AVT Pike

Technical Manual

V3.1.0

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Legal notice

For customers in the 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 residential 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. However there is no guarantee that interferences will not occur in a particular installation. If the equipment does cause harmful interference to radio or television reception, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the distance between the equipment and the receiver.
- Use a different line outlet for the receiver.
- Consult a radio or TV technician for help.

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 B of Part 15 of FCC Rules.

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.

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Introduction

Document history

Version	Date	Remarks
V2.0.0	07.07.2006	New Manual - RELEASE status
PRE_V3.0.0	22.09.2006	Minor corrections Added Pike F-145 Pike F-210 AOI frame rates corrected: Chapter PIKE F-210: AOI frame rates on page 180 New advanced registers: Chapter Advanced features on page 216
V3.0.1	29.09.2006	Minor corrections
V3.1.0	13.02.2007	Changed camera status register (Table 112: Camera status register on page 222) Added description for the following mode *Output state follows PinState bit (Table 39: Output routing on page 94)* Added M39-Mount for Pike F-201 and F-421 (Chapter F-Mount, K-Mount, M39-Mount on page 72)

Table 1: Document history

Conventions used in this manual

To give this manual an easily understood layout and to emphasize important information, the following typographical styles and symbols are used:

Styles

Style	Function	Example
Bold	Programs, inputs or highlighting important things	**bold**
Courier	Code listings etc.	`Input`
Upper case	Register	REGISTER

Table 2: Styles

Style	Function	Example
Italics	Modes, fields	*Mode*
Parentheses and/or blue	Links	(Link)

Table 2: Styles

Symbols

Note

This symbol highlights important information.

Caution

This symbol highlights important instructions. You have to follow these instructions to avoid malfunctions.

www

This symbol highlights URLs for further information. The URL itself is shown in blue.

Example:

http://www.alliedvisiontec.com

Before operation

We place the highest demands for quality on our cameras. This Technical Manual is the guide to the installation and setting up of the camera for operation. You will also find the specifications and interfaces here.

Please read through this manual carefully before operating the camera.

Declarations of conformity

Allied Vision Technologies declares under its sole responsibility that the following products

Category Name	Model Name
Digital Camera (IEEE 1394)	PIKE F-032B
	PIKE F-032C
	PIKE F-032B fiber
	PIKE F-032C fiber
	PIKE F-100B
	PIKE F-100C
	PIKE F-100B fiber
	PIKE F-100C fiber
	PIKE F-145B
	PIKE F-145C
	PIKE F-145B fiber
	PIKE F-145C fiber
	PIKE F-210B
	PIKE F-210C
	PIKE F-210B fiber
	PIKE F-210C fiber
	PIKE F-421B
	PIKE F-421C
	PIKE F-421B fiber
	PIKE F-421C fiber

Table 3: Model names

to which this declaration relates are in conformity with the following standard(s) or other normative document(s):

- EN 55022
- EN 55024
- EN 61000
- FCC Class B
- RoHS (2002/95/EC)

Following the provisions of 89/336/EEC directive(s), amended by directive 91/263 EEC, 92/31/EEC and 93/68/EEC.

Safety instructions

Note

- There are no switches or parts inside the camera that require adjustment. The guarantee becomes void upon opening the camera casing.
- If the product is disassembled, reworked or repaired by other than a recommended service person, AVT or its suppliers will take no responsibility for the subsequent performance or quality of the camera.
- The camera does NOT generate dangerous voltages internally. However, because the IEEE 1394b standard permits cable power distribution at voltages higher than 24 V, various international safety standards apply.

Reference documents applicable in the United States

The reference documents include

- Information Processing and Business Equipment, UL 478
- National Electric Code, ANSI/NFPA 70
- Standard for the Protection of Electronic Computer/Data-Processing Equipment, ANSI/NFPA 75

Reference documents applicable in Europe

The reference documents include materials to ensure the European Union CE marking as follows:

- Telecommunications Terminal Equipment (91/263/EEC)
- EMC Directive (89/339/EEC)
- CE Marking Directive (93/68/EEC)
- LOW Voltage Directive (73/23/EEC) as amended by the CE Marking

Reference documents applicable in Japan

The reference documents include:

- Electronic Equipment Technology Criteria by the Ministry of Trading and Industry (Similar to NFPA 70)

- Wired Electric Communication Detailed Law 17 by the Ministry of Posts and Telecom Law for Electric Equipment
- Dentori law issued by the Ministry of Trading and Industry
- Fire law issued by the Ministry of Construction

Cautions

Caution

- Make sure NOT to touch the shield of the camera cable connected to a computer and the ground terminal of the lines at the same time.
- Use only DC power supplies with insulated cases. These are identified by having only TWO power connectors.
- Although IEEE 1394b is functionally plug and play, the physical ports may be damaged by excessive ESD (electrostatic discharge), when connected under powered conditions. It is good practice to ensure proper grounding of computer case and camera case to the same ground potential, before plugging the camera cable into the port of the computer. This ensures that no excessive difference of electrical potential exists between computer and camera.
- If you feel uncomfortable with the previous advice or if you have no knowledge about the connectivity of an installation, we strongly recommend powering down all systems before connecting or disconnecting a camera.

Environmental conditions

Housing temperature (when camera in use): + 5 °C ... + 50 °C

Ambient temperature during storage: - 10 °C ... + 60 °C

Relative humidity: 20 % ... 80 % without condensation

Protection: IP 30

PIKE types and highlights

With Pike cameras, entry into the world of digital image processing is simpler and more cost-effective than ever before.

With the new Pike, Allied Vision Technologies presents the broadest range of cameras in the market with IEEE 1394b interfaces. Moreover, with daisy chain as well as Direct Fiber technology they gain the highest level of acceptance for demanding areas of use in manufacturing industry.

Allied Vision Technologies can provide users with a range of products that meet almost all the requirements of a very wide range of image applications.

The industry standard IEEE 1394 (FireWire or i.Link) facilitates the simplest computer compatibility and bidirectional data transfer using the plug & play process. Further development of the IEEE 1394 standard has already made 800 Mbit/second possible – and the firewire roadmap is already envisaging 1600 Mbit/second, with 3.2 Gbit/second as the next step. Investment in this standard is therefore secure for the future; each further development takes into account compatibility with the preceding standard, and vice versa, meaning that IEEE 1394b is reverse-compatible with IEEE 1394a. Your applications will grow as technical progress advances.

For further information on FireWire read Chapter FireWire on page 17.

The AVT Pike family consists of five IEEE 1394b C-Mount cameras, which are equipped with highly sensitive high-quality CCD sensors.

Each of these cameras is available in black/white and color versions.

A large selection of different sensor sizes (type 1/3, type 2/3, type 1, type 1.2) and resolutions ensures the suitability of the cameras for all applications.

The Pike family consists of the following models:

Pike type	Sensor	Picture size	Frame rates, full resolution
PIKE F-032B/C PIKE F-032B/C fiber	Type 1/3 KODAK KAI-340 Progressive Scan CCD imager	640 (h) x 480 (v)	Up to 202 fps
PIKE F-100B/C PIKE F-100B/C fiber	Type 2/3 KODAK KAI-1020 Progressive Scan CCD imager	1000 (h) x 1000 (v)	Up to 59.9 fps
PIKE F-145B/C PIKE F-145B/C fiber	Type 2/3 SONY ICX285 Progressive Scan CCD imager	1388 (h) x 1038 (v)	Up to 30 fps

Table 4: PIKE camera types

Pike type	Sensor	Picture size	Frame rates, full resolution
PIKE F-210B/C PIKE F-210B/C fiber	Type 1 KODAK KAI-2093 Progressive Scan CCD imager	1920 (h) x 1080 (v)	Up to 31 fps
PIKE F-421B/C PIKE F-421B/C fiber	Type 1.2 KODAK KAI-4021 Progressive Scan CCD imager	2048 (h) x 2048 (v)	Up to 15 fps

Table 4: PIKE camera types

Operating in 8-bit and 14-bit mode, the cameras ensure very high quality images under almost all circumstances. The Pike is equipped with an asynchronous trigger shutter as well as true partial scan, and integrates numerous useful and intelligent Smart Features for image processing.

Note

- All **color models** are equipped with an **optical filter** to eliminate the influence of infrared light hitting the sensor. Please be advised that, as a side effect, this filter reduces sensitivity in the visible spectrum. The optical filter is part of the back focus ring, which is threaded into the C-Mount.
- **B/w models** come with a **sensor protection glass** mounted in the back focus ring.
- **Changing filters** is achieved by changing back focus rings with the appropriate filter already mounted. Please be advised that back focus adjustment will be necessary in order to match C-Mount distance of 17.526 mm after changing back focus ring. Ask your dealer for further information or assistance.

Warning

Mount/dismount lenses and filters in a **dust-free environment**, and **do not** use compressed air (which can push dust into cameras and lenses).

Use only **optical quality tissue**/cloth if you must clean a lens or filter.

Warning

Special warning for all PIKE models with GOF connectors:

GOF connectors are very sensitive. Any dust or dirt may cause damage.

- Always keep the GOF connector and optical fiber plug clean.
- If GOF connection is not in use, keep GOF dust cover on the GOF connector.
- Reduce mating cycles to a minimum to prevent abrasion.
- Please note that optical fiber cables have a very limited deflection curve radius.

FireWire

Overview

FireWire provides one of the most comprehensive, high-performance, cost-effective solutions platforms. **FireWire** offers very impressive throughput at very affordable prices.

Definition

FireWire (also known as **i.Link** or **IEEE 1394**) is a personal computer and digital video serial bus interface standard, offering high-speed communications and isochronous real-time data services. **FireWire** has low implementation costs and a simplified and adaptable cabling system.

Figure 1: FireWire Logo

IEEE 1394 standards

FireWire was developed by Apple Computer in the late 1990s, after work defining a slower version of the interface by the IEEE 1394 working committee in the 1980s. Apple's development was completed in 1995. It is defined in IEEE standard 1394 which is currently a composite of three documents:

- the original IEEE Std. 1394-1995
- the IEEE Std. 1394a-2000 amendment
- the IEEE Std. 1394b-2002 amendment

FireWire is used to connect digital cameras, especially in industrial systems for machine vision. An advantage over USB is its faster effective speed and higher power distribution capabilities. Multi-camera applications are easier to set up than in USB.

Why use FireWire?

Digital cameras with on-board **FireWire** (IEEE 1394a or 1394b) communications conforming to the IIDC standard (V1.3 or V1.31) have created cost-effective and powerful solutions options being used for thousands of different applications around the world. **FireWire** is currently the premier robust digital interface for industrial applications for many reasons, including:

- Guaranteed bandwidth features to ensure fail-safe communications
- Interoperability with multiple different camera types and vendors
- Diverse camera powering options, including single-cable solutions up to 45 W
- Effective multiple-camera solutions
- Large variety of **FireWire** accessories for industrial applications
- Availability of repeaters and optical fibre cabling
- Forwards and backward compatibility blending 1394a and 1394b
- Both real-time (isochronous) and demand-driven asynchronous data transmission capabilities

FireWire in detail

Serial bus

Briefly summarized, **FireWire** is a very effective way to utilize a low-cost serial bus, through a standardized communications protocol, that establishes packetized data transfer between two or more devices. FireWire offers real time isochronous bandwidth for image transfer with guaranteed low latency. It also offers asynchronous data transfer for controlling camera parameters, such as gain and shutter, on the fly. As illustrated in the diagram below, these two modes can co-exist by using priority time slots for video data transfer and the remaining time slots for control data transfer.

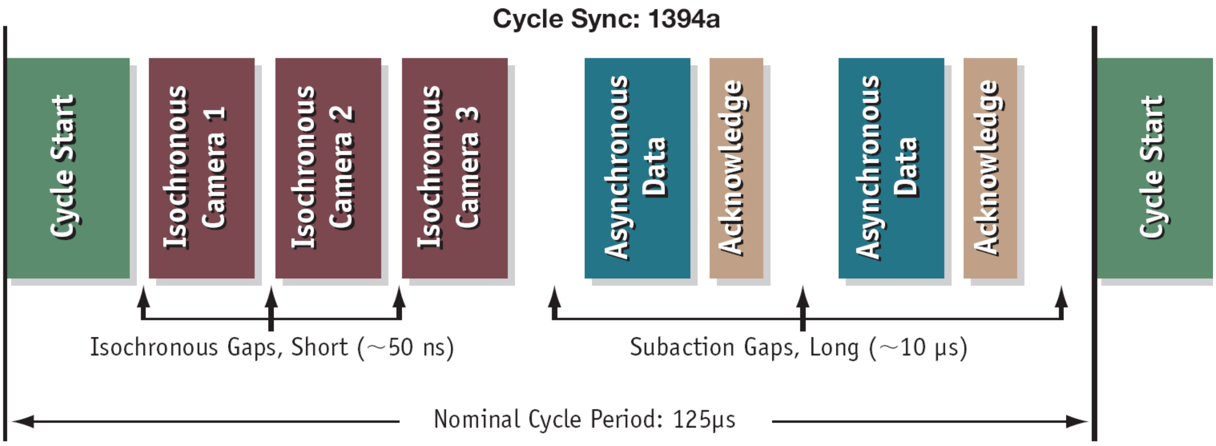


Figure 2: 1394a data transmission

In case of 1394b no gaps are needed due to parallel arbitration, handled by bus owner supervisor selector (BOSS) (see the following diagram). Whereas 1394a works in half duplex transmission, 1394 does full duplex transmission.

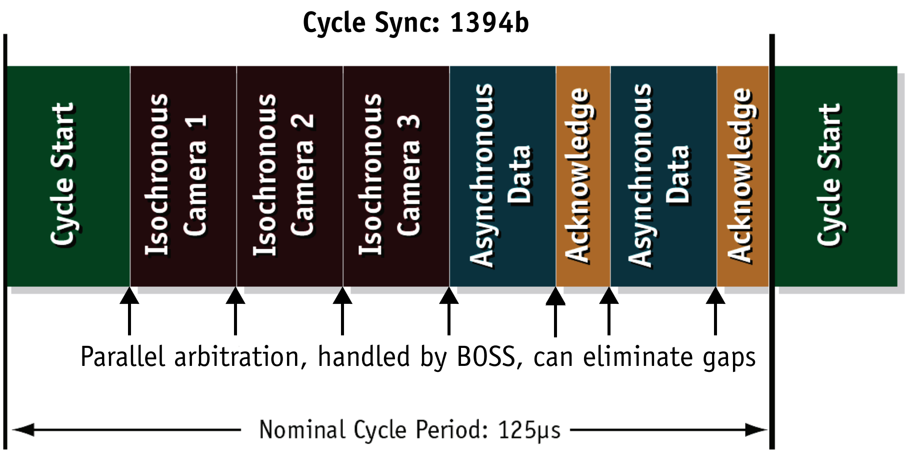


Figure 3: 1394b data transmission

Additional devices may be added up to the overall capacity of the bus, but throughput at guaranteed minimum service levels is maintained for all devices with an acknowledged claim on the bus. This deterministic feature is a huge advantage for many industrial applications where robust performance is required. Such is the case when it is not acceptable to drop images within a specific time interval.

FireWire connection capabilities

FireWire can connect together up to 63 peripherals in an acyclic network structure (hubs). It allows peer-to-peer device communication (between digital cameras), to take place without using system memory or the CPU.

But even more importantly, a **FireWire camera** can directly, via direct memory access (DMA), write into or read from the memory of the computer with almost no CPU load.

FireWire also supports multiple hosts per bus. **FireWire** requires only a cable with the correct number of pins on either end (normally 6 or 9). It is designed to support plug-and-play and hot swapping. Its six-wire cable can supply up to 54 W of power per port at 36 V, allowing moderate-consumption devices to operate without a separate power cord.

Capabilities of 1394a (FireWire 400)

FireWire 400 (S400) is able to transfer data between devices at 100, 200 or 400 MBit/s data rates. Although USB 2.0 claims to be capable of higher speeds (480 Mbit/s), FireWire is, in practice, not slower than USB 2.0.

The 1394a capabilities in detail:

- 400 Mbit/s
- Hot-pluggable devices
- Peer-to-peer communications
- Direct Memory Access (DMA) to host memory
- Guaranteed bandwidth
- Multiple devices (up to 45 W) powered via FireWire bus

IIDC V1.3 camera control standards

IIDC V1.3 released a set of camera control standards via 1394a which established a common communications protocol on which most current FireWire cameras are based.

In addition to common standards shared across manufacturers, a special Format_7 mode also provided a means by which a manufacturer could offer special features (smart features), such as:

- higher resolutions
- higher frame rates
- diverse color modes

as extensions (advanced registers) to the prescribed common set.

Capabilities of 1394b (FireWire 800)

FireWire 800 (S800) was introduced commercially by Apple in 2003 and has a 9-pin FireWire 800 connector (see details in Chapter IEEE 1394b port pin assignment on page 76). This newer 1394b specification allows a transfer rate of 800 MBit/s with backward compatibilities to the slower rates and 6-pin connectors of FireWire 400.

The 1394b capabilities in detail:

- 800 Mbit/s
- All previous benefits of 1394a (see above)
- Interoperability with 1394a devices
- Longer communications distances (up to 500 m using GOF cables)

IIDC V1.31 camera control standards

Twinned with 1394b, the IIDC V1.31 standard arrived in January 2004, evolving the industry standards for digital imaging communications to include I/O and RS232 handling, and adding further formats. At such high bandwidths it has become possible to transmit high-resolution images to the PC's memory at very high frame rates.

Compatibility between 1394a and 1394b

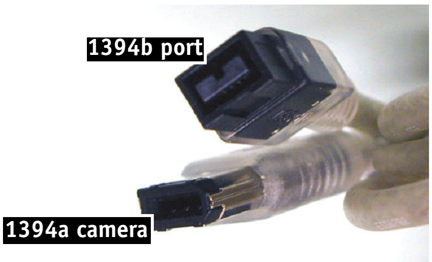
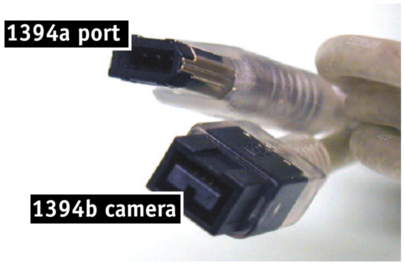
 **1394a camera connected to 1394b bus** The cable explains dual compatibility: This cable serves to connect an IEEE 1394a camera with its **six-pin** connector to a bilingual port (a port which can talk in a- or b-language) of a 1394b bus. In this case the b-bus communicates in a-language and a-speed with the camera achieving a-performance	 **1394b camera connected to 1394a bus** The cable explains dual compatibility: In this case, the cable connects an IEEE 1394b camera with its **nine-pin** connector to a 1394a port. In this case the b-camera communicates in a-language with the camera achieving a-performance

Figure 4: 1394a and 1394b cameras and compatibility

Compatibility example

It's possible to run a 1394a and a 1394b camera on the 1394b bus.

