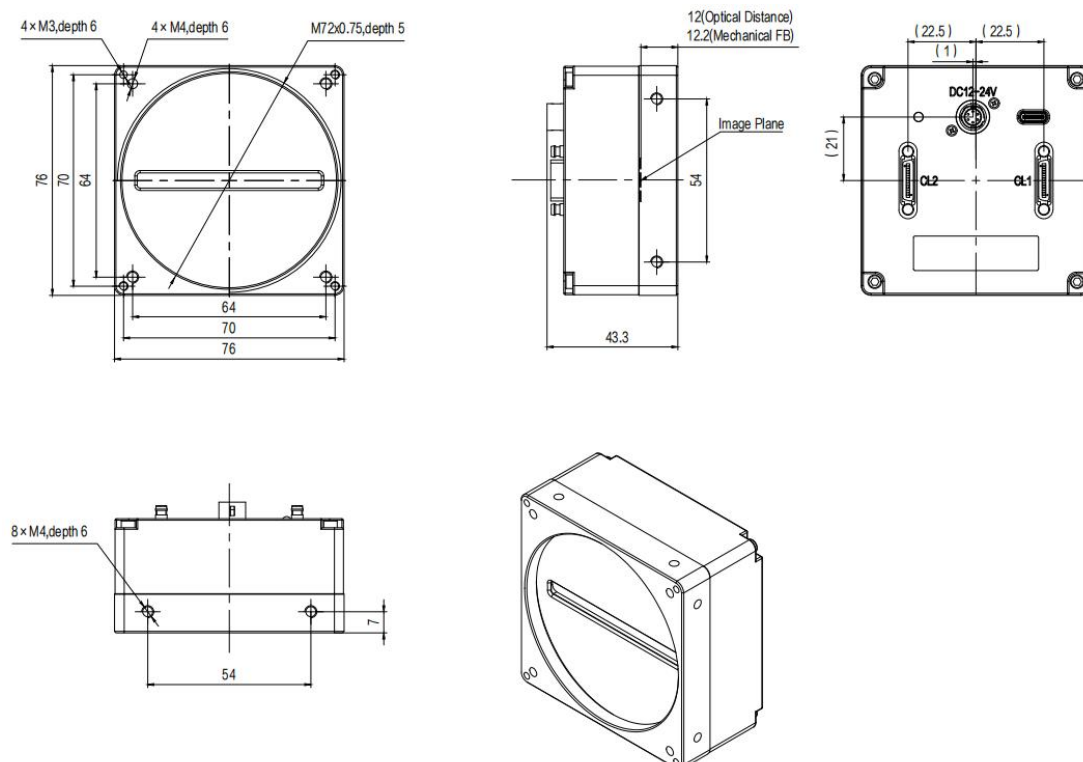
5 Mechanical Dimensions and Interfaces

5.1 Mechanical Dimensions

PN4KCL camera:



PN8KCL-33KC/PN16KCL-50KT camera (new version):



PN8KCL/PN16KCL camera (old version):

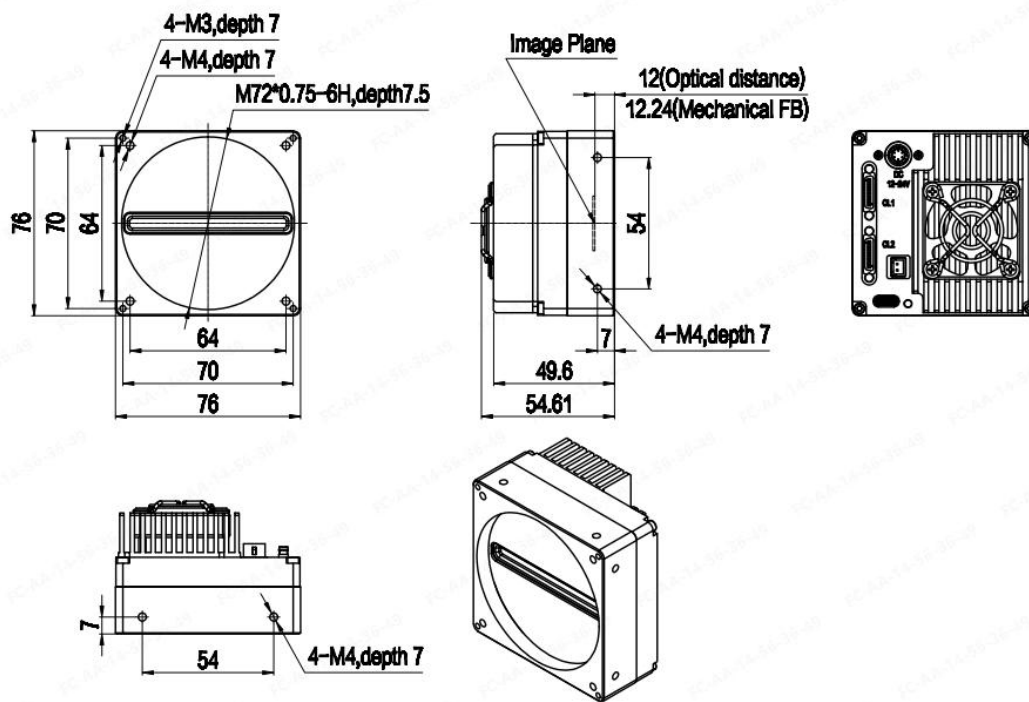
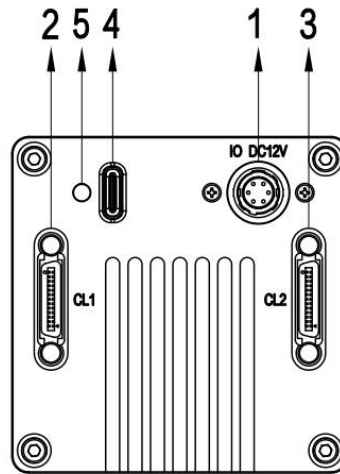


Fig.5 Camera Mechanical Dimensions

5.2 Camera Interface

PN4KCL camera:



PN8KCL/PN16KCL camera:

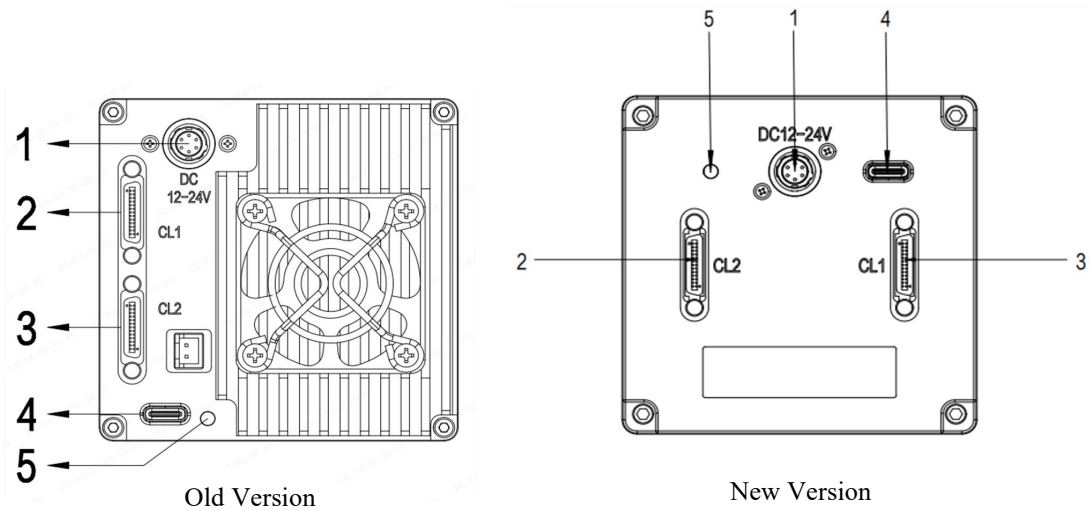


Fig.6 External Interfaces of Camera

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

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:

Table11 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:

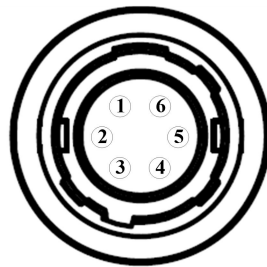


Fig.7 Pin Assignments for Power Interface

Table 12 Power Interface Pin Definition

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

5.2.3 Data Interface

PN-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:

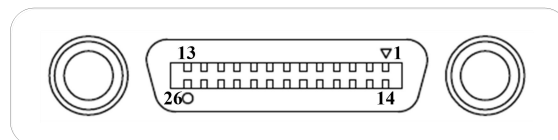


Fig.8 Mini Camera Link Connector

Table 13 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 14 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 15 Port Assignments (2tap @ Mono 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 16 Port Assignments (4tap @ Mono 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 17 Port Assignments (8tap @ Mono 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 18 Port Assignments (10tap @ Mono 8bit)

	8bit		8bit
	10tap/8bit		10tap/8bit
Port A0	A0	Port F0	F0
Port A1	A1	Port F1	F1
Port A2	A2	Port F2	F2
Port A3	A3	Port F3	F3
Port A4	A4	Port F4	F4
Port A5	A5	Port F5	F5
Port A6	A6	Port F6	F6
Port A7	A7	Port F7	F7
Port B0	B0	Port G0	G0
Port B1	B1	Port G1	G1
Port B2	B2	Port G2	G2
Port B3	B3	Port G3	G3
Port B4	B4	Port G4	G4
Port B5	B5	Port G5	G5
Port B6	B6	Port G6	G6
Port B7	B7	Port G7	G7
Port C0	C0	Port H0	H0
Port C1	C1	Port H1	H1
Port C2	C2	Port H2	H2
Port C3	C3	Port H3	H3
Port C4	C4	Port H4	H4
Port C5	C5	Port H5	H5
Port C6	C6	Port H6	H6
Port C7	C7	Port H7	H7
Port D0	D0	Port I0	I0
Port D1	D1	Port I1	I1
Port D2	D2	Port I2	I2
Port D3	D3	Port I3	I3
Port D4	D4	Port I4	I4
Port D5	D5	Port I5	I5
Port D6	D6	Port I6	I6
Port D7	D7	Port I7	I7
Port E0	E0	Port J0	J0
Port E1	E1	Port J1	J1
Port E2	E2	Port J2	J2
Port E3	E3	Port J3	J3
Port E4	E4	Port J4	J4
Port E5	E5	Port J5	J5
Port E6	E6	Port J6	J6
Port E7	E7	Port J7	J7



