# Unibrain Ultra Compact firewire cameras

# Models: 530/550/630/830/850

# User Operation Manual

Version 2.0

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unibrain

The 1394 Innovators

# Legal Notice

**For Customers in U.S.A.**

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense. You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment. The shielded interface cable recommended in this manual must be used with this equipment in order to comply with the limits for a computing device pursuant to Subpart J of Part 15 of FCC Rules.

**For customers in Europe**

This apparatus has been certified to meet or exceed the standards for CE compliance per the Council Directives. Pertinent testing documentation is available for verification.

**For customers in Canada**

This apparatus complies with the Class B limits for radio noise emissions set out in the Radio Interference Regulations.

**Pour utilisateurs au Canada**

Cet appareil est conforme aux normes Classe B pour bruits radioélectriques, spécifiées dans le Règlement sur le brouillage radioélectrique.

**Life support applications**

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Allied customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify allied for any damages resulting from such improper use or sale.

# Before You Start

This manual should help you in installation and setting of the camera and we recommend you to carefully follow the instruction described.

To ensure that your warranty remains valid, read the manual carefully before using the camera.

DO NOT disassemble, modify or repair the camera since there is no user serviceable part inside and may void warranty. For prevention of fire or electric shock DO NOT remove screws or cover from the camera.

Operation in wet are is NOT recommended and camera SHOULD NOT be exposed to rain or moisture. For prolong life and use of camera's CCD, do not point the camera directly to the sun or strong spotlight which may result CCD blooming and permanent damage. DO NOT operate camera beyond operation temperature range stated and AVOID usage in conditions exceeding 90% humidity.

DO NOT use unregulated power supply source to prevent camera's circuit damage.

Use soft materials such as lens tissue or cotton tipped applicator with ethanol for CCD faceplate cleaning ONLY when necessary and AVOID contact with fingers or any hard object. Do not use solvent, abrasives or detergent in case of cleaning camera body.

Warranty shall be voided for improper usage or fault caused by user or damage caused by other equipments due to negligence

# Warranty

Unibrain warrants the original components free of defects for one year from purchase date. This warranty covers failures and damage due to defect which may occur during normal use. It does not cover damages or failure resulting from mishandling, abuse, misuse or modification. For every repair or replacement, RMA numbers must be obtained in advance.

# Disclaimer

The information in this document has been carefully checked and is believed to be reliable. However, no responsibility is assumed for inaccuracies, nor is any responsibility assumed by Unibrain. There is no legal obligation to documenting internal relationships in any functional module of its products, which is realized in either hardware or software.

# Copyright

# Table of contents

# 1. Introduction

## 1.1. Overview

Unibrain's **Fire-i ultra compact Industrial Firewire cameras (Bonsai) series** opens up a new horizon in digital image processing; by providing more features in a very small form factor while still maintaining excellent cost effectiveness and high quality. These models are comprised of a wide range of resolutions and are equipped with a FireWire interface and a trigger to suit the needs of every application. The **Bonsai series** offer the highest frame rate in each of its resolutions compared with other products currently available. The very small form factor design has expanded the implementation and broadens application areas by eliminating the limits that currently exist due to size and weight.

A selection of cameras is available which consist of sensors sizes (1/3", 1/1.8") and resolution (VGA, XGA, UXGA) both in color and black and white.

| | Model Name | CCD | CMOS | Resolution | FPS at Max Res. |
|---|---|---|---|---|---|
| Black & White | Fire-i 830b | 1/1.8" | | 1600x1200 | 16 |
| | Fire-i 630b | 1/3" | | 1024 x 768 | 36 |
| | Fire-i 530b | 1/3" | | 640 x 480 | 86 |
| | Fire-i 550b | | 1/3" | 752 x 480 | 60 |
| Color | Fire-i 830c | 1/1.8" | | 1600x1200 | 16 |
| | Fire-i 850c | | 1/2" | 2048x1536 | 10 |
| | Fire-i 630c | 1/3" | | 1024 x 768 | 36 |
| | Fire-i 530c | 1/3" | | 640 x 480 | 86 |
| | Fire-i 550c | | 1/3" | 752 x 480 | 60 |

**Unibrain Bonsai camera series** possess unique features that support external trigger mode 0~5 plus 14,15, multi camera auto-sync, one-shot and multi-shot, a wide range of shutter speed, RS232C pass through via FIREWIRE™, Fast format 7, partial scan, and a high speed up trigger frame rate, which would provide maximum flexibility in applications. Industrial Screw Lock cable support has been added for more reliable connectivity.

**Software support**

All cameras are fully supported from Unibrain's Fire-i™ drivers and software and embed a Fire-i API™ SDK license. Latest versions of Fire-i™ software and SDK can be downloaded from our web site: http://www.unibrain.com/downloads/

## 1.2. Dimensions and Description

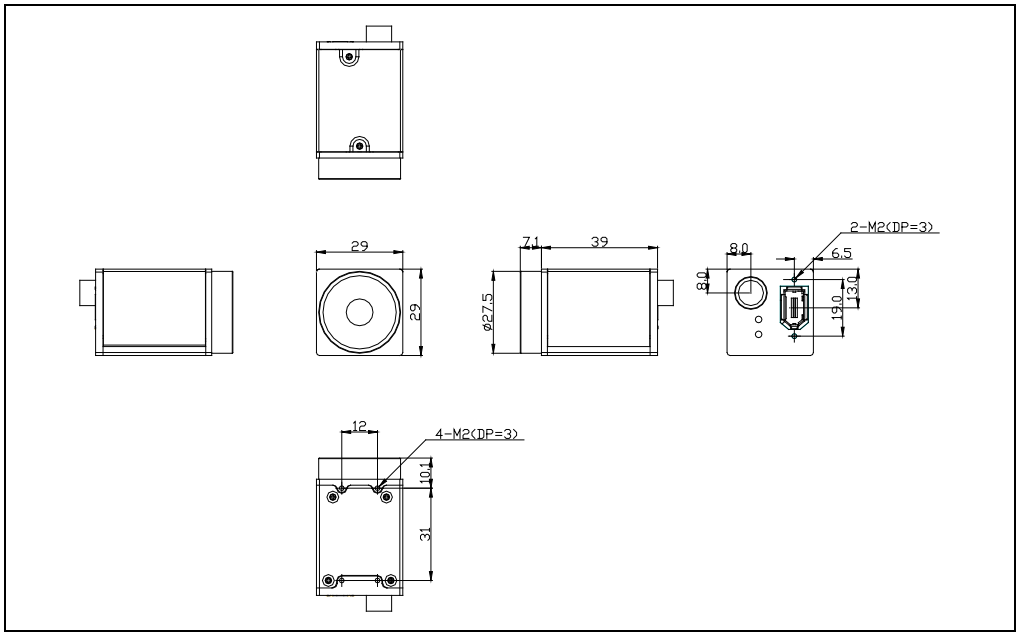
Camera Body Size : 29 (w) x 29 (H) x 39(D) mm

Camera Body Weight: approx. 63 gram

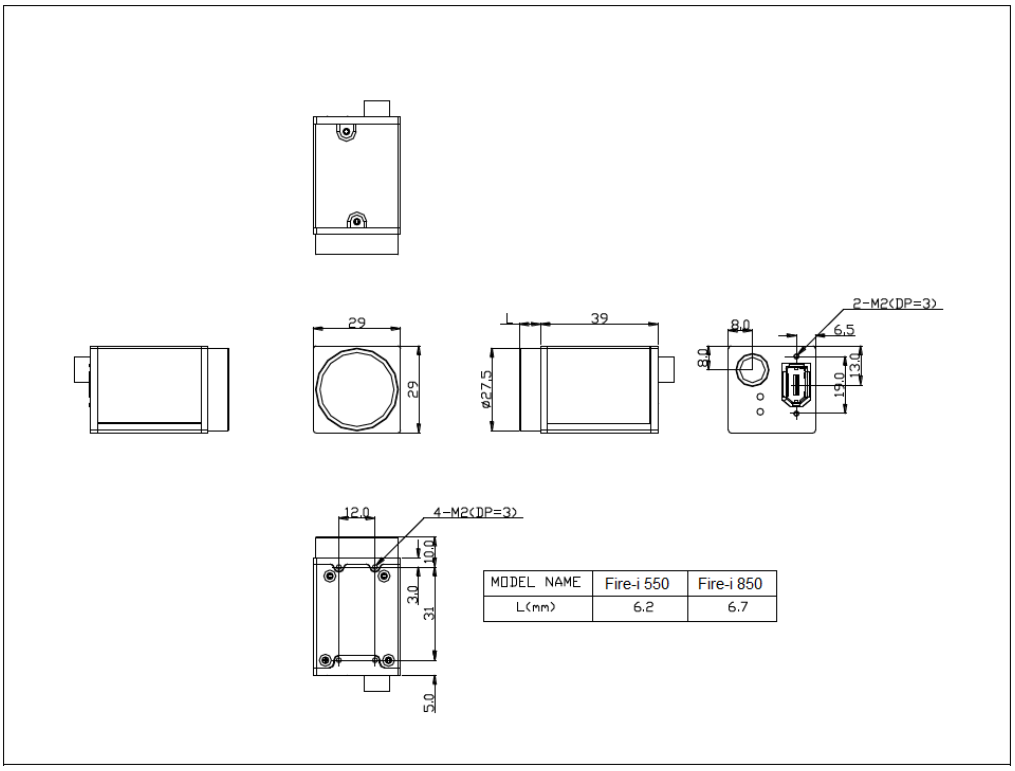
Operation Temperature: -5°C ~ 45°C / Storage Temperature: -20°C ~ 65°C

Avoid operation in environment of high humidity over 90% and allow sufficient airflow for prevention of heat buildup.

Fire-i 530, 630, 830

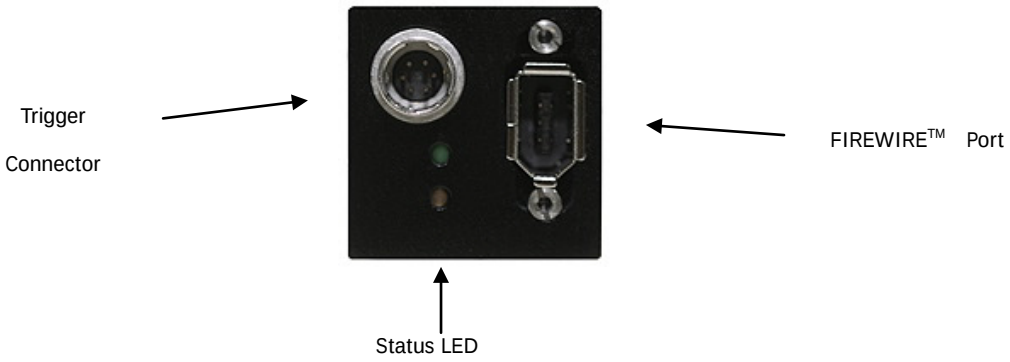


Fire-i 550, 850



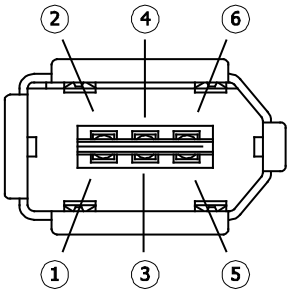

## 1.3. Camera Interface

The camera's interface is located on the back of the camera (assuming lens mount is front) as per the following.



## 1.4. Firewire Port

The industry standard FireWire (IEEE-1394) port has the following pin assignment. Data and control of the camera and power are provided by the firewire port.

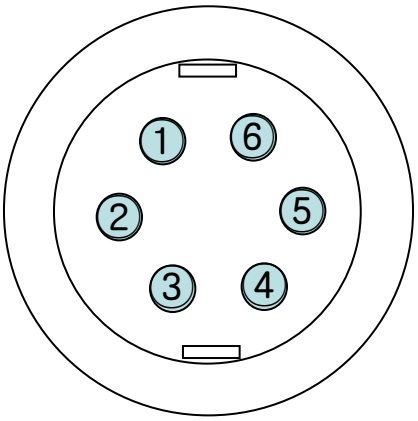



| Pin | Signal |
|---|---|
| 1 | VP |
| 2 | VG(Ground) |
| 3 | TPB- |
| 4 | TPB+ |
| 5 | TPA |
| 6 | TPA- |

CAUTION: DO NOT reverse the polarity. This could result in damage to the camera.

### 1.4.1. Trigger Connector Port

External Trigger Connector provides the access to multiple I/O.




<Camera Side>

| Pin | I/O | Signal Name |
|---|---|---|
| 1 | O | TX232 |
| 2 | I | RX232 |
| 3 | X | NC |
| 4 | O | Strobe |
| 5 | I | Ext. Trigger |
| 6 | I | GND |

Note: NC pins must have no connection

### 1.4.2. Status LED

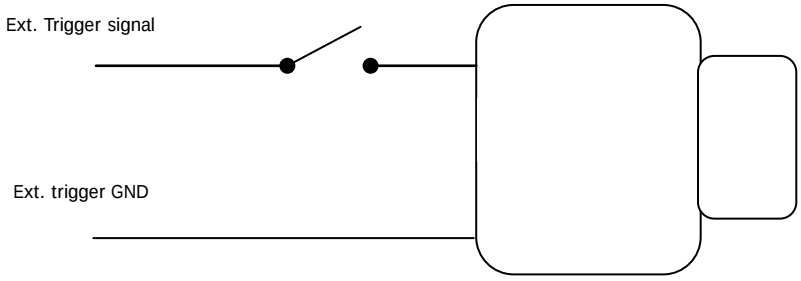
| LED Status | Isochronous channel | Packet Transfer |
|---|---|---|
| RED | Disable | NO |
| GREEN | Enable | YES |
| OFF | Enable | NO |

Remark: Also when power off, LED is OFF

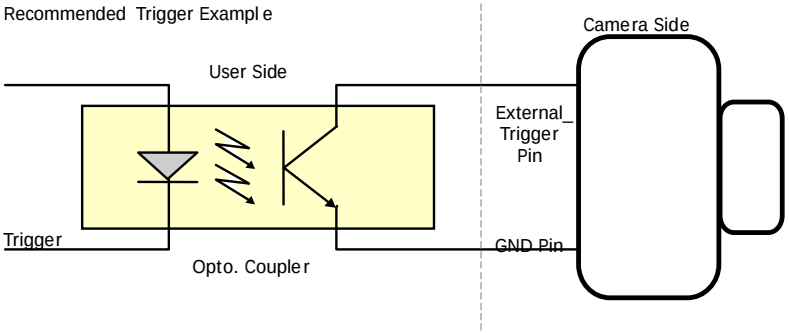
## 1.5. Electrical Operating Condition

**Trigger**

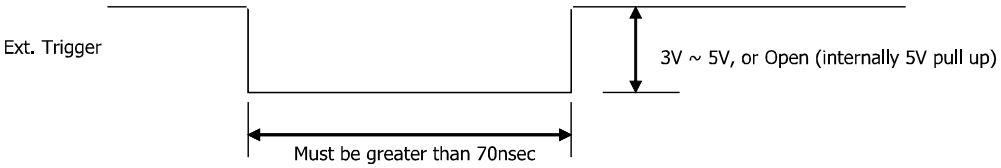
Recommended Trigger Example 1




Recommended Trigger Example 2

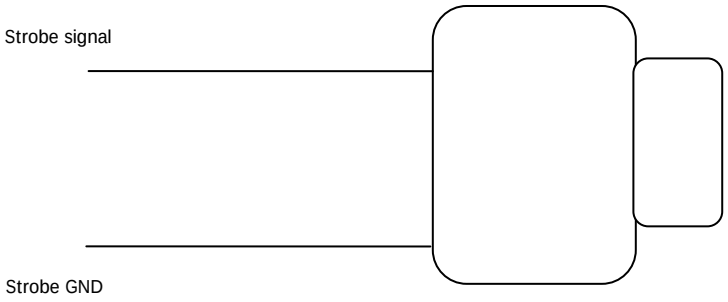



Electrical Specification

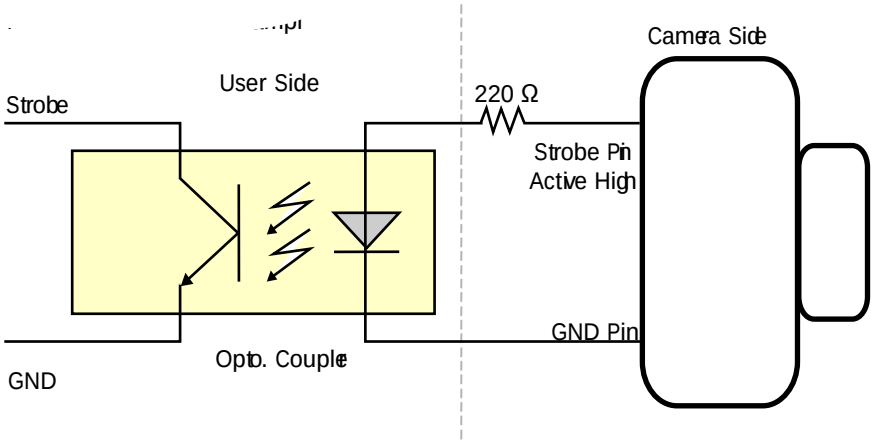


**Strobe**

Recommended Strobe Example 1



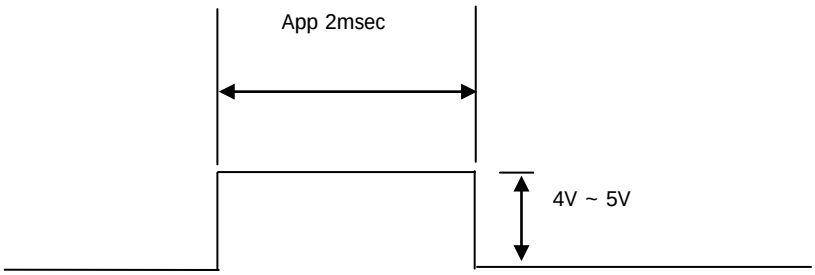

Recommended Strobe Example 2




Electrical Specification

Strobe

User can set strobe duration



## 1.6. Pixel Data

The **Unibrain Fire-i ultra compact form Series** complies with the IIDC 1394-Based Digital Camera Specification V1.31 where data packets are transmitted by a FireWire™ interface as isochronous packets. Every video format, mode and frame rate has a different video data format. (Pixel data source: IIDC V1.31 Specification)

**Isochronous Data Block Packet Format**

| 0 - 7 | 8 - 15 | 16 - 23 | | 24 - 31 | |
|---|---|---|---|---|---|
| Data Length | | tg | channel | tCode | Sy |
| Header CRC | | | | | |
| Video data payload | | | | | |
| Data CRC | | | | | |

Where the following fields are defined in the IEEE 1394 standard as:

***Data length****: number of bytes in the data field* ***tg:*** *(tag field) shall be set to zero*

***channel:*** *isochronous channel number, as programmed in the iso_channel field of the cam_sta_ctrl register*

***tCode:*** *(transaction code) shall be set to the isochronous data block packet tCode*

***sy****: (synchronization value) shall be set to 0001h on the first isochronous data block of a frame, and shall be set to zero on all other isochronous data blocks*

***Video data payload:*** *shall contain the digital video information, as defined in the following sections* of the Video data Payload Structure

Pn : Pixel number / packet

K : Pn x n (n = 0.....N-1)

(Pn x N = Total pixel number /frame)

**<YUV (4: 2: 2) format >**

| | | | |
|---|---|---|---|
| U-(K+0) | Y-(K+0) | V-(K+0) | Y-(K+1) |
| U-(K+2) | Y-(K+2) | V-(K+2) | Y-(K+3) |
| U-(K+4) | Y-(K+4) | V-(K+4) | Y-(K+5) |
| | | | |
| U-(K+Pn-6) | Y-(K+Pn-6) | V-(K+Pn-6) | Y-(K+Pn-5) |
| U-(K+Pn-4) | Y-(K+Pn-4) | V-(K+Pn-4) | Y-(K+Pn-3) |
| U-(K+Pn-2) | Y-(K+Pn-2) | V-(K+Pn-2) | Y-(K+Pn-1) |

**<YUV (4: 1: 1) format >**

| | | | |
|---|---|---|---|
| U-(K+0) | Y-(K+0) | Y-(K+1) | V-(K+0) |
| Y-(K+2) | Y-(K+3) | U-(K+4) | Y-(K+4) |
| Y-(K+5) | V-(K+4) | V-(K+4) | Y-(K+5) |

| | | | |
|---|---|---|---|
| | | | |
| U-(K+Pn-8) | Y-(K+Pn-8) | Y-(K+Pn-7) | V-(K+Pn-8) |
| Y-(K+Pn-6) | Y-(K+Pn-5) | U-(K+Pn-4) | Y-(K+Pn-4) |
| Y-(K+Pn-3) | V-(K+Pn-4) | Y-(K+Pn-2) | Y-(K+Pn-1) |

**<Y(Mono) Format >**

| | | | |
|---|---|---|---|
| Y-(K+0) | Y-(K+1) | Y-(K+2) | Y-(K+3) |
| Y-(K+4) | Y-(K+5) | Y-(K+6) | Y-(K+7) |
| | | | |
| Y-(K+Pn-8) | Y-(K+Pn-7) | Y-(K+Pn-6) | Y-(K+Pn-5) |
| Y-(K+Pn-4) | V-(K+Pn-3) | Y-(K+Pn-2) | Y-(K+Pn-1) |

**<Y(Mono) Format >**

| | |
|---|---|
| High Byte | Low Byte |

| | |
|---|---|
| Y-(K+0) | Y-(K+1) |
| Y-(K+2) | Y-(K+3) |
| | |
| Y-(K+Pn-4) | Y-(K+Pn-3) |
| V-(K+Pn-2) | Y-(K+Pn-1) |

**Data Structure**

**<Y, R, G, B >**

**ach component has 8 bit data. The data type is “Unsigned Char”**

| | Signal Level (Decimal) | Data (Hexadecimal) |
|---|---|---|
| Highest | 255 | 0xFF |
| | 254 | 0xFE |
| | . | . |
| | . | . |
| | 1 | 0x01 |
| Lowest | 0 | 0x00 |

**<U, V>**

Each component has 8 bit data. The data type is “Straight Binary”

| | Signal Level (Decimal) | Data (Hexadecimal) |
|---|---|---|
| Highest(+) | 127 | 0xFF |
| | 126 | 0xFE |
| | . | . |
| | . | . |
| | 1 | 0x81 |
| Lowest | 0 | 0x80 |
| | -1 | 0x7F |
| | . | . |
| | . | . |
| | -127 | 0x01 |
| Lowest | -128 | 0x00 |

**<Y (Mono16)>**

Y component has 16 bit data. The data type is “Unsigned Short (big-endian)”

| Y | Signal Level (Decimal) | Data (Hexadecimal) |
|---|---|---|
| Highest | 65535 | 0xFFFF |
| | 65534 | 0xFFFE |
| | . | . |
| | . | . |
| | 1 | 0x0001 |
| Lowest | 0 | 0x0000 |