You can e.g. run a PIKE F-032b and a MARLIN F-033b on the same bus:

- PIKE F-032b @ S800 and 120 fps (5120 bytes per cycle, 64% of the cycle slot)
- MARLIN F-033b @ S400 and 30 fps (1280bytes, 32% of the cycle slot)

Bus runs at 800 Mbit/s for all devices. Data from Marlin's port is up-converted from 400 Mbit/s to 800 Mbit/s by data doubling (padding), still needing 32% of the cycle slot time. This doubles the bandwidth requirement for this port, as if the camera were running at 60 fps. Total consumption is thus 5120 + 2560 = 7680 bytes per cycle.

Image transfer via 1394a and 1394b

Technical detail	1394a	1394b
Transmission mode	Half duplex (both pairs needed) 400 Mbit/s data rate aka: a-mode, data/strobe (D/S) mode, legacy mode	Full duplex (one pair needed) 1 Gbit/s signaling rate, 800 Mbit/s data rate 10b/8b coding (Ethernet), aka: b-mode (beta mode)
Devices	Up to 63 devices per network	
Number of cameras	Up to 16 cameras per network	
Number of DMAs	4 to 8 DMAs (parallel) cameras / bus	
Real time capability	Image has real time priority	
Available bandwidth acc. IIDC (per cycle 125 µs)	4096 bytes per cycle ~ 1000q @ 400 Mbit/s	8192 bytes per cycle ~ 2000q @ 800 Mbit/s (@1 GHz clock rate)
	For further detail read Chapter Frame rates on page 172.	
Max. image bandwidth	31.25 MByte/s	62.5 MByte/s
Max. total bandwidth	~45 MByte/s	~85 MByte/s
Number of busses	Multiple busses per PC limit: PCI bus	Multiple busses per PC limit: PCI (Express) bus
CPU load	Almost none for DMA image transfer	
Gaps	Gaps negatively affect asynchronous performance of widespread network (round trip delay), reducing efficiency	No gaps needed, BOSS mode for parallel arbitration

Table 5: Technical detail comparison: 1394a and 1394b

Note

The bandwidth values refer to the fact:

1 MByte = 1024 kByte

1394b bandwidths

According to the 1394b specification on isochronous transfer, the largest data payload size of 8192 bytes per 125 µs cycle is possible with a bandwidth of 800 Mbit/s.

For further details read Chapter How does bandwidth affect the frame rate? on page 182.

Requirements for PC and 1394b

One PIKE camera connected to a PC's 1394b bus saturates the standard PCI bus.

1394b also requires low latency for data transmission (due to small receive-FIFO). In order to get the most out of your camera-to-PC configuration, we recommend the following chipsets for your PC:

- 915 (SONOMA) with ICH-6 south-bridge or
- 945 chipset (Core duo) with 82801GBM/82801GHM

For multi-camera applications one of the following bus cards is needed:

- PCI ExpressCard with potential 250 MByte/s per lane (up to four supported by chipset) or
- 64-bit PCI-X card (160 MByte/s)

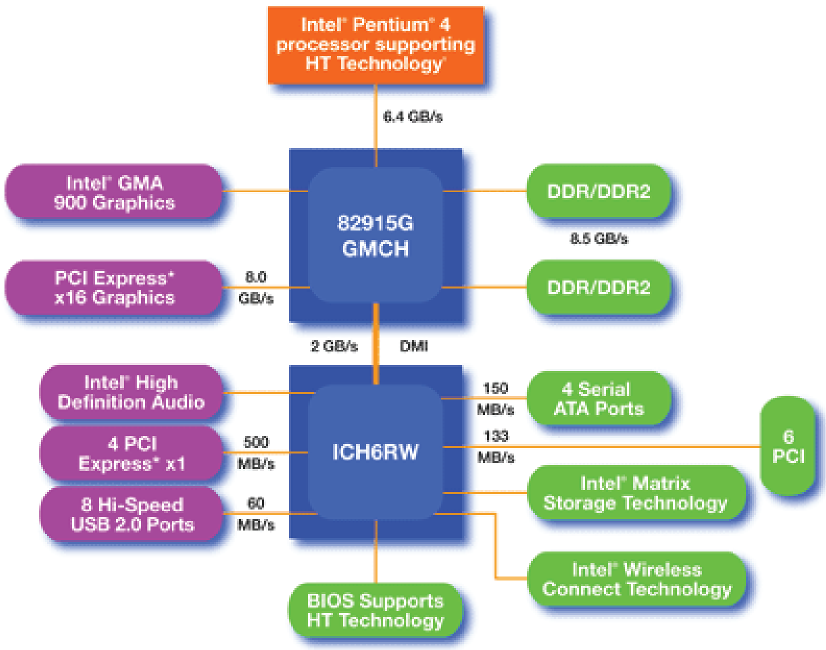


Figure 5: Block diagram of modern PC (915 chipset by INTEL)

Requirements for laptop and 1394b

As mentioned above, 1394b requires low latency for data transmission (small receive-FIFO). In order to get the most out of your camera-to-laptop configuration, we recommend the following chipset for your laptop:

- Mobile PCI-Express chipset

Because most laptops have (only) one PC-card interface, it is possible to connect one PIKE camera to your laptop at full speed. Alternatively laptops with an additional 1394 ExpressCard interface can be used.

Figure 6: ExpressCard Logo, ExpressCard/54 (SIIG)

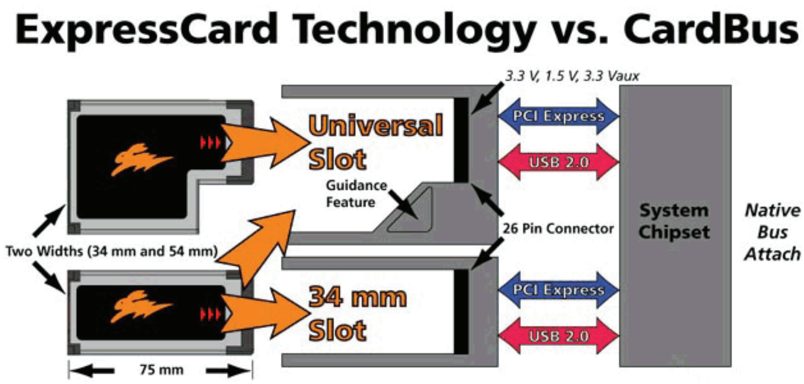


Figure 7: ExpressCard technology

www

ExpressCard is a new standard set by PCMCIA.

For more information visit:

http://www.expresscard.org/web/site/

Example1: 1394b bandwidth of PIKE cameras

PIKE model	Resolution	Frame rate	Bandwidth
Pike F-032 B/C	VGA	202 fps	61.61 MByte/s
Pike F-100 B/C	1 megapixel	60 fps	57.62 MByte/s
Pike F-145 B/C	1.45 megapixel	30 fps	41.41 MByte/s
Pike F-210 B/C	2.1 megapixel	31 fps	62.5 MByte/s
Pike F-421 B/C	4 megapixel	15 fps	62.5 MByte/s

Table 6: Bandwidth of PIKE cameras

Note All data are calculated using Raw8 / Mono8 color mode.

Example 2: More than one PIKE camera at full speed

Due to the fact that one PIKE camera saturates a 32 bit PCI bus, you are advised to use either a PCI-Express card and/or multiple 64-bit PCI bus cards, if you want to use 2 or more PIKE cameras simultaneously (see the following table).

# cameras	PC hardware required
1 PIKE camera at full speed	1 x 32-bit PCI bus card (85 MByte/s)
2 or more PIKE cameras at full speed	PCI-ExpressCard and/or Multiple 64-bit PCI bus cards

Table 7: Required hardware for multiple camera applications

FireWire Plug & play capabilities

FireWire devices implement the ISO/IEC 13213 **configuration ROM** model for device configuration and identification, to provide plug & play capability. All FireWire devices are identified by an IEEE EUI-64 unique identifier (an extension of the 48-bit Ethernet MAC address format) in addition to well-known codes indicating the type of device and protocols it supports. For further details read Chapter Configuration of the camera on page 186.

FireWire hot plug precautions

Although FireWire devices can be hot-plugged without powering down equipment, we recommend turning the computer power off, before connecting a digital camera to it via a FireWire cable.

Operating system support

<table>
<tr><th>Operating system</th><th>1394a</th><th>1394b</th></tr>
<tr><td>Linux</td><td>Full support</td><td>Full support</td></tr>
<tr><td>Apple Mac OS X</td><td>Full support</td><td>Full support</td></tr>
<tr><td>Windows XP</td><td colspan="2">With service pack 2 the default speed for 1394b is S100 (100 Mbit/s). A download and registry modification is available from Microsoft to restore performance to either S400 or S800.

http://support.microsoft.com/kb/885222

Alternatively use the drivers of SP1 instead.

We strongly recommend to install AVT FirePackage, which replaces the Microsoft driver. (See PIKE Getting Started Manual for details.)</td></tr>
<tr><td>Windows Vista</td><td>Full support from beginning</td><td>Support only with service pack, coming later.</td></tr>
</table>

Table 8: FireWire and operating systems

1394a/b comparison

Interface	IEEE 1394a	IEEE 1394b
Maximum bit rate	400 Mbit/s	800 Mbit/s
Isochronous (video) mode	Yes	Yes
Bandwidth/total usable bandwidth	Video: 31.25 MByte/s (80%) Total: ~45 MByte/s	Video: 62.5 MByte/s (80%) Total: ~85 MByte/s
Topology	Peer-to-peer (On the go)	Peer-to-peer
Single cable distance in copper or other media	• 4.5 m, worst case • 10 m, typical camera application • 500 m GOF	• 7.5 m copper • 500 m GOF
Max. distance copper using repeaters	70 m	70 m
Bus power	Up to 1.5 A and 36 V	Up to 1.5 A and 36 V
Motherboard support	Many	Some
PC load	Very low	Very low
OS support	Windows, Linux	Windows, Linux
Main applications	Multimedia electronics	Multimedia electronics
Camera standard	IIDC V1.3	IIDC V1.31
Devices per bus	63; 4 (8) simult./ card accord. to 4 (8) DMAs typical	63; 4 simult./ card accord. to 4 DMAs typical

Table 9: 1394a and 1394b comparison

System components

Each camera package consists of the following system components:

AVT PIKE

4.5 m cable with screw locking

Color version:
Jenofilt 217 IR cut filter (built-in)

B/w version:
only protection glass (no filter)

CD with driver and documentation

Optional: tripod adapter

Optional: GOF cable

Optional: HIROSE connector for cable mount HR10A-10P-12S

Figure 8: System components

The following illustration shows the spectral transmission of the IR cut filter:

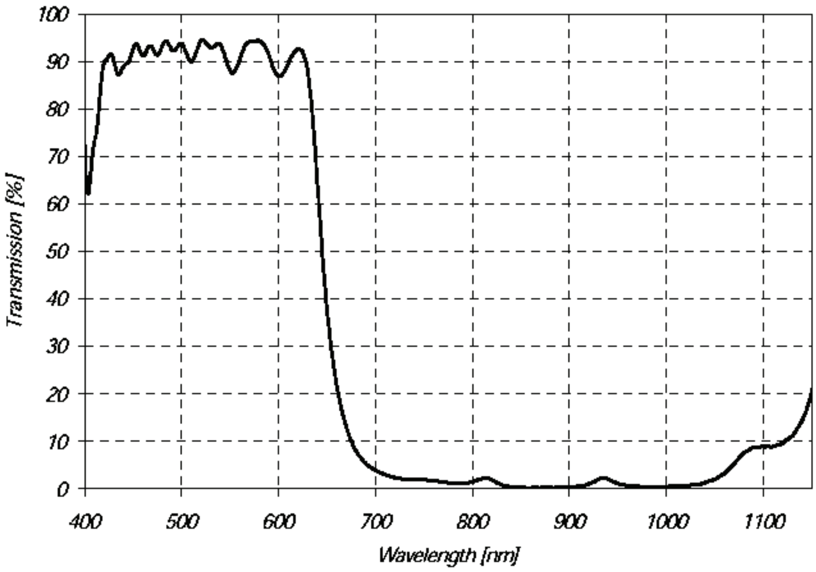


Figure 9: Spectral transmission of Jenofilt 217

Note

To demonstrate the properties of the camera, all examples in this manual are based on the **FirePackage** OHCI API software and the **SmartView** application.

www

These utilities can be obtained from Allied Vision Technologies (AVT). A free version of **SmartView** is available for download at:

www.alliedvisiontec.com

Note

The camera also works with all IIDC (formerly DCAM) compatible IEEE 1394 programs and image processing libraries.

Camera lenses

AVT offers different lenses from a variety of manufacturers. The following table lists selected image formats depending on camera type, distance and the focal length of the lens.

Focal length for type 1/3 sensors PIKE F-032	Distance = 0.5 m	Distance = 1 m
4.8 mm	0.375 m x 0.5 m	0.75 m x 1 m
8 mm	0.22 m x 0.29 m	0.44 m x 0.58 m
12 mm	0.145 m x 0.19 m	0.29 m x 0.38 m
16 mm	11 cm x 14.7 cm	22 cm x 29.4 cm
25 mm	6.9 cm x 9.2 cm	13.8 cm x 18.4 cm
35 mm	4.8 cm x 6.4 cm	9.6 cm x 12.8 cm
50 mm	3.3 cm x 4.4 cm	6.6 cm x 8.8 cm

Table 10: Focal length vs. field of view (PIKE F-032)

Focal length for type 2/3 sensors PIKE F-100/F-145	Distance = 0.5 m	Distance = 1 m
4.8 mm	0.7 m x0.93 m	1.4 m x 1.86 m
8 mm	0.4 m x 0.53 m	0.8 m x 1.06 m
12 mm	0.27 m x 0.36 m	0.54 m x 0.72 m
16 mm	0.2 m x 0.27 m	0.4 m x 0.54 m
25 mm	12.5 cm x 16.625 cm	25 cm 33.25 cm
35 mm	8.8 cm x 11.7 cm	17.6 cm x 23.4 cm
50 mm	6 cm x 7.98 cm	12 cm x 15.96 cm

Table 11: Focal length vs. field of view (PIKE F-100/F-145)

Focal length for type 1 sensors PIKE F-210	Distance = 0.5 m	Distance = 1 m
8 mm	0.6 m x 0.8 m	1.2 m x 1.6 m
12 mm	0.39 m x 0.52 m	0.78 m x 1.16 m
16 mm	0.29 m x 0.38 m	0.58 m x 0.76 m
25 mm	18.2 cm x 24.2 cm	36.4 cm x 48.8 cm
35 mm	12.8 cm x 17.02 cm	25.6 cm x 34.04 cm
50 mm	8.8 cm x 11.7 cm	17.6 cm x 23.4 cm

Table 12: Focal length vs. field of view (PIKE F-210)

Note

Lenses with focal lengths < 35 mm will very likely show excessive shading in the edges of the image due to the fact that the image size of the sensor is slightly bigger than the C-mount itself and due to micro lenses on the sensor's pixel.

Ask your dealer if you require non C-Mount lenses.

Focal length for type 1.2 sensors PIKE F-421	Distance = 0.5 m	Distance = 1 m
35 mm	15.4 cm x 20.4 cm	30.7 cm x 40.8 cm
50 mm	10.6 cm x 14.0 cm	21.1 cm x 28.1 cm

Table 13: Focal length vs. field of view (PIKE F-421)

Specifications

Note

H-binning means horizontal binning.

V-binning means vertical binning.

H-sub-sampling means horizontal sub-sampling.

V-sub-sampling means vertical sub-sampling.

PIKE F-032B / F-032B fiber

Feature	Specification
Image device	Type 1/3 (diag. 5.92 mm) type progressive scan KODAK IT CCD KAI340
Effective picture elements	648 (H) x 488 (V)
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) Mechanical Flange Back to filter distance: 12.5 mm (see Figure 31: Pike C-Mount dimensions (VGA size filter for Pike F-032) on page 69)
Picture sizes	640 x 480 pixels (Format_0 Mode_5 and Mode_6) 640 x 480 pixels (Format_7 Mode_0) 320 x 480 pixels (Format_7 Mode_1, 2 x H-binning) 640 x 240 pixels (Format_7 Mode_2, 2 x V-binning) 320 x 240 pixels (Format_7 Mode_3, 2 x full binning) 320 x 480 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 640 x 240 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 320 x 240 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps; 120 fps up to 202 fps in Format_7 (Mono8)
Gain control	Manual: 0-22 dB (0.0353 dB/step); auto gain (select. AOI)
Shutter speed	26 … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 105 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 64 MByte image memory, mirror, binning, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE

Table 14: Specification PIKE F-032B / F-032B fiber

Feature	Specification
Power consumption	Typical 5 watt (@ 12 V DC); **fiber:** typical 5.75 watt (@ 12 V DC) (full resolution and maximal frame rates)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	IR cut filter, IR pass filter, host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 14: Specification PIKE F-032B / F-032B fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-032C / F-032C fiber

Feature	Specification
Image device	Type 1/3 (diag. 5.92 mm) type progressive scan KODAK IT CCD KAI340
Effective picture elements	648 (H) x 488 (V)
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) Mechanical Flange Back to filter distance: 12.5 mm (see Figure 31: Pike C-Mount dimensions (VGA size filter for Pike F-032) on page 69)
Picture sizes	320 x 240 pixels (Format_0 Mode_1) 640 x 480 pixels (Format_0 Mode_2 to Mode-5) 640 x 480 pixels (Format_7 Mode_0) 320 x 480 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 640 x 240 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 320 x 240 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Color modes	Raw8, Raw16, Mono8, YUV4:2:2, YUV4:1:1, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps; 120 fps up to 202 fps in Format_7 (Mono8, Raw8) up to 139 fps (YUV 4:1:1) up to 105 fps (YUV 4:2:2, Raw 16) up to 70 fps (RGB8)
Gain control	Manual: 0-20 dB (0.0353 dB/step); auto gain (select. AOI)
Shutter speed	26 … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 105 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), color correction, hue, saturation, real-time shading correction, LUT, 64 MByte image memory, mirror, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 15: Specification PIKE F-032C / F-032C fiber

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5 watt (@ 12 V DC); **fiber:** typical 5.75 watt (@ 12 V DC) (full resolution and maximal frame rates)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	Protection glass, host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 15: Specification PIKE F-032C / F-032C fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-100B / F-100B fiber