Table 19 Port Assignments (2Tap @ RGB 8/10bit)

	8 bit RGB o/e	10bit RGB o/e
	2tap/8bit	2tap/10bit
Port A0	Ro0	Ro0
Port A1	Ro1	Ro1
Port A2	Ro2	Ro2
Port A3	Ro3	Ro3
Port A4	Ro4	Ro4
Port A5	Ro5	Ro5
Port A6	Ro6	Ro6
Port A7	Ro7	Ro7
Port B0	Go0	Ro8
Port B1	Go1	Ro9
Port B2	Go2	-
Port B3	Go3	-
Port B4	Go4	Bo8
Port B5	Go5	Bo9
Port B6	Go6	-
Port B7	Go7	-
Port C0	Bo0	Bo0
Port C1	Bo1	Bo1
Port C2	Bo2	Bo2
Port C3	Bo3	Bo3
Port C4	Bo4	Bo4
Port C5	Bo5	Bo5
Port C6	Bo6	Bo6
Port C7	Bo7	Bo7
Port D0	Re0	Re0
Port D1	Re1	Re1
Port D2	Re2	Re2
Port D3	Re3	Re3
Port D4	Re4	Re4
Port D5	Re5	Re5
Port D6	Re6	Re6
Port D7	Re7	Re7

	8 bit RGB o/e	10bit RGB o/e
	2tap/8bit	2tap/10bit
Port E0	Ge0	Go0
Port E1	Ge1	Go1
Port E2	Ge2	Go2
Port E3	Ge3	Go3
Port E4	Ge4	Go4
Port E5	Ge5	Go5
Port E6	Ge6	Go6
Port E7	Ge7	Go7
Port F0	Be0	Go8
Port F1	Be1	Go9
Port F2	Be2	Be0
Port F3	Be3	Be1
Port F4	Be4	Re8
Port F5	Be5	Re9
Port F6	Be6	Be8
Port F7	Be7	Be9
Port G0	-	Ge0
Port G1	-	Ge1
Port G2	-	Ge2
Port G3	-	Ge3
Port G4	-	Ge4
Port G5	-	Ge5
Port G6	-	Ge6
Port G7	-	Ge7
Port H0	-	Ge8
Port H1	-	Ge9
Port H2	-	Be2
Port H3	-	Be3
Port H4	-	Be4
Port H5	-	Be5
Port H6	-	Be6
Port H7	-	Be7



Table 20 Port Assignments (3Tap @ RGB 8bit)

	8 bit RGB o/e/v
	3tap/8bit
Port A0	Ro0
Port A1	Ro1
Port A2	Ro2
Port A3	Ro3
Port A4	Ro4
Port A5	Ro5
Port A6	Ro6
Port A7	Ro7
Port B0	Go0
Port B1	Go1
Port B2	Go2
Port B3	Go3
Port B4	Go4
Port B5	Go5
Port B6	Go6
Port B7	Go7
Port C0	Bo0
Port C1	Bo1
Port C2	Bo2
Port C3	Bo3
Port C4	Bo4
Port C5	Bo5
Port C6	Bo6
Port C7	Bo7
Port D0	Re0
Port D1	Re1
Port D2	Re2
Port D3	Re3
Port D4	Re4
Port D5	Re5
Port D6	Re6
Port D7	Re7
Port E0	Ge0
Port E1	Ge1
Port E2	Ge2
Port E3	Ge3
Port E4	Ge4
Port E5	Ge5
Port E6	Ge6
Port E7	Ge7

	8 bit RGB o/e/v
	3tap/8bit
Port F0	Be0
Port F1	Be1
Port F2	Be2
Port F3	Be3
Port F4	Be4
Port F5	Be5
Port F6	Be6
Port F7	Be7
Port G0	Rv0
Port G1	Rv1
Port G2	Rv2
Port G3	Rv3
Port G4	Rv4
Port G5	Rv5
Port G6	Rv6
Port G7	Rv7
Port H0	Gv0
Port H1	Gv1
Port H2	Gv2
Port H3	Gv3
Port H4	Gv4
Port H5	Gv5
Port H6	Gv6
Port H7	Gv7
Port I0	Bv0
Port I1	Bv1
Port I2	Bv2
Port I3	Bv3
Port I4	Bv4
Port I5	Bv5
Port I6	Bv6
Port I7	Bv7

6 Camera Features

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

6.1 Trigger Mode

PN-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.

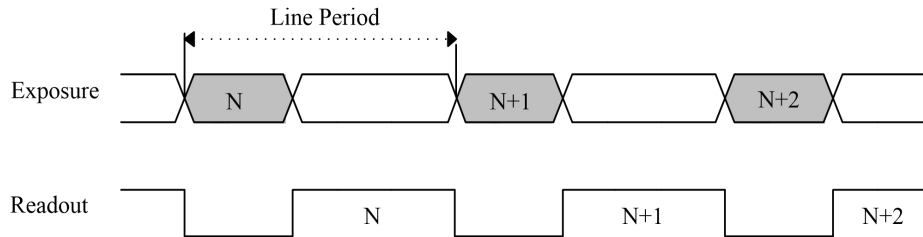


Fig.9 Free-Run Mode

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.

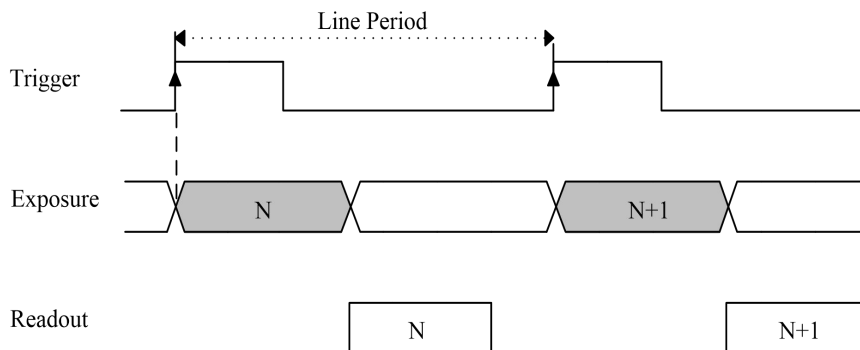


Fig.10 External Pulse Trigger Mode

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.

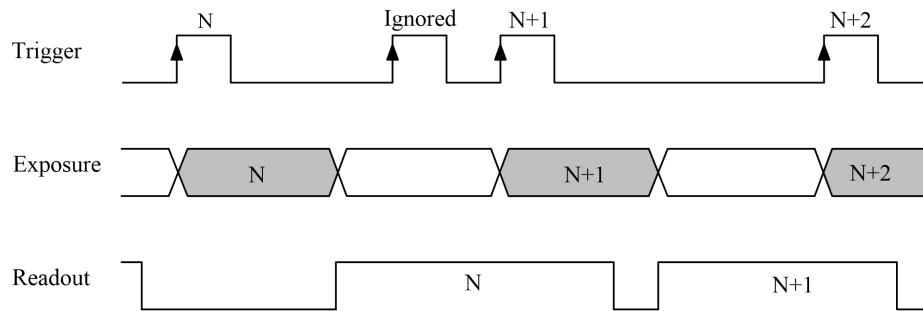


Fig.11 External Trigger Interval is Too Short

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.

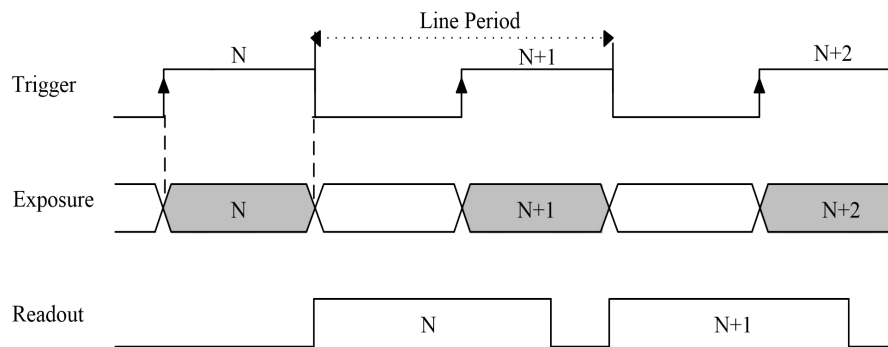


Fig.12 External PWM Trigger Mode

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.