# 2. Camera Specifications

## 2.1. Monochrome cameras

### 2.1.1. Fire-i 830b Specification

| Features | | |
|---|---|---|
| Image Sensor Type | | 1/1.8-inch Interline CCD (Sony ICX274AL) |
| Effective pixels | | 2,010,000 pixels 1628(H) x 1236(V) |
| Picture Size | | 1600x1200, 1280x960, 1024x768, 800x600, 640x480 |
| Cell Size(um) | | 4.4 x 4.4 |
| Real Frame Rate | | 15, 7.5, 3.75, 1.875 / Y8, Y16<br>16 (1600x1200, Format 7 mode 0)<br>32 (640x480, Format 7 mode 0)<br>29 (800x600, Format7 mode 1, 2x2 binning)<br>29 (1600x600, Format7 mode 2, 1x2 binning) |
| Lens Mount | | C Mount |
| Scanning System | | Progressive System |
| Binning | | 2x2, 1x2 |
| Format7 | | Partial Scan (Unit: 4x4) |
| Trigger | Edge | Rising Edge or Falling Edge |
| | Mode | 0, 1, 2, 3, 4, 5, 14,15 |
| | Source | External Trigger or Software Trigger |
| Strobe | | Active High, Support Normal Mode or Trigger Mode. |
| Multi-camera auto sync | | -144 us ~ +144 us at 15,7.5 frame rate |
| Memory Save/Load | | 16 Channels(0:factory, 1~4:feature, 5~15:mode/feature) |
| One-shot/Multi-shot | | 65535 Shots |
| Control Functions | | Brightness, Sharpness, Gamma, Auto-Exposure, Shutter, Gain, Pan/Tilt,<br>High speed up trigger frame rate |
| SIO(RS-232) | | IIDC v1.31 version : Path through or custom command |
| Frame Delay from Read-out | | Min. 106us |
| Digital Interface / Transfer Rate | | IEEE 1394 1 port(6pin) / 400Mpbs |
| Gain | | 0 ~ 27 dB (Manual or Auto) |
| Shutter Speed | | 1 usec ~ 3600 sec (Manual or Auto) |
| Data Depth | | 12 bit |
| S/N Ratio | | 56dB or better |
| Supply Voltage & Power | | Less than 2 Watts (@12V DC) |
| External Dimension / Weight | | 29(W) x 29(H) x 39(D) mm / Approx 63g |
| Operation Temp. | | -5°C to 45°C |

Remark: Camera Specification described above may be changed without notice

### 2.1.2. Fire-i 630b Specification

| Features | | |
|---|---|---|
| Image Sensor Type | | 1/3-inch Interline CCD (Sony ICX204AL) |
| Effective pixels | | 800,000 pixels 1034(H) x 779(V) |
| Picture Size | | 1024x768, 800x600, 640x480, 320x240 |
| Cell Size(um) | | 4.65x4.65 |
| Real Frame Rate | | 30, 15, 7.5, 3.75, 1.875 / Y8, Y16<br>36 (1024x768, Format 7 mode 0)<br>58 (1024x384, Format7 mode2, 1x2 binning)<br>58 (512x384, Format7 mode1, 2x2 binning) |
| Lens Mount | | C Mount |
| Scanning System | | Progressive System |
| Binning | | Not supported |
| Format7 | | Partial Scan (Unit: 4x4) |
| Trigger | Edge | Rising Edge or Falling Edge |
| | Mode | 0, 1, 2, 3, 4, 5, 14, 15 |
| | Source | External Trigger or Software Trigger |
| Strobe | | Active High, Support Normal Mode or Trigger Mode. |
| Multi-camera auto sync | | -144 us ~ +144 us at 30,15,7.5 frame rate |
| Memory Save/Load | | 16 Channels(0:factory, 1~4:feature, 5~15:mode/feature) |
| One-shot/Multi-shot | | 65535 Shots |
| Control Functions | | Brightness, Sharpness, Gamma, Auto-Exposure, Shutter, Gain, Pan/Tilt,<br>High speed up trigger frame rate |
| SIO(RS-232) | | IIDC v1.31 version : Path through or custom command |
| Frame Delay from Read-out | | Min. 70us |
| Digital Interface / Transfer Rate | | IEEE 1394 1 port(6pin) / 400Mpbs |
| Gain | | 0 ~ 27 dB (Manual or Auto) |
| Shutter Speed | | 1 usec ~ 3600 sec (Manual or Auto) |
| Data Depth | | 12 bit |
| S/N Ratio | | 56dB or better |
| Supply Voltage & Power | | Less than 2 Watts (@ 12 V DC) |
| External Dimension / Weight | | 29(W) x 29(H) x 39(D) mm / Approx 63g |
| Operation Temp. | | -5°C to 45°C |

Remark: Camera Specification described above may be changed without notice

### 2.1.3. Fire-i 530b Specification

| Features | | |
|---|---|---|
| Image Sensor | | 1/3-inch Interline CCD (Sony ICX424AL) |
| Effective Pixels | | 330,000 pixels 659(H) x 494(V) |
| Picture Size | | 640 x 480, 320 x 240 |
| Cell Size | | 7.40 x 7.40 |
| Real Frame Rate | | 60, 30, 15, 7.5, 3.75, 1.875 / Y8, Y16<br>86 (640x480, Format 7 mode 0)<br>120 (640x240, Format7 mode2, 1x2 binning)<br>120 (320x240, Format7 mode1, 2x2 binning) |
| Lens Mount | | C-mount |
| Scanning System | | Progressive System |
| Binning | | Not supported |
| Format 7 | | Partial Scan (Unit: 4x4) |
| Trigger | Edge | Rising Edge or Falling Edge |
| | Mode | 0, 1, 2, 3, 4, 5, 14, 15 |
| | Source | External Trigger or Software Trigger |
| Strobe | | Active High, Support Normal Mode or Trigger Mode. |
| Multi-camera auto sync | | -144 us ~ +144 us at 60,30,15,7.5 frame rate |
| Memory Save/Load | | 16 Channels(0:factory, 1~4:feature, 5~15:mode/feature) |
| One-shot/Multi-shot | | 65535 Shots |
| Control Functions | | Brightness, Sharpness, Gamma, Auto-Exposure, Shutter, Gain, Pan/Tilt,<br>High speed up trigger frame rate |
| SIO(RS-232) | | IIDC v1.31 version : Path through or custom command |
| Frame Delay from Read-out | | Min. 43us |
| Digital Interface / Transfer Rate | | IEEE 1394 1 port(6pin) / 400Mbps |
| Gain | | 0 ~ 27 dB (Manual or Auto) |
| Shutter Speed | | 1 usec ~ 3600 sec (Manual or Auto) |
| Data Depth | | 12 bit |
| S/N Ratio | | 56dB or better |
| Supply Voltage & Power | | Less than 2 Watts (@ 12 V DC) |
| External Dimension / Weight | | 29(W) x 29(H) x 39(D) mm / Approx 63g |
| Operation Temp. | | -5°C to 45°C |

Remark: Camera Specification described above may be changed without notice

### 2.1.4. Fire-i 550b Specification

| Features | | |
|---|---|---|
| Image Sensor | | 1/3-inch MT9V022177ATM (Micron CMOS) |
| Effective Pixels | | 360,960 pixels 752 (H) x 480(V) |
| Picture Size | | 752 x 480, 640 x 480, 376 x 240 |
| Cell Size | | 6 x 6 |
| Real Frame Rate | | 60, 30, 15, 7.5, 3.75, 1.875 / Y8, Y16<br>60 (752x480, Format 7 mode 0)<br>110 (376x240, Format7 mode1, 2x2 binning) |
| Lens Mount | | C-mount |
| Scanning System | | Progressive System |
| Binning | | 2 x 2 |
| Format 7 | | Partial Scan (Unit: 4x4) |
| Trigger | Edge | Rising Edge or Falling Edge |
| | Mode | 0 |
| | Source | External Trigger or Software Trigger |
| Strobe | | Active High, Support Normal Mode or Trigger Mode. |
| Multi-camera auto sync | | Not supported |
| Memory Save/Load | | 16 Channels(0:factory, 1~4:feature, 5~15:mode/feature) |
| One-shot/Multi-shot | | Not supported |
| Control Functions | | Brightness, Sharpness, Gamma, Auto-Exposure, Shutter, Gain, Pan/Tilt |
| SIO(RS-232) | | IIDC v1.31 version : Path through or custom command |
| Frame Delay from Read-out | | Min. 70us |
| Digital Interface / Transfer Rate | | IEEE 1394 1 port(6pin) / 400Mbps |
| Gain | | 0 ~ 18 dB (Manual or Auto) |
| Shutter Speed | | 93 usec ~ 100 msec (Manual or Auto) |
| Data Depth | | 10 bit |
| S/N Ratio | | 45dB or better |
| Supply Voltage & Power | | Less than 2 Watts (@ 12 V DC) |
| External Dimension / Weight | | 29(W) x 29(H) x 39(D) mm / Approx 63g |
| Operation Temp. | | -5°C to 45°C |

Remark: Camera Specification described above may be changed without notice

## 2.2. Color Cameras

### 2.2.1. Fire-i 830c Specification

| Features | | |
|---|---|---|
| Image Sensor Type | | 1/1.8-inch Interline CCD (Sony ICX-274AQ) |
| Effective pixels | | 2,010,000 pixels 1600(H) x 1200(V) |
| Picture Size | | 1600x1200, 1280x960, 1024x768, 800x600, 640x480 |
| Cell Size(um) | | 4.4 x 4.4 |
| Real Frame Rate | | 15, 7.5, 3.75, 1.875 / Y8, Y16, YUV422<br>16 (1600x1200, Format 7 mode 0)<br>32 (640x480, Format 7 mode 0)<br>29 (800x600, Format7 mode 1, 2x2 binning)<br>29 (1600x600, Format7 mode 2, 1x2 binning) |
| Lens Mount | | C Mount |
| Scanning System | | Progressive System |
| Binning | | 2x2, 1x2 |
| Format7 | | Partial Scan (Unit: 4x4) |
| Trigger | Edge | Rising Edge or Falling Edge |
| | Mode | 0, 1, 2, 3, 4, 5, 14,15 |
| | Source | External Trigger or Software Trigger |
| Strobe | | Active High, Support Normal Mode or Trigger Mode. |
| Multi-camera auto sync | | -144 us ~ +144 us at 15,7.5 frame rate |
| Memory Save/Load | | 16 Channels(0:factory, 1~4:feature, 5~15:mode/feature) |
| One-shot/Multi-shot | | 65535 Shots |
| Control Functions | | Brightness, Sharpness, Gamma, Auto-Exposure, Shutter, Gain, Pan/Tilt,<br>High speed up trigger frame rate, AWB |
| SIO(RS-232) | | IIDC v1.31 version : Path through or custom command |
| Frame Delay from Read-out | | Min. 106us |
| Digital Interface / Transfer Rate | | IEEE 1394 1 port(6pin) / 400Mpbs |
| Gain | | 0 ~ 25 dB (Manual or Auto) |
| Shutter Speed | | 1 usec ~ 3600 sec (Manual or Auto) |
| Data Depth | | 12 bit |
| S/N Ratio | | 56dB or better |
| Supply Voltage & Power | | Less than 2Watts(@12V DC) |
| External Dimension / Weight | | 29(W) x 29(H) x 39(D) mm / Approx 63g |
| Operation Temp. | | -5°C to 45°C |

Remark: Camera Specification described above may be changed without notice

### 2.2.2. Fire-i 630c Specification

| Features | | |
|---|---|---|
| Image Sensor Type | | 1/3-inch Interline CCD (Sony ICX-204AK) |
| Effective pixels | | 800,000 pixels 1034(H) x 779(V) |
| Picture Size | | 1024x768, 800x600, 640x480, 320x240 |
| Cell Size(um) | | 4.65 x 4.65 |
| Real Frame Rate | | 30, 15, 7.5, 3.75, 1.875 / Y8, Y16, YUV422<br>36 (1024x768, Format 7 mode 0) |
| Lens Mount | | C Mount |
| Scanning System | | Progressive System |
| Binning | | Not supported |
| Format7 | | Partial Scan (Unit: 4x4) |
| Trigger | Edge | Rising Edge or Falling Edge |
| | Mode | 0, 1, 2, 3, 4, 5, 14, 15 |
| | Source | External Trigger or Software Trigger |
| Strobe | | Active High, Support Normal Mode or Trigger Mode. |
| Multi-camera auto sync | | -144 us ~ +144 us at 30,15,7.5 frame rate |
| Memory Save/Load | | 16 Channels(0:factory, 1~4:feature, 5~15:mode/feature) |
| One-shot/Multi-shot | | 65535 Shots |
| Control Functions | | Brightness, Sharpness, Gamma, Auto-Exposure, Shutter, Gain, Pan/Tilt,<br>High speed up trigger frame rate, AWB |
| SIO(RS-232) | | IIDC v1.31 version : Path through or custom command |
| Frame Delay from Read-out | | Min. 70us |
| Digital Interface / Transfer Rate | | IEEE 1394 1 port(6pin) / 400Mbps |
| Gain | | 0 ~ 25 dB (Manual or Auto) |
| Shutter Speed | | 1 usec ~ 3600 sec (Manual or Auto) |
| Data Depth | | 12 bit |
| S/N Ratio | | 56dB or better |
| Supply Voltage & Power | | Less than 2Watts(@12V DC) |
| External Dimension / Weight | | 29(W) x 29(H) x 39(D) mm / Approx 63g |
| Operation Temp. | | -5°C to 45°C |

Remark: Camera Specification described above may be changed without notice

### 2.2.3. Fire-i 530c Specification

| Features | | |
|---|---|---|
| Image Sensor Type | | 1/3-inch Interline CCD (ICX-424AQ) |
| Effective pixels | | 330,000 pixels 659(H) x 494(V) |
| Picture Size | | 640 x 480, 320 x 240 |
| Cell Size(um) | | 7.40 x 7.40 |
| Real Frame Rate | | 60, 30, 15, 7.5, 3.75, 1.875 / Y8, Y16, YUV422<br>86 (640x480, Format 7 mode 0) |
| Lens Mount | | C Mount |
| Scanning System | | Progressive System |
| Binning | | Not supported |
| Format7 | | Partial Scan (Unit: 4x4) |
| Trigger | Edge | Rising Edge or Falling Edge |
| | Mode | 0, 1, 2, 3, 4, 5, 14, 15 |
| | Source | External Trigger or Software Trigger |
| Strobe | | Active High, Support Normal Mode or Trigger Mode. |
| Multi-camera auto sync | | -144 us ~ +144 us at 60,30,15,7.5 frame rate |
| Memory Save/Load | | 16 Channels(0:factory, 1~4:feature, 5~15:mode/feature) |
| One-shot/Multi-shot | | 65535 Shots |
| Control Functions | | Brightness, Sharpness, Gamma, Auto-Exposure, Shutter, Gain, Pan/Tilt,<br>High speed up trigger frame rate, AWB |
| SIO(RS-232) | | IIDC v1.31 version : Path through or custom command |
| Frame Delay from Read-out | | Min. 43us |
| Digital Interface / Transfer Rate | | IEEE 1394 1 port(6pin) / 400Mbps |
| Gain | | 0 ~ 25 dB (Manual or Auto) |
| Shutter Speed | | 1 usec ~ 3600 sec (Manual or Auto) |
| Data Depth | | 12 bit |
| S/N Ratio | | 56dB or better |
| Supply Voltage & Power | | Less than 2Watts(@12V DC) |
| External Dimension / Weight | | 29(W) x 29(H) x 39(D) mm / Approx 63g |
| Operation Temp. | | -5°C to 45°C |

Remark: Camera Specification described above may be changed without notice

### 2.2.4. Fire-i 850c Specification

| Features | | |
|---|---|---|
| Image Sensor Type | | 1/2-inch MT9T031 (Micron CMOS) |
| Effective pixels | | 3,145,728 pixels 2048(H) x 1536(V) |
| Picture Size | | 2048x1536, 1600x1200, 1280x960, 1024x768, 800x600, 640 x 480 |
| Cell Size(um) | | 3.2 x 3.2 |
| Real Frame Rate | | 60, 30, 15, 7.5, 3.75 / Y8, Y16, YUV422<br>10 (2048x1536, Format 7 mode 0)<br>26 (1024x768, Format 7 mode 1, 2x2 binning) |
| Lens Mount | | C Mount |
| Scanning System | | Progressive System |
| Binning | | 2x2 |
| Format7 | | Partial Scan (Unit: 4x4) |
| Trigger | Edge | Rising Edge or Falling Edge |
| | Mode | 0 |
| | Source | External Trigger or Software Trigger |
| Strobe | | Active High, Support Normal Mode or Trigger Mode. |
| Multi-camera auto sync | | Not supported |
| Memory Save/Load | | 16 Channels(0:factory, 1~4:feature, 5~15:mode/feature) |
| One-shot/Multi-shot | | Not supported |
| Control Functions | | Brightness, Sharpness, Gamma, Auto-Exposure, Shutter, Gain, Pan/Tilt,<br>High speed up trigger frame rate, AWB |
| SIO(RS-232) | | IIDC v1.31 version : Path through or custom command |
| Frame Delay from Read-out | | Min. 43us |
| Digital Interface / Transfer Rate | | IEEE 1394 1 port(6pin) / 400Mbps |
| Gain | | 0 ~ 63 dB (Manual or Auto) |
| Shutter Speed | | 63 usec ~ 1 sec (Manual or Auto) |
| Data Depth | | 10 bit |
| S/N Ratio | | 43dB or better |
| Supply Voltage & Power | | Less than 2Watts(@12V DC) |
| External Dimension / Weight | | 29(W) x 29(H) x 39(D) mm / Approx 63g |
| Operation Temp. | | -5°C to 45°C |

Remark: Camera Specification described above may be changed without notice

### 2.2.5. Fire-i 550c Specification

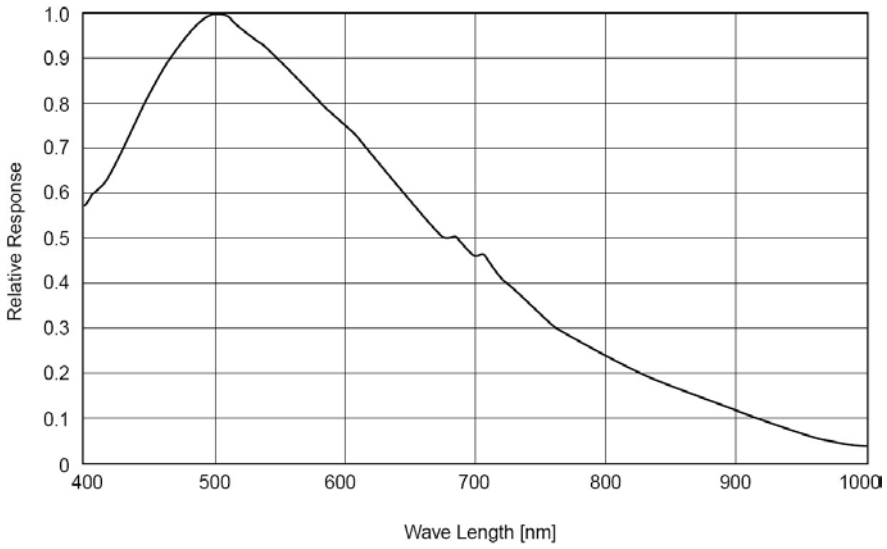
| Features | | |
|---|---|---|
| Image Sensor Type | | 1/3-inch MT9V022177ATC (Micron CMOS) |
| Effective pixels | | 360,960 pixels 752(H) x 480(V) |
| Picture Size | | 752 x 480, 752 x 476, 640 x 480 |
| Cell Size(um) | | 6.0 x 6.0 |
| Real Frame Rate | | 60, 30, 15, 7.5, 3.75 / Y8, Y16, YUV422<br>60 (752x480, Format 7 mode 0)<br>60 (752x476, Format 7 mode 2, YUV422) |
| Lens Mount | | C Mount |
| Scanning System | | Progressive System |
| Binning | | Not supported |
| Format7 | | Partial Scan (Unit: 4x4) |
| Trigger | Edge | Rising Edge or Falling Edge |
| | Mode | 0 |
| | Source | External Trigger or Software Trigger |
| Strobe | | Active High, Support Normal Mode or Trigger Mode. |
| Multi-camera auto sync | | Not supported |
| Memory Save/Load | | 16 Channels(0:factory, 1~4:feature, 5~15:mode/feature) |
| One-shot/Multi-shot | | Not supported |
| Control Functions | | Brightness, Sharpness, Gamma, Auto-Exposure, Shutter, Gain, Pan/Tilt,<br>High speed up trigger frame rate, AWB |
| SIO(RS-232) | | IIDC v1.31 version : Path through or custom command |
| Frame Delay from Read-out | | Min. 70us |
| Digital Interface / Transfer Rate | | IEEE 1394 1 port(6pin) / 400Mbps |
| Gain | | 0 ~ 12 dB (Manual or Auto) |
| Shutter Speed | | 93 usec ~ 100 msec (Manual or Auto) |
| Data Depth | | 10 bit |
| S/N Ratio | | 45dB or better |
| Supply Voltage & Power | | Less than 2Watts(@12V DC) |
| External Dimension / Weight | | 29(W) x 29(H) x 39(D) mm / Approx 63g |
| Operation Temp. | | -5°C to 45°C |

Remark: Camera Specification described above may be changed without notice

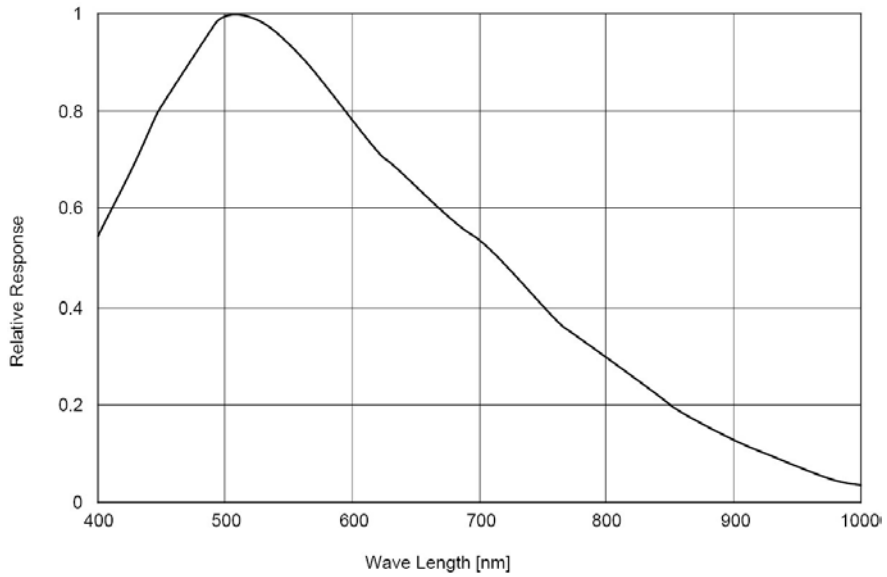
## 2.3. Spectral Sensitivity

Excludes lens and light source characteristics.