Feature	Specification
Image device	Type 2/3 (diag. 10.5 mm) type progressive scan KODAK IT CCD KAI1020
Effective picture elements	1000 (H) x 1000 (V)
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) Mechanical Flange Back to filter distance: 12.5 mm (see Figure 32: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421) on page 70)
Picture sizes	640 x 480 pixels (Format_0 Mode_5 and Mode_6) 800 x 600 pixels (Format_1 Mode_2 and Mode_6) 1000 x 1000 pixels (Format_7 Mode_0) 500 x 1000 pixels (Format_7 Mode_1, 2 x H-binning) 1000 x 500 pixels (Format_7 Mode_2, 2 x V-binning) 500 x 500 pixels (Format_7 Mode_3, 2 x full binning) 500 x 1000 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 1000 x 500 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 500 x 500 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps up to 59.9 fps in Format_7 (Mono8)
Gain control	Manual: 0-22 dB (0.0353 dB/step); auto gain (select. AOI)
Shutter speed	75 µs … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 32 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 64 MByte image memory, mirror, binning, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)

Table 16: Specification PIKE F-100B / F-100B fiber

Feature	Specification
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5 watt (@ 12 V DC); **fiber:** typical 5.75 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	IR cut filter, IR pass filter, host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 16: Specification PIKE F-100B / F-100B fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-100C / F-100C fiber

Feature	Specification
Image device	Type 2/3 (diag. 10.5 mm) type progressive scan KODAK IT CCD KAI1020
Effective picture elements	1000 (H) x 1000 (V)
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) Mechanical Flange Back to filter distance: 12.5 mm (see Figure 32: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421) on page 70)
Picture sizes	320 x 240 pixels (Format_0 Mode_1) 640 x 480 pixels (Format_0 Mode_2 to Mode_5) 800 x 600 pixels (Format_1 Mode_0 to Mode_2) 1000 x 1000 pixels (Format_7 Mode_0) 500 x 1000 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 1000 x 500 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 500 x 500 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Color modes	Raw8, Raw16, Mono8, YUV4:2:2, YUV4:1:1, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps; 120 fps up to 59.9 fps in Format_7 (Mono8) up to 43 fps (YUV 4:1:1) up to 32 fps (YUV 4:2:2, Raw16) up to 21 fps (RGB8)
Gain control	Manual: 0-20 dB (0.0353 dB/step); auto gain (select. AOI)
Shutter speed	75 µs … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 32 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), color correction, hue, saturation, real-time shading correction, LUT, 64 MByte image memory, mirror, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 17: Specification PIKE F-100C / F-100C fiber

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5 watt (@ 12 V DC); **fiber:** typical 5.75 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	Protection glass, host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 17: Specification PIKE F-100C / F-100C fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-145B / F-145B fiber

Feature	Specification
Image device	Type 2/3 (diag. 11.2 mm) type progressive scan SONY ICX285
Effective picture elements	1392 (H) x 1040 (V)
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) Mechanical Flange Back to filter distance: 12.5 mm (see Figure 32: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421) on page 70)
Picture sizes	640 x 480 pixels (Format_0 Mode_5 and Mode_6) 800 x 600 pixels (Format_1 Mode_2 and Mode_6) 1024 x 768 pixels (Format_1 Mode_5 and Mode_7) 1280 x 960 pixels (Format_2 Mode_2 and Mode_6) 1388 x 1038 pixels (Format_7 Mode_0) 692 x 1038 pixels (Format_7 Mode_1, 2 x H-binning) 1388 x 518 pixels (Format_7 Mode_2, 2 x V-binning) 692 x 518 pixels (Format_7 Mode_3, 2 x full binning) 692 x 1038 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 1388 x 518 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 692 x 518 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	6.45 µm x 6.45 µm
ADC	14 bit
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps up to 30.02 fps in Format_7 (Mono8) up to 22.70 fps in Format_7 (Mono16)
Gain control	Manual: 0-32 dB (0.0358 dB/step); auto gain (select. AOI)
Shutter speed	36 µs … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 22 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 64 MByte image memory, mirror, binning, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 18: Specification PIKE F-145B / F-145B fiber

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5 watt (@ 12 V DC); **fiber:** typical 5.75 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	IR cut filter, IR pass filter, host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 18: Specification PIKE F-145B / F-145B fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-145C / F-145C fiber

Feature	Specification
Image device	Type 2/3 (diag. 11.2 mm) type progressive scan SONY ICX285
Effective picture elements	1392 (H) x 1040 (V)
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) Mechanical Flange Back to filter distance: 12.5 mm (see Figure 32: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421) on page 70)
Picture sizes	320 x 240 pixels (Format_0 Mode_1) 640 x 480 pixels (Format_0 Mode_2 to Mode_5) 800 x 600 pixels (Format_1 Mode_0 to Mode_2) 1024 x 768 pixels (Format_1 Mode_3 to Mode_5) 1280 x 960 pixels (Format_2 Mode_0 to Mode_2) 1388 x 1038 pixels (Format_7 Mode_0) 692 x 1038 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 1388 x 518 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 692 x 518 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	6.45 µm x 6.45 µm
ADC	14 bit
Color modes	Raw8, Raw16, Mono8, YUV4:2:2, YUV4:1:1, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps up to 30.02 fps in Format_7 (Mono8, Raw8) up to 30.02 fps (YUV 4:1:1) up to 22.70 fps (YUV 4:2:2, Raw16) up to 15.14 fps (RGB8)
Gain control	Manual: 0-32 dB (0.0358 dB/step); auto gain (select. AOI)
Shutter speed	36 µs … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 22 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), color correction, hue, saturation, real-time shading correction, LUT, 64 MByte image memory, mirror, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)

Table 19: Specification PIKE F-145C / F-145C fiber

Feature	Specification
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5 watt (@ 12 V DC); **fiber:** typical 5.75 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	Protection glass, host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 19: Specification PIKE F-145C / F-145C fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-210B / F210B fiber

Feature	Specification
Image device	Type 1 (diag. 15.3 mm) type progressive scan KODAK IT CCD KAI2093
Effective picture elements	1928 (H) x 1084 (V)
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) Mechanical Flange Back to filter distance: 12.5 mm (see *Figure 32: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421)* on page 70)
Picture sizes	640 x 480 pixels (Format_0 Mode_5 and Mode_6) 800 x 600 pixels (Format_1 Mode_2 and Mode_6) 1024 x 768 pixels (Format_1 Mode_5 and Mode_7) 1280 x 960 pixels (Format_2 Mode_2 and Mode_6) 1600 x 1200 pixels (Format_2 Mode_5 and Mode_7) 1920 x 1080 pixels (Format_7 Mode_0) 960 x 1080 pixels (Format_7 Mode_1, 2 x H-binning) 1920 x 540 pixels (Format_7 Mode_2, 2 x V-binning) 960 x 540 pixels (Format_7 Mode_3, 2 x full binning) 960 x 1080 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 1920 x 540 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 960 x 540 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps up to 30 fps in Format_7 (Mono8)
Gain control	Manual: 0-22 dB (0.0353 dB/step); auto gain (select. AOI)
Shutter speed	77 … 67.108.864 µs (~67s); auto shutter (select. AOI)
External Trigger Shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 15 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 64 MByte image memory, mirror, binning, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 20: Specification PIKE F-210B / F-210B fiber

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5.5 watt (@ 12 V DC); **fiber:** typical 6.25 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	IR cut filter, IR pass filter M39-Mount suitable for e.g. Voigtländer optics Adjustable M39-Mount: 28.80 mm (in air); M39 x 26 tpi Mechanical Flange Back to filter distance: 24.2 mm (see Figure 34: Pike M39-Mount dimensions (only Pike F-210 and Pike F-421) on page 72) host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 20: Specification PIKE F-210B / F-210B fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-210C / F-210C fiber

Feature	Specification
Image device	Type 1 (diag. 15.3 mm) type progressive scan KODAK IT CCD KAI2093
Effective picture elements	1928 (H) x 1084 (V)
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) Mechanical Flange Back to filter distance: 12.5 mm (see Figure 32: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421) on page 70)
Picture sizes	320 x 240 pixels (Format_0 Mode_1) 640 x 480 pixels (Format_0 Mode_2 to Mode_5) 800 x 600 pixels (Format_1 Mode_0 to Mode_2) 1024 x 768 pixels (Format_1 Mode_3 to Mode_5) 1280 x 960 pixels (Format_2 Mode_0 to Mode_2) 1600 x 1200 pixels (Format_2 Mode_3 to Mode_5) 1920 x 1080 pixels (Format_7 Mode_0) 960 x 1080 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 1920 x 540 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 960 x 540 pixels (Format_7 Mode_6, 2 out of 4 sub-sampling)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Color modes	Raw8, Raw16, Mono8, YUV4:2:2, YUV4:1:1, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps up to 30 fps (Mono8, Raw8) up to 21 fps (YUV 4:1:1) up to 15 fps (YUV 4:2:2, Raw16) up to 10 fps (RGB8)
Gain control	Manual: 0-20 dB (0.0353 dB/step); auto gain (select. AOI)
Shutter speed	77 … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 15 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)

Table 21: Specification PIKE F-210C / F-210C fiber

Feature	Specification
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), color correction, hue, saturation, real-time shading correction, LUT, 64 MByte image memory, mirror, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5.5 watt (@ 12 V DC); **fiber:** typical 6.25 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	Protection glass M39-Mount suitable for e.g. Voigtländer optics Adjustable M39-Mount: 28.80 mm (in air); M39 x 26 tpi Mechanical Flange Back to filter distance: 24.2 mm (see Figure 34: Pike M39-Mount dimensions (only Pike F-210 and Pike F-421) on page 72) host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 21: Specification PIKE F-210C / F-210C fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-421B / F-421B fiber

Feature	Specification
Image device	Type 1.2 (diag. 21.4 mm) type progressive scan KODAK IT CCD KAI4021
Effective picture elements	2056 (H) x 2062 (V)
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) Mechanical Flange Back to filter distance: 12.5 mm (see Figure 32: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421) on page 70)
Picture sizes	640 x 480 pixels (Format_0 Mode_5 and Mode_6) 800 x 600 pixels (Format_1 Mode_2 and Mode_6) 1024 x 768 pixels (Format_1 Mode_5 and Mode_7) 1280 x 960 pixels (Format_2 Mode_2 and Mode_6) 1600 x 1200 pixels (Format_2 Mode_5 and Mode_7) 2048 x 2048 pixels (Format_7 Mode_0) 1024 x 2048 pixels (Format_7 Mode_1, 2 x H-binning) 2048 x 1024 pixels (Format_7 Mode_2, 2 x V-binning) 1024 x 1024 pixels (Format_7 Mode_3, 2 x full binning) 1024 x 2048 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 2048 x 1024 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 1024 x 1024 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps up to 15 fps in Format_7 (Mono8)
Gain control	Manual: 0-22 dB (0.0353 dB/step); auto gain (select. AOI)
Shutter speed	93 … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 6 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 64 MByte image memory, mirror, binning, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 22: Specification PIKE F-421B / F-421B fiber

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5.5 watt (@ 12 V DC); **fiber:** typical 6.25 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	IR cut filter, IR pass filter M39-Mount suitable for e.g. Voigtländer optics Adjustable M39-Mount: 28.80 mm (in air); M39 x 26 tpi Mechanical Flange Back to filter distance: 24.2 mm (see Figure 34: Pike M39-Mount dimensions (only Pike F-210 and Pike F-421) on page 72) host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 22: Specification PIKE F-421B / F-421B fiber

Note

The design and specifications for the products described above may change without notice.

PIKE F-421C / F-421 C fiber

Feature	Specification
Image device	Type 1.2 (diag. 21.4 mm) type progressive scan KODAK IT CCD KAI4021
Effective picture elements	2056 (H) x 2062 (V)
Lens mount	Adjustable C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) Mechanical Flange Back to filter distance: 12.5 mm (see Figure 32: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421) on page 70)
Picture sizes	320 x 240 pixels (Format_0 Mode_1) 640 x 480 pixels (Format_0 Mode_2 to Mode_5) 800 x 600 pixels (Format_1 Mode_0 to Mode_2) 1024 x 768 pixels (Format_1 Mode_3 to Mode_5) 1280 x 960 pixels (Format_2 Mode_0 to Mode_2) 1600 x 1200 pixels (Format_2 Mode_3 to Mode_5) 2048 x 2048 pixels (Format_7 Mode_0) 1024 x 2048 pixels (Format_7 Mode_4, 2 out of 4 H-sub-sampling) 2048 x 1024 pixels (Format_7 Mode_5, 2 out of 4 V-sub-sampling) 1024 x 1024 pixels (Format_7 Mode_6, 2 out of 4 full sub-sampling)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Color modes	Raw8, Raw16, Mono8, YUV4:2:2, YUV4:1:1, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps up to 15 fps (Mono8, Raw8) up to 10 fps (YUV 4:1:1) up to 7 fps (YUV 4:2:2, Raw16) up to 5 fps (RGB8)
Gain control	Manual: 0-20 dB (0.0353 dB/step); auto gain (select. AOI)
Shutter speed	93 … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	Up to 6 frames
# look-up tables	4 user programmable (14 bit → 14 bit); gamma (0.45 and 0.7)

Table 23: Specification PIKE F-421C / F-421C fiber

Feature	Specification
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), color correction, hue, saturation, real-time shading correction, LUT, 64 MByte image memory, mirror, sub-sampling, High SNR, storable user sets Two configurable inputs, four configurable outputs RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical 5.5 watt (@ 12 V DC); **fiber:** typical 6.25 watt (@ 12 V DC)
Dimensions	96.8 mm x 44 mm x 44 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	250 g (without lens)
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, DIN ISO 9022, RoHS (2002/95/EC)
Options	Protection glass M39-Mount suitable for e.g. Voigtländer optics Adjustable M39-Mount: 28.80 mm (in air); M39 x 26 tpi Mechanical Flange Back to filter distance: 24.2 mm (see Figure 34: Pike M39-Mount dimensions (only Pike F-210 and Pike F-421) on page 72) host adapter card, angled head, power out (HIROSE), API (FirePackage, Direct FirePackage, Fire4Linux)

Table 23: Specification PIKE F-421C / F-421C fiber

Note

The design and specifications for the products described above may change without notice.