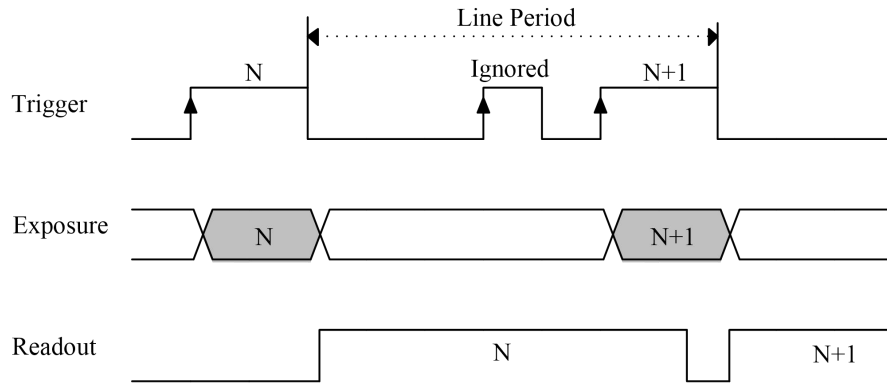


Fig.13 External Trigger Interval is Too Short

6.2 Camera Scanning Direction

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

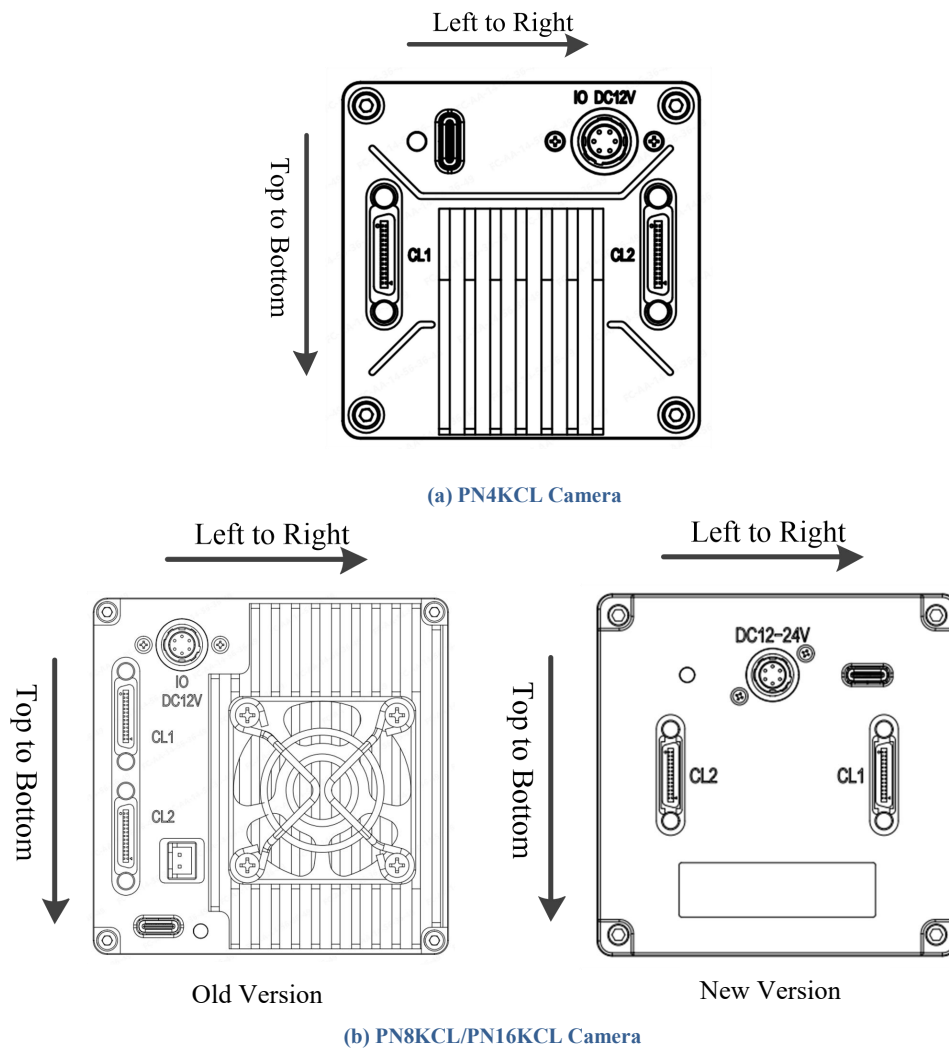
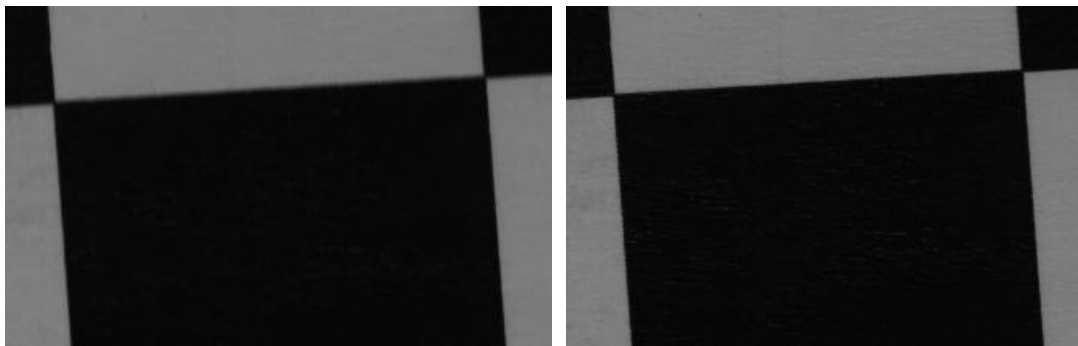


Fig.14 Camera Scanning Direction

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

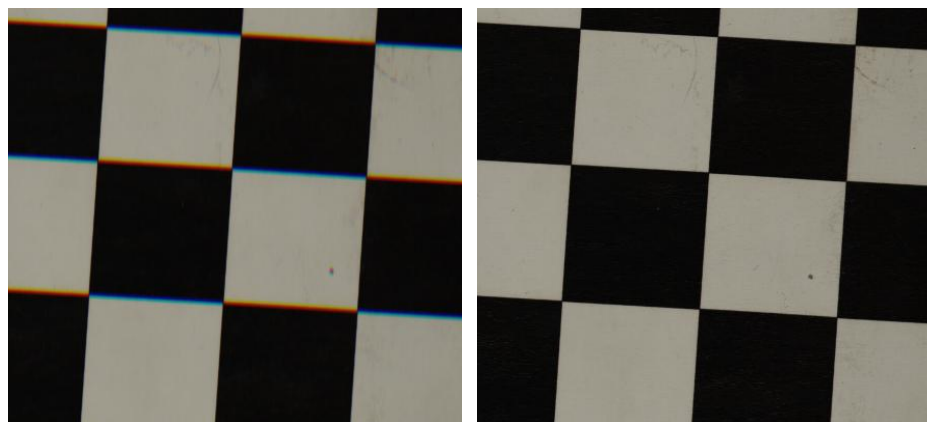
The vertical direction supports the output of images from top to bottom or bottom to top. The direction can be controlled internally by camera or externally by CC3 signal.

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

PN-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.

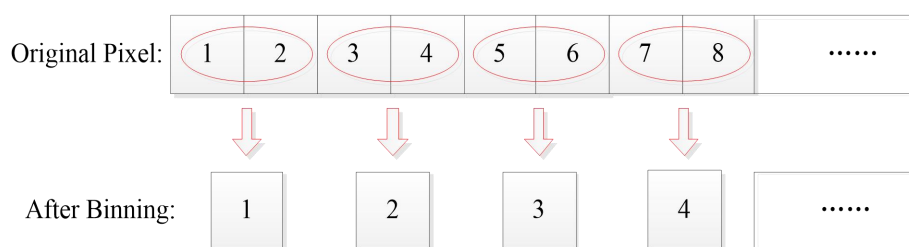


Fig.17 Horizontal Binning_2x1

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.

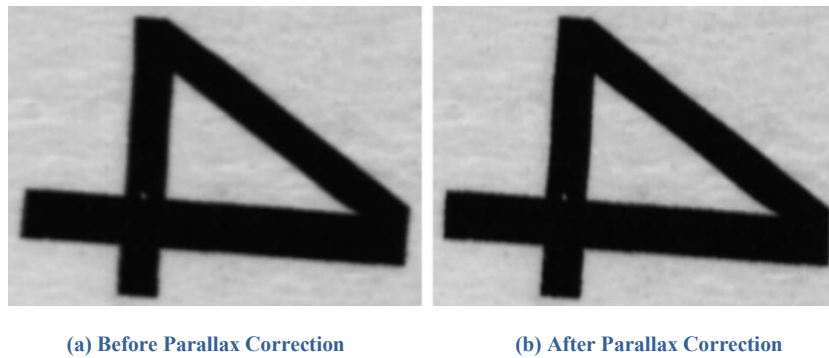
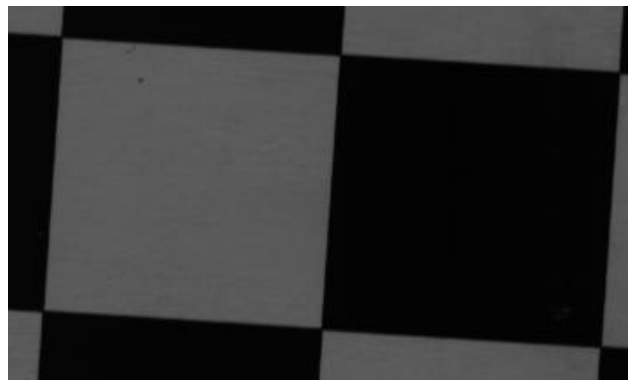


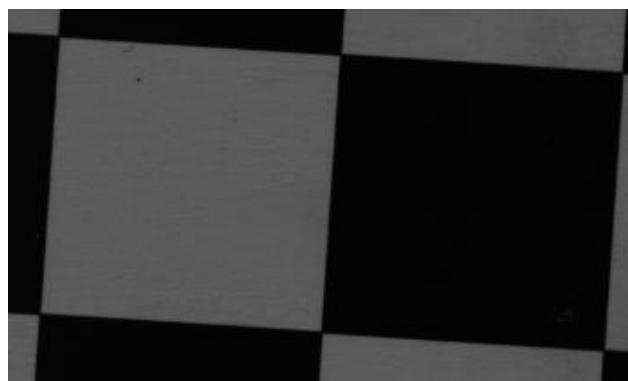
Fig.19 Parallax Correction Effect

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



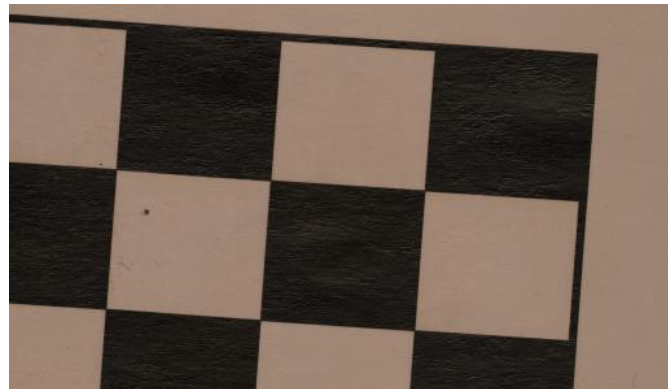
(b) Edge Clear

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

PN-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:

- Test image 1: Fixed image with gray gradient in horizontal direction.
- Test image 2: Scroll image with gray gradient in the vertical direction.