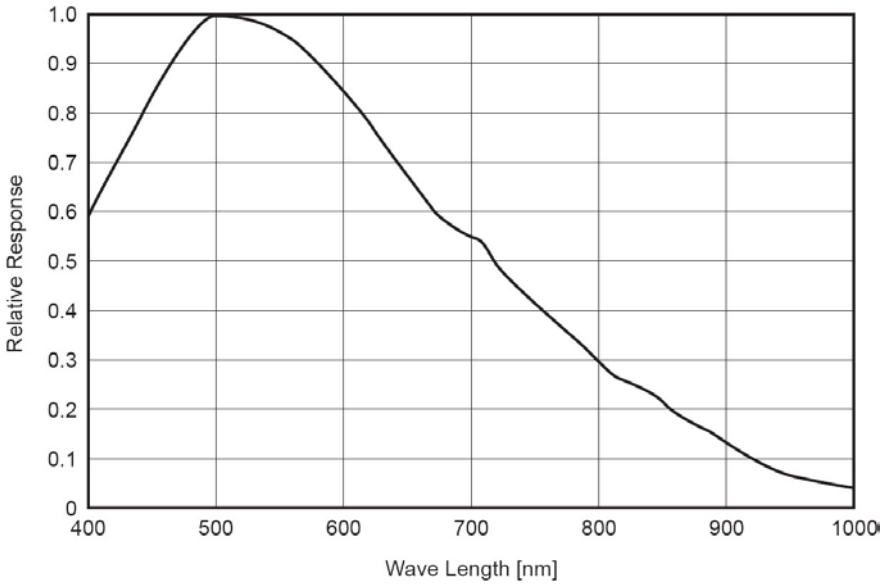
### 2.3.1. B&W Cameras



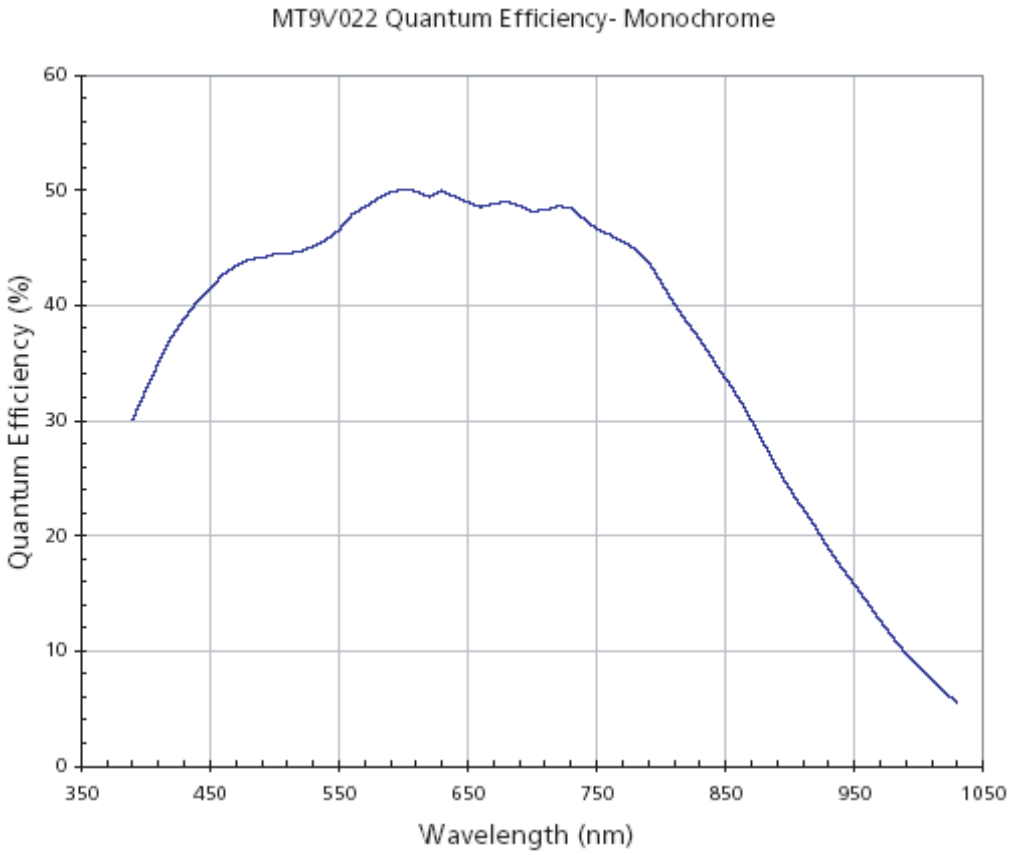

Spectral Sensitivity for Fire-i 830b




Spectral Sensitivity for Fire-i 630b

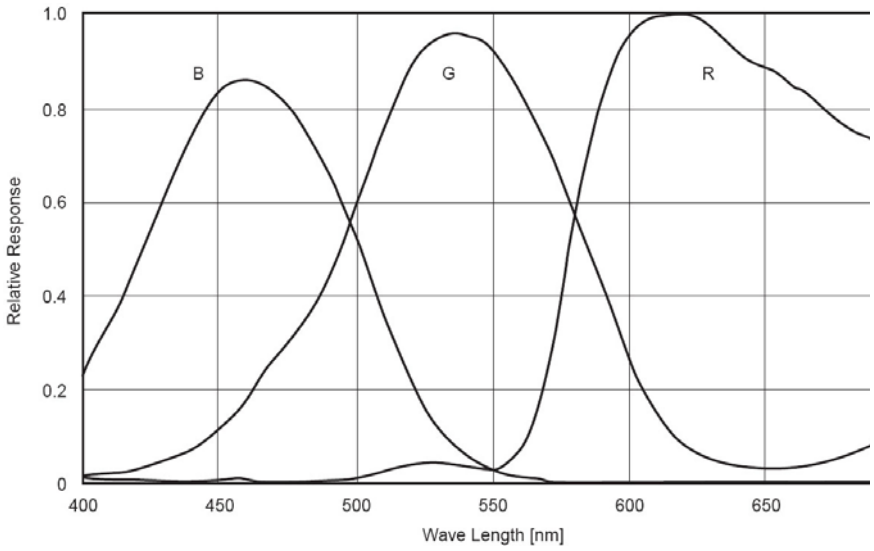



Spectral Sensitivity for Fire-i 530b

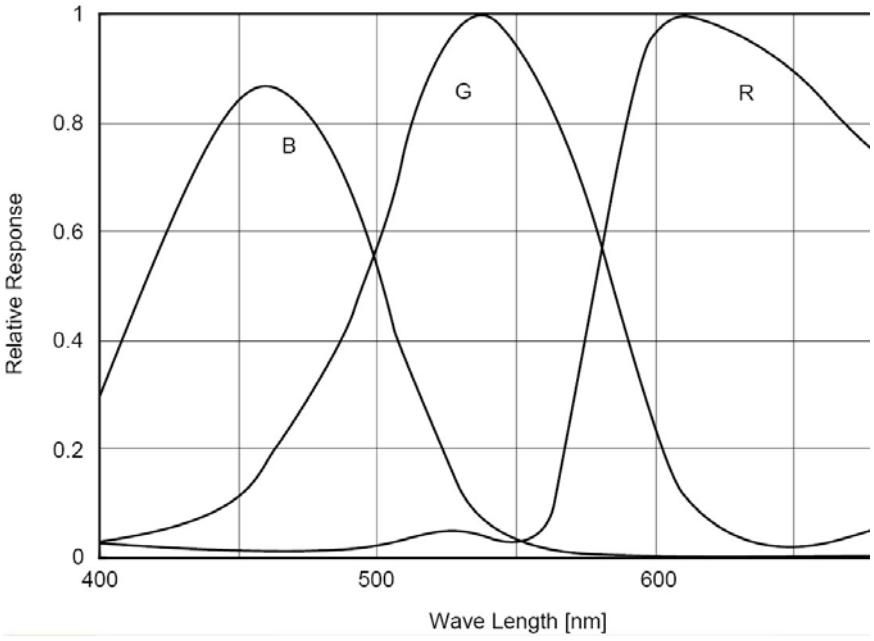



Spectral Sensitivity for Fire-i 550b

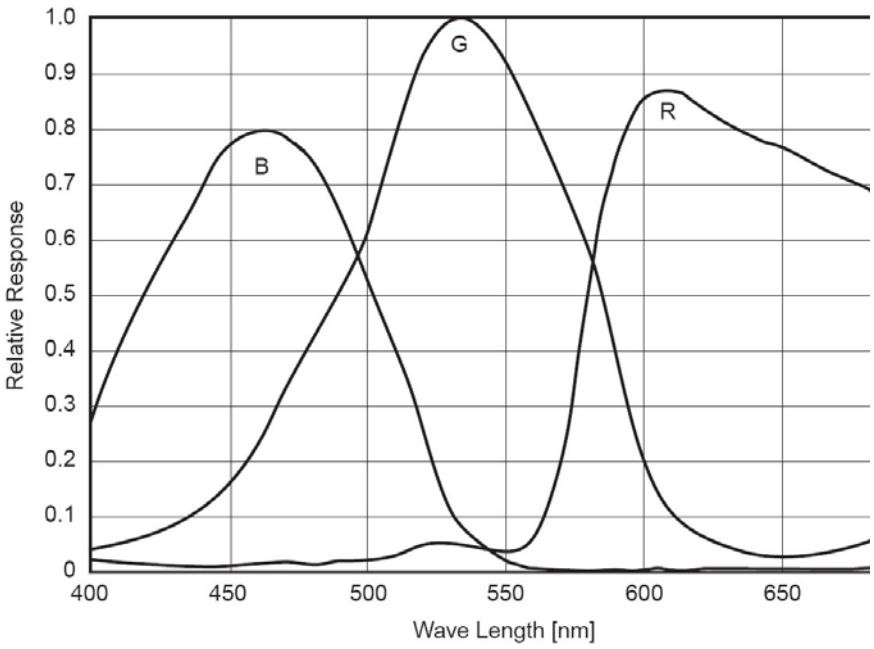
### 2.3.2. Color Cameras



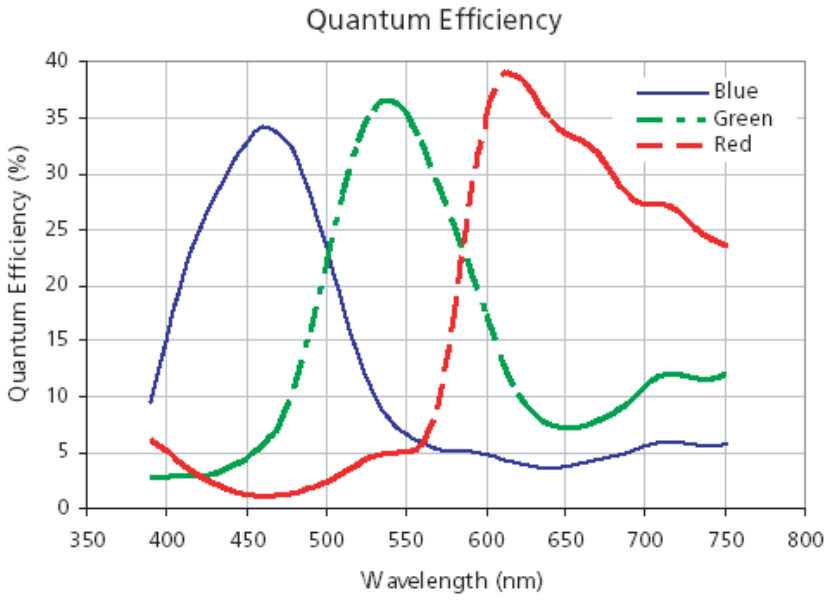

Spectral Sensitivity for Fire-i 830c



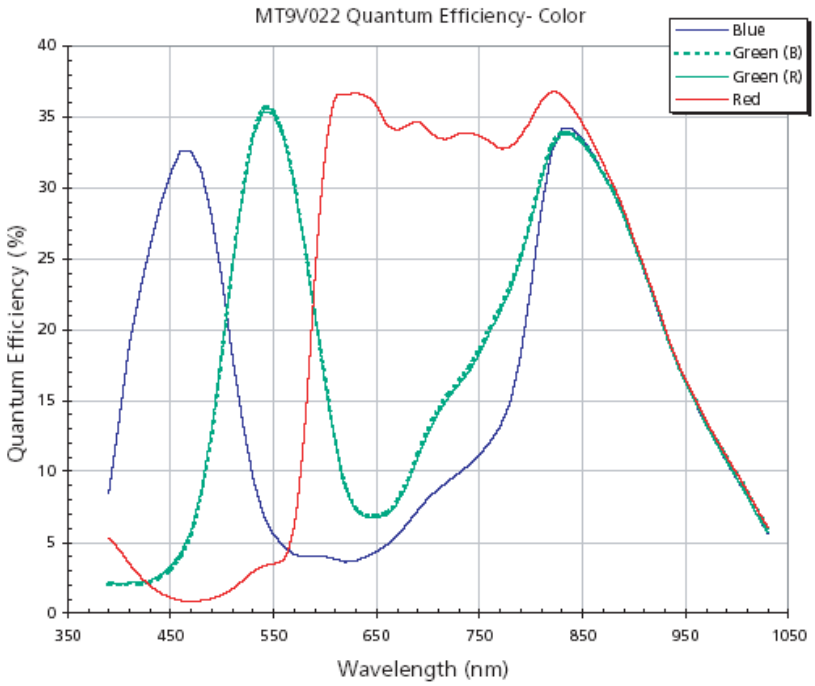

Spectral Sensitivity for Fire-i 630c




Spectral Sensitivity for Fire-i 530c




Spectral Sensitivity for Fire-i 850c




Spectral Sensitivity for Fire-i 550c

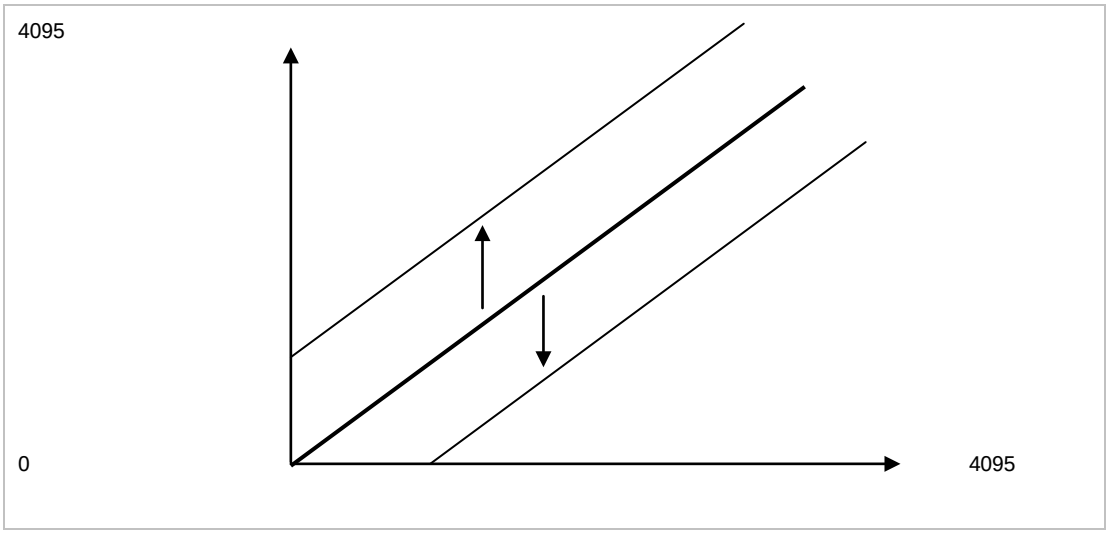
# 3. Basic Operation and Features

The Fire-i x3x cameras employ a progressive scan CCD sensor which provides different features for each model. Basic functions and features are similar, while each camera has its own specific function support. The cameras-fully support the IIDC V1.31 specification with regards to registers, video format, mode of operation and control.

The Fire-i x5x cameras employ a CMOS sensor.

## 3.1. Brightness

Brightness of the camera can be controlled by changing the black level in the camera. The user can determine the setting of the camera and control them using the status control register. Adjust the brightness if the appropriate gradation cannot be obtained due to blurring of black portions of the image. The parameters of Brightness are changed inside the camera. For brightness, the parameters are shifted by the black level.




**Inquiry Register**

| Address | Name | Field | Bit | Description |
|---|---|---|---|---|
| 500h | BRIGHTNESS_INQ | Presence_Inq | [0] | Presence of this feature |
| | | Abs_Control_Inq | [1] | Capability of control with absolute value |
| | | - | [2] | Reserved |
| | | One_Push_Inq | [3] | One push auto mode (Controlled automatically by camera only once) |
| | | ReadOut_Inq | [4] | Capability of reading the value of this feature |
| | | On/OFF_Inq | [5] | Capability of switching this feature ON and OFF |
| | | Auto_Inq | [6] | Auto Mode (Controlled automatically by camera) |
| | | Manual_Inq | [7] | Manual Mode (Controlled by user) |
| | | Min_Value | [8..19] | Minimum value for this feature control |
| | | Max_Value | [20..31] | Maximum value for this feature control |

**Status Control Register**

| Address | Name | Field | Bit | Description |
|---|---|---|---|---|
| 800h | BRIGHTNESS | Presence_Inq | [0] | Presence of this feature<br>0:N/A 1:Available |

| | | | | |
|---|---|---|---|---|
| | | Abs_Control | [1] | Absolute value control<br>0: Control with value in Value field<br>1: Control with value in Absolute value<br>CSR if this bit =1, value in Value filed is ignored |
| | | - | [2..4] | Reserved |
| | | One_Push | [5] | Write '1': begin to work(Self cleared after operation)<br>Read : Value='1' in operation<br>Value ='0' not in operation<br>If A_M_Mode=1, this bit is ignored |
| | | On/OFF | [6] | Write : ON or OFF this feature<br>Read : read a status<br>0: OFF, 1:ON<br>If this bit=0, other fields will be read only. |
| | | A_M_Mode | [7] | Write : Set the mode<br>Read : Read a current mode<br>0: Manual, 1:Auto |
| | | - | [8..19] | Reserved |
| | | Value | [20..31] | Minimum value for this feature control |

## 3.2. Auto Exposure Control

The automatic shutter/gain mode is based on a feedback loop which calculates the average pixel luminance. Then the average is compared with the exposure reference value, adjusting shutter and gain accordingly. This feature is similar to "Contrast Control".

**Inquiry Register**

| Address | Name | Field | Bit | Description |
|---|---|---|---|---|
| 504h | AUTO_EXPOSURE_INQ | Presence_Inq | [0] | Presence of this feature |
| | | Abs_Control_Inq | [1] | Capability of control with absolute value |
| | | - | [2] | Reserved |
| | | One_Push_Inq | [3] | One push auto mode(Controlled automatically by camera only once) |
| | | ReadOut_Inq | [4] | Capability of reading the value of this feature |
| | | On/Off_Inq | [5] | Capability of switching this feature On and OFF |
| | | Auto_Inq | [6] | Auto mode (Controlled automatically by camera) |
| | | Manual_Inq | [7] | Manual mode(Controlled by user) |
| | | Min_Value | [8..19] | Minimum value for this feature control |
| | | Max_Value | [20..31] | Maximum value for this feature control |

**Status Control Register**

| Address | Name | Field | Bit | Description |
|---|---|---|---|---|
| 804h | AUTO_EXPOSURE | Presence_Inq | [0] | Presence of this feature<br>0:N/A 1:Available |
| | | Abs_Control | [1] | Absolute value control<br>0: Control with value in the Value field<br>1: Control with value in the Absolute value CSR<br>If this bit = 1, value in the Value field is ignored. |
| | | - | [2..4] | Reserved |
| | | One_Push | [5] | Write '1' :begin to work (Self cleared after operation)<br>Read: Value='1' in operation Value='0' not in operation<br>If A_M_Mode =1, this bit is ignored |

| | | | | |
|---|---|---|---|---|
| | | ON_OFF | [6] | Write: ON or OFF this feature,<br>Read: read a status<br>0:OFF, 1:ON<br>If this bit=0, other fields will be read only. |
| | | A_M_Mode | [7] | Write: set the mode,<br>Read: read a current mode<br>0: Manual, 1:Auto |
| | | - | [8..19] | Reserved |
| | | Value | [20..31] | Value : Write the value in Auto mode, this filed is ignored.<br>If “ReadOut” capability is not available, read value Has no meaning |

## 3.3. Sharpness

The sharpness control feature may be used to compensate low-pass effects caused for instance by the special color interpolation. If you do not prefer such signal manipulation, you may switch it OFF.

For sharpness control inquiry and status register, follow the same definition as “BRIGHTNESS”.

## 3.4. White Balance

Color models have the white balance feature which can be controlled automatically or manually, U/R(Red/Green) and V/B(Green/Blue) alter the degree to which Red and Blue CCD component pixels are weighed to form composite pixels. In manual mode you can adjust the white balance by altering the Blue(U/V) and Red Value(V/R). In addition, the one push white balance option can be used for a non-interactive calibration.