Spectral sensitivity

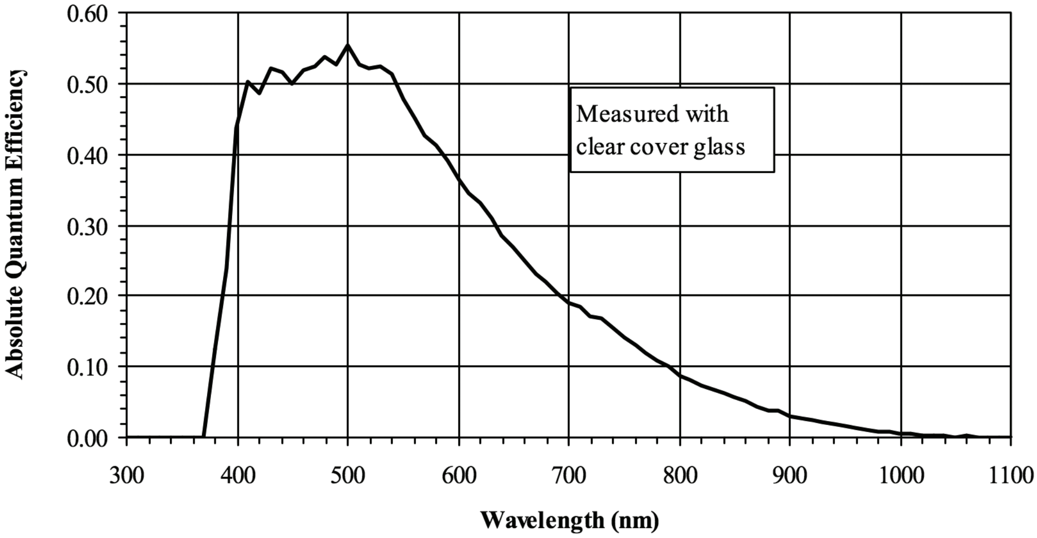


Figure 10: Spectral sensitivity of Pike F-032B

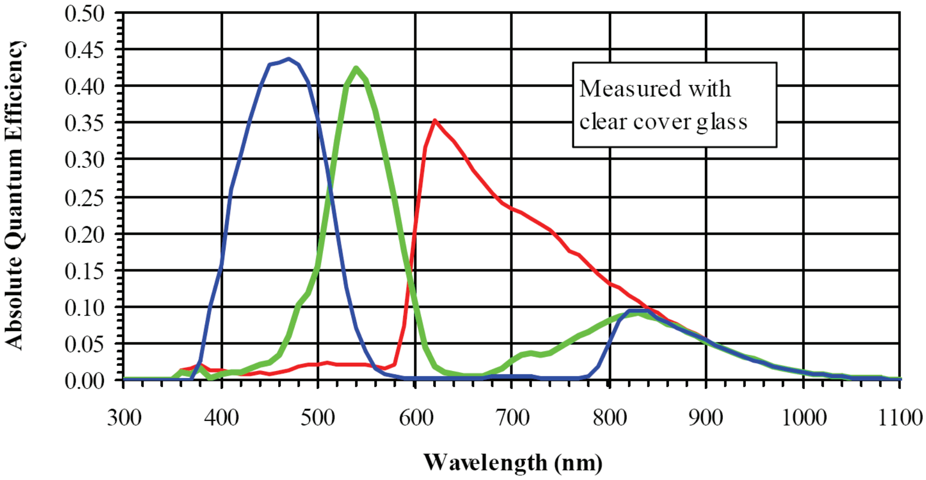


Figure 11: Spectral sensitivity of Pike F-032C

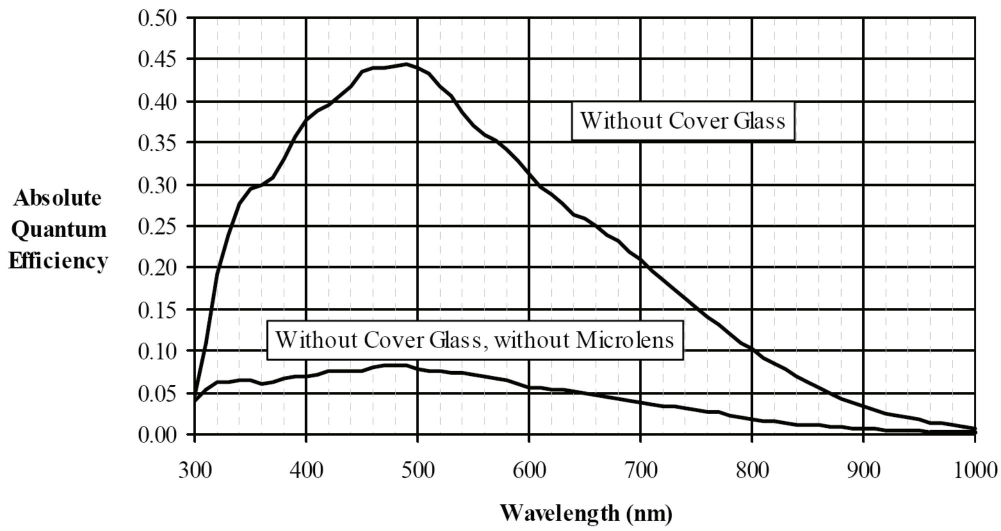


Figure 12: Spectral sensitivity of Pike F-100B

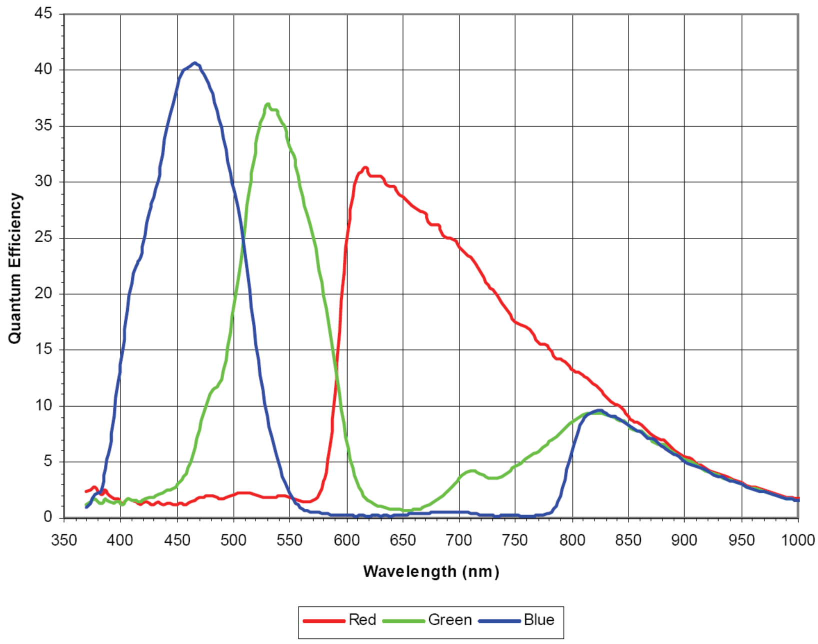


Figure 13: Spectral sensitivity of Pike F-100C

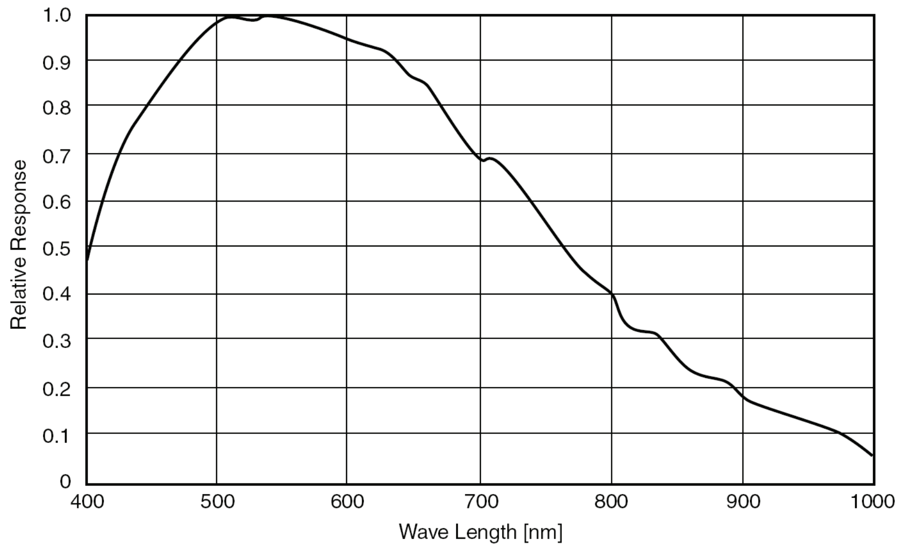


Figure 14: Spectral sensitivity of Pike F-145B

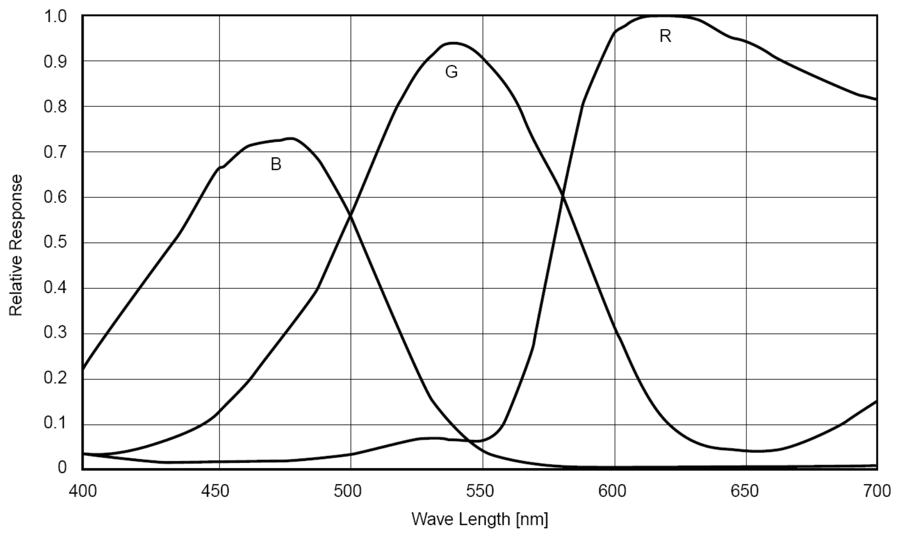


Figure 15: Spectral sensitivity of Pike F-145C

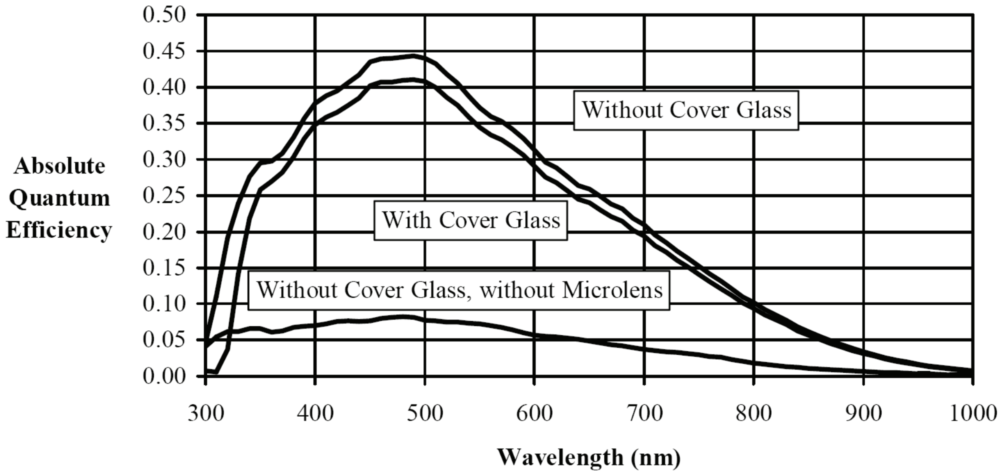


Figure 16: Spectral sensitivity of Pike F-210B

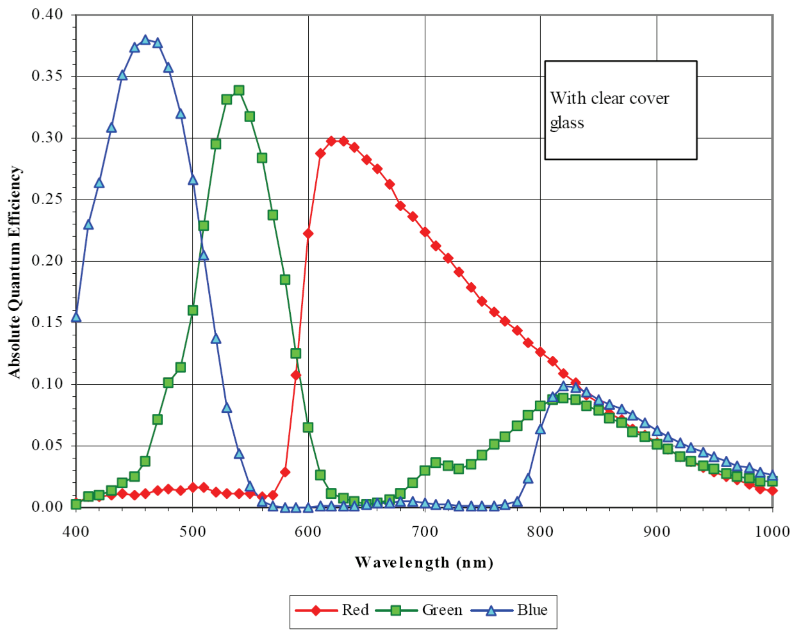


Figure 17: Spectral sensitivity of Pike F-210C

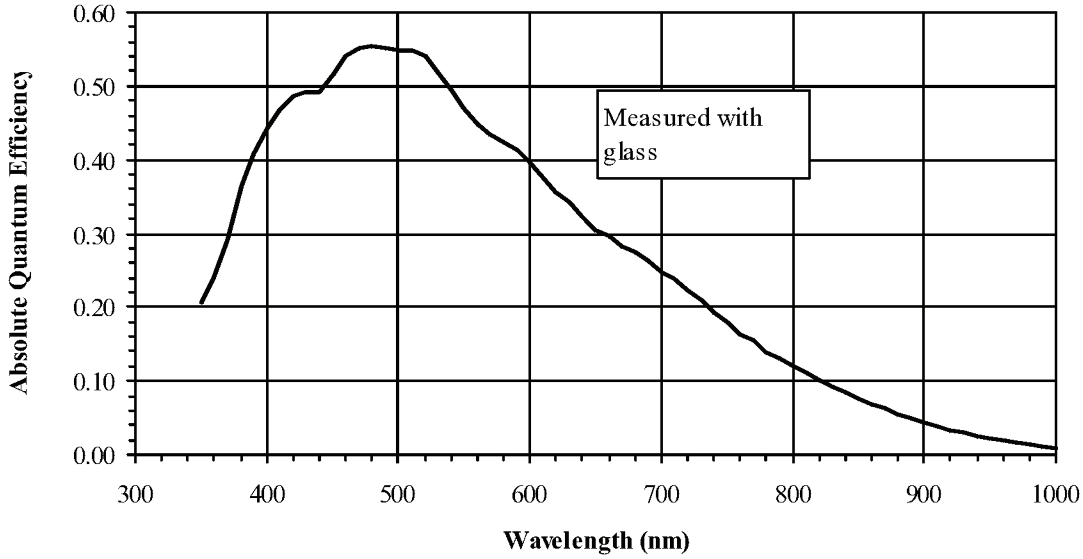


Figure 18: Spectral sensitivity of Pike F-421B

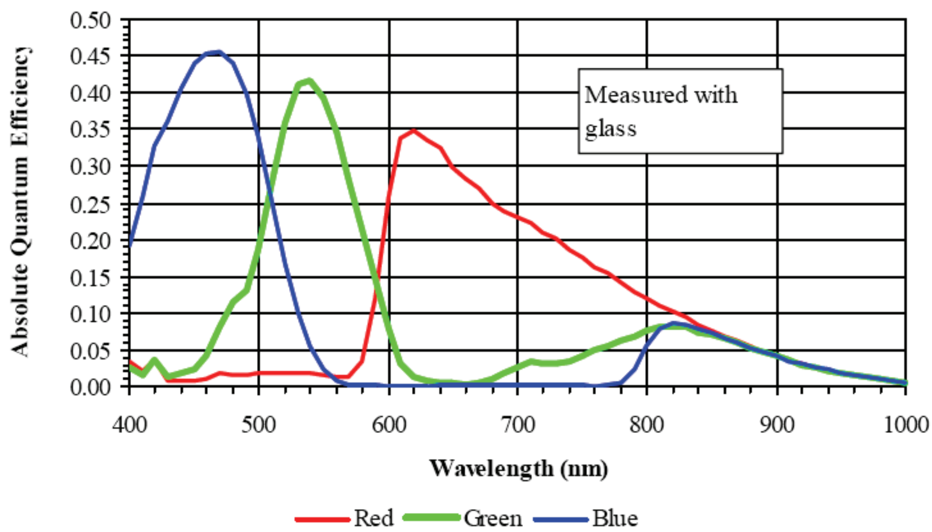
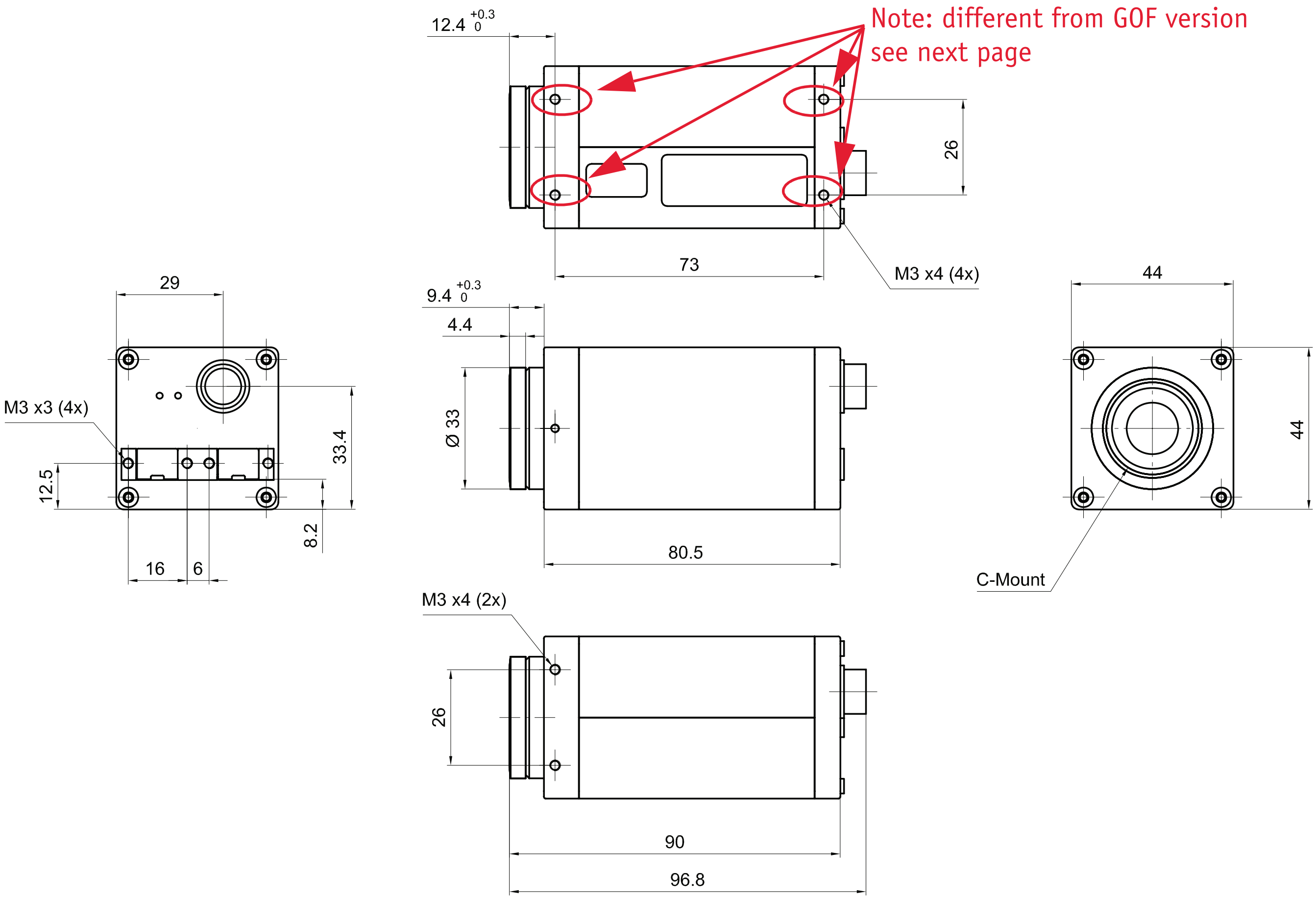


Figure 19: Spectral sensitivity of Pike F-421C

Camera dimensions

PIKE standard housing (2 x 1394b copper)

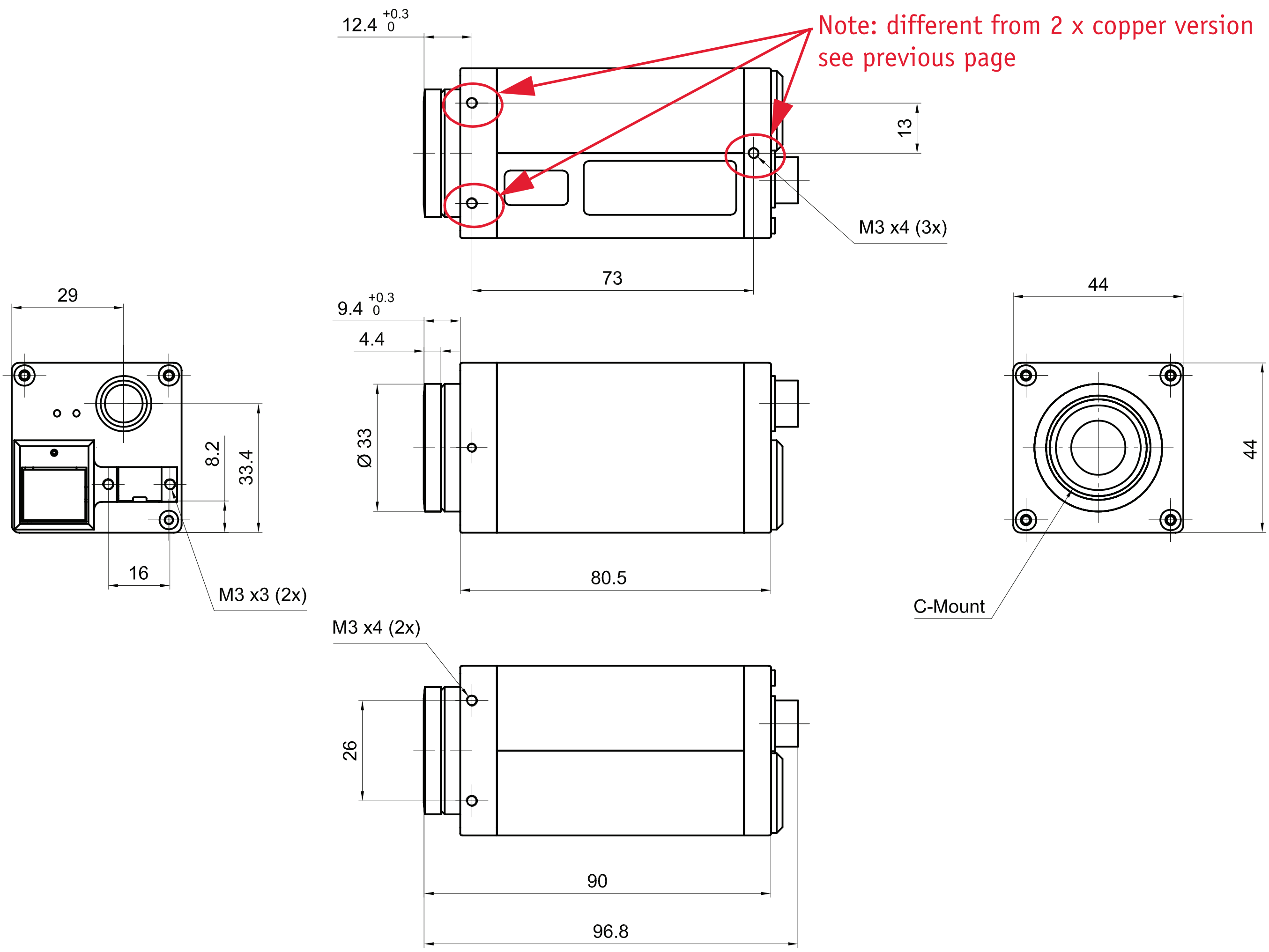


Body size: 96.8 mm x 44 mm x 44 mm (L x W x H)

Mass: 250 g (without lens)

Figure 20: Camera dimensions (2 x 1394b copper)

PIKE (1394b: 1 x GOF, 1 x copper)



Body size: 96.8 mm x 44 mm x 44 mm (L x W x H)

Mass: 250 g (without lens)

Figure 21: Camera dimensions (1394b: 1 x GOF, 1 x copper)

Tripod adapter

This tripod adapter is only designed for standard housings, but not for the angled head versions.