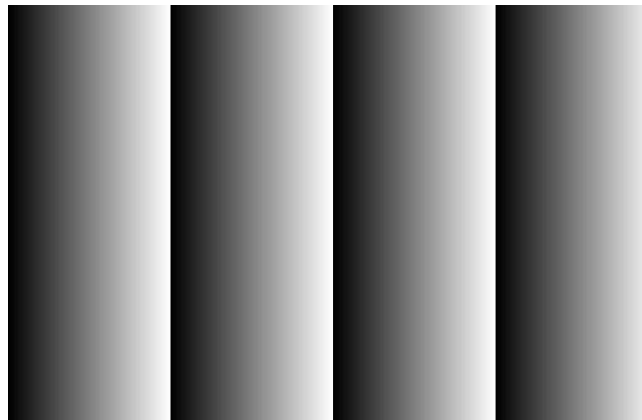


Fig.22 Test Image 1



Fig.23 Test Image 2

6.9 Data Format

PN-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.

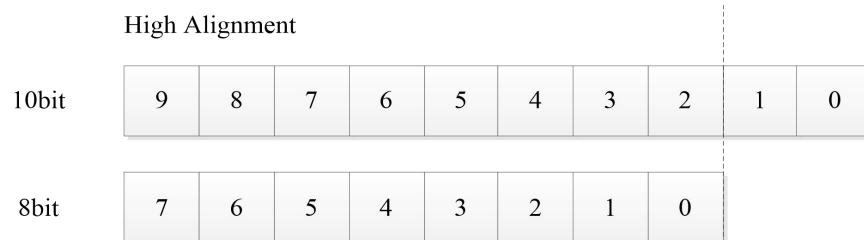


Fig.24 Data Format

6.10 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:

$$\text{Data value (Output)} = \text{Data value (digital gain=1 \& digital offset=0)} * \text{Digital gain value}$$

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

$$\text{Data value (Output)} = \text{Data value (digital offset=0)} + \text{Digital offset value}$$

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

6.11 LUT

LUT uses a look-up table with 10bit input and 10bit output to map and convert the values of the original image. Users can use this function to implement gamma correction.

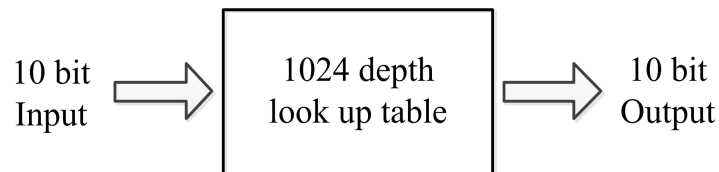


Fig.25 LUT Structure

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

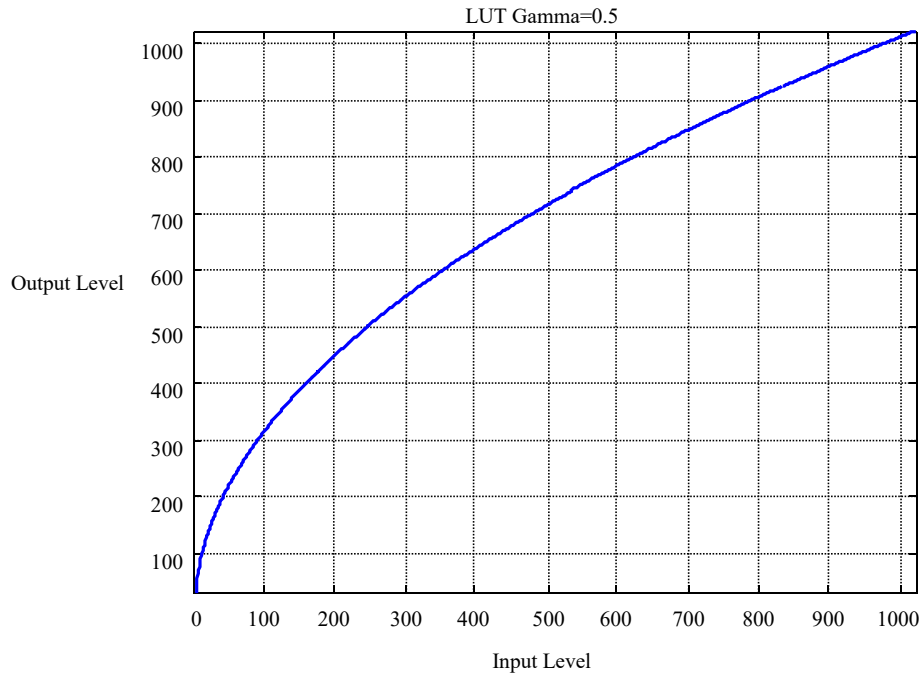


Fig.26 LUT Gamma = 0.5

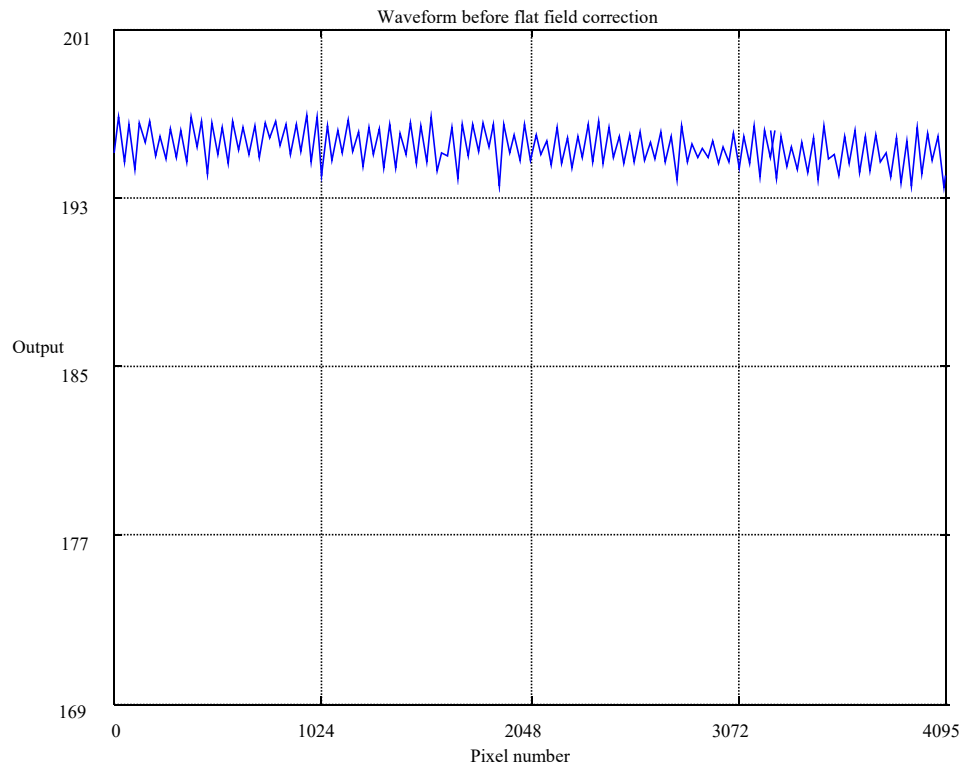
6.12 Flat Field Correction

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. PN-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.

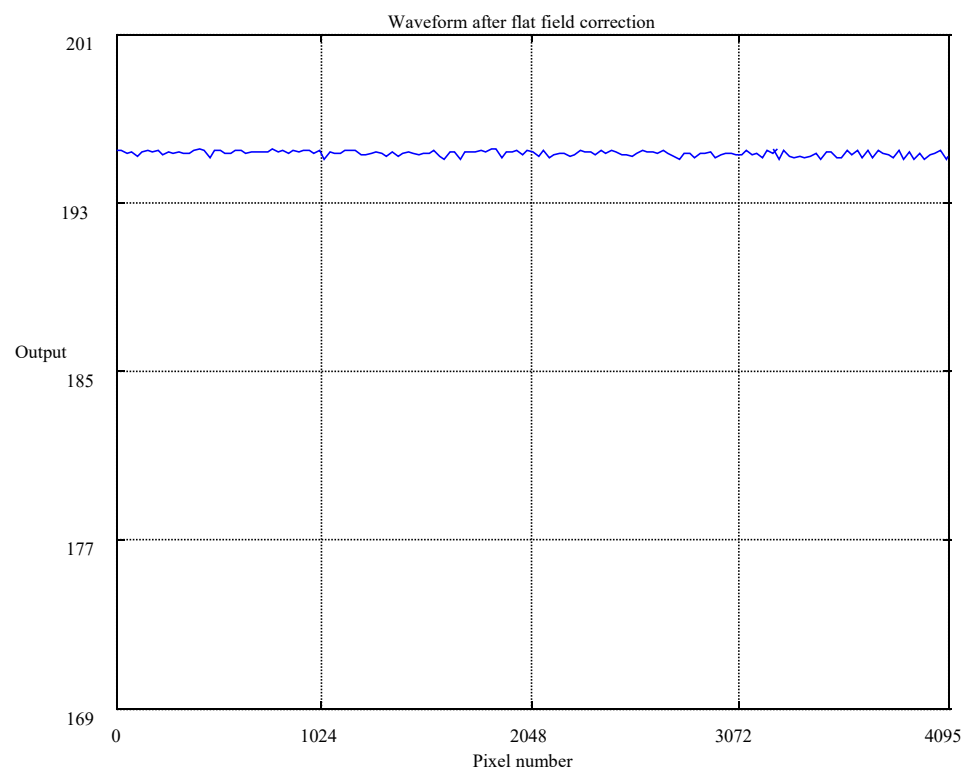
Ideally, when camera imitates a uniform target, gray value of all pixels in resulting image should theoretically be the same. However, values of each pixel in image often vary considerably. These differences may result from uneven illumination, inconsistent light transmittance between lens center and 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:

(1) PN4KCL camera:

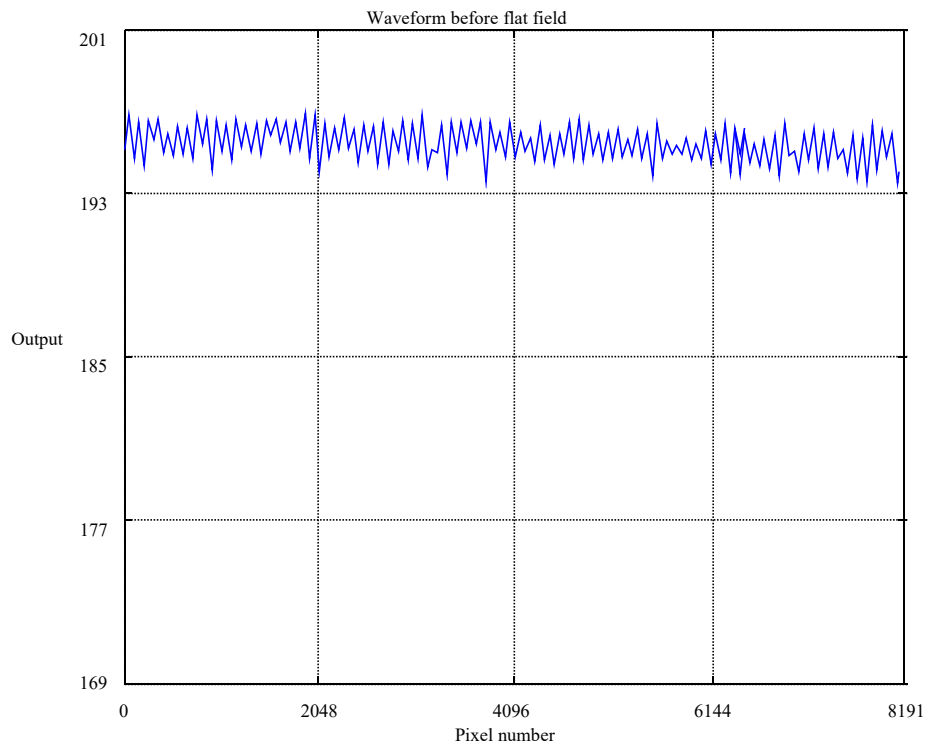


(a) Before Flat Field Correction

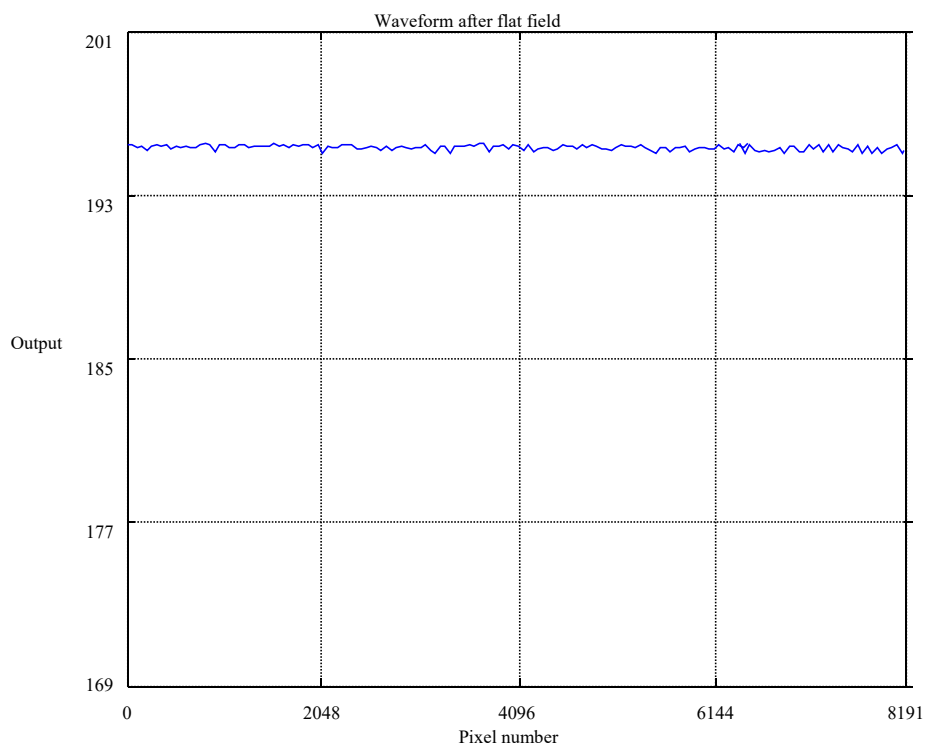


(b) After Flat Field Correction

(2) PN8KCL camera:

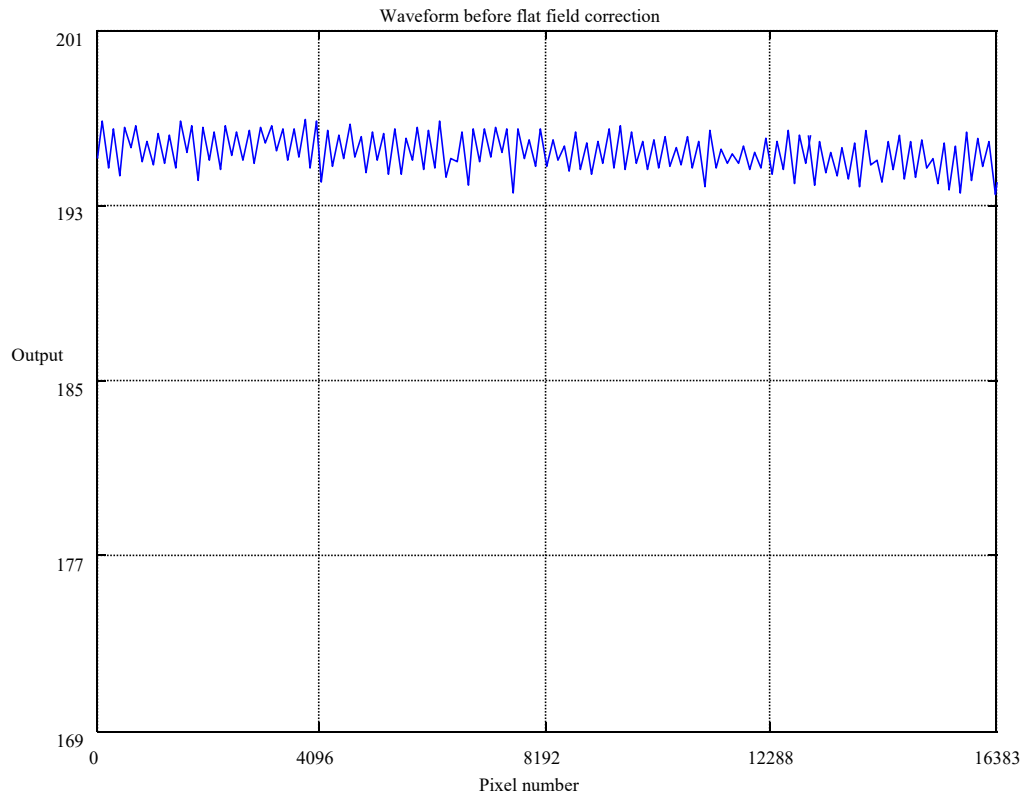


(a) Before Flat Field Correction

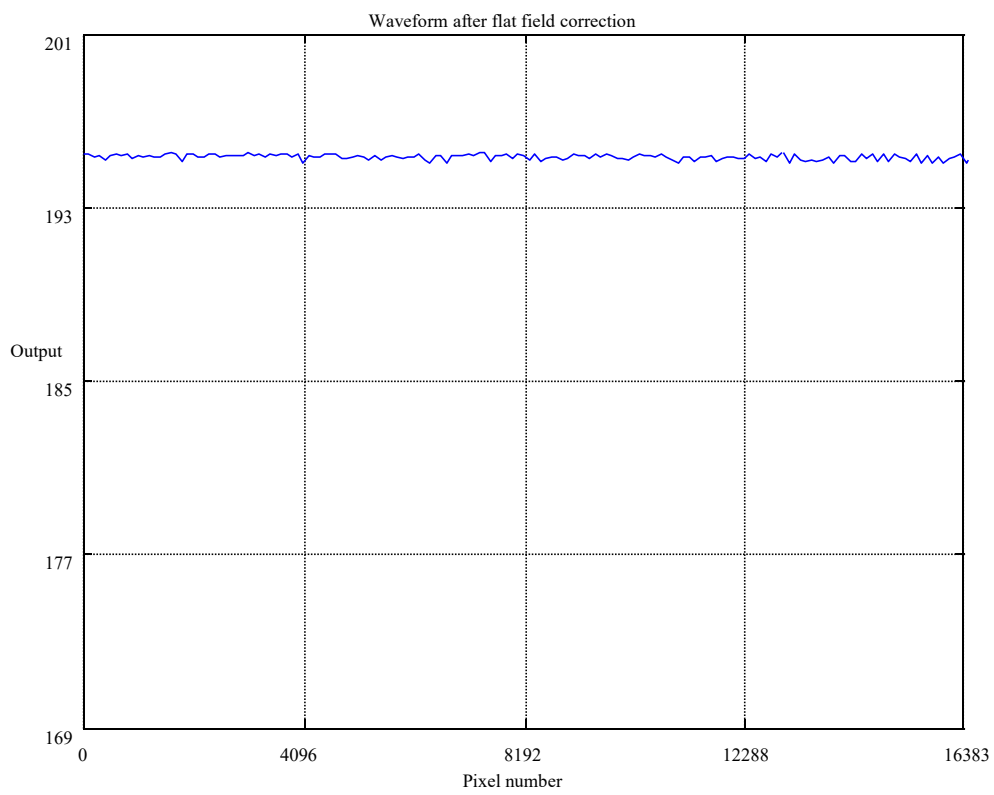


(b) After Flat Field Correction

(3) PN16KCL camera:



(a) Before Flat Field Correction



(b) After Flat Field Correction

Fig.27 Waveform of Flat Field Correction



6.13 Camera Temperature

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

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

6.14 Load/Save Configuration

PN-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

PN-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 21 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 22 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 PN-CL series camera is as follows. After connecting the camera through serial port, you can input relevant commands to configure the camera.