**Inquiry Register**

| Address | Name | Field | Bit | Description |
|---|---|---|---|---|
| 50Ch | WHITE_BAL<br>_INQ | Presence_Inq | [0] | Presence of this feature |
| | | Abs_Control_Inq | [1] | Capability of control with absolute value |
| | | - | [2] | Reserved |
| | | One_Push_Inq | [3] | One push auto mode(Controlled automatically by camera only once) |
| | | ReadOut_Inq | [4] | Capability of reading the value of this feature |
| | | On/Off_Inq | [5] | Capability of switching this feature On and OFF |
| | | Auto_Inq | [6] | Auto mode(Controlled automatically by camera) |
| | | Manual_Inq | [7] | Manual mode(Controlled by user) |
| | | Min_Value | [8..19] | Minimum value for this feature control |
| | | Max_Value | [20..31] | Maximum value for this feature control |

**Status Control Register**

| Address | Name | Field | Bit | Description |
|---|---|---|---|---|
| 80Ch | WHITE_BALANCE | Presence_Inq | [0] | Presence of this feature. 0:N/A 1:Available |
| | | Abs_Control | [1] | Absolute value control<br>0: Control with value in the Value field<br>1: Control with value in the Absolute value CSR<br>If this bit = 1, value in the Value field is ignored. |
| | | - | [2..4] | Reserved |
| | | One_Push | [5] | Write '1' :begin to work(Self cleared after operation)<br>Read: Value='1' in operation<br>Value='0' not in operation<br>If A_M_Mode =1, this bit is ignored |
| | | ON_OFF | [6] | Write: ON or OFF this feature,<br>Read: read a status<br>0:OFF, 1:ON<br>If this bit=0, other fields will be read only. |
| | | A_M_Mode | [7] | Write: set the mode,<br>Read: read a current mode<br>0: Manual, 1:Auto |
| | | - | [8..19] | U Value / B_Value.<br>Write the value in AUTO mode, this field is ignored.<br>If "ReadOut" capability is not available,, read value has no mean |
| | | Value | [20..31] | V Value / R_Value<br>Write the value in AUTO mode, this field is ignored.<br>If "ReadOut" capability is not available, read value has no meaning |

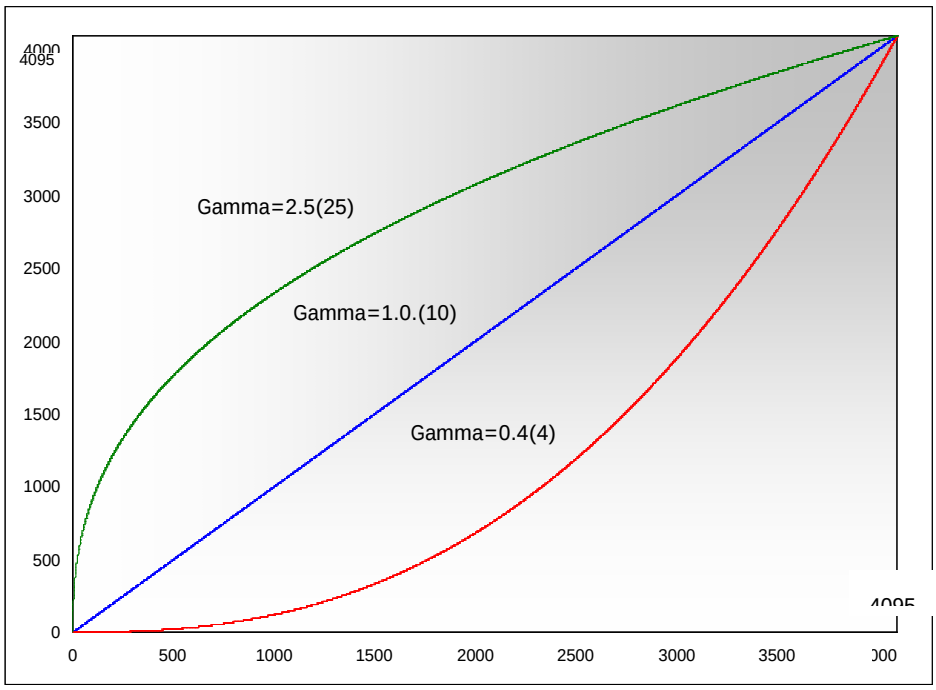
## 3.5. Hue

Color models support Hue control which changes the color phase of the picture by adjusting the Green gain. You may use this feature when white balance correction adjusting Red and Blue value does not give satisfying result.

## 3.6. Gamma

Gamma control defines the function between incoming light level and output picture level. The Factory default setting for Gamma is set to 1.0. Gamma value is adjustable in the range of 0.4 ~ 2.5 as per the table below.

For Gamma control inquiry and status register, follow the same definition as "BRIGHTNESS".




Gamma Range Table

| Gamma Value | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gamma | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 |

| Gamma Value | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gamma | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 |

## 3.7. Shutter

Shutter is defined as the integration time of the incoming light where both the Manual and the Auto Shutter are supported. The shutter range varies from 1us ~ 3600sec. For Shutter control inquiry and status register, follow the same definition as “BRIGHTNESS”.

#### 3.7.1.1. Fire-i x3x models (530, 630, 830)

**Shutter Speed Value & Range**

| 1394 Shutter Value (Y) | Increment Step | Shutter Speed Time : T | |
|---|---|---|---|
| | | Exposure Time | Range |
| 1~500 | 1us | T= Y us | 1us ~ 500us |
| 501~1000 | 10us | T= (Y-500)*10+500 us | 510us ~ 5500us |
| 1001~1705 | 100us | T= (Y-1000)*100+5500 us | 5.6ms ~ 76ms |

| | | | |
|---|---|---|---|
| 1706 ~ 2399 | 1ms | T= (Y-1705)+76 ms | 77ms ~ 770ms |
| 2400~2902 | 10ms | T= (Y-2399)*10+770 ms | 780ms ~ 5800ms |
| 2903~3304 | 100ms | T= (Y-2902)*100+5800 ms | 5.9s ~ 46s |
| 3305~3508 | 1s | T= (Y-3304)*1000+46000 ms | 47s ~ 250s |
| 3509~3843 | 10s | T= (Y-3508)*10 + 250 s | 260s ~ 3600s |

**Shutter Speed Example**

| Example Shutter Speed Table | | | | | |
|---|---|---|---|---|---|
| 1394 Shutter | Exposure Time | 1394 Shutter | Exposure Time | 1394 Shutter | Exposure Time |
| 1 | 1us | 1729 | 100ms | 3378 | 2 min |
| 10 | 10us | 1829 | 200ms | 3438 | 3 min |
| 100 | 100us | 2129 | 500ms | 3513 | 5 min |
| 500 | 500us | 2422 | 1s | 3525 | 7min |
| 550 | 1ms | 2522 | 2s | 3543 | 10 min |
| 650 | 2ms | 2822 | 5s | 3603 | 20 min |
| 950 | 5ms | 2944 | 10s | 3663 | 30 min |
| 1045 | 10ms | 3044 | 20s | 3723 | 40 min |
| 1145 | 20ms | 3318 | 60s | 3783 | 50 min |
| 1445 | 50ms | 3323 | 65s | 3843 | 60 min |

### 3.7.1.2. Fire-i x5x models (550, 850)

**Shutter Speed Value & Range**

| 1394 Shutter Value (Y) | Increment Step | Shutter Speed Time : T | |
|---|---|---|---|
| | | Exposure Time | Range |
| 1~500 | 1us | T= Y us | 1us ~ 500us |
| 501~1000 | 10us | T= (Y-500)*10+500 us | 510us ~ 5500us |
| 1001~1705 | 100us | T= (Y-1000)*100+5500 us | 5.6ms ~ 76ms |
| 1706 ~ 2399 | 1ms | T= (Y-1705)+76 ms | 77ms ~ 770ms |
| 2400~2422 | 10ms | T= (Y-2399)*10+770 ms | 780ms ~ 100ms |

**Shutter Speed Example**

| Example Shutter Speed Table | | | |
|---|---|---|---|
| 1394 Shutter | Exposure Time | 1394 Shutter | Exposure Time |
| 1 | 1us | 1729 | 100ms |
| 10 | 10us | 1829 | 200ms |
| 100 | 100us | 2129 | 500ms |
| 500 | 500us | 2422 | 1s |

## 3.8. Gain

Gain refers to the amount of the CCD output signal amplification where gain and shutter have similar effect on the image. Manual and Automatic gain mode are supported and manual adjustment is possible for the following range. For Gain control inquiry and status register, follow the same definition as “BRIGHTNESS”.

#### 3.8.1.1. Fire-i x3x models (530, 630, 830)

| Camera Type | Step Range | Range in dB | Increment Length |
|---|---|---|---|
| Monochrome Camera | 0 ~ 723 | 0 ~ 27 | approx. 0.0345 dB/step |
| Color Camera | 0 ~ 723 | 0 ~ 25 | approx. 0.0319 dB/step |
| Auto Gain | 0 ~ 528 | All models except Fire-i 530 | |
| Auto Gain | 0 ~ 468 | Fire-i 530 | |

#### 3.8.1.2. Fire-i x5x models (550, 850)

| Camera Type | Step Range | Range in dB | Increment Length |
|---|---|---|---|
| Fire-i 550 (b/c) | 16 ~ 64 | 0 ~ 12 | (16~31) – 20 x Log(step x 0.0625)<br>(32~64) – 20 x Log(step/2 x 0.0625) |
| Fire-i 850c | 0 ~ 63 | Digital gain | |

## 3.9. Trigger & Strobe

The cameras support external trigger by receiving input through the external trigger port. The falling edge and rising edge can be detected as a trigger according to the modes it supports as per the following table. Strobe timing is user controllable while signal output is TTL. The cameras can also be used with a software trigger that issues a trigger signal via a software command.

### 3.9.1. Supported Trigger

#### 3.9.1.1. Fire-i x3x models (530, 630, 830)

| | | |
|---|---|---|
| Trigger | Edge | Rising Edge or Falling Edge |
| | Mode | 0, 1, 2, 3, 4, 5, 14, 15 |
| | Source | External or Software Trigger |

#### 3.9.1.2. Fire-i x5x models (550, 850)

| | | |
|---|---|---|
| Trigger | Edge | Rising Edge or Falling Edge |
| | Mode | 0 |
| | Source | External or Software Trigger |

**Inquiry Register**

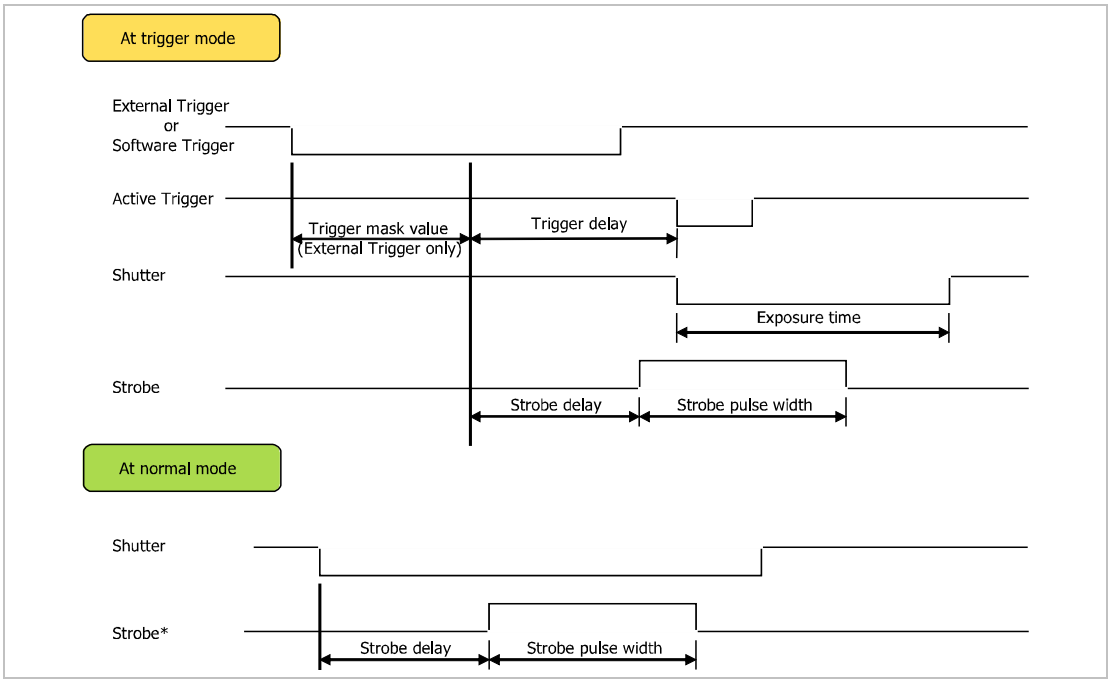
| Address | Name | Field | Bit | Description |
|---|---|---|---|---|
| 530h | TRIGGER_INQ | Presence_Inq | [0] | Presence of this feature |
| | | Abs_Control_Inq | [1] | Capability of control with absolute value |
| | | - | [2..3] | Reserved |
| | | ReadOut_Inq | [4] | Capability of reading the value of this feature |
| | | On/Off_Inq | [5] | Capability of switching this feature On and OFF |
| | | Polarity_Inq | [6] | Capability of changing polarity of trigger input |
| | | | [7..15] | Reserved |
| | | Trigger_Mode0_Inq | [16] | Presence of Trigger Mode0 |
| | | Trigger_Mode1_Inq | [17] | Presence of Trigger Mode1 |
| | | Trigger_Mode2_Inq | [18] | Presence of Trigger Mode2 |
| | | Trigger_Mode3_Inq | [19] | Presence of Trigger Mode3 |
| | | | [20..31] | Reserved |

**Status Control Register**

| Address | Name | Field | Bit | Description |
|---|---|---|---|---|
| 830h | TRIGGER_MODE | Presence_Inq | 0 | Presence of this feature<br>0:N/A 1:Available |
| | | Abs_Control | [1] | Absolute value control<br>0: Control with value in the Value field<br>1: Control with value in the Absolute value CSR<br>If this bit = 1, value in the Value field is ignored. |
| | | - | [2..5] | Reserved |
| | | ON_OFF | [6] | Write: ON or OFF this feature<br>Read: read a status<br>0: OFF, 1: ON<br>If this bit=0, other fields will be read only. |
| | | Trigger_Polarity | [7] | If Polarity_Inq is “1”, Write to change polarity of the trigger input Read to get polarity of trigger input<br>If Polarity_Inq is “0”, Read only. (0: Low active input, 1: High active input) |
| | | | [8..11] | Reserved |
| | | Trigger_Mode | [12..15] | Trigger mode.(Trigger_Mode_0-15) |
| | | | [16..19] | Reserved |
| | | Parameter | [20..31] | Parameter for trigger function, if required. |

## 3.9.2. Trigger and Strobe Signal Relation

### 3.9.2.1. Fire-i 530, 630, 830




**Trigger overlapping function : max trigger frame rate speed up to normal mode frame rate.**

**Previous version**

$$\text{Trigger max frame rate} = \frac{1}{1/\text{fps} + \textbf{shutter\_time(0xf0f0081c)} + \text{trigger\_delay(0xf0f00834)} + \text{trigger\_noise\_filter(0xf2f10110)}}$$

**Version 3.10**

**At trigger mode 0 :**

$$\text{Trigger max frame rate} = \frac{1}{1/\text{fps} + \text{trigger\_delay(0xf0f00834)} + \text{trigger\_noise\_filter(0xf2f10110)} + 200\ \text{usec}}$$

**If trigger delay = 0 and trigger noise filer is disabled, trigger max frame rate speeds up to frame rate at normal mode**

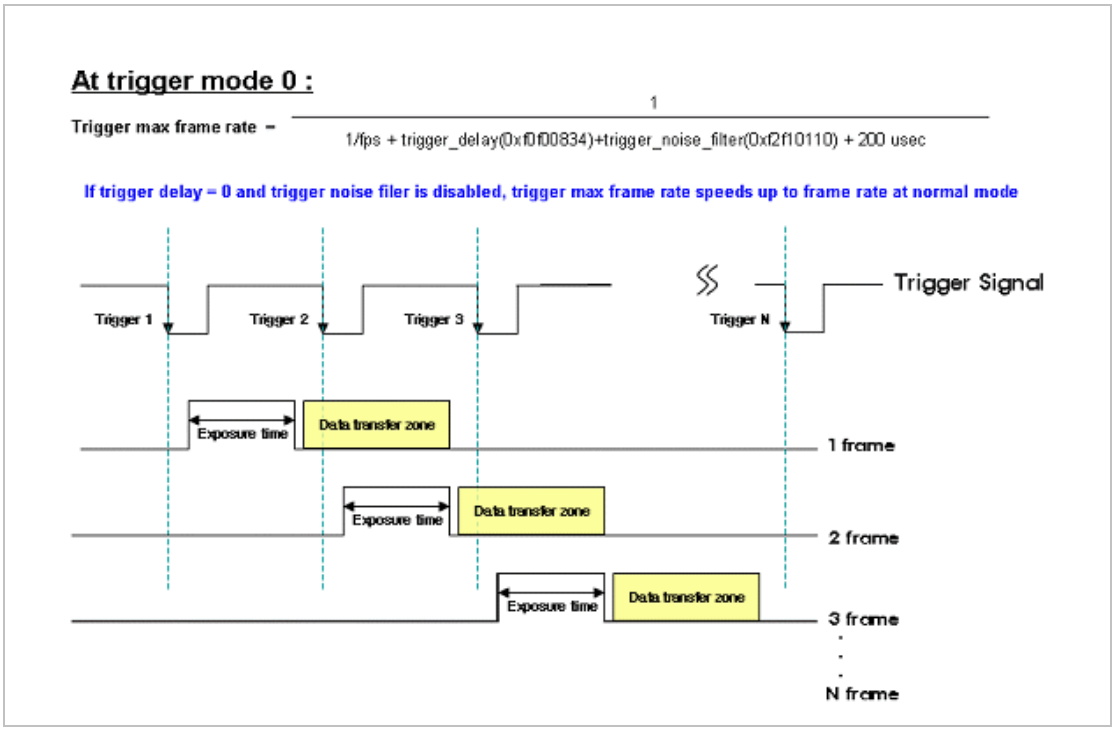
**Caution:**

If the next trigger pulse interval is less than (1/fps + trigger_delay(0xf0f00834)+trigger_noise_filter(0xf2f10110) + 200 usec), this trigger pulse may be lost.

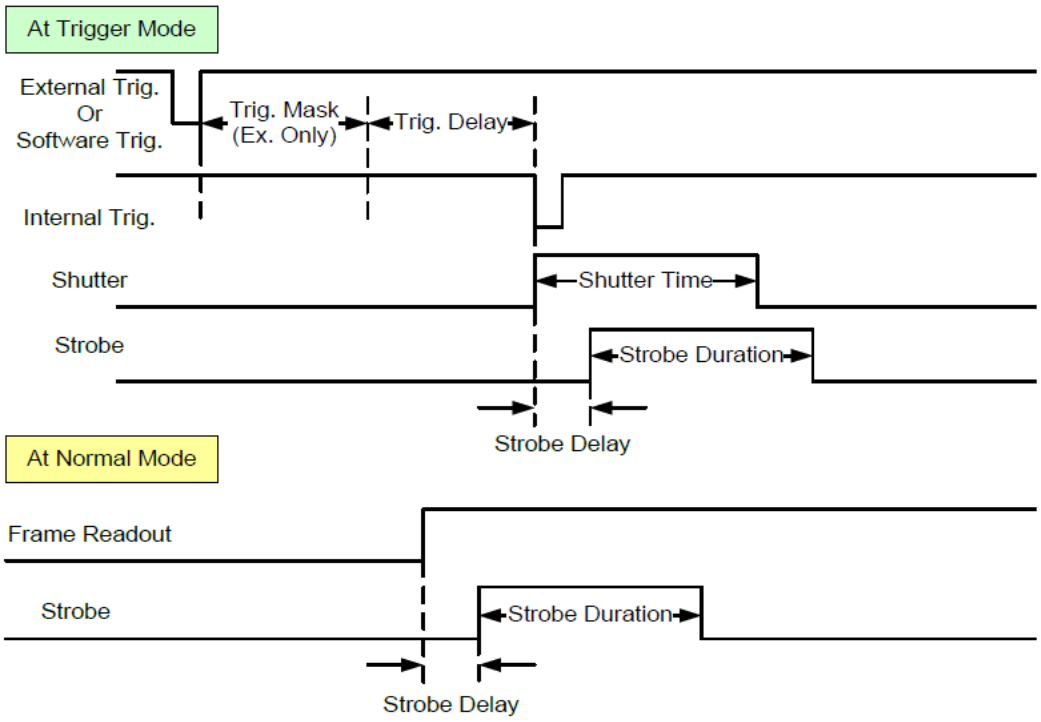
**At other trigger mode : equal to the previous frame rate.**

$$\text{Trigger max frame rate} = \frac{1}{1/\text{fps} + \textbf{shutter\_time(0xf0f0081c)} + \text{trigger\_delay(0xf0f00834)} + \text{trigger\_noise\_filter(0xf2f10110)}}$$

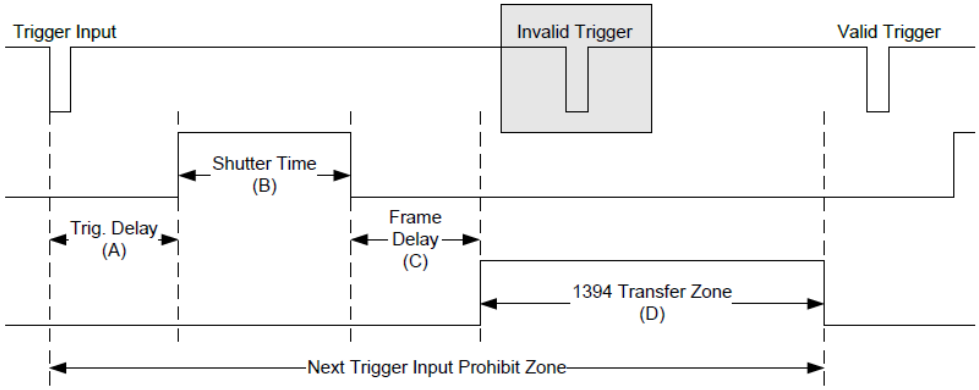
**If trigger interval is less than (1/fps + shutter_time), bar noise may be detected.**




### 3.9.2.2. Fire-i 550, 850



### 3.9.2.3. Trigger Timing Diagram for Fire-i 550, 850



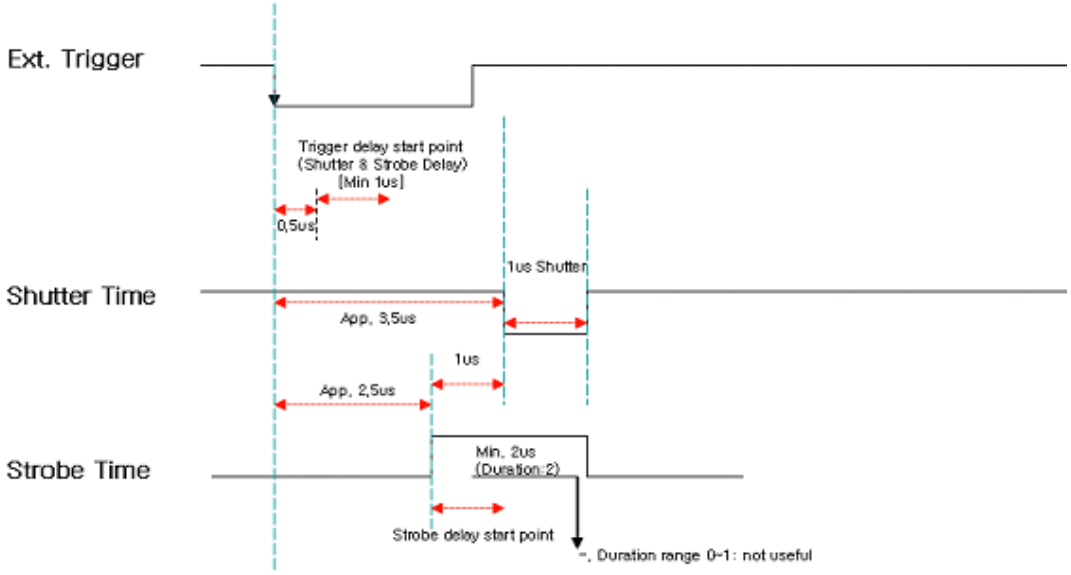

Correlation of VD and fps

| Cameras | A | B | C | D (Y8) | | |
|---|---|---|---|---|---|---|
| Fire-i 530b<br>Fire-i 530c | Trigger Mask +<br>Trigger delay+<br>350ns | Exposure<br>Time | 7HD | 640 x 480 | 60fps | 1VD |
| | | | | | 30fps | 2VD |
| | | | | | 15fps | 4VD |
| | | | | | 7.5fps | 8VD |
| | | | | | 3.75fps | 16VD |
| | | | | 752 x 480 | Format 7 | 1VD |
| Fire-i 850 | Trigger Mask +<br>Trigger delay+<br>250ns | Exposure<br>Time | 29 HD | 640 x 480 | 60fps | 1VD |
| | | | | | 30fps | 2VD |
| | | | | | 15fps | 4VD |
| | | | | | 7.5fps | 8VD |
| | | | | | 3.75fps | 16VD |
| | | | | 800 x 600 | 30fps | 1 VD |
| | | | | | 15fps | 2 VD |
| | | | | | 7.5fps | 4 VD |
| | | | | | 3.75fps | 8 VD |
| | | | | 1024 x 768<br>1280 x 960<br>1600 x 1200 | 15fps<br>7.5fps<br>3.75fps | 1 VD<br>2 VD<br>4 VD |
| | | | | 2048 x 1536 | Format 7 | 1VD |

#### 3.9.2.4. Timing Diagram for External Trigger and Shutter and Strobe

**Fire-i 530, 630, 830**

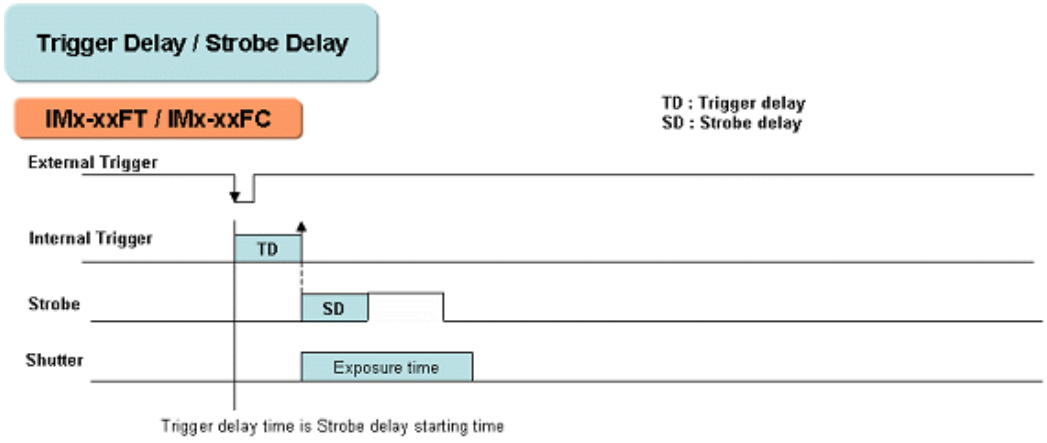
This diagram shows the necessary time related to each signal for External trigger and Shutter and Strobe.