Note

If you need a tripod adapter for angled head versions, please contact AVT support.

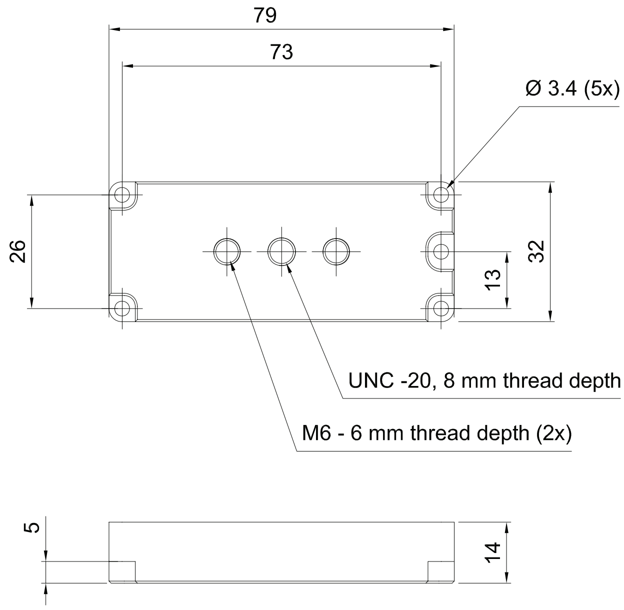


Figure 22: Tripod dimensions

Pike W90 (2 x 1394b copper)

This version has the sensor tilted by 90 degrees clockwise, so that it views upwards.

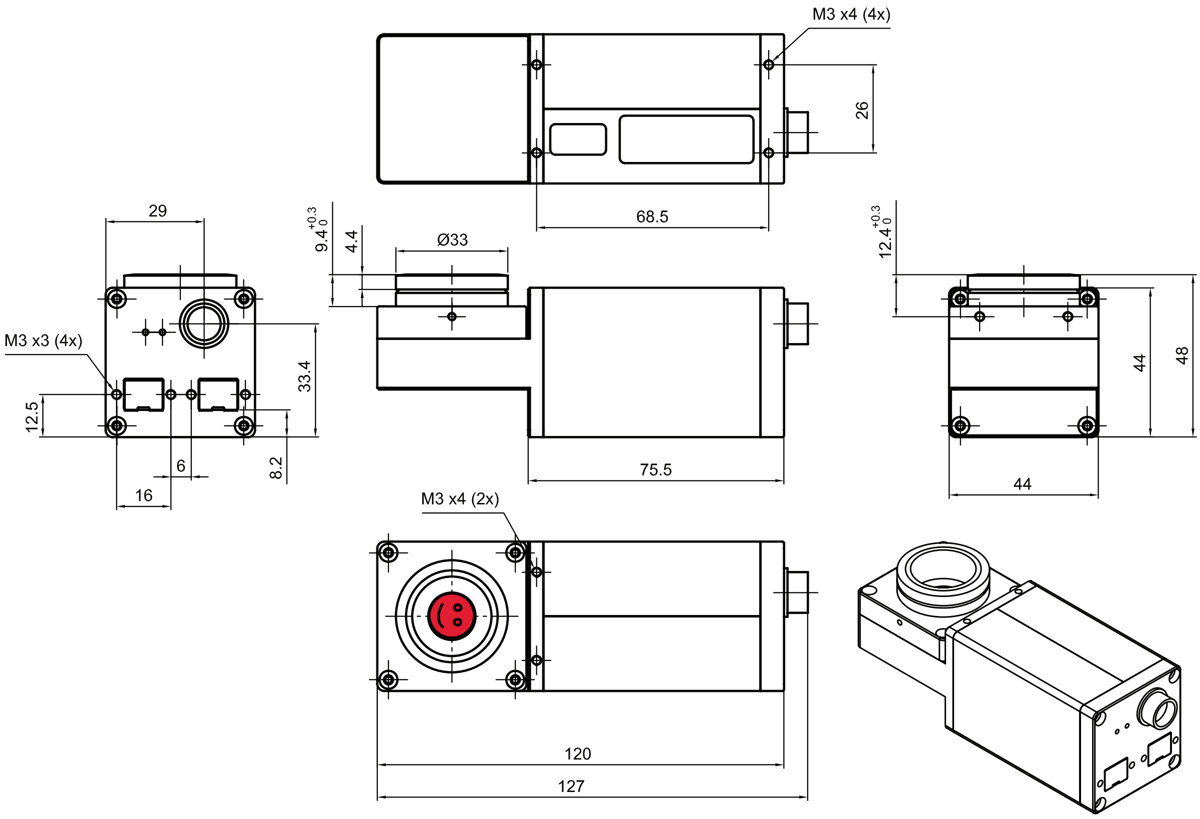


Figure 23: Pike W90 (2 x 1394b copper)

Pike W90 (1394b: 1 x GOF, 1 x copper)

This version has the sensor tilted by 90 degrees clockwise, so that it views upwards.

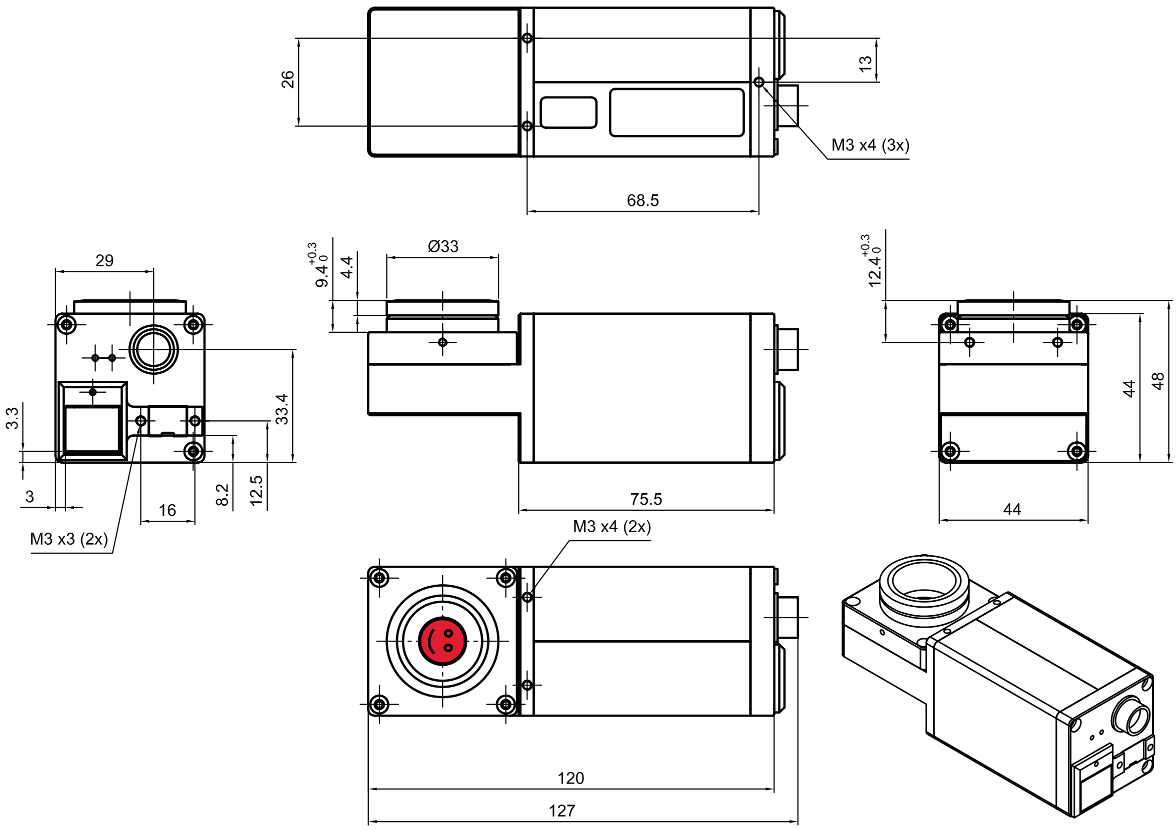


Figure 24: Pike W90 (1394b: 1 x GOF, 1 x copper)

Pike W90 S90 (2 x 1394b copper)

This version has the sensor tilted by 90 degrees clockwise, so that it views upwards.

The sensor is also rotated by 90 degrees clockwise.

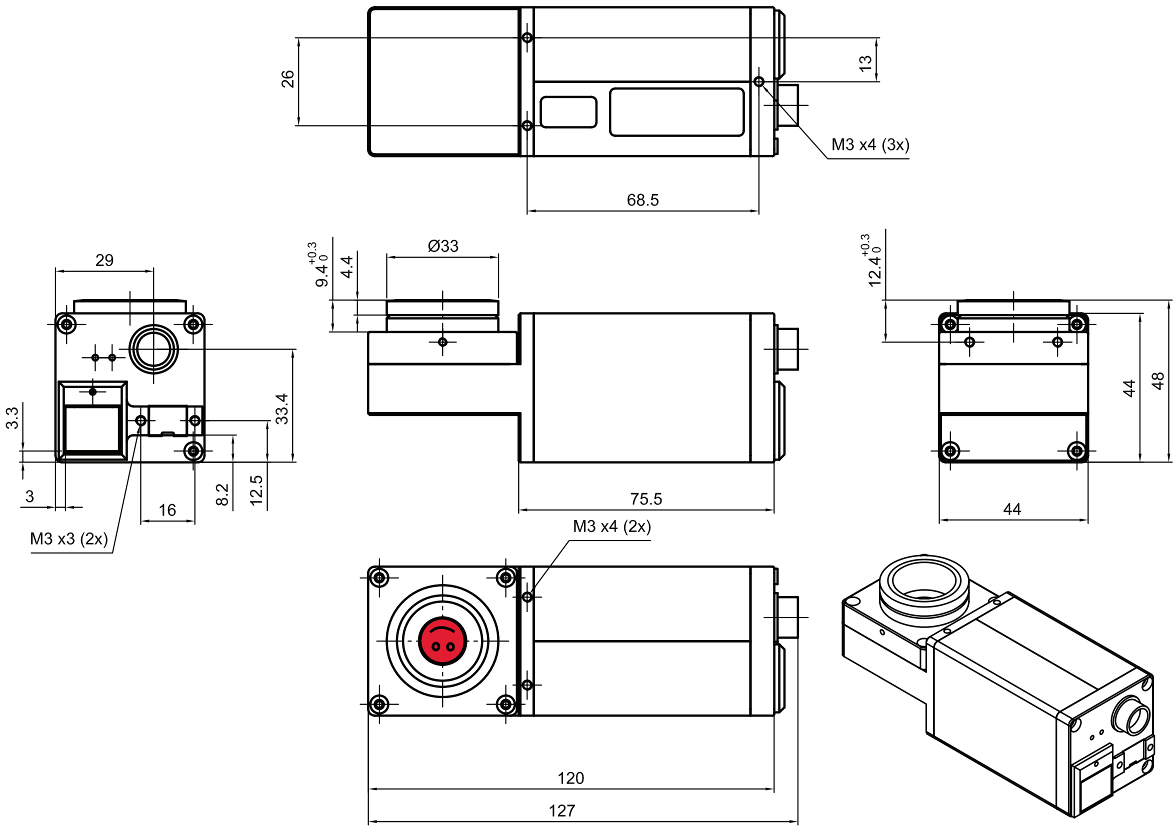


Figure 25: Pike W90 S90 (1394b: 1 x GOF, 1 x copper)

Pike W90 S90 (1394b: 1 x GOF, 1 x copper)

This version has the sensor tilted by 90 degrees clockwise, so that it views upwards.

The sensor is also rotated by 90 degrees clockwise.

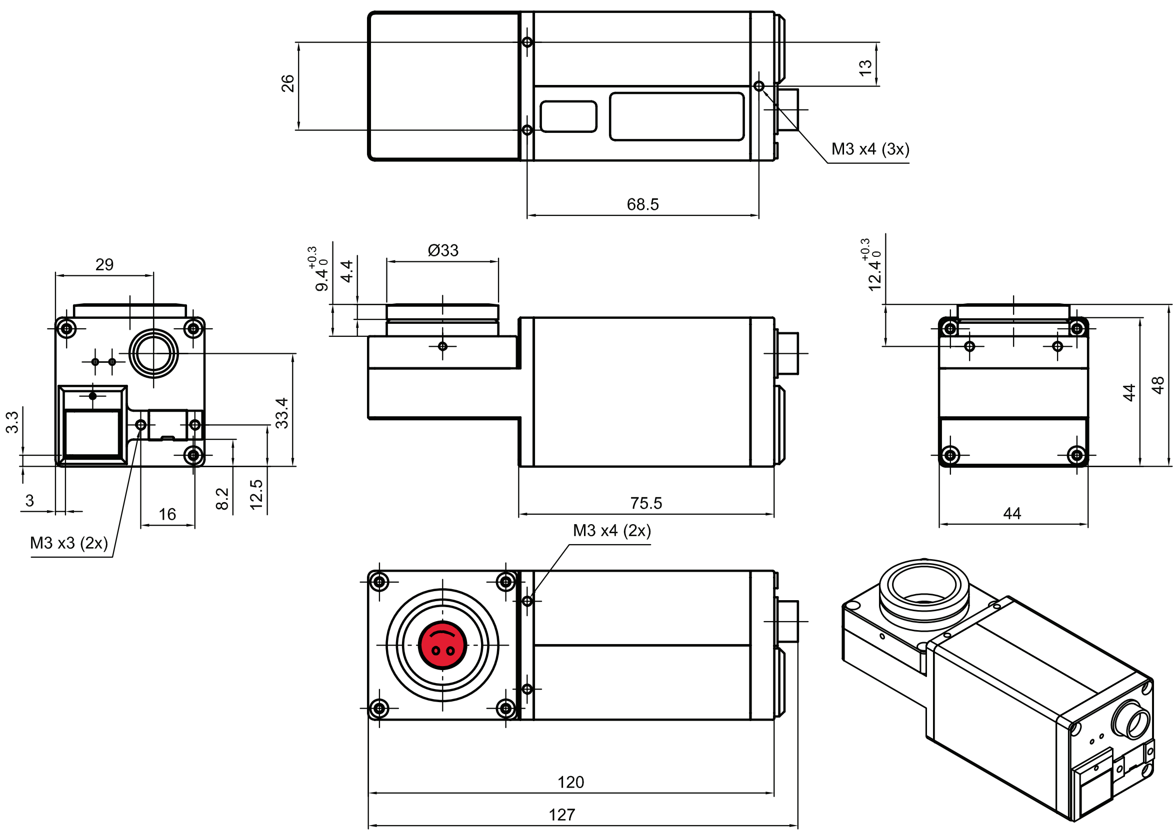


Figure 26: Pike W90 S90 (1394b: 1 x GOF, 1 x copper)

Pike W270 (2 x 1394b copper)

This version has the sensor tilted by 270 degrees clockwise, so that it views downwards.

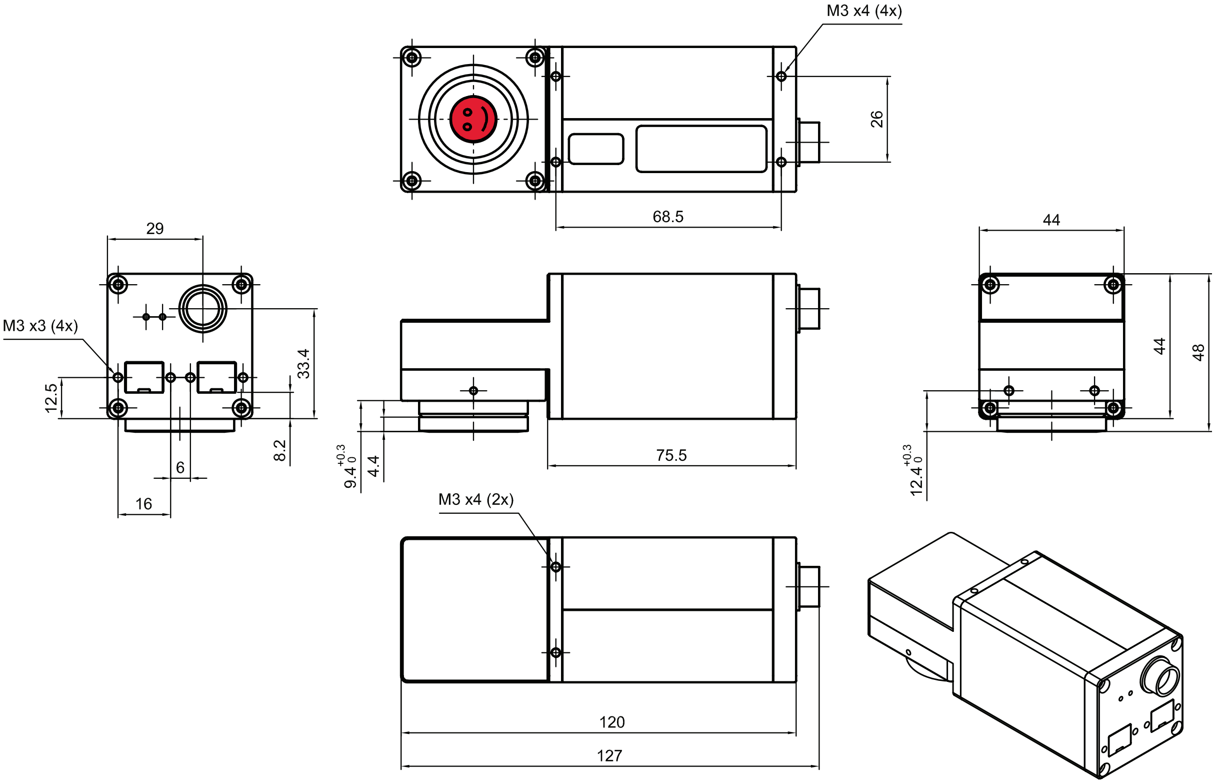


Figure 27: Pike W270 (2 x 1394b copper)

Pike W270 (1394b: 1 x GOF, 1 x copper)

This version has the sensor tilted by 270 degrees clockwise, so that it views downwards.