Table 23 PN8KCL-33KC Camera Instruction List

Command	Description
help	Show this information
list	Show Current Configurations
load	Load Configuration From Flash (0/1/2: Factory/User1/User2)
save	Save Current Configuration To Flash (1/2: User1/User2)
temp	Get Current Camera Temperature
sync	Set Synchronization Mode (0/1/2: Free Run/External Pulse/External PWM)
clnk	Set Camera Link Mode (0/1/2/3/6:
tprd	Set Line Period Time in microsecond (49.20us to 64000us)
lrps	Set LineRate (15.63 to 20326.00)
texp	Set Exposure Time in microsecond (3.500000us to 64000.000000us)
dmod	Set Data Mode (0/1/2/3: Original/Corrected/Test Pattern1/Test Pattern2)
hdir	Set Horizontal Scan Direction (0/1: Left to Right/Right to Left)
binn	Set Horizontal Binning Mode (0/1: 1x1/2x1)
sdwm	Set the scan direction working mode(0/1: Internal Control/External Control)
sdit	Set the scan direction internal control type(0/1: BottomToTop/TopToBottom)
sdrv	Set the scan direction signal polarity(0/1: Original/Reverse)
dign	Set Digital Gain (x0.01 to x8)
dios	Set Digital Offset (-1023 to 1023)
ffcl	Flat Field Calibration (line(bit0..2 for line1/line2/line3),0/1 (Init/Exec))
ffer	Flat Field Correction (0/1 Disable/Enable)
ffem	Set Flat Field Calibration Mode (0/1 Disable/Enable Calibration Reference)
ffcs	Set Flat Field Calibration Start Position (0~8192 Multiples of 16)



ffcw	Set Flat Field Calibration Width (1024~8192 Multiples of 16)
refr	Set Flat Field Data Reference for Line_R (128 to 4095)
refg	Set Flat Field Data Reference for Line_G (128 to 4095)
refb	Set Flat Field Data Reference for Line_B (128 to 4095)
wbcl	White Balance Calibration (0/1 Init/Calibrate)
wbcr	White Balance Correction (0/1 Disable/Enable)
wbpr	White Balance Reference for Red (256~4096)
wbpg	White Balance Reference for Green (256~4096)
wbpb	White Balance Reference for Blue (256~4096)
sroi	Set Region of Interest (0/1: Disable/Enable)
ries	Set ROI Start Column (0~8192 Multiples of 16)
rice	Set ROI Column Count (128~8192 Multiples of 128)
lscr	Set Line Spatial Correction Mode (0/1: Disable/Enable)
lscf	Set Line Spatial Correction Factor (0.5 to 2.0)
ldly	Set Line Delay to Correct Chromatic Aberration(-1.0 to 1.0)
pxcf	Set Parallax Correction Factor (-15 to 15)
doff	Set Black Level (0 to 1023)
angn	Set Analog Gain (1~8: x1~x8)
rbmd	Set RB Channel Mode(0/1: default/reverse)
sclr	Color Correction (0/1 Disable/Enable)
clrr	Color Correction Red-Red Gain (-2047~2047)
clrg	Color Correction Red-Green Gain (-2047~2047)
clrb	Color Correction Red-Blue Gain (-2047~2047)
clgr	Color Correction Green-Red Gain (-2047~2047)
clgg	Color Correction Green-Green Gain (-2047~2047)
clgb	Color Correction Green-Blue Gain (-2047~2047)
clbr	Color Correction Blue-Red Gain (-2047~2047)
clbg	Color Correction Blue-Green Gain (-2047~2047)
clbb	Color Correction Blue-Blue Gain (-2047~2047)
hmod	Set high speed mode (0~1)
baud	Set Camera Link Serial Port Baudrate 4800~460800

Table 24 PN8KCL-33KC2 Camera Instruction List

Command	Description
help	Show this information
list	Show Current Configurations
load	Load Configuration From Flash (0/1/2: Factory/User1/User2)
save	Save Current Configuration To Flash (1/2: User1/User2)
temp	Get Current Camera Temperature
sync	Set Synchronization Mode (0/1/2: Free Run/External Pulse/External PWM)
clnk	Set Camera Link Mode (0/1/2/3/6:



tprd	Set Line Period Time in microsecond (49.20us to 64000us)
lrps	Set LineRate (15.63 to 20326.00)
texp	Set Exposure Time in microsecond (3.500000us to 64000.000000us)
dmod	Set Data Mode (0/1/2/3: Original/Corrected/Test Pattern1/Test Pattern2)
hdir	Set Horizontal Scan Direction (0/1: Left to Right/Right to Left)
bin	Set Horizontal Binning Mode (0/1: 1x1/2x1)
sdwm	Set the scan direction working mode(0/1: Internal Control/External Control)
sdir	Set the scan direction internal control type(0/1: BottomToTop/TopToBottom)
sdrv	Set the scan direction signal polarity(0/1: Original/Reverse)
dign	Set Digital Gain (x0.01 to x8)
dios	Set Digital Offset (-1023 to 1023)
ffcl	Flat Field Calibration (line(bit0..2 for line1/line2/line3),0/1 (Init/Exec))
ffcr	Flat Field Correction (0/1 Disable/Enable)
ffcm	Set Flat Field Calibration Mode (0/1 Disable/Enable Calibration Reference)
ffcs	Set Flat Field Calibration Start Position (0~8192 Multiples of 16)
ffcw	Set Flat Field Calibration Width (1024~8192 Multiples of 16)
refr	Set Flat Field Data Reference for Line_R (128 to 4095)
refg	Set Flat Field Data Reference for Line_G (128 to 4095)
refb	Set Flat Field Data Reference for Line_B (128 to 4095)
wbel	White Balance Calibration (0/1 Init/Calibrate)
wber	White Balance Correction (0/1 Disable/Enable)
wbpr	White Balance Reference for Red (256~4096)
wbpg	White Balance Reference for Green (256~4096)
wbpb	White Balance Reference for Blue (256~4096)
sroi	Set Region of Interest (0/1: Disable/Enable)
rics	Set ROI Start Column (0~8192 Multiples of 16)
rice	Set ROI Column Count (128~8192 Multiples of 128)
lscr	Set Line Spatial Correction Mode (0/1: Disable/Enable)
lscf	Set Line Spatial Correction Factor (0.5 to 2.0)
ldly	Set Line Delay to Correct Chromatic Aberration(-1.0 to 1.0)
pxcf	Set Parallax Correction Factor (-15 to 15)
doff	Set Black Level (0 to 1023)
angn	Set Analog Gain (1~8: x1~x8)
rbmd	Set RB Channel Mode(0/1: default/reverse)
slcr	Color Correction (0/1 Disable/Enable)
clrr	Color Correction Red-Red Gain (-2047~2047)
clrg	Color Correction Red-Green Gain (-2047~2047)
clrb	Color Correction Red-Blue Gain (-2047~2047)
clgr	Color Correction Green-Red Gain (-2047~2047)
clgg	Color Correction Green-Green Gain (-2047~2047)
clgb	Color Correction Green-Blue Gain (-2047~2047)



clbr	Color Correction Blue-Red Gain (-2047~2047)
clbg	Color Correction Blue-Green Gain (-2047~2047)
clbb	Color Correction Blue-Blue Gain (-2047~2047)
hmod	Set high speed mode (0~1)
baud	Set Camera Link Serial Port Baudrate 4800~460800

Table 25 PN8KCL-80KT Camera Instruction List

Command	Description
help	Show this information
list	Show Current Configurations
load	Load Configuration From Flash (0/1/2: Factory/User1/User2)
save	Save Current Configuration To Flash (1/2: User1/User2)
temp	Get Current Camera Temperature
sync	Set Synchronization Mode (0/1/2: Free Run/External Pulse/External PWM)
clk	Set Camera Link Mode (0 to 6: 2tap@8bit/4tap@8bit/8tap@8bit/10tap@8bit/2tap@10bit/4tap@10bit/8tap@10bit)
tprd	Set Line Period Time in microsecond (49.00us to 64000us)
lrps	Set LineRate (15.63 to 20409.00)
texp	Set Exposure Time in microsecond (3.500000us to 64000.000000us)
dmod	Set Data Mode (0/1/2/3: Original/Corrected/Test Pattern1/Test Pattern2)
hdir	Set Horizontal Scan Direction (0/1: Left to Right/Right to Left)
bin	Set Horizontal Binning Mode (0/1: 1x1/2x1)
sdwm	Set the scan direction working mode(0/1: Internal Control/External Control)
sdir	Set the scan direction internal control type(0/1: BottomToTop/TopToBottom)
sdrv	Set the scan direction signal polarity(0/1: Original/Reverse)
dign	Set Digital Gain (x0.01 to x8)
dios	Set Digital Offset (-1023 to 1023)
ffcl	Flat Field Calibration (line(bit0..2 for line1/line2/line3),0/1 (Init/Exec))
ffcr	Flat Field Correction (0/1 Disable/Enable)
ffcm	Set Flat Field Calibration Mode (0/1 Disable/Enable Calibration Reference)
ffcs	Set Flat Field Calibration Start Position (0~8192 Multiples of 16)
ffcw	Set Flat Field Calibration Width (1024~8192 Multiples of 16)
refm	Set Flat Field Data Reference (128 to 4095)
sroi	Set Region of Interest (0/1: Disable/Enable)
rics	Set ROI Start Column (0~8192 Multiples of 16)
rice	Set ROI Column Count (128~8192 Multiples of 128)
lscr	Set Line Spatial Correction Mode (0/1: Disable/Enable)
lscf	Set Line Spatial Correction Factor (0.5 to 2.0)
ldly	Set Line Delay to Correct Chromatic Aberration(-1.0 to 1.0)
pxcf	Set Parallax Correction Factor (-15 to 15)
doff	Set Black Level (0 to 1023)



angn	Set Analog Gain (1~8: x1~x8)
hmod	Set high speed mode (0~1)
baud	Set Camera Link Serial Port Baudrate 4800~460800