### 3.9.3. Trigger and Strobe delay

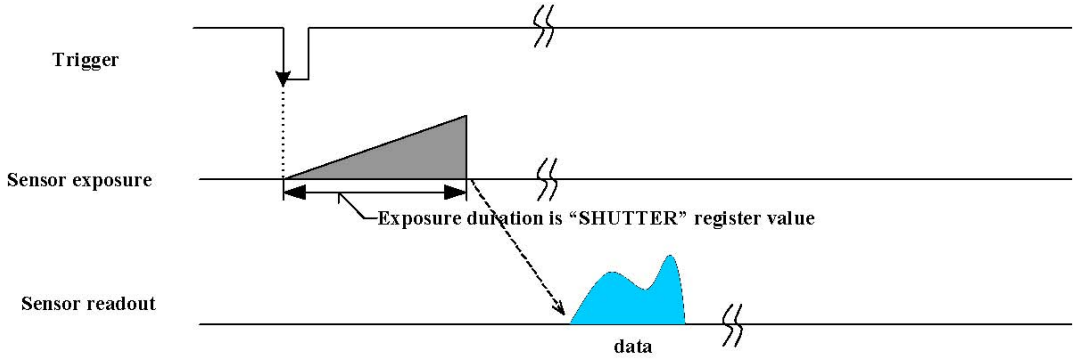
The starting point for the Strobe signal is the same as the Starting point for the External trigger

**Fire-i 530, 550, 630, 830, 850**



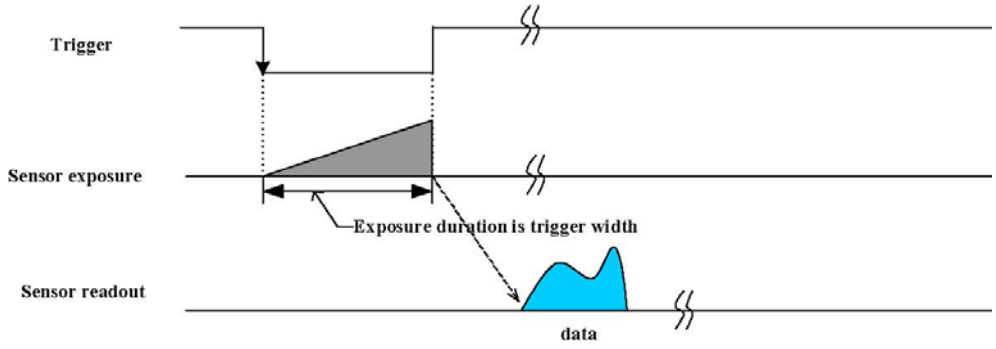
### 3.9.4. Trigger Mode 0

The Camera starts integration of the incoming light from the external trigger input falling edge. The Integration time is described in the "Shutter" register. No parameter is needed.



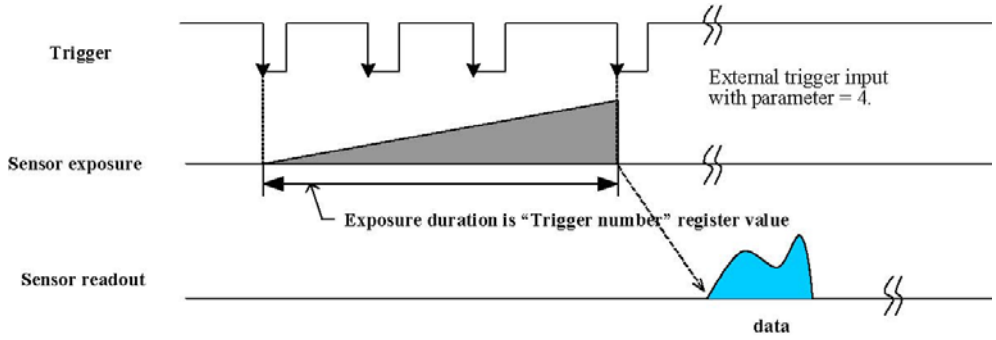

### 3.9.5. Trigger Mode 1

The camera starts the integration of the incoming light from the external trigger input falling edge. The integration time is equal to the low state time of the external trigger input. No parameter is needed.




### 3.9.6. Trigger Mode 2

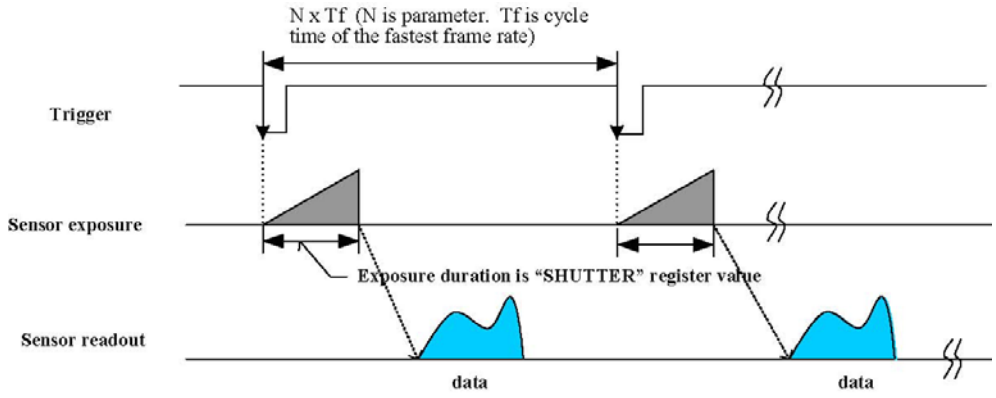
The camera starts the integration of incoming light from the first external trigger input falling edge. At the N-th (parameter) external trigger input falling edge, the integration will be stopped. A parameter is required and shall be two or more. (N >= 2).



### 3.9.7. Trigger Mode 3

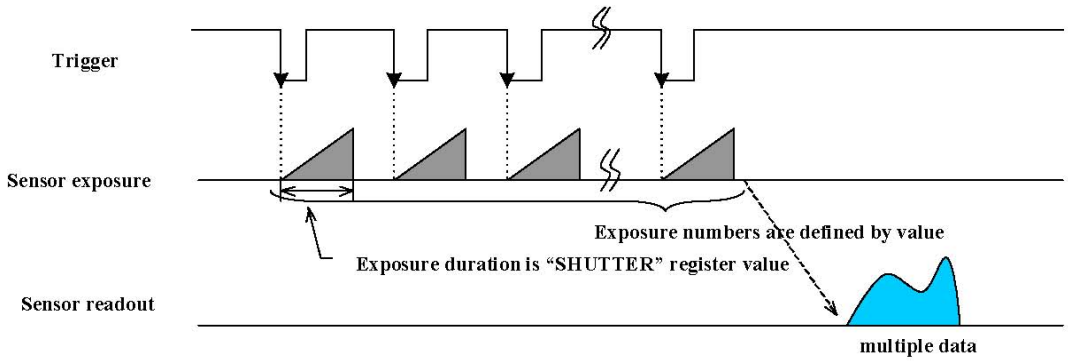
Not supported at Format 7 Mode

This is an internal trigger mode. The camera will issue a trigger internally and the cycle time is N times (parameter) the cycle time of the fastest frame rate. The Integration time of the incoming light is described in the “Shutter” register. A Parameter is required and shall be one or more (N>=1).



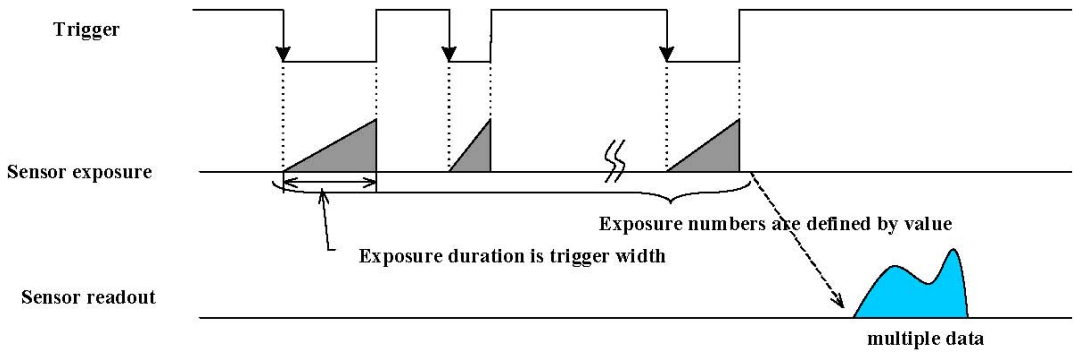

### 3.9.8. Trigger Mode 4

This mode is the “multiple shutter preset mode”. The camera starts the integration of the incoming light from the first external trigger input falling edge and exposes the incoming light at shutter time. Repeat this sequence for the N-th (parameter) external trigger input falling edge and then finish integration. A parameter is required and shall be one or more. (N >= 1).



### 3.9.9. Trigger Mode 5

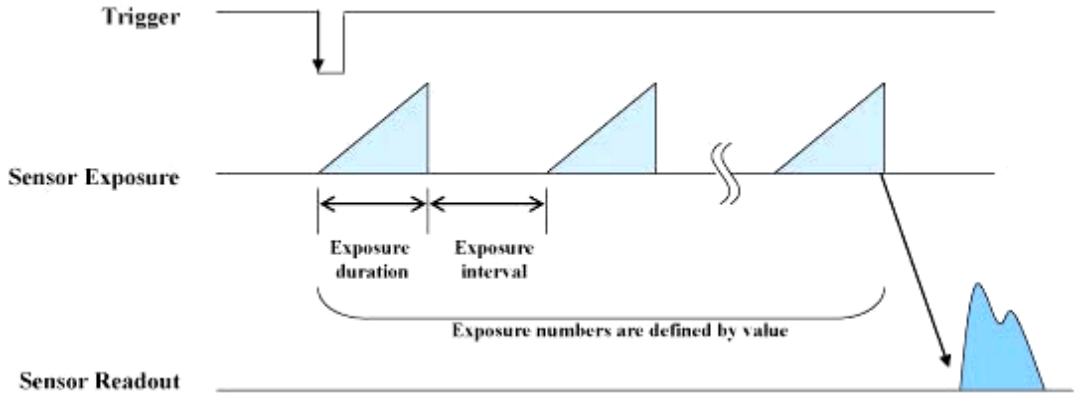
This mode is the “multiple shutter pulse width mode”. The camera starts the integration of the incoming light from the first external trigger input falling edge and exposes the incoming light until the trigger is inactive. Repeat this sequence for the N-th (parameter) external trigger input falling edge and then finish integration. A parameter is required and shall be one or more. (N >= 1)




### 3.9.10. Trigger Mode 14

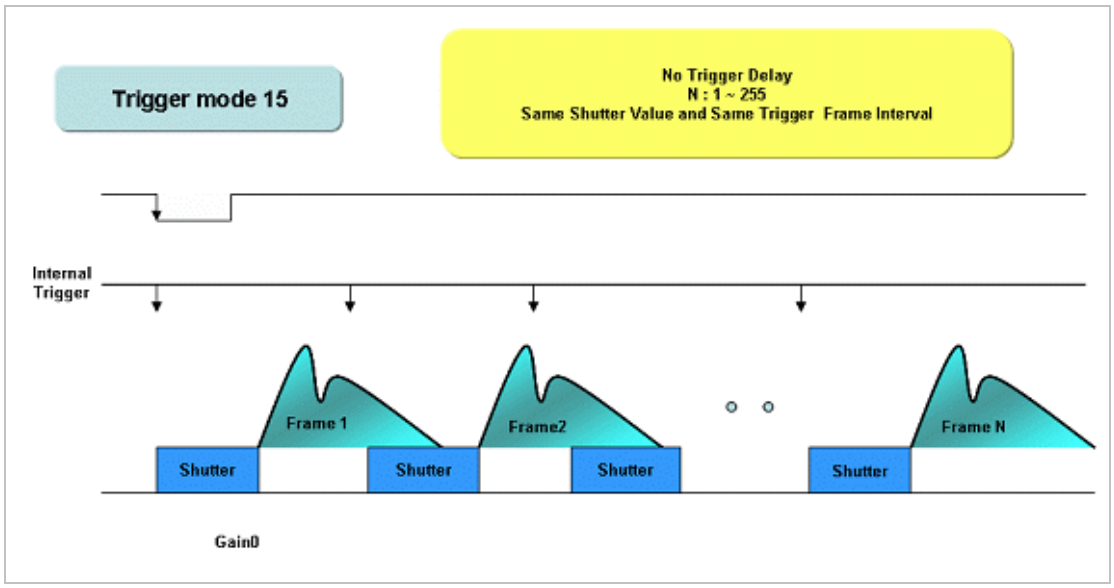
This mode is the “preset multiple shutter mode with a single trigger”.

This mode is Similar to “trigger mode 4” but the difference is that all the parameters are preset by the users using only a single trigger. “Exposure Number”, “Exposure Duration”, and “Exposure Interval” are the parameters required for this mode. However, the exposure duration and interval in each multiple shutter is equal and cannot be different. Exposure duration & interval is defined by a user defined 1394 address (0xF2F10114)




### 3.9.11. Trigger Mode 15

Trigger mode 15 is the new function. The user can capture as many images as they want with one external trigger signal. This mode is called ‘One-trigger Multi-frames’. For this mode 15, the value of the shutter time should be fixed. The mode 15 is supported by both H/W trigger and S/W trigger.


Trigger mode 15
No Trigger Delay
N : 1 ~ 255
Same Shutter Value and Same Trigger Frame Interval
Internal Trigger
Frame 1
Frame2
Frame N
Shutter
Shutter
Shutter
Shutter
Gain0

## 3.10. Strobe Control Register

**Base Address: 0xF2F23000h**

| Address | Name | Field | Bit | Description |
|---|---|---|---|---|
| 000h | Strobe_CTRL_Inq | Strobe_0_Inq | [0] | Presence of strobe 0 signal |
| | | Strobe_1_Inq | [1] | Presence of strobe 1 signal |
| | | Strobe_2_Inq | [2] | Presence of strobe 2 signal |
| | | Strobe_3_Inq | [3] | Presence of strobe 3 signal |
| | | - | [4..31] | Reserved |
| 004h<br>.<br>.<br>0FCh | Reserved | | | |
| 100h | Strobe_0_Inq | Presence_Inq | [0] | Presence of this function |
| | | - | [1..3] | Reserved |
| | | ReadOut_Inq | [4] | Capability of reading the value of this feature |
| | | On/Off_Inq | [5] | Capability of switching this function ON and OFF |
| | | Polarity_Inq | [6] | Capability of changing polarity of the signal |
| | | - | [7] | Reserved |
| | | Min_Value | [8..19] | Minimum value of this function control |
| | | Max_Value | [20..31] | Maximum value of this function control |
| 104h | Strobe_1_Inq | Same definition to Strobe_0_Inq | | |
| | Strobe_2_Inq | Same definition to Strobe_1_Inq | | |
| | Strobe_3_Inq | Same definition to Strobe_2_Inq | | |
| 110h<br>.<br>.<br>1FCh | Reserved | | | |
| 200h | Strobe_0_Cnt | Presence_Inq | [0] | Presence of this function<br>0:N/A 1: Available |
| | | - | [1..5] | Reserved |
| | | ON_OFF | [6] | Write : ON or OFF this function<br>Read: read a status 0: OFF, 1: ON<br>if this bit=0, other fields will be read only |
| | | Signal Polarity | [7] | Select signal polarity<br>If Polarity_Inq is “1” Write to change polarity of the strobe output Read to get polarity of the strobe output<br>If Polarity_Inq is “0” Read only ( 0: lowa |

| | | | | |
|---|---|---|---|---|
| | | | | active output, 1: High active output) |
| | | Delay_Value | [8..19] | Delay after start of exposure until the strobe signal asserts |
| | | Duration_Value | [20..31] | Duration of the strobe signal<br>A value 0 means dessert at the end of exposure function if required. |
| 204h | Strobe_1_Cnt | Same definition to Strobe_0_Inq | | |
| 208h | Strobe_2_Cnt | Same definition to Strobe_1_Inq | | |
| 20Ch | Strobe_3_Cnt | Same definition to Strobe_2_Inq | | |
| 210h<br>.<br>.<br>2FFh | Reserved | | | |

## 3.11. Trigger Delay Control

Based on the external triggers, the user can delay image acquisition by the trigger delay control feature.

**Trigger Delay Table**

| Mode | Value range | Trigger delay Time : T | |
|---|---|---|---|
| | | DelayTime | Range |
| All Cameras | 0 ~ 4000 | T = Yus | 0 usec ~ 4000 usec |

**Inquiry Register**

| Address | Name | Field | Bit | Description |
|---|---|---|---|---|
| 534h | TRIGGER_DLY_INQ | Presence_Inq | [0] | Presence of this feature |
| | | Abs_Control_Inq | [1] | Capability of control with absolute value |
| | | - | [2] | Reserved |
| | | One_Push_Inq | [3] | One push auto mode (Controlled automatically by camera only once) |
| | | ReadOut_Inq | [4] | Capability of reading the value of this feature |
| | | On/OFF_Inq | [5] | Capability of switching this feature ON and OFF |
| | | Auto_Inq | [6] | Auto Mode (Controlled automatically by camera) |
| | | Manual_Inq | [7] | Manual Mode (Controlled by user) |
| | | Min_Value | [8..19] | Minimum value for this feature control |
| | | Max_Value | [20..31] | Maximum value for this feature control |

**Status Control Register**

| Address | Name | Field | Bit | Description |
|---|---|---|---|---|
| 834h | TRIGGER_DELAY | Presence_Inq | [0] | Presence of this feature<br>0:N/A 1:Available |
| | | Abs_Control | [1] | Absolute value control<br>0: Control with value in Value field<br>1: Control with value in Absolute value CSR if this bit =1, value in Value filed is ignored |
| | | - | [2..5] | Reserved |
| | | On/OFF | [6] | Write : ON or OFF this feature<br>Read : read a status<br>0: OFF, 1: ON<br>If this bit=0, other fields will be read only. |
| | | - | [7..19] | Reserved |
| | | Value | [20..31] | Minimum value for this feature control |

The table shows the strobe index by the increment step through strobe delay time and strobe duration time. Increment Step is different according to strobe index.

| Strobe Delay/Duration Table | | | | |
|---|---|---|---|---|
| Strobe Index(Y) | Increment Step | Strobe Delay Time : T | | |
| | | Delay Time | Duration Time | Range |
| 0 | | 0us | N.A | |
| 1 | | 1us | N.A | |
| 2 | | 2us | 2us | |
| 3~250 | 1us | T=Y us | T=Y us | 3us~250us |
| 251~489 | 250us | T=(Y-250)*250us+250us | T=(Y-250)*250us+250us | 500us~60ms |

| Strobe Delay/Duration Index | Strobe Delay Time | Strobe Duration Time |
|---|---|---|
| 0 | 0us | N.A |
| 1 | 1us | N.A |
| 2 | 2us | 2us |
| 10 | 10us | 10us |
| 100 | 100us | 100us |
| 250 | 250us | 250us |
| 253 | 1ms | 1ms |
| 257 | 2ms | 2ms |
| 269 | 5ms | 5ms |
| 289 | 10ms | 10ms |
| 329 | 20ms | 20ms |
| 449 | 50ms | 50ms |
| 489 | 60ms | 60ms |

## 3.12. Optical Filter Control

The Optical Filter control allows the user to change the optical filter of the camera. You can change the Bayer pattern by moving the starting position of the pattern by one position up, down, right or left. (Only for color models)

**Inquiry Register**

| Address | Name | Field | Bit | Description |
|---|---|---|---|---|
| 58Ch | OPTICAL_FILTER_INQ | Presence_Inq | [0] | Presence of this feature |
| | | Abs_Control_Inq | [1] | Capability of control with absolute value |
| | | - | [2] | Reserved |
| | | One_Push_Inq | [3] | One push auto mode (Controlled automatically by camera only once) |
| | | ReadOut_Inq | [4] | Capability of reading the value of this feature |
| | | On/OFF_Inq | [5] | Capability of switching this feature ON and OFF |
| | | Auto_Inq | [6] | Auto Mode (Controlled automatically by camera) |
| | | Manual_Inq | [7] | Manual Mode (Controlled by user) |
| | | Min_Value | [8..19] | Minimum value for this feature control |
| | | Max_Value | [20..31] | Maximum value for this feature control |

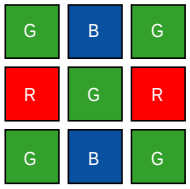
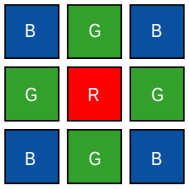
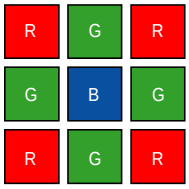
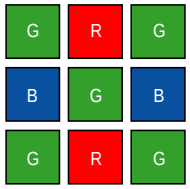
**Status Control Register**

| Address | Name | Field | Bit | Description |
|---|---|---|---|---|
| 88Ch | OPTICAL_FILTER | Presence_Inq | [0] | Presence of this feature<br>0:N/A 1:Available |
| | | Abs_Control | [1] | Absolute value control<br>0: Control with value in Value field<br>1: Control with value in Absolute value<br>CSR if this bit =1, value in Value filed is ignored |
| | | - | [2..5] | Reserved |
| | | On/OFF | [6] | Write : ON or OFF this feature<br>Read : read a status<br>0: OFF, 1:ON<br>If this bit=0, other fields will be read only. |
| | | - | [7..19] | Reserved |
| | | Value | [20..31] | Minimum value for this feature control |

## 3.13. Color (Bayer) Patterns Conversion

Color sensors capture images through an optical low pass filter placed over the individual pixels in a Bayer mosaic layout. The Imaged data is transferred to the PC where the color processing can save bandwidth gaining higher frame rate and flexibility of applying different Bayer Patterns on the PC side.