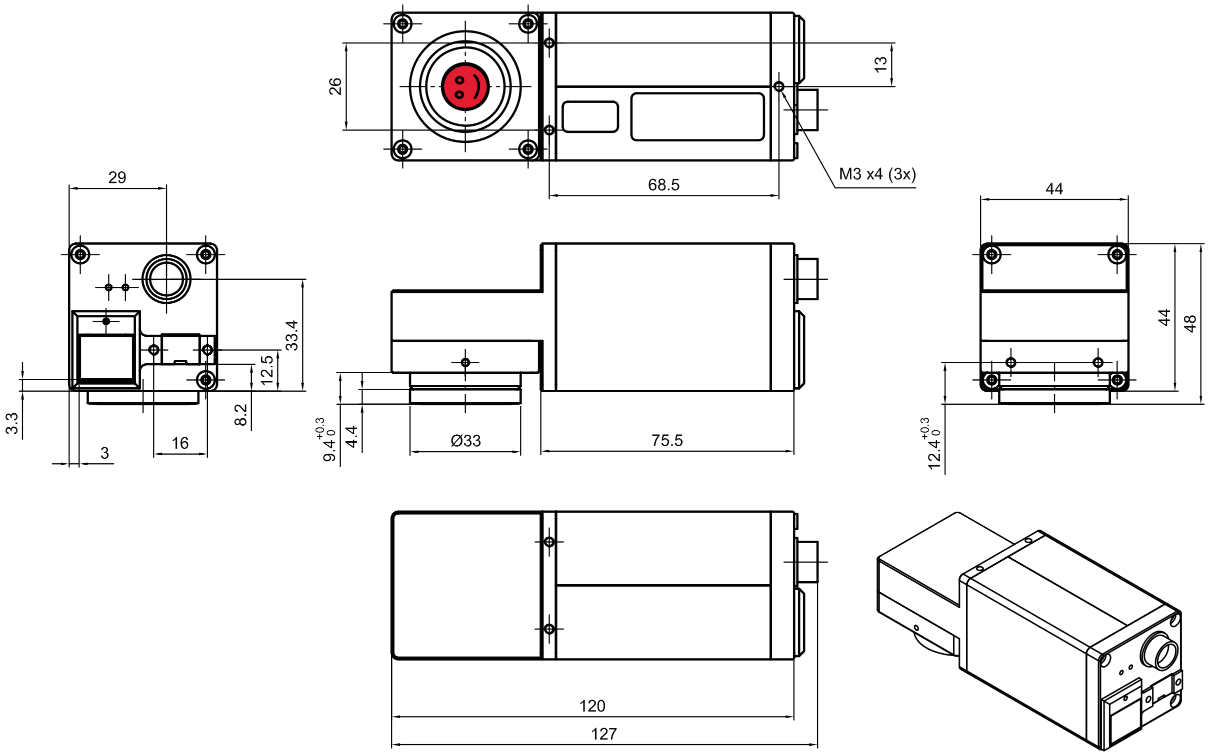


Figure 28: Pike W270 (1394b: 1 x GOF, 1 x copper)

Pike W270 S90 (2 x 1394b copper)

This version has the sensor tilted by 270 degrees clockwise, so that it views downwards.

The sensor is also rotated by 90 degrees clockwise.

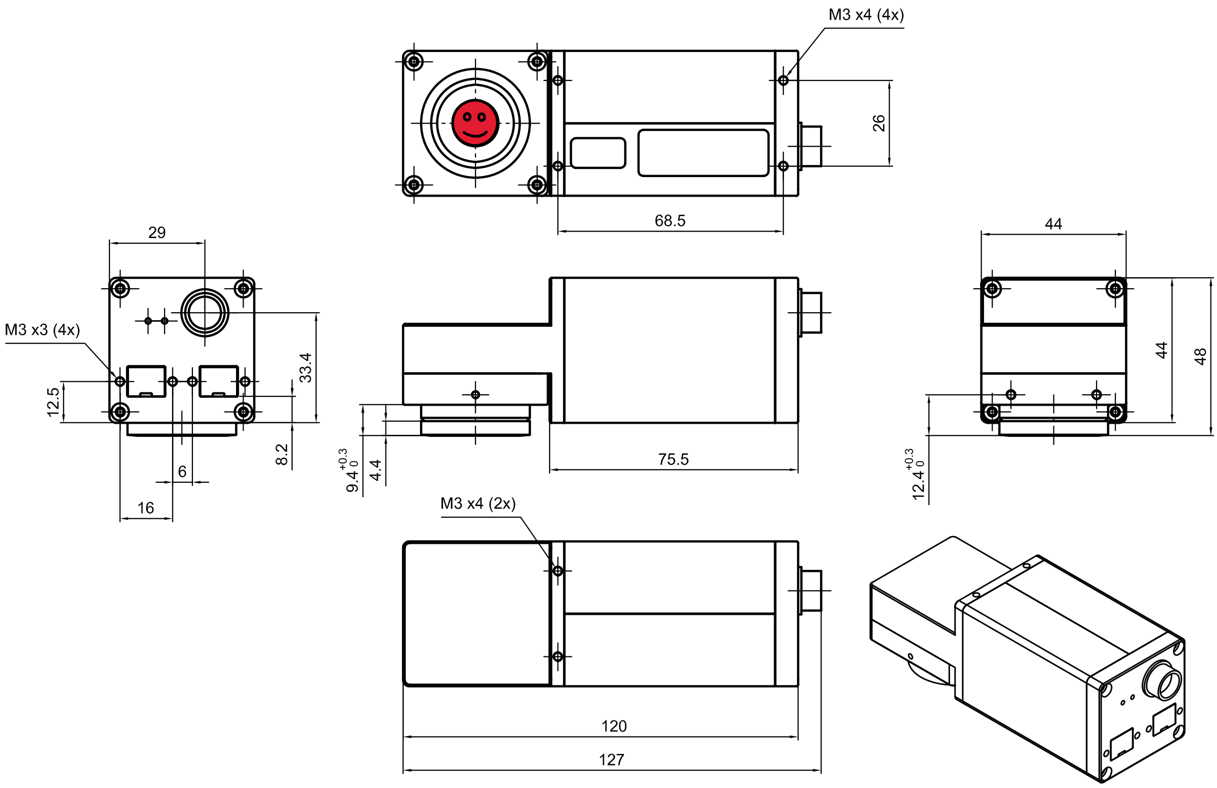


Figure 29: Pike W270 S90 (2 x 1394b copper)

Pike W270 S90 (1394b: 1 x GOF, 1 x copper)

This version has the sensor tilted by 270 degrees clockwise, so that it views downwards.

The sensor is also rotated by 90 degrees clockwise.

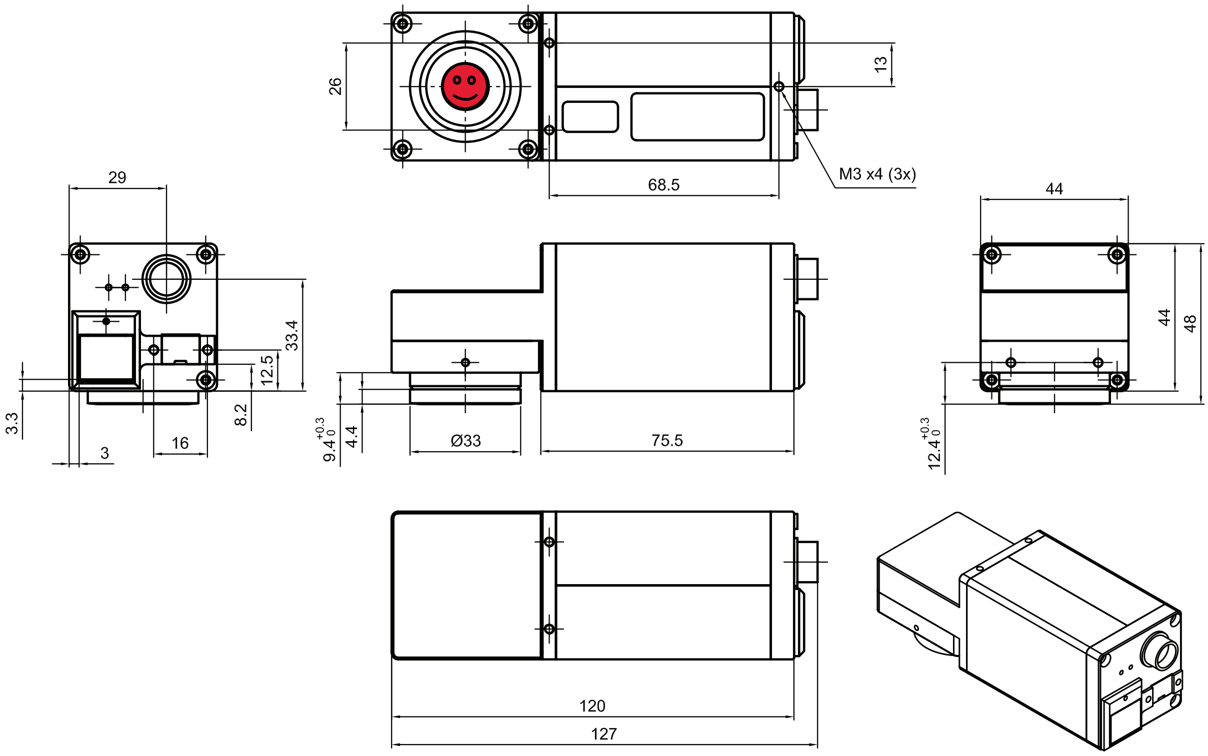
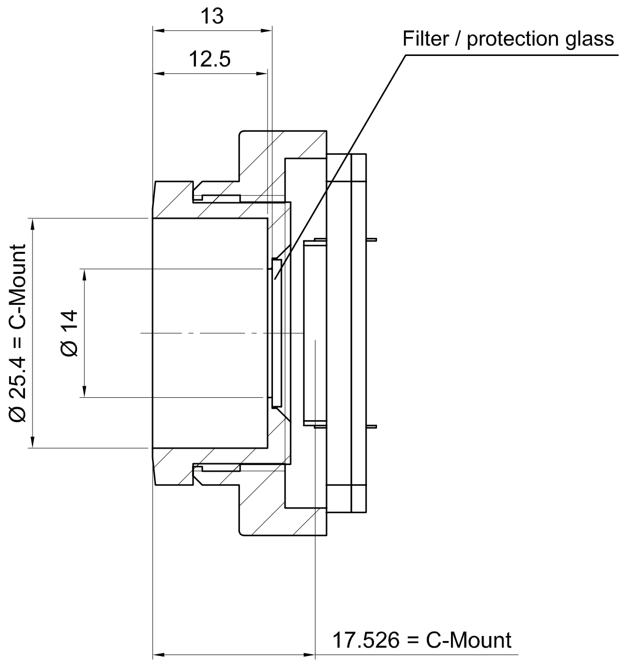


Figure 30: Pike W270 S90 (1394b: 1 x GOF, 1 x copper)

Cross section: C-Mount (VGA size filter)

PIKE F-032 cameras are equipped with VGA size filter.



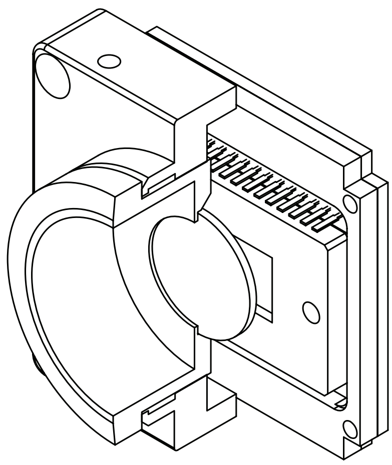


Figure 31: Pike C-Mount dimensions (VGA size filter for Pike F-032)

Cross section: C-Mount (large filter)

PIKE F-100, PIKE F-145, PIKE F-210, PIKE F-421 are equipped with a large filter.

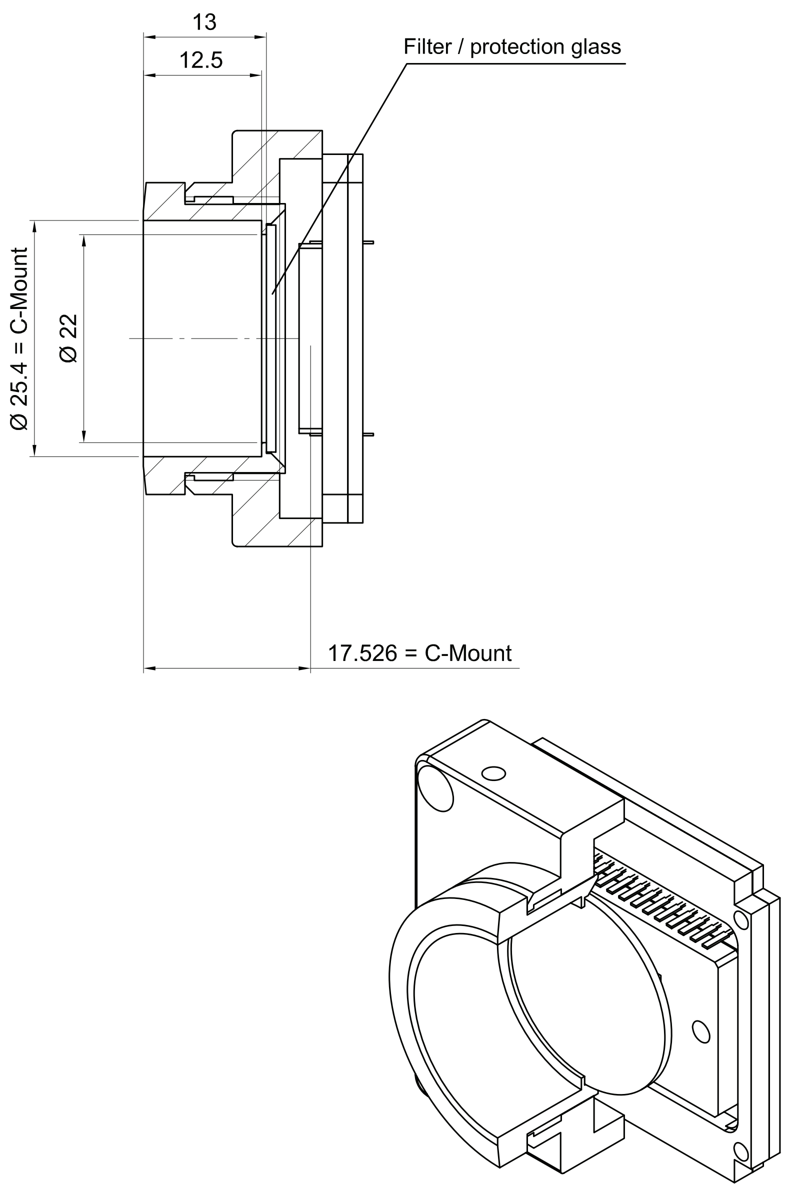


Figure 32: Pike C-Mount dimensions (large filter for Pike F-100, F-145, F-210, F-421)

Adjustment of C-Mount

PIKE cameras allow the precise adjustment of the back focus of the C-Mount by means of a **back focus ring** which is threaded into the C-Mount and held by **two** screws on either side of the camera. The mechanical adjustment of the imaging device is important in order to achieve a perfect alignment with the focal point of the lens.

This adjustment is made before leaving the factory to conform to the standard of 17.526 mm and should normally not require adjustment in the field.

However, if the back focal plane of your lens does not conform to the C-Mount back-focus specification or if you have e.g. removed the IR cut filter, renewed adjustment may be required in the field.

Figure 33: Back focus adjustment

Do the following:

1. Loosen screws (location as shown above by arrow) with an Allen key (1.3 x 50; Order#: K 9020411).
2. With the lens set to infinity or a known focus distance, set the camera to view an object located at 'infinity' or the known distance.
3. Rotate the C-Mount ring and lens forward or backwards on its thread until the object is in sharp focus. Be careful that the lens remains seated in the C-Mount.
4. Once focus is achieved, tighten the two locking screws without applying excessive torque.

F-Mount, K-Mount, M39-Mount

Note

For other mounts (e.g. **F-Mount**, **K-Mount**) please contact your distributor.

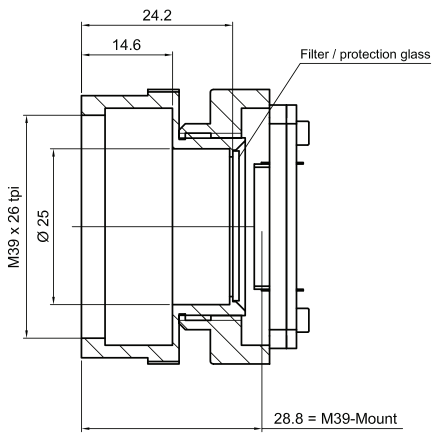
Note

Pike F-201 and Pike F-421 can be equipped at factory site with **M39-Mount** instead of C-Mount.

M39-Mount is ideally suited for Voigtländer (aka Voigtlander) short focal length optics. See drawing below for further details.

Please ask AVT or your local dealer if you require further information.