Table 26 PN16KCL-51KM Camera Instruction List

Command	Description
help	Show this information
list	Show Current Configurations
load	Load Configuration From Flash (0/1/2: Factory/User1/User2)
save	Save Current Configuration To Flash (1/2: User1/User2)
temp	Get Current Camera Temperature
sync	Set Synchronization Mode (0/1/2: Free Run/External Pulse/External PWM)
clnk	Set Camera Link Mode (0 to 6: 2tap@8bit/4tap@8bit/8tap@8bit/10tap@8bit/2tap@10bit/4tap@10bit/8tap@10bit)
tprd	Set Line Period Time in microsecond (97.99us to 64000us)
lrps	Set LineRate (15.63 to 10205.00)
texp	Set Exposure Time in microsecond (3.500000us to 64000.000000us)
dmod	Set Data Mode (0/1/2/3: Original/Corrected/Test Pattern1/Test Pattern2)
hdir	Set Horizontal Scan Direction (0/1: Left to Right/Right to Left)
bin	Set Horizontal Binning Mode (0/1: 1x1/2x1)
dign	Set Digital Gain (x0.01 to x8)
dios	Set Digital Offset (-1023 to 1023)
ffcl	Flat Field Calibration (line(bit0..2 for line1/line2/line3),0/1 (Init/Exec))
ffcr	Flat Field Correction (0/1 Disable/Enable)
ffem	Set Flat Field Calibration Mode (0/1 Disable/Enable Calibration Reference)
ffcs	Set Flat Field Calibration Start Position (0~8192 Multiples of 16)
ffcw	Set Flat Field Calibration Width (1024~8192 Multiples of 16)
refm	Set Flat Field Data Reference (128 to 4095)
sroi	Set Region of Interest (0/1: Disable/Enable)
rics	Set ROI Start Column (0~8192 Multiples of 16)
rice	Set ROI Column Count (128~8192 Multiples of 128)
lscr	Set Line Spatial Correction Mode (0/1: Disable/Enable)
lscf	Set Line Spatial Correction Factor (0.5 to 2.0)
doff	Set Black Level (0 to 1023)
angn	Set Analog Gain (1~4: x1~x4)
hmod	Set high speed mode (0~1)
baud	Set Camera Link Serial Port Baudrate 4800~460800

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 Device Control Category

Feature	Value
- DeviceControl	
DeviceVendorName	I-TEKOptoElectronicsCo.,Ltd.
DeviceModelName	PN8KCL-33KC
DeviceManufactureInfo	I-TEKOptoelectronics
DeviceVersion	0103-810A
DeviceSerialNumber	2320H041
DeviceScanType	LineScan
DeviceProtocol	Ascii_Only
McuTemperature	34.810
SensorTemperature	0.000
BaudRate	Baud460800
Device Clock Frequency	85MHz

Fig.28 Device Control Category

- **DeviceVendorName**
Device vendor name.
- **DeviceModelName**
Device model name.
- **DeviceManufactureInfo**
Device manufacturer information.
- **DeviceVersion**
Device version.
- **DeviceSerialNumber**
Device serial number.



- **DeviceScanType**
Device scan type.
- **DeviceProtocol**
Device protocol.
- **MCUTemperature**
MCU temperature.
- **SensorTemperature**
Sensor temperature.
- **DeviceSerialPortBaudRate**
Device serial port rate. The enumeration names as follows:
 - Baud9600
 - Baud19200
 - Baud38400
 - Baud57600
 - Baud115200
 - Baud230400
 - Baud460800
- **DeviceClockFrequency**
Device clock frequency. The enumeration names as follows:
 - 85MHz
 - 70MHz
 - 60MHz

8.2 Image Format Control Category

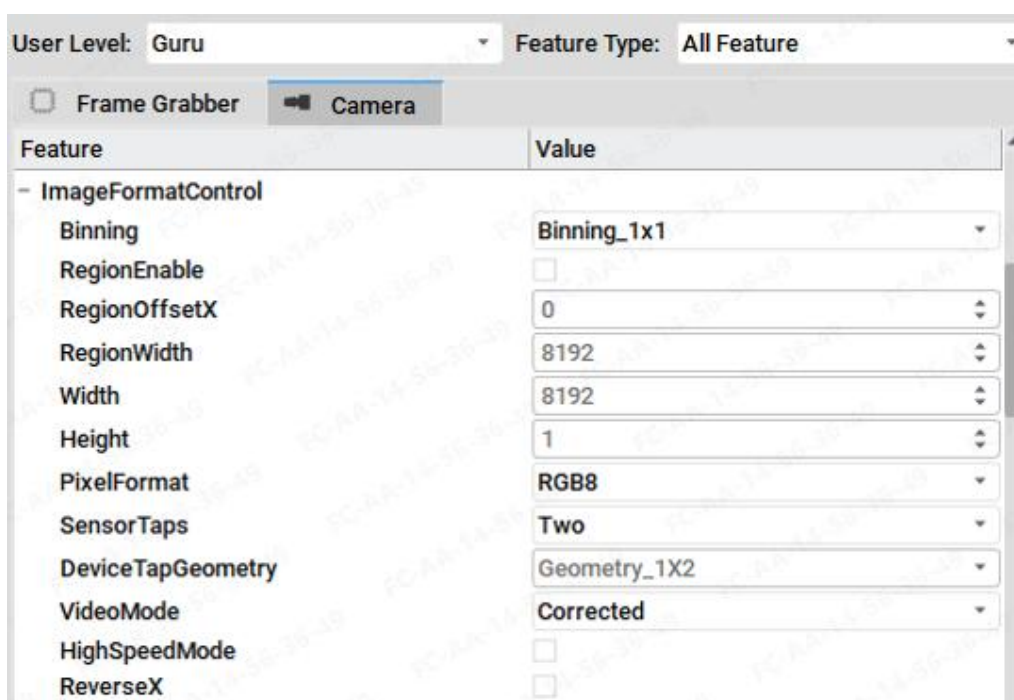


Fig.29 Image Format Control Category

- **Binning**
Binning. The enumeration names as follows:
 - Binning_1x1
 - Binning_2x1
- **RegionEnable**
Enable region of interest.
- **RegionOffsetX**
ROI horizontal offset.
- **RegionWidth**
ROI width.
- **Width**
Actual width of output image.
- **Height**
Actual height of output image.
- **PixelFormat**
Pixel format. The enumeration names as follows:
 - RGB8: RGB color 8bit, only color camera can set this enumeration
 - RGB10: RGB color 10bit, only color camera can set this enumeration
 - Mono8: Monochrome 8bit, only monochrome camera can set this enumeration



- Mono10: Monochrome 10bit, only monochrome camera can set this enumeration
- **SensorTaps**
Number of sensor taps. The enumeration names as follows:
 - Two
 - Three: Only color camera can set this enumeration
 - Four: Only monochrome camera can set this enumeration
 - Eight: Only monochrome camera can set this enumeration
 - Ten: Only monochrome camera can set this enumeration
- **DeviceTapGeometry**
Tap arrangement.
- **VideoMode**
Output image mode. The enumeration names as follows:
 - Original: Original image
 - Corrected: Corrected image
 - TestPattern1: Test image 1
 - TestPattern2: Test image 2
- **HighSpeedMode**
High speed mode.
- **ReverseX**
Horizontal flipping.

8.3 Acquisition Control Category

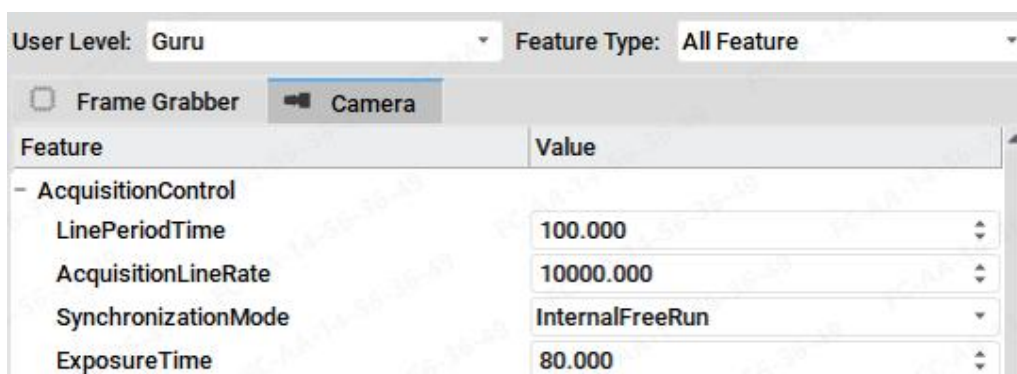


Fig.30 Acquisition Control Category

- **LinePeriodTime**
Acquisition line period, unit is us.
- **AcquisitionLineRate**
Acquisition line rate, unit is Hz.