Obtained Images can be processed in any of the following 4 different conversion algorithms on the PC side.

| Modes | Mode 0 GB/RG | Mode 1 BG/GR | Mode 2 RG/GB | Mode 3 GR/BG |
|---|---|---|---|---|
| Color(Bayer) Pattern |  |  |  |  |

# 4. Advanced Features

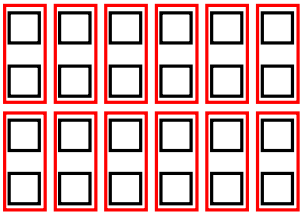
## 4.1. Binning Mode

Binning is defined as reading neighboring pixels from the CCD and combining them to create one pixel value. Binning has an advantage in the following situations as well as in various applications. Relative binning mode per camera model is described in each camera specification.

- Low Light Operation: Combining neighboring pixels increases the area of the unit pixel receiving light and may obtain a brighter picture in low light conditions with a possible noise reduction.
- High Frame Rate Operation: Vertical Binning accelerates the speed of the CCD data transfer rate by combining multiple vertical lines per single horizontal line of the CCD; resulting in a significant gain in frame rate.

### 4.1.1. Vertical Binning

Vertical binning combines neighboring CCD pixels vertically into a single pixel; increasing the light sensitivity of the camera. Since a CCD acquires data horizontally, multiple lines are acquired in the case of vertical binning which results in a significant speed gain. Thus the vertical resolution is reduced. Due to the increased CCD area per pixel, over exposure may occur which may require adjustment.



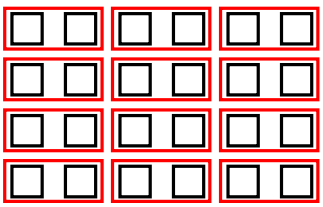
1x2 Vertical Binning

Example

### 4.1.2. Horizontal Binning

Horizontal binning combines neighboring CCD pixels horizontally into a single pixel; increasing the light sensitivity of the camera. However, due to the nature of a CCD transferring each horizontal line at a time, there is no speed gain in horizontal binning. Light sensitivity increase may occur, due to the increased CCD area per pixel, similar to vertical binning. The horizontal resolution is reduced

.

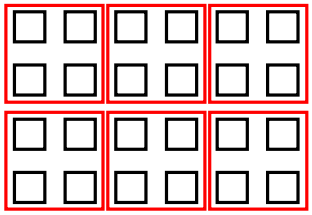


2x1 Horizontal Binning

Example

### 4.1.3. Full Binning

Full binning mode can be obtained by combining both vertical and horizontal binning. First horizontal pixels are combined; followed by a vertical conjunction of these pixels. This would increase light sensitivity by a factor of 4 in the case of 2 x 2 (Horizontal x Vertical) binning. However as described above, only vertical binning would result in a speed gain while horizontal binning gives no speed gain. Thus, the speed gain result is similar to vertical binning. Resolution in this mode would be reduced both horizontally and vertically.



2x2 Full Binning

Example

## 4.2. Partial Scan

Cameras provide a certain resolution which is dictated by the image sensor. Often, a certain region may be of interest to the user. Partial scan mode provides the function to capture a certain region of interest (ROI) which can provide an advantage in data transfer speed, resulting in a faster operation. As described in binning mode, the speed gain would occur only if vertical resolution decreases. Partial Scan is only supported in Format 7 by setting the following registers described in the IIDC1.31 specification. Unit size of the partial scan is described in the camera specification, which the user must consider in setting the increment configuration.

IMAGE POSITION & IMAGE SIZE register

Left = Hposunit * n1

Top = Vposunit * m1

Width = Hunit * n2

Height = Vunit * m2

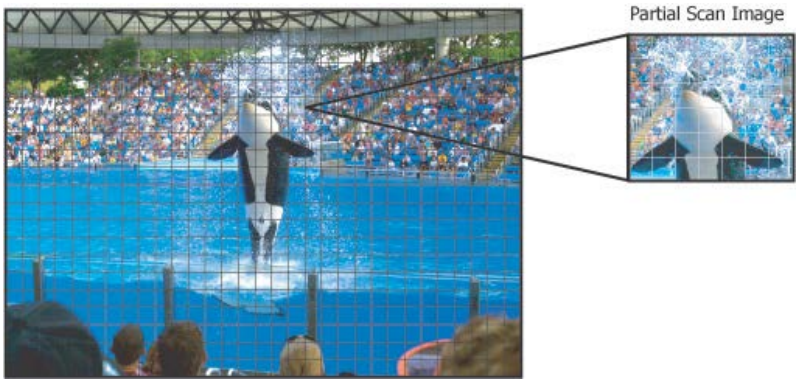
Left + Width < = Hmax

Top + Height < = Vmax

(n1,n2, m1, m2 are integer)

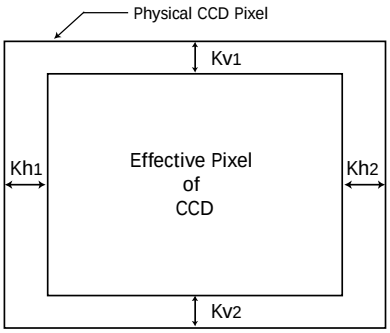
| 0 - 7 | 8 – 15 | 16 – 23 | 24 - 31 |
|---|---|---|---|
| Left | | Top | |
| 0 - 7 | 8 – 15 | 16 – 23 | 24 - 31 |
| Width | | Height | |

| | |
|---|---|
| Initial Values | System Dependant |
| Read Values | Last Update Value |
| Write Effect | Stored |



## 4.3. Pan/Tilt

Pan/Tilt is a function used to move a camera up and down or left and right. However, unlike the mechanical Pan /Tilt which is carried out by physically moving the camera up and down, this function by using a smaller video mode than the CCD's effective pixels and moving the image up and down. This results in a reduced resolution, which the user can specify by the Pan/Tilt command. Pan/Tilt range and values depend on the characteristic of each CCD used in the camera respectively as per the following tables. Note that at Format 7 mode, the pan/tilt value must be set at non-format 7 mode before operation.




$Kh = Kh_1 + Kh_2$ $Kv = Kv_1 + Kv_2$

**Pan/Tilt Details for Fire-i 530b & Fire-i 530b**

| Image Size | Movement | Fire-i 530b Kh =12, Kv=12 | | Fire-i 530c Kh=8, Kv=10 | |
|---|---|---|---|---|---|
| | | Range(Incr.=1) | Default | Range(Incr.=2) | Default |
| 320 x 240 | Pan | 160 ~ 492 | 326 | 160 ~ 488 | 324 |
| | Tilt | 120 ~ 372 | 246 | 120 ~ 370 | 242 |
| 640 x 480 | Pan | 320 ~ 332 | 326 | 320 ~ 328 | 324 |
| | Tilt | 240 ~ 252 | 246 | 240 ~ 250 | 242 |

*At format7 mode, PAN/TITL value must be set at non-format7 mode.

**Pan/Tilt Details for Fire-i 630b & Fire-i 630c**

| Image Size | Movement | Fire-i 630b Kh=8, Kv=8 | | Fire-i 630c Kh=8, Kv=8 | |
|---|---|---|---|---|---|
| | | Range(Incr.=1) | Default | Range(Incr.=2) | Default |
| 320 x 240 | Pan | 160 ~ 872 | 516 | 160 ~ 872 | 516 |
| | Tilt | 120 ~ 656 | 388 | 120 ~ 656 | 388 |
| 640 x 480 | Pan | 320 ~ 712 | 516 | 320 ~ 712 | 516 |
| | Tilt | 240 ~ 536 | 388 | 240 ~ 536 | 388 |
| 800 x 600 | Pan | 400~632 | 516 | 400~632 | 516 |
| | Tilt | 300~476 | 388 | 300~476 | 388 |
| 1024 x 768 | Pan | 400 ~ 632 | 516 | 400 ~ 632 | 516 |
| | Tilt | 300 ~ 476 | 388 | 300 ~ 476 | 388 |

*At format7 mode, PAN/TITL value must be set at non-format7 mode

**Pan/Tilt Details for Fire-i 830b & Fire-i 830c**

| Image Size | Movement | Fire-i 830b Kh=22, Kv=34 | | Fire-i 830c Kh=20, Kv=34 | |
|---|---|---|---|---|---|
| | | Range(Incr.=1) | Default | Range(Incr.=2) | Default |
| 320 x 240 | Pan | 160 ~ 1462 | 810 | 160 ~ 1460 | 810 |
| | Tilt | 120 ~ 1114 | 616 | 120 ~ 1114 | 616 |
| 640 x 480 | Pan | 320 ~ 1302 | 810 | 320 ~ 1300 | 810 |
| | Tilt | 240 ~ 994 | 616 | 240 ~ 994 | 616 |
| 800 x 600 | Pan | 400 ~ 1222 | 810 | 400 ~ 1220 | 810 |
| | Tilt | 300 ~ 934 | 616 | 300 ~ 934 | 616 |
| 1024 x 768 | Pan | 512 ~ 1110 | 810 | 512 ~ 1108 | 810 |
| | Tilt | 384 ~ 850 | 616 | 384 ~ 850 | 616 |
| 1280 x 960 | Pan | 640 ~ 982 | 810 | 640 ~ 980 | 810 |
| | Tilt | 480 ~ 754 | 616 | 480 ~ 754 | 616 |
| 1600 x 1200 | Pan | 800 ~ 822 | 810 | 800 ~ 820 | 810 |
| | Tilt | 600 ~ 634 | 616 | 600 ~ 634 | 616 |
| 1600 x 1200 Format 7 Mode 0 | Pan | | | | |
| | Tilt | | | | |
| 800 x 600 Format 7 Mode 1 | Pan | | | | |
| | Tilt | | | | |
| 1600 x 600 Format 7 Mode 2 | Pan | | | | |
| | Tilt | | | | |

## 4.4. One-Shot and Multi-Shot

This camera supports One-Shot and Multi-Shot features. The camera should be in ISO disabled mode before the execution of these commands. If the camera is in ISO enabled mode, these commands are ignored. One-Shot is used to grab only one frame. Multi-Shot is used to grab 1~65,535 frames. One-Shot and Multi-Shot can be used combined with a hardware trigger which grabs either one frame or multi frames according to the respective command. The command can be executed configuring the following registers.

Caution: One-Shot and Multi-Shots are not supported in trigger mode

| **One-Shot** | | **Multi-Shot** | |
|---|---|---|---|
| Address | F0F0061CH | Address | F0F0061CH |
| Data | 80000000h | Data | 4000nnnh |

nnnn is the number of output frames which can be any number between 0001h ~ FFFFh.(1~ 65,535)

Priority of the command execution is as follows. Continuous → One-shot → Multi-shot.

When a command with higher priority is being executed, the command with lower priority will be ignored.

This function is Not supported by Fire-i 550 and Fire-i 850 models.

## 4.5. Multi-Camera Auto-sync.

**Not supported in 3.75 fps**

In applications incorporating Multi-Camera, there is often a need to synchronize the cameras. Multi-Camera Auto Synchronization is supported utilizing the FireWire bus time cycle register which is connected on the same FireWire bus without an external signal. Max 3 cameras can be supported for auto-sync on an OHCI card.

The video mode of the camera must be set within the limit of a single FireWire bus bandwidth of 400Mbps. Also, the maximum shutter value must be set as per the table below, not exceeding the FireWire bus cycle time. Jitter may occur due to CPU operation timing. In the auto-sync mode, the shutter time and the fps should be set as follows: (This function is Not supported by Fire-i 550 and Fire-i 850 models)

| FPS | **Fire-i 530x** | | **Fire-i 630x** | | **Fire-i 830x** | |
|---|---|---|---|---|---|---|
| | Max Shutter | | Max Shutter | | Max Shutter | |
| | Value | Time | Value | Time | Value | Time |
| 60 | 1110 | 16.5ms | - | - | - | |
| 30 | 1276 | 33.1ms | 1270 | 32.5ms | - | - |
| 15 | 1608 | 66.3ms | 1598 | 65.3ms | 1606 | 66.1ms |
| 7.5 | 1760 | 131ms | 1758 | 129ms | 1760 | 131ms |
| ~~3.75~~ | ~~1893~~ | ~~264ms~~ | ~~1889~~ | ~~260ms~~ | ~~1893~~ | ~~264ms~~ |

To utilize Auto-sync, please set Bit 31 to Auto-sync Enable, and then check the Bit 27 to verify whether it is ready. Please refer the details as the following table.

| | | |
|---|---|---|
| 0xF2F10018 | **Auto-Sync Mode control register**<br>Bit 31 : auto sync enable<br>Bit 30 : SIO enable mode (0 : Custom mode, 1 : IIDC v1.31)<br>Bit 27 : auto sync complete (read only. 1: ready, 0: not yet auto-sync) | Read/Write |

## 4.6. Asynchronous Broadcasting

Asynchronous broadcasting is supported when using node 63 of the FireWire bus as a target node for an asynchronous write request. This enables all the cameras to be triggered by software simultaneously. By utilizing Asynchronous Broadcasting, the user can operate and control all the cameras on the same FireWire bus at the same time, with a single command.

## 4.7. Memory Channel Save / Load

The setting of the camera features (Shutter, Gain, etc) and video mode can be stored in a non-volatile memory. The camera supports 16 memory channels as per the table below for the user to conveniently save and load different features as well as video modes. Channel 0 is for factory default and Channels 1~4 are for saving features. Channels 5~15 are for resolution, mode and frame rate plus saving other features.

| Address | Name | Bit | Description |
|---|---|---|---|
| 618h | Memory_Save | [0] | Saves the current setting |
| | | [1..31] | Reserved |
| Address | Name | Bit | Description |
| 620h | Mem_Save_Ch | [0] | Factory Default Setting Cannot overwrite |
| | | [1..4] | Write Channel for Memory Save for Channel 1 ~ 4<br>( Only for Features ) |
| | | [5..15] | Write Channel for Memory Save for Channel 5 ~ 15<br>(For Features, Format and Mode Save) |
| Address | Name | Bit | Description |
| 624h | Cur_Save_Ch | [0] | Read and Load Factory Default Setting |
| | | [1..4] | Read and Load Memory Channel 1 ~ 4 |
| | | [5..15] | Read and Load Load Memory Channel 5 ~ 15 |

**User Defined FireWire Register Control**

The values saved in the channel are users define; and can be made the default values at power-on. The channels from 1 to 15 are to be set in the power-on default mode.

| Address | Description( bit : msb*) | Read/Write |
|---|---|---|
| 0xF2F1011C | **Power on default memory channel**<br>Bit 0 ~ Bit 3 : power on initial memory channel | Read/Write |

## 4.8. Time Stamp Register

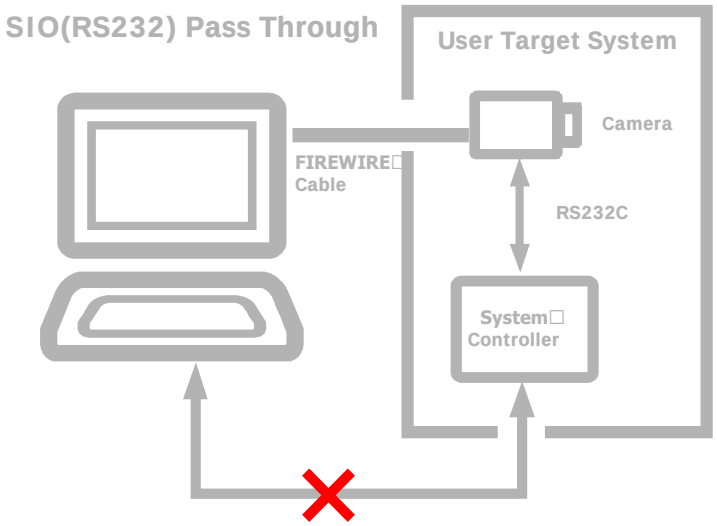
The Time stamp register may be inquired from the Native FireWire Bus (IEEE-1394.a) CYCLE_TIME registers as follows. You may also get the same value from user defined registers but we recommend this.

<table>
<tr><th>Address</th><th>Description( bit : msb*)</th><th>Read/Write</th></tr>
<tr><td>0xF0000200</td><td>
CYCLE_TIME
<table>
<tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td><td>24</td><td>25</td><td>26</td><td>27</td><td>28</td><td>29</td><td>30</td><td>31</td></tr>
<tr><td colspan="7">SECONDS COUNT</td><td colspan="13">CYCLE COUNT</td><td colspan="12">CYCLE OFFSET</td></tr>
</table>
<table>
<tr><th>Bit Number</th><th>Bit Name</th><th>Function</th><th>DIR</th><th>Description</th></tr>
<tr><td>0 - 6</td><td>SECONDS COUNT</td><td>Seconds Count</td><td>R/W</td><td>1 Hz cycle timer counter</td></tr>
<tr><td>7 - 19</td><td>CYCLE COUNT</td><td>Cycle Count</td><td>R/W</td><td>8,000 Hz cycle timer counter</td></tr>
<tr><td>20 - 31</td><td>CYCLE OFFSET</td><td>Cycle Offset</td><td>R/W</td><td>24.576 MHz cycle timer counter</td></tr>
</table>
</td><td>Read</td></tr>
</table>

## 4.9. Serial Interface

The cameras are equipped with the SIO (Serial input/output) feature described in the IIDC 1.31 specification. By using the serial interface, the user can execute commands by writing data in a specific address in the FireWire address range. SIO can be further used as an RS232 interface which supports pass through and custom commands.

### 4.9.1. SIO Pass Through Scheme




**SIO (RS232) Control Setting Procedure**

**STEP 1. Configuration of Registers Address : F2F22000h**

Baud Rate : 9600, No Parity, 1 bit Stop, 8 bit data length

Write : F2F22000h, Data = 050800000h

Value read after write = 050800020h 20 is the buffer of TX and RX

**STEP 2. Enable RS232 TX / RX Address : F2F22004h**

Write Data : C00000000 : Now RS232 TX / RX port is enabled

**SIO (RS232) RX Control Procedure**

**STEP 1 Read RBUF_ST of the Receive Buffer Status Control Register (address : F2F22008h) and check number of RX data buffered in the camera.**

If (RBUF_ST !=0) the RX is Ready else RX is NOT Ready

RBUF_ST : The number of current data buffered in the camera (Unit : byte)

RBUF_CNT : READ : Remaining RX buffer size

**STEP 2 Write number of RX data intended to read from RBUF_CNT of the Receive Buffer Status Control Register (address : F2F22008h)**

RBUF_CNT can be configured by unit of byte.

**STEP 3 Read RS232 RX data from SIO_Data_Register (addr. : F2F22100 )**

**STEP 4 If data is further required repeat from STEP1**

Note that 1394 data consist of 32 bit data the data read should

Bit 0 ~ Bit 7 : 1st Data Bit 8 ~ Bit 15 : 2nd Data

Bit 16 ~ Bit 23 : 3rd Data Bit 24 ~ Bit 31 : 4th Data

Bit 0 : Msb Bit 31 : Lsb

## SIO (RS232) TX Control Procedure Method I

**STEP 1 Check TX buffer size by reading TBUF_ST of the Transmit_Buffer_Status_Control register(Addr. : F2F220Ch)**

If ((TBUF_ST == Buffer_Size_Inq) or (TBUF_TDRD ==1)) then TX is COMPLETE else TX is INCOMPLETE

TBUF_ST : Current TX Data buffer(Unit:byte) of the camera

TBUF_CNT : Read : Number of data transmitted by RS232 TX

Buffer_Size_Inq : Defined in Serial_Mode_Reg( Addr. : F2F22000h)

Ex) 20050000h : valid data buffer size = 20 number of data sent : 05

**STEP 2 Write number of RS232 TX data to be set for TBUF_CNT at SIO_Data_Register(Addr: F2F22100h)**

**STEP 3 Write number of TX data to be transferred to TBUF_CNT of Transmit_Buffer_Status_Control Register(Addr:F2F2200Ch)**

TBUF_CNT can be configured by unit of byte.

The value of TBUF_CNT must be smaller than data written at SIO_Data_Register.

If (write data number > = TBUF_CNT)

{

RS232TX Start

Write Data number larger that TBUF_CNT is discarded.

For example if TBUF_CNT = 5 , in IEEE-1394 write is done by a unit of 4 bytes where 8 bytes shall be written at SIO_Data_Register but only 5 bytes are transmitted and the 3 bytes remaining shall be discarded.