Cross section: M39-Mount



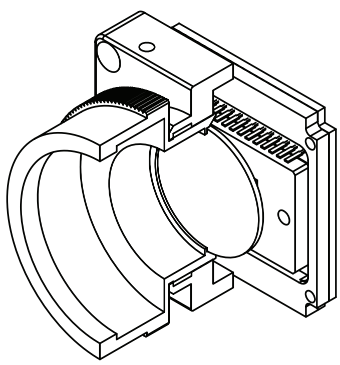


Figure 34: Pike M39-Mount dimensions (only Pike F-210 and Pike F-421)

Camera interfaces

In addition to the two status LEDs (see Chapter Status LEDs on page 80), there are three jacks located at the rear of the camera.

- The 12-pin camera I/O connector provides different control inputs and output lines.
- Both IEEE 1394b connectors with screw lock mechanism provide access to the IEEE 1394 bus and thus makes it possible to control the camera and output frames. Connect the camera by using either of the connectors. The other connector can be used to daisy chain a second camera.

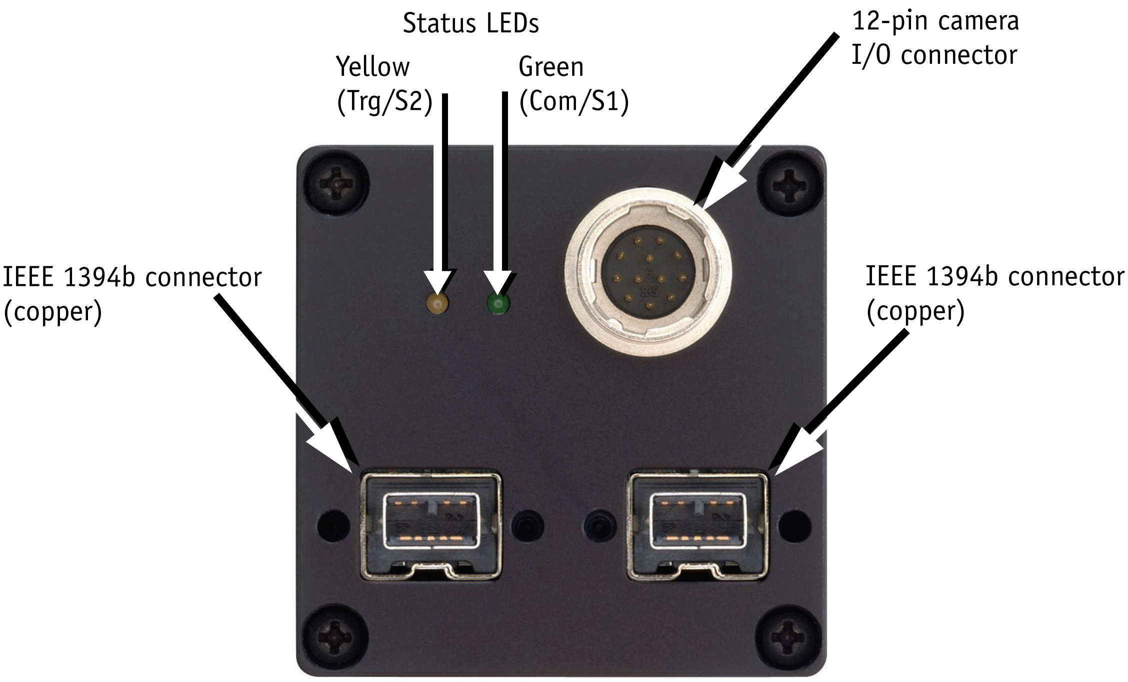


Figure 35: Rear view of camera (2 x 1394b copper)

PIKE fiber

All PIKE cameras are also available as fiber version with 1 x GOF connector and 1 x copper connector.

The GOF connector is of the following type: 2 x optical fiber on LCLC

The GOF transmission uses MMF (multi-mode fiber at 850 nm).

Connect the camera by using either of the connectors. The other connector can be used to daisy chain a second camera. In case of long distances between PC and camera, use the GOF connector for the long distance and the IEEE 1394b connector for optional daisy-chaining. Please ensure that you use a GOF hub on the PC side for reconversion from GOF to copper (order number E3000074 (with mounting plate) or E3000084 (with top-hat rail)). Alternatively use PCI or PCIExpress cards with built in GOF port. Ask your dealer for availability and details of these cards.

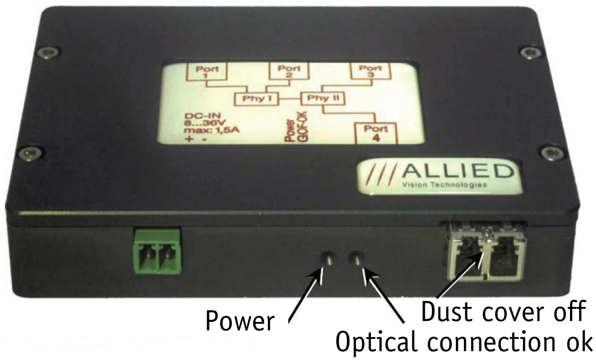


Figure 36: GOF hub

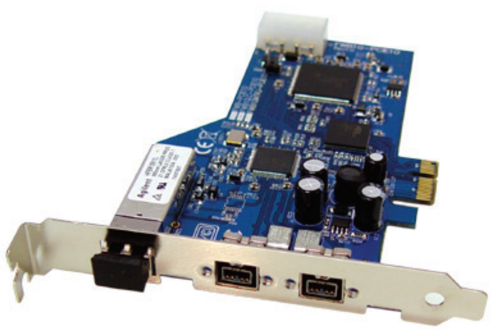


Figure 37: PCI Express card (1 x GOF, 2 x 1394 bilingual)

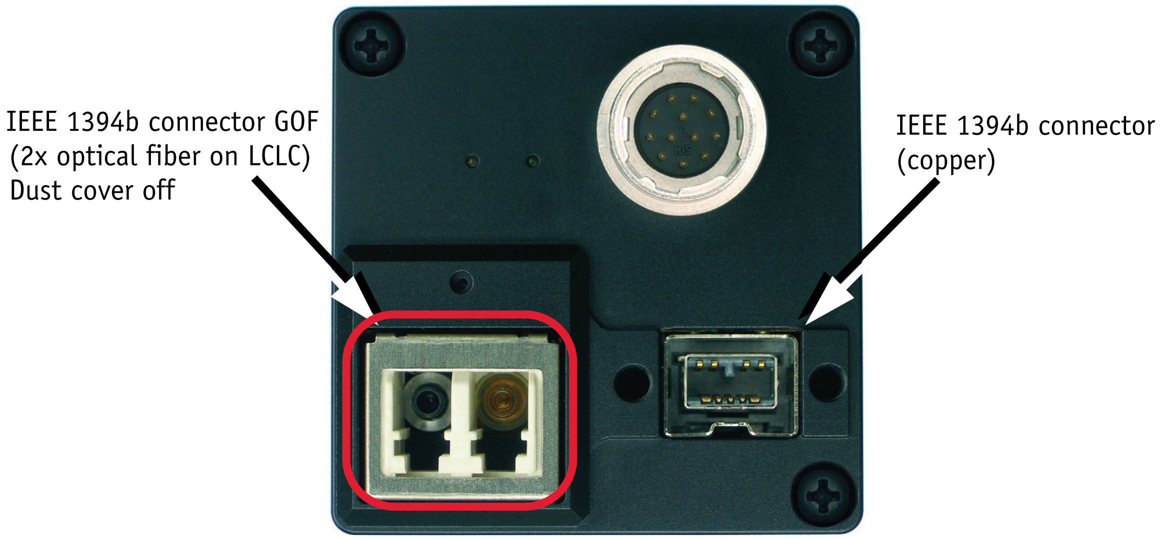


Figure 38: Rear view of camera (1394b: 1 x GOF, 1 x copper)

Warning

Special warning for all PIKE models with GOF connectors:

GOF connectors are very sensitive. Any dust or dirt may cause damage.

- Always keep the GOF connector and optical fiber plug clean.
- If GOF connection is not in use, keep GOF dust cover on the GOF connector.
- Reduce mating cycles to a minimum to prevent abrasion.
- Please note that optical fiber cables have a very limited deflection curve radius.

IEEE 1394b port pin assignment

The IEEE 1394b connector is designed for industrial use and has the following pin assignment as per specification:

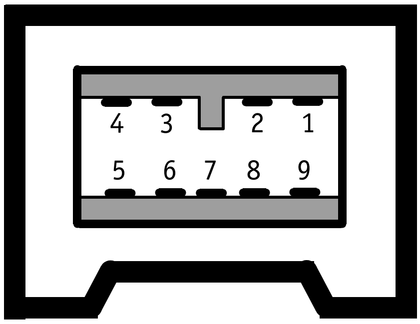


Figure 39: IEEE 1394b connector

Pin	Signal
1	TPB-
2	TPB+
3	TPA-
4	TPA+
5	TPA (Reference ground)
6	VG (GND)
7	N.C.
8	VP (Power, VCC)
9	TPB (Reference ground)

Table 24: IEEE 1394b pin assignment

Note

Cables with latching connectors on one or both sides can be used and are available with lengths of 5 m or 7.5 m. Ask your local dealer for more details.

Camera I/O connector pin assignment

The camera I/O connector is also designed for industrial use and, in addition to providing access to the inputs and outputs on the camera, it also provides a serial interface for e.g. the firmware update. The following diagram shows the pinning as viewed in pin direction.

The connector is available in straight and angled version under the following numbers:

Order text	Order number
PC-12P 12-Pin HR10A-10P-12S cable connector female	K7600040
PC-12PW 12-Pin HR10A-10LT-12S angled cable connector female	K7600044

Table 25: Order numbers: I/O connector

Note

AVT supplies suitable I/O cables of different lengths (up to 10 m) as shown below.

Order text	Length	Order number
Trigger cable 12-pin HIROSE female to BNC	2.0 m	E1000648
Trigger cable 12-pin HIROSE female to BNC	5.0 m	E1000772
Trigger cable 12-pin HIROSE female to open end	2.0 m	E1000728
Trigger cable 12-pin HIROSE female to open end	10.0 m	E1000736
I/O cable 12-pin HIROSE female to open end	2.0 m	E1000746
I/O cable 12-pin HIROSE female to open end	3.0 m	E1000732

Table 26: Order numbers: trigger and I/O cables

Order text	Length	Order number
I/O cable 12-pin HIROSE female to open end	5.0 m	E1000786
I/O cable 12-pin HIROSE female to open end	10.0 m	E1000749

Table 26: Order numbers: trigger and I/O cables

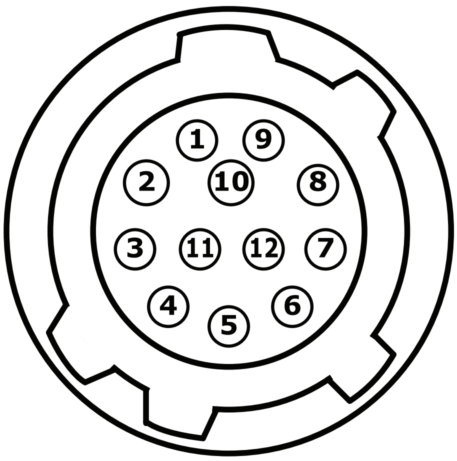


Figure 40: Camera I/O connector pin assignment

Pin	Signal	Direction	Level	Description
1	External GND		GND for RS232 and ext. power	External Ground for RS232 and external power
2	ExtPower		+8...+36 V DC	Power Supply
3	CameraOut4	Out	Open emitter	Camera Output 4 (GPOut4) default: -
4	CameraIn1	In	CMOS / TTL max. 5 V	Camera Input 1 (GPIn1) default: Trigger
5	CameraOut3	Out	Open emitter	Camera Output 3 (GPOut3) default: Busy
6	CameraOut1	Out	Open emitter	Camera Output 1 (GPOut1) default: IntEna

Table 27: Camera I/O connector pinning

Pin	Signal	Direction	Level	Description
7	CameraIn GND	In	Common GND for inputs	Camera Common Input Ground (In GND) See Figure 44: Input Ground (InGND) (Pin no. 7 from camera I/O connector) on page 84
8	RxD_RS232	In	RS232	Terminal Receive Data
9	TxD_RS232	Out	RS232	Terminal Transmit Data
10	CameraOutPower	In	Common VCC for outputs max. 35 V DC	Camera Output Power for digital outputs (OutVCC)
11	CameraIn2	In	CMOS/TTL max. 5 V	Camera Input 2 (GPIn2) default: -
12	CameraOut2	Out	Open emitter	Camera Output 2 (GPOut2) default: -

Table 27: Camera I/O connector pinning

Note

GP = General Purpose

Note

Pin 1 is **not** internally bridged with pin 7 to avoid ground noise being induced in the camera and to prevent ground loops. Use pin 1 only if you want to power the camera by HIROSE or to connect to the serial interface of the camera in combination with pin 8 and 9.

Status LEDs

On LED (green)

The green power LED indicates that the camera is being supplied with sufficient voltage and is ready for operation.

Status LED

The following states are displayed via the LED:

State	Description
Com/S1 (green)	Asynchronous and isochronous data transmission active (indicated asynchronously to transmission via the 1394 bus)
Trg/S2 (yellow)	LED on - waiting for external trigger LED off - triggered / internal sync

Table 28: LED indication

Blink codes are used to signal warnings or error states:

Class S1 → Error code S2 ↓	Warning 1 blink	DCAM 2 blinks	MISC 3 blinks	FPGA 4 blinks	Stack 5 blinks
FPGA boot error				1-5 blinks	
Stack setup					1 blink
Stack start					2 blinks
No FLASH object			1 blink		
No DCAM object		1 blink			
Register mapping		3 blinks			
VMode_ERROR_STATUS	1 blink				
FORMAT_7_ERROR_1	2 blinks				
FORMAT_7_ERROR_2	3 blinks				

Table 29: Error codes

The following sketch illustrates the series of blinks for a Format_7_error_1:

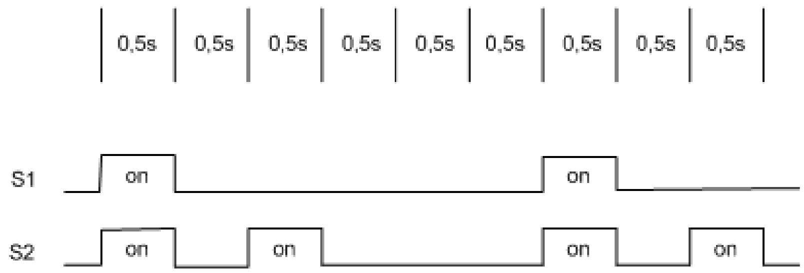


Figure 41: Warning and error states

You should wait for at least 2 full cycles because the display of blinking codes starts asynchronously - e.g. on the second blink from S2.

Operating the camera

Power for the camera is supplied either via the FireWire™ bus or the camera I/O connector's pin 2.

The input voltage must be within the following range:

Vcc min.: +8 V

Vcc max.: +36 V

Note

- An input voltage of 12 V is recommended for most efficient use of the camera
- As mentioned above: The camera I/O supplies power to the camera via a diode. This means that there is no power out at pin 2 if the camera is powered via the bus. Consult the factory if you need power output at this pin instead of power in.

Control and video data signals

The camera has 2 inputs and 4 outputs. These can be configured by software. The different modes are described below.

Inputs

All inputs have been implemented as shown in the diagram below.

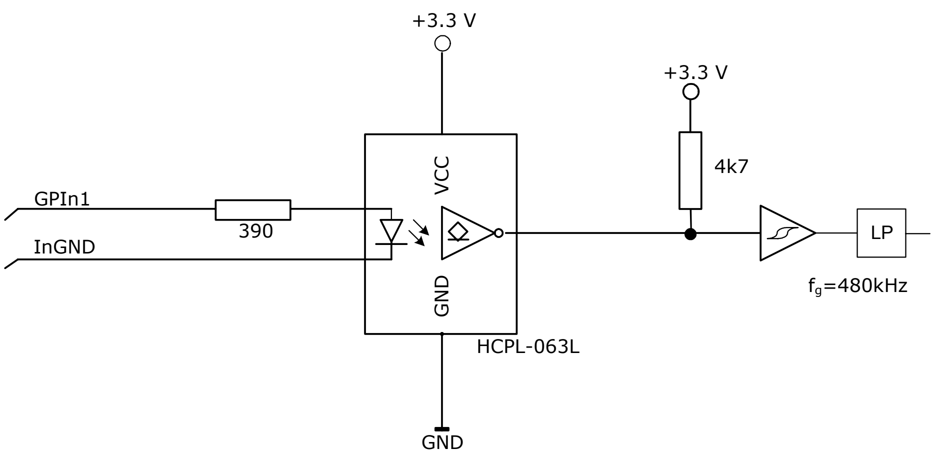


Figure 42: Input schematics

Flux voltage from LED type 1.5 V at 10 mA	
Initial on-current:	5 mA
Max. off-current:	0.25 mA
Max. input current:	15 mA
Min. pulse width	2.2 µs

Table 30: Input characteristics: Flux voltage

Cycle delay of the optocoupler	
tpdLH:	2275 ns
tpdHL:	2290 ns

Table 31: Input characteristics: Cycle delay

The inputs can be connected directly to +5 V. If a higher voltage is used, an external resistor must be placed in series. Use at +12 V a 820 Ω resistor and at +24 V a 2.2 kΩ resistor.

Caution Voltages above +45 V may damage the optical coupler.

The optocoupler inverts all input signals. Inversion of the signal is controlled via the IO_INP_CTRL1..2 register (see Table 32: Input configuration register on page 85).