● SynchronizationMode

Synchronization mode. The enumeration names as follows:

- InternalFreeRun: Free-Run
- ExternalPulse: External pulse
- ExternalPWM: External PWM

● ExposureTime

Exposure time, unit is us.

8.4 Analog Control Category



Fig.31 Analog Control Category

● AnalogGain

Analog gain. The enumeration names as follows:

- x1
- x2
- x3
- x4
- x5: PN16KCL camera does not support this enumeration
- x6: PN16KCL camera does not support this enumeration
- x7: PN16KCL camera does not support this enumeration
- x8: PN16KCL camera does not support this enumeration

8.5 IO Control Category

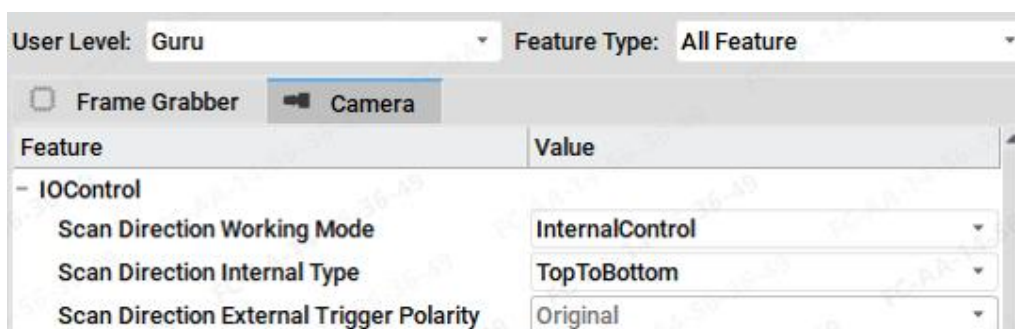


Fig.32 IO Control Category

● ScanDirectionWorkingMode



Scan direction working mode. The enumeration names as follows:

- InternalControl: Internal control
- ExternalControl: External control

- **ScanDirectionInternalType**

Scan direction internal control type. The enumeration names as follows:

- BottomToTop: From bottom to top
- TopToBottom: From top to bottom

- **ScanDirectionExternalTriggerPolarity**

Scan direction external trigger polarity. The enumeration names as follows:

- Original: Same as original signal
- Reverse: Opposite to original signal

8.6 Image Correction Category

Feature	Value
- ImageCorrection	
ParallaxCorrectionFactor	0.000
SpatialCorrectionEnable	☐
SpatialCorrectionFactor	1.000
TDIMode(Fine)	0.000
TDIMode(Coarse)	Delay1Line
ColorCorrectionEnable	☐
ColorCorrectionRRGain	1024
ColorCorrectionRGGain	0
ColorCorrectionRBGain	0
ColorCorrectionRGGain	0
ColorCorrectionGGGain	1024
ColorCorrectionGBGain	0
ColorCorrectionBRGain	0
ColorCorrectionBGGain	0
ColorCorrectionBBGain	1024

Fig.33 Image Correction Category

- **ParallaxCorrectionFactor**

Parallax correction factor.

- **SpatialCorrectionEnable**

Enable spatial correction.



- **SpatialCorrectionFactor**
Spatial correction factor.
- **TDIFineAdjust**
TDI fine adjustment.
- **TDICoarse**
TDI coarse adjustment. The enumeration names as follows:
 - Delay1Line
 - Delay2Line
- **ColorCorrectionEnable**
Enable color correction function, only color camera can set this parameter.
- **ColorCorrectionRedRedGain**
Color correction of red gain in R channel, only color camera can set this parameter.
- **ColorCorrectionRedGreenGain**
Color correction of green gain in R channel, only color camera can set this parameter.
- **ColorCorrectionRedBlueGain**
Color correction of blue gain in R channel, only color camera can set this parameter.
- **ColorCorrectionGreenRedGain**
Color correction of red gain in G channel, only color camera can set this parameter.
- **ColorCorrectionGreenGreenGain**
Color correction of green gain in G channel, only color camera can set this parameter.
- **ColorCorrectionGreenBlueGain**
Color correction of blue gain in G channel, only color camera can set this parameter.
- **ColorCorrectionBlueRedGain**
Color correction of red gain in B channel, only color camera can set this parameter.
- **ColorCorrectionBlueGreenGain**
Color correction of green gain in B channel, only color camera can set this parameter.
- **ColorCorrectionBlueBlueGain**
Color correction of blue gain in B channel, only color camera can set this parameter.

8.7 Digital Control Category

Feature	Value
- DigitalControl	
Gain	1.000
Offset	0
Black Level	2
WhiteBalanceRedGain	1024
WhiteBalanceGreenGain	1024
WhiteBalanceBlueGain	1024
WhiteBalanceEnable	☒
WhiteBalanceInitialize	Exec
WhiteBalanceCalibrate	Exec

Fig.34 Digital Control Category

- **Gain**
Digital gain.
- **Offset**
Digital offset.
- **BlackLevel**
Black level, used to adjust the bottom value of camera output in dark field condition. The smaller black level is, the smaller gray value of image in dark field condition is.
- **WhiteBalanceRedGain**
White balance R channel gain, only color camera can set this parameter.
- **WhiteBalanceGreenGain**
White balance G channel gain, only color camera can set this parameter.
- **WhiteBalanceBuleGain**
White balance B channel gain, only color camera can set this parameter.
- **WhiteBalanceEnable**
Enable white balance function, only color camera can set this parameter.
- **WhiteBalanceInit**
Initialize white balance correction, which can reset white balance parameters to default setting. Only color camera can set this parameter.
- **WhiteBalanceExec**
Execute white balance correction, that is, execute white balance correction in current condition.



Only color camera can set this parameter.

8.8 Lookup Table Category

Feature	Value
LUTControl	
Gamma	0.010

Fig.35 Lookup Table Category

- **Gamma**
Gamma correction factor.

8.9 Flat Field Correction Category

Feature	Value
FlatFieldCorrection	
FlatField Correction Enable	☒
FlatField Correction Low Pass Filter	0
FlatField Correction Reference Mode	☐
FlatField Correction Reference Red	768
FlatField Correction Reference Green	768
FlatField Correction Reference Blue	768
FlatField Correction Offset X	0
FlatField Correction Width	8192
FlatField Correction Line Select	Calibrate
Flat Field Correction Start	Exec
Flat Field Correction Reset	Exec

Fig.36 Flat Field Correction Category

- **FlatFieldCorrectionEnable**
Enable flat field correction.
- **FlatFieldCorrectionLowPassFilter**
Flat field correction low pass filtering.
- **FlatFieldCorrectionReferenceMode**
Flat field correction reference mode. Check this parameter to correct gray value of the selected region to the set value.



- **FlatFieldCorrectionReferenceRed**
Target gray value of flat field correction R channel, only color camera can set this parameter.
- **FlatFieldCorrectionReferenceGreen**
Target gray value of flat field correction G channel, only color camera can set this parameter.
- **FlatFieldCorrectionReferenceBlue**
Target gray value of flat field correction B channel, only color camera can set this parameter.
- **FlatFieldCorrectionReference**
Target gray value of flat field correction monochrome channel, only monochrome camera can set this parameter.
- **FlatFieldCorrectionOffsetX**
Horizontal offset of flat field correction region.
- **FlatFieldCorrectionWidth**
Width of flat field correction region.
- **FlatFieldCorrectionLineSelect**
Flat field correction line select. The enumeration names as follows:
 - Calibrate: Only color camera can set this enumeration
 - R: Only color camera can set this enumeration
 - G: Only color camera can set this enumeration
 - R/G: Only color camera can set this enumeration
 - B: Only color camera can set this enumeration
 - R/B: Only color camera can set this enumeration
 - G/B: Only color camera can set this enumeration
 - R/G/B: Only color camera can set this enumeration
 - All: Only monochrome camera can set this enumeration
- **FlatFieldCorrectionExec**
Execute flat field correction.
- **FlatFieldCorrectionInit**
Initialize flat field correction.

8.10 User Set Control Category

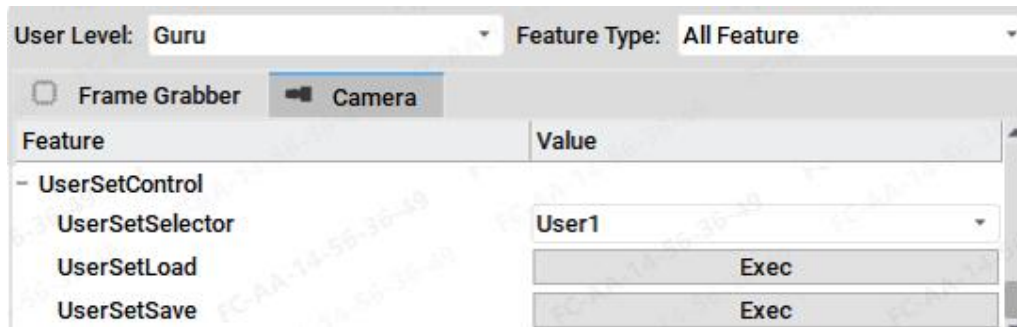


Fig.37 User Set Control Category

- **UserSetSelector**
User configuration selector. The enumeration names as follows:
 - Factory: Factory configuration
 - User1: User configuration 1
 - User2: User configuration 2
- **UserSetLoad**
Load selected camera configuration.
- **UserSetSave**
Save selected camera configuration.



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.



10 After Sales and Warranty Policy

Our products strictly follow the national “three guarantees” policy, with a one-year warranty period for the entire machine (if there are special agreements, the contract or agreement shall prevail). For problems caused by non use reasons during the warranty period, our company can provide free repairs; Any problems caused by usage reasons can be repaired for a fee by our company. The warranty period for repaired parts shall be recalculated from the date of replacement.

If there are problems with the product beyond the warranty period, our company can provide paid repairs, and the warranty period for the repaired parts is 3 months.

For any problems that users encounter during the use of the camera, please contact our technical support in a timely manner, and we will provide you with service as soon as possible.