}

**STEP4 If there is data to be transmitted repeat from Step 1 .**

Bit 0 ~ Bit 7: 1st Data Bit 8 ~ Bit 15: 2nd Data

Bit 16 ~ Bit 23: 3rd Data Bit 24 ~ Bit 31: 4th Data

Bit 0 : Msb Bit 31 : Lsb

## SIO (RS232) TX Control Procedure Method II

**STEP 1 Check TX buffer size by reading TBUF_ST of the Transmit_Buffer_Status_Control register(Addr. : F2F220Ch)**

If ((TBUF_ST == Buffer_Size_Inq) or (TBUF_TDRD ==1)) then TX is COMPLETE else TX is INCOMPLETE

TBUF_ST : Current TX Data buffer(Unit:byte) of the camera

TBUF_CNT : Read : Number of data transmitted by RS232 TX

Buffer_Size_Inq : Defined in Serial_Mode_Reg( Addr. : F2F22000h)

Ex) 20050000h : valid data buffer size = 20 number of data sent : 05

**STEP 2 Write number of RS232 TX data to be set for TBUF_CNT at Transmit_Buffer_Status_Control Register(Addr:F2F2200Ch)**

TBUF_CNT can be configured by unit of byte.

The value of TBUF_CNT must be smaller than data written at SIO_Data_Register.

**STEP 3 Write RS232 TX data set at TBUF_CNT to SIO_Data Register(Addr. : F2F22100h)**

If (write data number > = TBUF_CNT)

{

RS232TX Start

Write Data number larger that TBUF_CNT is discarded.

For example if TBUF_CNT = 5 , in IEEE-1394 write is done by a unit of 4 bytes where 8 bytes shall be written at SIO_Data_Register but only 5 bytes are transmitted and the 3 bytes remaining shall be discarded.

}

**STEP4 If there is data to be transmitted repeat from Step 1 .**

Bit 0 ~ Bit 7 : 1st Data Bit 8 ~ Bit 15 : 2nd Data

Bit 16 ~ Bit 23 : 3rd Data Bit 24 ~ Bit 31 : 4th Data

Bit 0 : Msb Bit 31 : Lsb

### 4.9.2. SIO(RS232) Registers

**Base address: F2F22000h, default baud rate is 57600**

| Address | Name | Field | Bit | Description |
|---|---|---|---|---|
| 000h | Serial_Mode_Reg | Baud Rate | [0..7] | Baud Rate Setting<br>Write : Set baud rate<br>Read : Get current baud rate<br>0: 300 bps 1: 600 bps<br>2: 1200 bps 3: 2400 bps<br>4: 4800 bps 5: 9600 bps<br>6: 19200 bps 7: 38400 bps<br>8: 57600 bps 9: 115200bps<br>10: 230400bps Other value reserved. |
| | | Char_Length | [8..15] | Character length setting<br>Write: Set data length (must not be 0)<br>Read : Get data length<br>7: 7 bits<br>8: 8 bits<br>Other values reserved. |
| | | Parity- | [16..17] | Parity setting<br>Write : Set Parity<br>Read : Get current parity<br>0: None 1 : Odd 2 : Even |
| | | Stop_bit | [18..19] | Stop bits<br>Write : Set stop bit<br>Read : Get current stop bit<br>0: 1 1: 1.5 2: 2. |
| | | - | [20..23] | Reserved |
| | | Buffer_Size_Inq | [24..31] | Buffer Size (Read Only)<br>This field indicates the maximum size of receive/transmit data buffer.<br>If this value=1, Buffer_Status_Control, SIO_Data_Register Char1-3 should be ignored |
| 004h | Serial_Control_Reg | RE | [0] | Receive enable<br>Read : Current status<br>Write : 0 : Disable 1: Enable |
| | | TE | [1] | Transmit enable<br>Read : Current status<br>Write : 0 : Disable 1: Enable |
| | | - | [2..7] | Reserved |
| | Serial_Status_Reg | TDRD | [8] | Transmit data buffer ready<br>Read only<br>0 : Not ready 1: Ready |
| | | - | [9] | Reserved |
| | | RDRD | [10] | Receive data buffer ready<br>Read only<br>0 : Not ready 1: Ready |
| | | - | [11] | Reserved |
| | | ORER | [12] | Receive buffer over run error<br>Read : Current status<br>Write : 0: Clear flag 1: Ignored |
| | | FER | [13] | Receive data framing error<br>Read : Current status |

| | | | | |
|---|---|---|---|---|
| | | | | Write : 0: Clear flag 1: Ignored |
| | | PER | [14] | Receive data parity error<br>Read : Current status<br>Write : 0: Clear flag 1: Ignored |
| | | - | [15] | Reserved |
| 008h | Receive_Buffer_Status_Control | RBUF_ST | [0..8] | SIO receive buffer status<br>Read :<br>Valid data size of current receive buffer<br>Write : Ignored |
| | | RBUF_CNT | [8..15] | SIO receive buffer control<br>Read : Remain data size for read<br>Write : Set input data size |
| | | - | [16..31] | Reserved |
| 00Ch | Transmit_Buffer_Status_Control | TBUF_ST | [0..7] | SIO ouput buffer status<br>Read :<br>Available data space of transmit buffer<br>Write : Ignored |
| | | TBUF_CNT | [8..15] | SIO output buffer control<br>Read : Written data size to buffer<br>Write : Set output data size for transmit |
| | | - | [16..31] | Reserved |
| 010h<br>..<br>0FFh | | | | Reserved |
| 100h | SIO_Data_Register | Char_0 | [0..7] | Chracter_0<br>Read : Read character from receive buffer<br>Padding data, if data is not available<br>Write : Character to transmit buffer<br>padding data if data is invalid |
| | | Char_1 | [8..15] | Chracter_1<br>Read : Read character from receive buffer +1 Padding data, if data is not available<br>Write : Character to transmit buffer +1<br>padding data if data is invalid |
| | | Char_2 | [8..15] | Chracter_2<br>Read : Read character from receive buffer +2 Padding data, if data is not available<br>Write : Character to transmit buffer +2<br>padding data if data is invalid |
| | | Char_3 | [16..31] | Chracter_3<br>Read : Read character from receive buffer +3 Padding data, if data is not available<br>Write : Character to transmit buffer +3<br>padding data if data is invalid |
| 104h<br>..<br>1FFh | SIO_Data_Register_Alias | | [0..31] | Alias SIO_Data_Register area for block transfer |

### 4.9.3. SIO(RS232) Special Commands

| | | |
|---|---|---|
| 0xF2F10018 | **Auto-Sync Mode control register**<br>Bit 31 : auto sync enable<br>Bit 30 : SIO enable mode (**0 : Custom mode**, 1 : IIDC v1.31)<br>Bit 27 : auto sync complete (read only. 1: ready, 0: not yet auto-sync) | Read/Write |

Custom commands are valid when the Bit30 is to be set “0”(zero).

SIO(RS232) custom commands are non IIDC compliant which is a specific mode for the cameras.

Before using these commands serial communication parameters must be set at **Serial_Mode_Reg(F2F22000h)**

F2F10018 means that the RS232 command is valid.

| Baud Rate | Stop Bit | Parity | Flow Control |
|---|---|---|---|
| 57600 bps (default) | 1 bit | None | Non |

- **Command format : [STX] [Command] [Data] [ETX]**

  [STX] : Command start character : ‘S’

  Command] : Command length is 2byte. See next page command table.

  [Data] : Data length is varied with each command. Data format is hexadecimal: ‘0’~’9’, ‘A’~’F’.

  [ETX] : Command end character : ‘Z’

- **Return value**

  ‘G’ : Command complete acknowledge.

  “Gdd..d” : “dd..d” is return data and hexadecimal character.

  ‘U’ : Undefined command.

- Valid Character: ‘0’~’9’, ‘A’~’F’, ‘S’,’Z’ Invalid character is received is discarded.

- **Example: Gain setting command with 0x200 value.**

  All of “SA0200Z”, “S A0 200 Z”, “SA0 200Z”, “S A0200 Z”, and “SKA0V200Z” are parsed to “SA0200Z Z”, and “SKA0V200Z” are parsed to “SA0200Z”.

- **SIO(RS232) Commands**

| STX | Command | Data Length | ETX | Return Value | Function |
|---|---|---|---|---|---|
| S | A0 | 3Bytes | Z | G | **Gain control** (0x000 ~ 0x30F(BW Model) or 2D3(Color Model)) (see gain mapping graph)<br>Ex) SA0200Z : Gain index value 512 (18dB) |
| S | A1 | 3Bytes | Z | G | **Shutter speed control**<br>(0x001 ~ 0xCFB) (see shutter speed table) |
| S | A2 | 1Bytes | Z | G | **Set/Clear auto shutter speed and auto gain**<br>Bit 0 : Auto gain Bit 1 : Auto shutter speed<br>Ex) SA21Z : set auto gain and clear auto shutter speed<br>SA23Z : set auto gain and auto shutter speed<br>SA20Z : clear auto gain and auto shutter speed |
| S | A3 | 2Bytes | Z | G | **Auto exposure control** (0x00~0x64) |
| S | A4 | 1Bytes | Z | G | **Gamma control** (0x0~0x19) (see gamma table) |
| S | A5 | 3Bytes | Z | G | **Brightness control** (0x000~0x800) |
| S | A6 | 3Bytes | Z | G | **Sharpness control** (0x000~0x3F8) |
| S | A7 | 1Bytes | Z | G | **ISO control** 1: ISO enable, 0 : disable |
| S | A8 | 1Bytes | Z | G | **Trigger control** 1: trigger enable, 0 : trigger disable |

| | | | | | |
|---|---|---|---|---|---|
| S | AF | 0Bytes | Z | 'G'+18 Byte | **Read feature control value**<br>Return value order<br>'G'[Gain] [Shutter] [Set/Clear auto gain and shutter] [Auto Exposure] [Gamma] [Brightness] [Sharpness] [ISO] [Trigger]<br><br>Ex) At Command SAFZ, if return value is G001200132F20020101,<br>Gain : 0x001 Shutter speed : 0x200<br>Set auto gain/Clear auto shutter speed : 0x1<br>Auto exposure : 0x32 Gamma : 0xF Brightness : 0x200<br>Sharpness : 0x201 ISO : 0x0 Trigger : 0x1 |
| S | B0 | 16Bytes | Z | G | **RS232 synchronization** : RS232 buffer cleared in camera. |
| S | B1 | 8Bytes | Z | G | **Write access of 1394 address**<br>Format : SB1 [address(8 byte)] [data(8byte)] Z<br>Ex) SB1F2F1010012345678Z :<br>write 0x12345678 data at 0xF2F10100 address |
| S | B2 | 0Bytes | Z | 'G'+8 Byte | **Read access of 1394 address**<br>Format : SB2 [address(8byte)] Z<br>Ex) If command is SB2F2F10100Z and return value is G12345678, Read value of address 0xF2F10100 is 0x12345678. |
| S | B3 | 3Bytes | Z | G | **Return to default feature value**<br>Return control feature : gain, shutter speed, auto exposure, brightness, sharpness, gamma, auto shutter speed, auto gain |
| S | Undefined Command | Any Byte | Z | U | **Undefined command**<br>Return Value is 'U' character. |

## 4.10. Frame Save Function

The Fire-i ultra compact form series cameras can save their frames in the camera memory. The camera can be instructed to stop running when the maximum frames are saved in the memory. Max savable frame numbers are different according to models. The saved images are useful for multi cameras applications. IEEE1394 images are transferred by the ISO channel and 400Mbps is the max bandwidth.

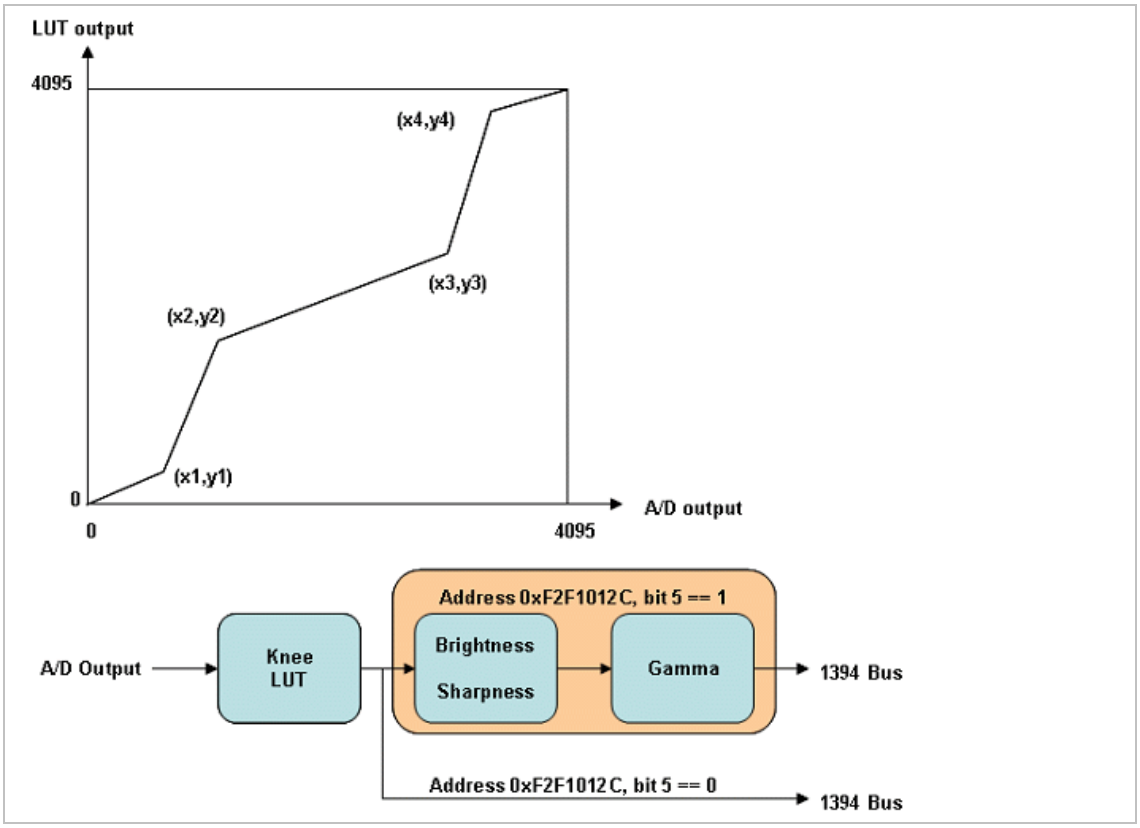
| of maximum save frames : address 0xF2F10128, bit 16 ~ bit 23 read value | | |
|---|---|---|
| Resolution | Mode 800 | Mode 1600/Y422 |
| 640 x 480 | 63 frames | 31 frames |
| 800 x 600 | 63 frames | 31 frames |
| 1024 x 768 | 31 frames | 15 frames |
| 1280 x 960 | 15 frames | 7 frames |
| 1600 x 1200 | 15 frames | 7 frames |

## 4.11. LUT (Lookup table)

The cameras support a LUT, which provides the user with an image with the user's defined dynamic range. Through the LUT, the user can process the images from saturation to dark. The LUT can be used optionally with Brightness, Sharpness and Gamma. However, the applied sequence is that the LUT is applied prior to the features like Brightness, Sharpness and Gamma.

### 4.11.1. 4 step knee lookup table

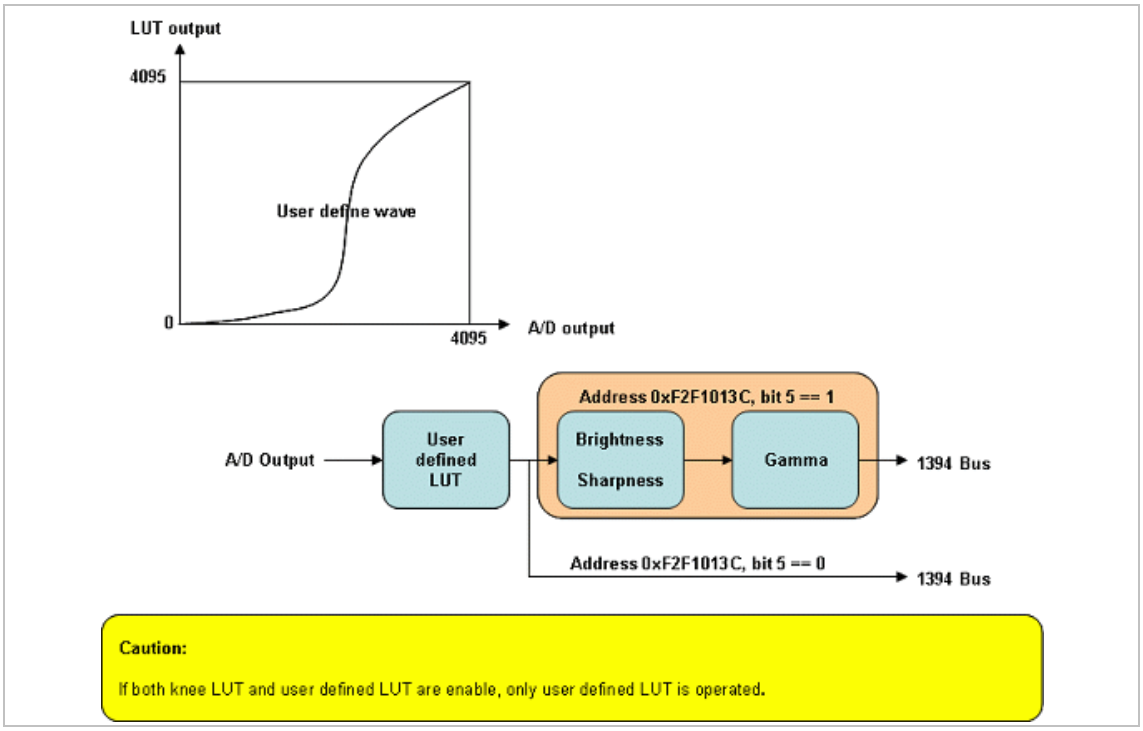
The user can set the 4 points for the images, called the knee, and apply them to the LUT.




### 4.11.2. User defined lookup table

The users can set defined points (data file) for the images and apply them to the LUT. The user's defined LUT running procedure is as follows: LUT index is N (o~15). The total index number of user's defined LUT is 16, but only one user defined LUT is used at a time.

Priority: User's defined LUT > 4 point LUT > Features (Brightness, Sharpness, Gamma)



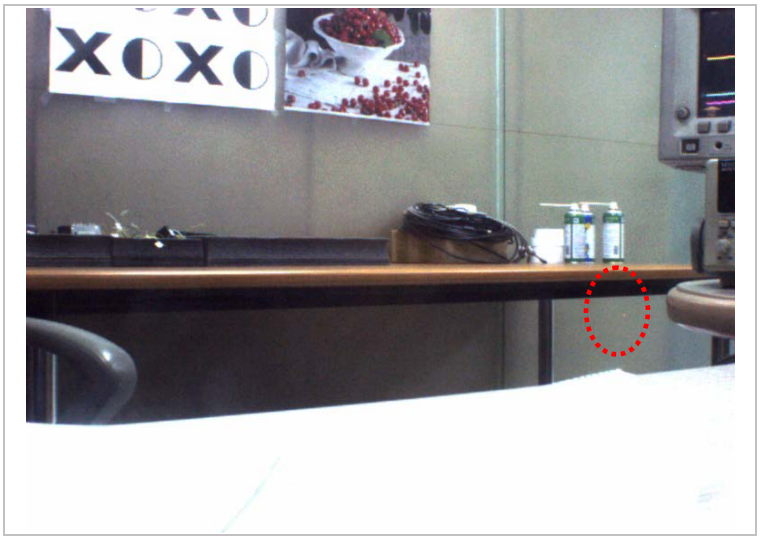

The user defined LUT save procedure is:

1. Check the save ready bit (bit1) status of the LUT save control register (0xF2F10140). If bit 1 is 0, wait.
2. Write 1 at the LUT buffer address init bit (bit7) of the LUT save control register (0xF2F10140) : 0xF2F10140 (<= 0x01000000).
3. Then write 4096 LUT data at the LUT data register (0xF2F10144).
4. Finally, write save command (bit0), LUT index (N: bit8~bit11) at the LUT save control Register (0xF2F10140): 0xF2F10140 (<= 0x80N00000).

## 4.12. One Pixel Snow Noise Remove

With this function, it is possible to average the value of snow noise pixel by using the neighboring pixels values. The formula used is: If ((Pi-Pi-1) > Threshold*16) and ((Pi-Pi+1) > (Threshold*16)), Pi is bad pixel. The purpose of the function is to increase the average pixels values for the whole image and be automatically displayed and the images can be compensated by over up to 50%. The register address and values for this function are:

| Address | Description (bit 0: msb) | Read/Write |
|---|---|---|
| 0xF2F20150 | **One Pixel Snow Noise Remove**<br>Bit 0 : presence inquiry (read only)<br>Bit 1 ~ Bit 5 : reserved<br>Bit 6 : on/off<br>Bit 7~Bit23 : reserved<br>Bit 24~Bit31 : Threshold Value (T) :<br>If Pixel difference value > Threshold Value, then replace near pixel average Value | Write only |



Before Snow noise image

After Snow noise removal

## 4.13. PIO Control Register

Short for Programmable Input/Output, PIO provides a set of IO ports which can be configured by the defined address. The PIO control register by 1394 address, for strobe and trigger signal, is as follows.

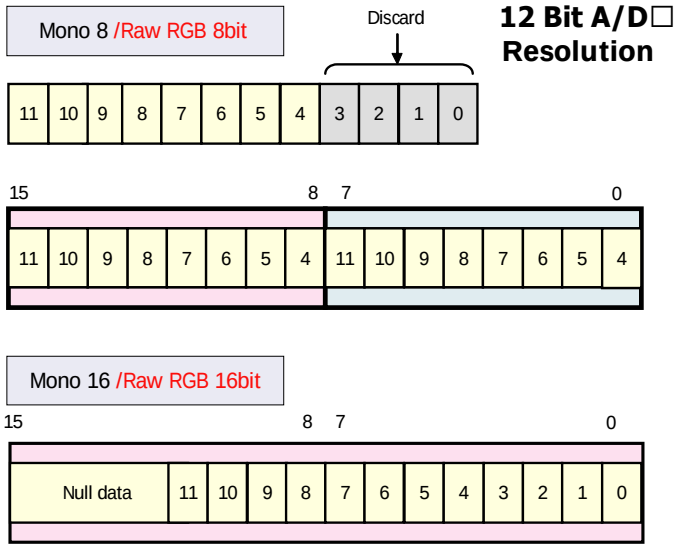
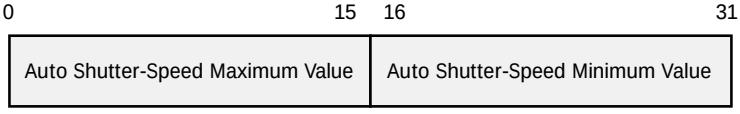
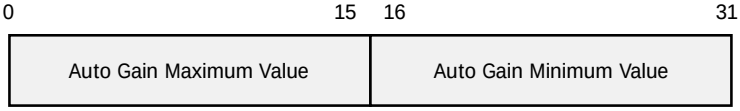
| Address | Description (bit 0: msb) | Read/Write |
|---|---|---|
| 0xF2F21000 | PIO output register<br>Bit 30 : Strobe GPIO output | Write only |
| 0xF2F21004 | PIO input register<br>Bit 31 : trigger GPIO input | Read only |
| 0xF2F21008 | PIO GPIO enable register.<br>Bit 30 : Strobe pin GPIO selector (1: GPIO, 0: strobe) | Read/Write |

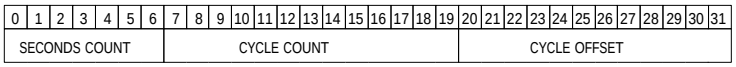
# 5. User Defined (custom) FIREWIRE Registers

User defined registers are features undefined in the IIDC specification which Unibrain cameras are capable of. The user can utilize extended features of the specific FireWire register for an application.

Note: For users who have had a previous version of an Unibrain Camera, several User Defined Registers have been incorporated in the IIDC V1.31 specification.

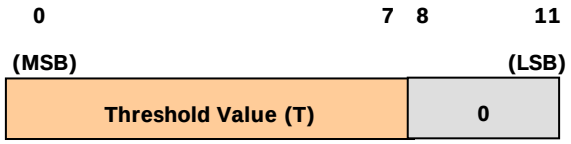
## 5.1. User Defined FIREWIRE Address

| Address | Description( bit : msb*) | Read/Write |
|---|---|---|
| 0xF2F10000 | **A/D bit resolution**<br>Bit 28~Bit31 : A/D bit resolution<br>Please refer to IIDC v1.31 data depth register (address: 0xF0F00630)<br>  | Read only |
| 0xF2F10004 | **Auto shutter-speed maximum/minimum value register**.(32bit)<br>At auto shutter mode, shutter speed value is checked between auto shutter-speed maximum value and minimum value<br>  | Read/Write |
| 0xF2F10008 | **Auto gain maximum/minimum value register**.*(32bit)<br>At auto gain mode, gain value is checked between auto gain maximum value and minimum value.<br>  | Read/Write |

<table>
<tr><td>0xF2F10018</td><td>Mode control register<br>Bit 31 : auto sync enable<br>Bit 30 : SIO enable mode (0 : Custom mode, 1 : IIDC v1.31)<br>Bit 27 : auto sync complete (read only. 1: ready, 0: not yet auto-sync)</td><td>Read/Write</td></tr>
<tr><td>0xF2F1001C</td><td>1394 time stamp register(msb:bit0)<br> 

<table>
<tr><th>Bit Number</th><th>Bit Name</th><th>Function</th><th>DIR</th><th>Description</th></tr>
<tr><td>0 - 6</td><td>SECONDS COUNT</td><td>Seconds Count</td><td>R/W</td><td>1 Hz cycle timer counter</td></tr>
<tr><td>7 - 19</td><td>CYCLE COUNT</td><td>Cycle Count</td><td>R/W</td><td>8,000 Hz cycle timer counter</td></tr>
<tr><td>20 - 31</td><td>CYCLE OFFSET</td><td>Cycle Offset</td><td>R/W</td><td>24.576 MHz cycle timer counter</td></tr>
</table>
We recommend using native CYCLE_TIME register in Chap. 5.7.</td><td>Read only</td></tr>
<tr><td>0xF2F10100</td><td>Power on reset condition control register<br>Not Recommended<br>Please refer to IIDC v1.31 memory save/load channel.</td><td>Read/Write<br>(Self Cleared)</td></tr>
<tr><td>0xF2F10104</td><td>Trigger control register<br>Not Recommended<br>Please refer to IIDC v1.31 trigger control register (address: 0xF0F00830)</td><td>Read/Write</td></tr>
<tr><td>0xF2F10108</td><td>Software trigger<br>Not Recommended<br>Please refer to IIDC v1.31 software trigger register (address: 0xF0F0062C)</td><td>Read only</td></tr>
<tr><td>0xF2F1010C</td><td>Strobe control register. Only supports active high polarity.<br>Not Recommended Please refer to IIDC v1.31strobe control register (address: 0xF0F0048C -> 0xF2F23200)</td><td>Read/Write</td></tr>
<tr><td>0xF2F10110</td><td>Trigger noise filter register (External trigger only)<br>Bit 22~Bit 31 : trigger masking range (M, unit : usec, range:0~1023)</td><td>Read/Write</td></tr>
<tr><td>0xF2F10114</td><td>Multi-cut exposure & interval time control (for Mode 14)<br>Bit 16 ~ 31 : exposure time (E)<br>Bit 0 ~ 15 : exposure time interval (P)</td><td>Read/Write</td></tr>
<tr><td>0xF2F10184</td><td>Local ISO_EN control register for one-shot/multi-shot<br>Bit 31 : iso_enable ( 1: enable. 0: disable)</td><td></td></tr>
<tr><td>0xF2F1011C</td><td>Power on default memory channel<br>Bit 0 ~ Bit 3 : power on initial memory channel</td><td>Read/Write</td></tr>
<tr><td>0xF2F10200</td><td>Camera version register<br>Bit 16~Bit 31 : camera version<br>(ex: If reading value: 0x00003000, camera version is 3.000)</td><td>Read only</td></tr>
<tr><td>0xF2F10120</td><td>Bright Level for Iris Control Application<br>Bit 24 ~ Bit 31 : Bright Level for Image Capture</td><td>Read only</td></tr>
<tr><td>0xF2F10124</td><td>Test Pattern<br>Bit 0 : Vertical Grey Bar<br>Bit 1: Bias Grey Bar</td><td>Read/Write</td></tr>
<tr><td>0xF2F10128</td><td>Defer Image control (Frame save)<br>Bit 0 : presence inquiry (read only)<br>Bit 6 : defer image On/Off control<br>( 1: image hold mode, 0 : normal real time mode)<br>Bit 7 : send image command :<br>If bit 6 is on status, this bit is send image command from camera to PC.<br>Bit 16 ~ Bit 23 : Queue size inquiry : Must check whenever format or mode is changed (read only)<br>Bit 24 ~ Bit 31 : At read operation, this value is the number of remained image at queue.<br>At write operation, this value is the number of sending images by bit 7 send</td><td>Read/Write</td></tr>
</table>

| | | |
|---|---|---|
| | image command | |
| 0xF2F1012C | **4 step knee LUT run control register**<br>LUT knee 1st point register<br>Bit 0 : presence inquiry (read only)<br>Bit 1 : LUT regeneration command (self cleared)<br>Bit 2~Bit4 : reserved<br>Bit 5 : enable brightness, sharpness, gamma feature with knee function<br>Bit 6 : On/Off<br>Bit 7 : reserved<br>Bit 8~Bit 19 : X coordination of 1st knee point<br>Bit 20~Bit31 : Y coordination of 1st knee point | Read only |
| 0xF2F10130 | LUT knee 2nd point register<br>Bit 0 : presence inquiry (read only)<br>Bit 1 : LUT regeneration command (self cleared)<br>Bit 2~Bit5 : reserved<br>Bit 6 : reserved<br>Bit 7 : reserved<br>Bit 8~Bit 19 : X coordination of 2nd knee point<br>Bit 20~Bit31 : Y coordination of 2nd knee point | Read/Write |
| 0xF2F10134 | LUT knee 3rd point register<br>Bit 0 : presence inquiry (read only)<br>Bit 1 : LUT regeneration command (self cleared)<br>Bit 2~Bit5 : reserved<br>Bit 6 : reserved<br>Bit 7 : reserved<br>Bit 8~Bit 19 : X coordination of 3rd knee point<br>Bit 20~Bit31 : Y coordination of 3rd knee point | Read/Write |
| 0xF2F10138 | LUT knee 4th point register<br>Bit 0 : presence inquiry (read only)<br>Bit 1 : LUT regeneration command (self cleared)<br>Bit 2~Bit5 : reserved<br>Bit 6 : reserved<br>Bit 7 : reserved<br>Bit 8~Bit 19 : X coordination of 4th knee point<br>Bit 20~Bit31 : Y coordination of 4th knee point | Read/Write |
| 0xF2F1013C | **User defined LUT run control register**<br>Bit 0 : presence inquiry (read only)<br>Bit 1 ~ Bit 4 : reserved<br>Bit 5 : enable brightness, sharpness, gamma feature with user defined LUT function<br>Bit 6 : On/Off<br>Bit 7 ~ Bit 11 : reserved<br>Bit 12 ~ Bit 15 : run LUT index<br>Bit 16 ~ Bit 31 : reserved | Read/Write |
| 0xF2F10140 | LUT save control register<br>Bit 0 : save command<br>Bit 1 : save ready status( read only)<br>Bit 2 ~ Bit 6 : reserved<br>Bit 7 : set LUT write buffer address to 0<br>Bit 8 ~ Bit 11 : save LUT index<br>Bit 12 ~ Bit 31 : reserved | Read/Write |
| 0xF2F10144 | LUT data register (block write command)<br>Save the first data at low word, then second data at high word<br>Bit 0 ~ Bit 3 : reserved<br>Bit 4 ~ Bit 15 : the second data<br>Bit 16 ~ Bit 19 : reserved<br>Bit 20 ~ Bit 31 : the first data | Write Only |

| | | |
|---|---|---|
| 0xF2F10150 | **Snow noise remove threshold register**<br>Bit 0 : presence inquiry (read only)<br>Bit 1 ~ Bit 5 : reserved<br>Bit 6 : on/off<br>Bit 7 : grid noise filter enable mode f or mono800 at color camera (0:disable, 1: enable)<br>Bit 8~Bit23 : reserved<br>Bit 24~Bit31 : Threshold Value (T) :<br>If Pixel difference value > Threshold Value, the pixel is replaced with near pixel average value<br>  <br><br>**Pixel compared threshold value bit map** | Read/Write |
| 0xF2F10168 | **Another sharpness**<br>Bit 0 : presence inquiry (read only)<br>Bit 1 ~ Bit5 : reserved<br>Bit 6 : On/Off<br>Bit 7 : reserved<br>Bit 8 ~ Bit 23 : reserved<br>Bit 24 ~ Bit 31 : sharpness value (10: normal, range 5 ~ 20) | Read/Write |

*msb : most significant bit

# 6. Video Formats and Modes

IIDC 1.31 defines several video formats which determine the video data output from the camera. An overview of those formats is:

- Format 0: Video formats up to VGA (640 x 480) resolution.
- Format 1: Video formats for SVGA (800 x 600) and XGA (1024x768) resolution.
- Format 2 : Video Formats for SXGA or higher resolutions ( 1280 x 960 and 1600 x 1200 )
- Format 6 : Still Images
- Format 7 : Scalable images sized ( User defined size and position )

## Format 0 / Format 1 / Format 2

In these formats, the frame rates are pre-defined for each video mode as per the IIDC specification.

There are several defined modes for each format where a mode specifies the size and color information of the pixels. By reading the inquiry register of the camera, the user may determine which frame rates are supported by the camera. Please refer to the IIDC specification for the details.

## Format 7

Format modes 0, 1, & 2 were defined at the early stage of the design and development of digital industrial cameras; where cameras supported these common VESA compliant resolutions. Because the user required a flexible and definable format; camera manufacturers utilized the user definable Format 7 to meet this demand. Format 7 is extremely flexible and allows the user to define the width, height, position and pixel format of the video data where separate sets of control registers exists for each Format 7 mode.

The cameras support Format 7 modes 0,1,2 with the following base address:

**Format 7 Mode 0 : F1F00000h Format 7 Mode 1 : F1F00100h Format 7 Mode 0 : F1F00200h**

| Offset | Name | Description |
|---|---|---|
| 000h | MAX_IMAGE_SIZE_INQ | Maximum Horizontal / Vertical pixel number |
| 004h | UNIT_SIZE_INQ | Horizontal and Vertical unit pixel number |
| 008h | IMAGE_POSITION | Left / Top position of requested image region (pixel) |
| 00Ch | IMAGE_SIZE | Width / Height of the requested image region (pixel) |
| 010h | COLOR_CODING_ID | Color coding ID from COLOR_CODING_INQ register |
| 014h | COLOR_CODEING_INQ | Inquiry register for color information setting |
| 034h | PIXEL_NUMBER_INQ | Pixel number per frame |
| 038h | TOTAL_BYTE_HI_INQ | Higher quadlet of total bytes of image data per frame |
| 03Ch | TOTAL_BYTE_LO_INQ | Lower quadlet of total bytes of image data per frame |
| 040h | PACKET_PARA_INQ | Unit (Minimum) bytes per packet Multiple by 4<br>Maximum bytes per packet Multiple by UnitBytePerPacket |
| 044h | BYTE_PER_PACKET | Packet size, Recommended bytes per packet. If this value is zero, shall ignore this field. |

Please refer to the IIDC specification for the details.

NOTE: In Format 7 Mode, frames rates may vary which may depend on Size, Color, and Maximum byte per packet, shutter and system performances.

## 6.1. Fire-i 830b / Fire-i 830c

| Format | Mode | Resolution | | 60fps | 30fps | 15fps | 7.5fps | 3.75fps | 1.875fps |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 160 x 120 | YUV 444 | | | | | | |
| | 1 | 320 x 240 | YUV 422 | | | | | | |
| | 2 | 640 x 480 | YUV 411 | | | | | | |
| | 3 | 640 x 480 | YUV 422 | | | O | O | O | |
| | 4 | 640 x 480 | RGB | | | | | | |
| | 5 | 640 x 480 | Mono 8 | | | O | O | O | |
| | 6 | 640 x 480 | Mono 16 | | | O | O | O | |
| 1 | 0 | 800 x 600 | YUV 422 | | | O | O | | |
| | 1 | 800 x 600 | RGB 8 | | | | | | |
| | 2 | 800 x 600 | Mono 8 | | | O | O | | |
| | 3 | 1024 x 768 | YUV 422 | | | O | O | O | O |
| | 4 | 1024 x 768 | RGB 8 | | | | | | |
| | 5 | 1024 x 768 | Mono 8 | | | O | O | O | O |
| | 6 | 800 x 600 | Mono 16 | | | O | O | O | |
| | 7 | 1024 x 768 | Mono 16 | | | O | O | O | O |
| 2 | 0 | 1280 x 960 | YUV 422 | | | | O | O | O |
| | 1 | 1280 x 960 | RGB 8 | | | | | | |
| | 2 | 1280 x 960 | Mono 8 | | | O | O | O | O |
| | 3 | 1600 x 1200 | YUV 422 | | | | O | O | O |
| | 4 | 1600 x 1200 | RGB 8 | | | | | | |
| | 5 | 1600 x 1200 | Mono 8 | | | O | O | O | O |
| | 6 | 1280 x 960 | Mono 16 | | | | O | O | O |
| | 7 | 1600 x 1200 | Mono 16 | | | | O | O | O |
| 7 | 0 | 1600 x 1200 | 16 fps Max at Mono 8 ( Frame rate may differ in YUV, Mono 16 and Bayer) | | | | | | |
| | 1 | 800 x 600 | 29 fps 2x2 binning ( H&V Binning ) | | | | | | |
| | 2 | 1600 x 600 | 29 fps 1x2 binning (V Binning ) | | | | | | |

## 6.2. Fire-i 630b / Fire-i 630c

| Format | Mode | Resolution | | 60fps | 30fps | 15fps | 7.5fps | 3.75fps | 1.875fps |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 160 x 120 | YUV 444 | | | | | | |
| | 1 | 320 x 240 | YUV 422 | | | | | | |
| | 2 | 640 x 480 | YUV 411 | | | | | | |
| | 3 | 640 x 480 | YUV 422 | | O | O | O | O | |
| | 4 | 640 x 480 | RGB | | | | | | |
| | 5 | 640 x 480 | Mono 8 | | O | O | O | O | |
| | 6 | 640 x 480 | Mono 16 | | O | O | O | O | |
| 1 | 0 | 800 x 600 | YUV 422 | | O | O | O | O | |
| | 1 | 800 x 600 | RGB 8 | | | | | | - |
| | 2 | 800 x 600 | Mono 8 | | O | O | O | | |
| | 3 | 1024 x 768 | YUV 422 | | | O | O | O | O |
| | 4 | 1024 x 768 | RGB 8 | | | | | | |
| | 5 | 1024 x 768 | Mono 8 | | O | O | O | O | O |
| | 6 | 800 x 600 | Mono 16 | | O | O | O | O | |
| | 7 | 1024 x 768 | Mono 16 | | | O | O | O | O |
| 7 | 0 | 1024 x 768 | 30 fps Max at Mono 8 ( Frame rate may differ in YUV, Mono 16 and Bayer) | | | | | | |
| | 1 | 512x384 | 58 (512x384, Format7 mode1, 2x2 binning, B/W only) | | | | | | |
| | 2 | 1024x384 | 58 (1024x384, Format7 mode2, 1x2 binning, B/W only) | | | | | | |

## 6.3. Fire-i 530b / Fire-i 530c

| Format | Mode | Resolution | | 60fps | 30fps | 15fps | 7.5fps | 3.75fps | 1.875fps |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 160 x 120 | YUV 444 | | | | | | |
| | 1 | 320 x 240 | YUV 422 | | | | | | |
| | 2 | 640 x 480 | YUV 411 | | | | | | |
| | 3 | 640 x 480 | YUV 422 | | O | O | O | O | |
| | 4 | 640 x 480 | RGB | | | | | | |
| | 5 | 640 x 480 | Mono 8 | O | O | O | O | O | |
| | 6 | 640 x 480 | Mono 16 | | O | O | O | O | |
| 7 | 0 | 640 x 480 | 60 fps Max at Mono 8 ( Frame rate may differ in YUV, Mono 16 and Bayer) | | | | | | |
| | 1 | 320x240 | 120 (320x240, Format7 mode1, 2x2 binning, B/W only) | | | | | | |
| | 2 | 640x240 | 120 40x240, Format7 mode2, 1x2 binning, B/W only) | | | | | | |

## 6.4. Fire-i 850c

| Format | Mode | Resolution | | 60fps | 30fps | 15fps | 7.5fps | 3.75fps | 1.875fps |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 3 | 640 x 480 | YUV 422 | | O | O | O | O | |
| | 5 | 640 x 480 | Mono 8 | O | O | O | O | O | |
| | 6 | 640 x 480 | Mono 16 | | O | O | O | O | |
| **1** | 0 | 800 x 600 | YUV 422 | | | O | O | O | |
| | 2 | 800 x 600 | Mono 8 | | O | O | O | | |
| | 3 | 1024 x 768 | YUV 422 | | | O | O | O | |
| | 5 | 1024 x 768 | Mono 8 | | O | O | O | O | |
| | 6 | 800 x 600 | Mono 16 | | | O | O | O | |
| | 7 | 1024 x 768 | Mono 16 | | | O | O | O | |
| **2** | 0 | 1280 x 960 | YUV 422 | | | | O | O | |
| | 2 | 1280 x 960 | Mono 8 | | | O | O | O | |
| | 3 | 1600 x 1200 | YUV 422 | | | | O | O | |
| | 5 | 1600 x 1200 | Mono 8 | | | O | O | O | |
| | 6 | 1280 x 960 | Mono 16 | | | | O | O | |
| | 7 | 1600 x 1200 | Mono 16 | | | | O | O | |
| **7** | 0 | 2048 x 1536 | 10 fps Max at Mono 8 ( Frame rate may differ in YUV, Mono 16 and Bayer) | | | | | | |
| | 1 | 1024 x 768 | 26 fps Max at Mono 8 ( Frame rate may differ in YUV, Mono 16 and Bayer) | | | | | | |

## 6.5. Fire-i 550b / Fire-i 550c

| Format | Mode | Resolution | | 60fps | 30fps | 15fps | 7.5fps | 3.75fps | 1.875fps |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 3 | 640 x 480 | YUV 422 | | O | O | O | O | |
| | 5 | 640 x 480 | Mono 8 | O | O | O | O | O | |
| | 6 | 640 x 480 | Mono 16 | | O | O | O | O | |
| **7** | 0 | 752 x 480 | 60 fps Max at Mono 8 ( Frame rate may differ in YUV, Mono 16 and Bayer) | | | | | | |
| | 1 | 320x240 | 110 fps Max at YUV | | | | | | |
| | 2 | 752x476 | 30 fps Ma at Mono 8 (B/W only) | | | | | | |

## 6.6. Trouble Shooting

FireWire based cameras are operated in connection with system where the user may encounter problems as they operate. These problems may orient either from the camera side or the system side that the camera is being used. We recommend reading the manual carefully beginning from the installation to features in concern. Also some system may not have enough power to operate these cameras, especially for high resolution and high frame rate. We recommend the system should be Pentium 4 or higher with 256MB of System memory and Graphic Accelerator with 32MB or more of video memory. When using Windows, due to high graphic requirements and DirectX support, we recommend using at least MX400 (Nvidia) or Radeon (ATI) or higher graphics controllers.

## 6.7. Hardware Related Issues

### 6.7.1. Camera is not recognized in the device manager

- Please check whether the LED on the back of the camera is ON. If the LED is tuned OFF, please check the camera connection. Please check the cable connection on both the camera and the PC. The LED status, when plugging in the camera is supposed to be normal when the LED light changes from an Orange light to a Red light.
- If you haven't installed the camera driver yet, please refer to the software installation manual and install the drivers and software provided.
- Please reconnect the camera by plugging the FireWire cable into the computer and then plugging the cable into the camera.

### 6.7.2. LED is OFF while power is provided either by FireWire or external power.

- Please check the supplied voltage and ensure that the supplied power is compliant with the operation manual.
- Please check the OHCI card and the 1394 cables.
- Please check the supplied voltage and ensure the supplied power is compliant with the operation manual.

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### 6.7.3. No Image or Black Image is Displayed

The "Status LED" should appear Green. If not, the camera is not Isochronous enabled; which means it is not transmitting any image and it is in an idle stage.

Check whether the lens is properly mounted and open the iris to the maximum level.

Check feature values such as shutter speed, gain and exposure. Also check whether the camera is in trigger mode.

# 7. Technical Support

We ensure the conformity of our product to be reliable and free from defects during manufacturing by testing all the cameras before release. However unexpected problems and technical issues may come up due to the complexity of the product. In case you require technical support contact the agent near you or may contact us directly at the following locations:

Web information, specifications, FAQs: http://www.unibrain.com/

Technical support email: support@unibrain.com

Sales inquiries: sales@unibrain.com

Telephone Numbers: Europe/Asia: +30210-6640600

USA/Canada/South America: +1-925-866-3000

In case of RMA, you must first contact us or your local reseller in order to obtain the RMA Number before sending the product to us. The returns contact email address is: rma@unibrain.com