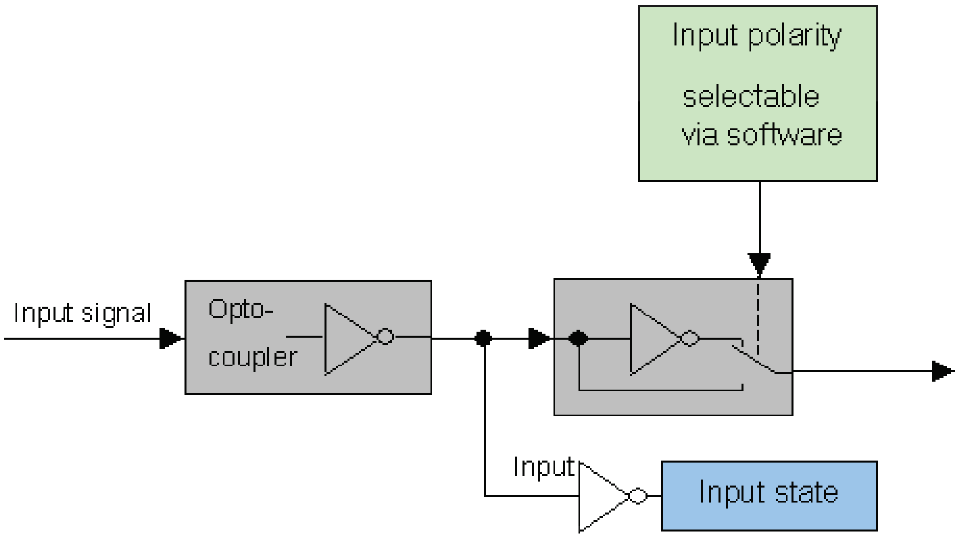


Figure 43: Input block diagram

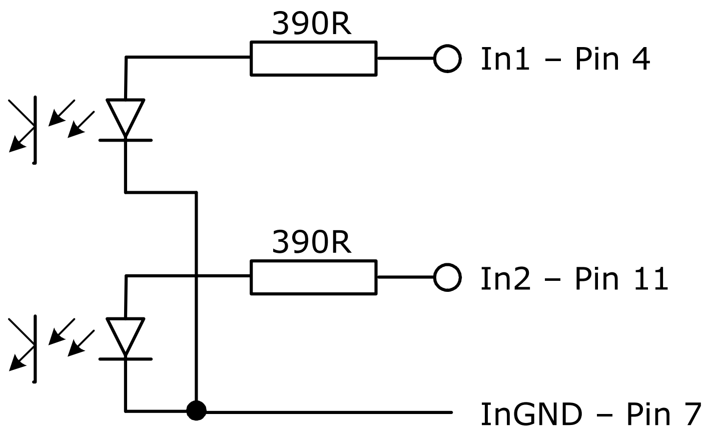


Figure 44: Input Ground (InGND) (Pin no. 7 from camera I/O connector)

Triggers

All inputs configured as triggers are linked by AND. If several inputs are being used as triggers, a high signal must be present on all inputs in order to generate a trigger signal. Each signal can be inverted. The camera must be set to **external triggering** to trigger image capture by the trigger signal.

Input/output pin control

All input and output signals running over the camera I/O connector are controlled by an advanced feature register.

Register	Name	Field	Bit	Description
0xF1000300	IO_INP_CTRL1	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..6]	Reserved
		Polarity	[7]	0: Signal not inverted 1: Signal inverted
		---	[8..10]	Reserved
		InputMode	[11..15]	Mode see Table 33: Input routing on page 86
		---	[16..30]	Reserved
		PinState	[31]	RD: Current state of pin
0xF1000304	IO_INP_CTRL2	Same as IO_INP_CTRL1		

Table 32: Input configuration register

IO_INP_CTRL 1-2

The **Polarity** flag determines whether the input is low active (0) or high active (1). The **input mode** can be seen in the following table. The **PinState** flag is used to query the current status of the input.

For inputs, the **PinState** bit refers to the inverted output side of the optical coupler. This means that an open input sets the **PinState** bit to **1**.

ID	Mode	Default
0x00	Off	
0x01	Reserved	
0x02	Trigger input	Input 1
0x03	Reserved	
0x06..0x0F	Reserved	
0x10..0x1F	Reserved	

Table 33: Input routing

Note

If you set more than 1 input to function as a trigger input, all trigger inputs are anded.

Trigger delay

The cameras feature various ways to delay image capture based on external trigger.

With IIDC V1.31 there is a standard CSR at Register F0F00534/834h to control a delay up to FFFh x time base value. The following table explains the inquiry register and the meaning of the various bits.

Register	Name	Field	Bit	Description
0xF0F00534	TRIGGER_DELAY_INQUIRY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One-push auto mode (controlled automatically by the camera once)
		Readout_Inq	[4]	Capability of reading out the value of this feature
		ON_OFF	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto mode (controlled automatically by the camera)
		Manual_Inq	[7]	Manual mode (controlled by user)
		Min_Value	[8..19]	Minimum value for this feature
		Max_Value	[20..31]	Maximum value for this feature

Table 34: Trigger delay inquiry register

Register	Name	Field	Bit	Description
0xF0F00834	TRIGGER_DELAY	Presence_Inq	[0]	Presence of this feature: 0:N/ 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the value field 1: Control with value in the absolute value CSR. If this bit=1 the value in the value field has to be ignored.
		-	[2..5]	Reserved
		ON_OFF	[6]	Write ON or OFF this feature, ON=1 Read: Status of the feature; OFF=0
		-	[7..19]	Reserved
		Value	[20..31]	Value

Table 35: Trigger Delay CSR

The cameras also have an advanced register which allows even more precise image capture delay after receiving a hardware trigger.

Trigger delay advanced register

Register	Name	Field	Bit	Description
0xF1000400	TRIGGER_DELAY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	-
		ON_OFF	[6]	Trigger delay on/off
		---	[7..10]	-
		DelayTime	[11..31]	Delay time in µs

Table 36: Trigger Delay Advanced CSR

The advanced register allows the start of the integration to be delayed by max. 2^{21} µs, which is max. 2.1 s after a trigger edge was detected.

Note

- Switching trigger delay to ON also switches external Trigger_Mode_0 to ON.
- This feature works with external Trigger_Mode_0 only.

Outputs

The camera has 4 non-inverting outputs with open emitters. These are shown in the following diagram:

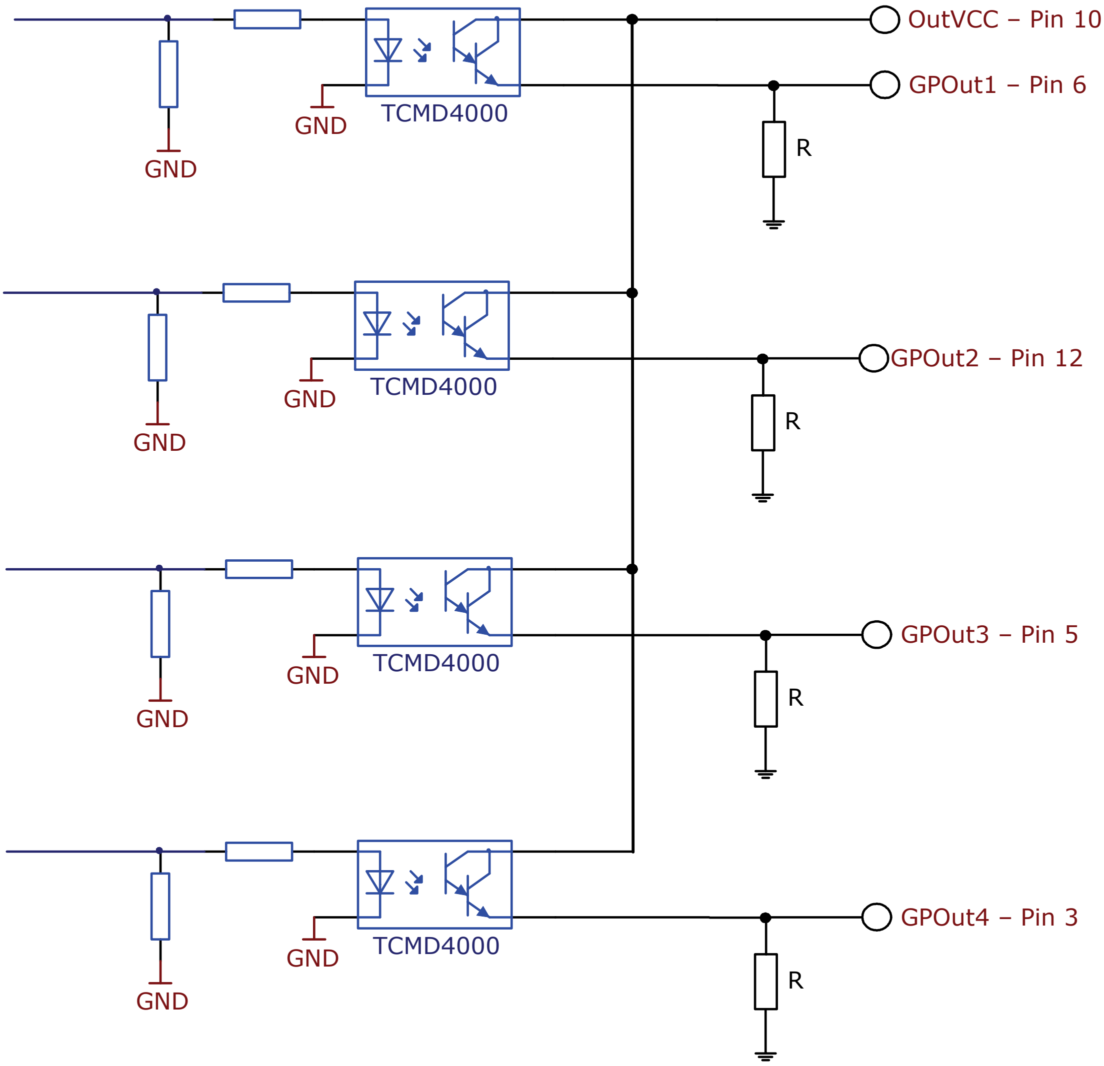


Figure 45: Output schematics with external resistors R (pin no. from camera I/O connector)

Parameter	Test condition	Value
Collector emitter voltage		Max. 35 V
Emitter collector voltage		Max. 7 V
Emitter current		Max. 50 mA
Collector current		Max. 80 mA
Collector peak current	$t_p/T=0.5$ $t_p \leq 10\,ms$	100 mA
Power dissipation		100 mW

OutVCC	Resistor value
5 V	1 kΩ
12 V	2.4 kΩ
24 V	4.7 kΩ

Note

- Voltage above +45 V may damage the optical coupler.
- The output connection is different to the AVT Dolphin series to achieve higher output swing.
- Depending on the voltage applied at OutVCC and the type of input which you want to drive, it may be necessary to switch an external resistor in series between GPOut1...4 and ground.
  See Figure 45: Output schematics with external resistors R (pin no. from camera I/O connector) on page 89.
- Typical delay is not more than 40 µs.

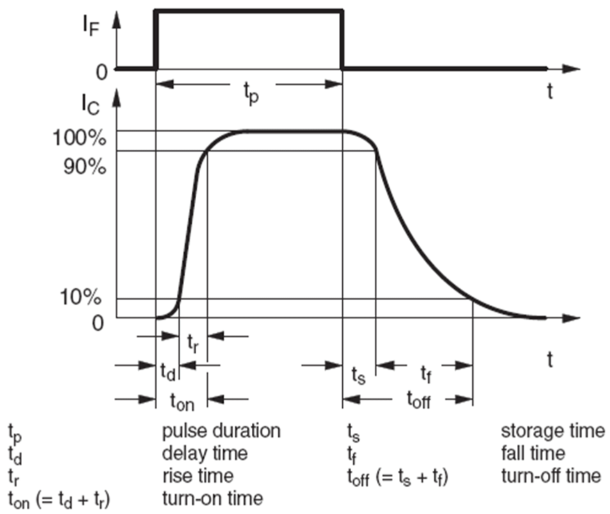


Figure 46: Output schematics: switching times

Parameter	Symbol	Value	Condition
Delay time	t_d	1.00 µs	OutVCC = 5 V Resistor value = 1 kΩ
Rise time	t_r	2.60 µs	
Storage time	t_s	48.00 µs	
Fall time	t_f	400.00 µs	

Output features are configured by software. Any signal can be placed on any output.

The main features of output signals are described below:

Signal	Description
IntEna (Integration Enable) signal	This signal displays the time in which exposure was made. By using a register this output can be delayed by up to 1.05 seconds.
Fval (Frame valid) signal	This feature signals readout from the sensor. This signal Fval follows IntEna.
Busy signal	This indicator appears when the exposure is being made; the sensor is being read from or data transmission is active. The camera is busy.

Table 37: Output signals

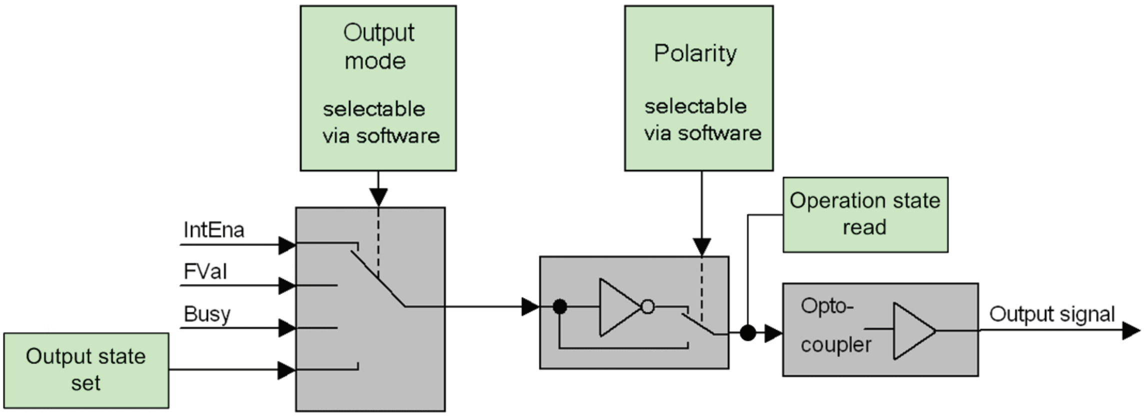


Figure 47: Output block diagram

IO_OUTP_CTRL 1-4

The outputs (Output mode, Polarity) are controlled via 4 advanced feature registers (see Table 38: Output configuration register on page 93).

The **Polarity** field determines whether the output is inverted or not. The **Output mode** can be viewed in the table below. The current status of the output can be queried and set via the **PinState**.

It is possible to read back the status of an output pin regardless of the output mode. This allows for example the host computer to determine if the camera is busy by simply polling the BUSY output.

Register	Name	Field	Bit	Description
0xF1000320	IO_OUTP_CTRL1	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..6]	Reserved
		Polarity	[7]	0: Signal not inverted 1: Signal inverted
		---	[8..10]	Reserved
		Output mode	[11..15]	Mode see Table 39: Output routing *on page 94*
		---	[16..30]	Reserved
		PinState	[31]	RD: Current state of pin WR: New state of pin
0xF1000324	IO_OUTP_CTRL2	Same as IO_OUTP_CTRL1		
0xF1000328	IO_OUTP_CTRL3	Same as IO_OUTP_CTRL1		
0xF100032C	IO_OUTP_CTRL4	Same as IO_OUTP_CTRL1		

Table 38: Output configuration register

Output modes

ID	Mode	Default / description
0x00	Off	
0x01	Output state follows **PinState** bit	Using this mode, the Polarity bit has to be set to 0 (not inverted). This is necessary for an error free display of the output status.
0x02	Integration enable	Output 1
0x03	Reserved	
0x04	Reserved	
0x05	Reserved	
0x06	FrameValid	
0x07	Busy	Output 2
0x08	Follow corresponding input (Inp1→ Out1, Inp2 → Out2)	
0x09..0x0F	Reserved	
0x10..0x1F	Reserved	

Table 39: Output routing

PinState 0 switches off the output transistor and produces a low level over the resistor connected from the output to ground.

The following diagram illustrates the dependencies of the various output signals.

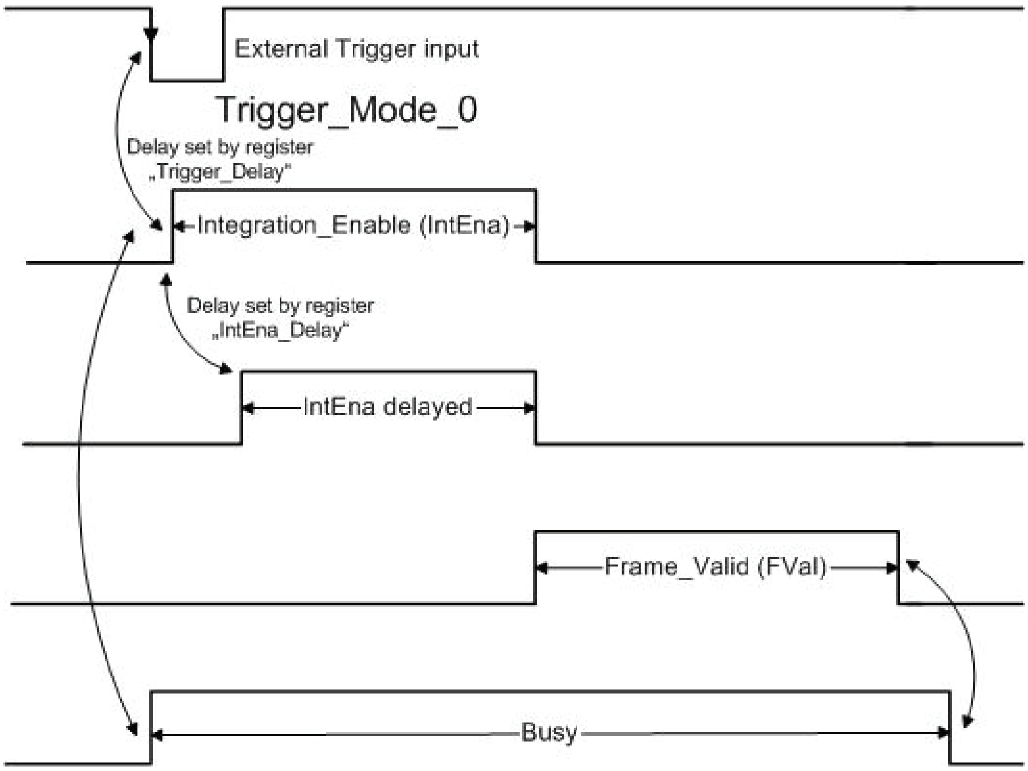


Figure 48: Output impulse diagram

Note

The signals can be inverted.

Caution

Firing a new trigger while **IntEna** is still active can result in **missing image.**

Note	
	• Note that **trigger delay** in fact delays the image capture whereas the **IntEna_Delay** only delays the leading edge of the IntEna output signal but does not delay the image capture. • As mentioned before, it is possible to set the outputs by software. Doing so, the achievable maximum frequency is strongly dependent on individual software capabilities. As a rule of thumb, the camera itself will limit the toggle frequency to not more than 700 Hz.

Pixel data

Pixel data are transmitted as isochronous data packets in accordance with the 1394 interface described in IIDC V1.31. The first packet of a frame is identified by the **1** in the **sync bit** (sy) of the packet header.

sync bit

<table>
<tr><td>0-7</td><td>8-15</td><td colspan="2">16-23</td><td colspan="2">24-31</td></tr>
<tr><td colspan="2">data_length</td><td>tg</td><td>channel</td><td>tCode</td><td>sy</td></tr>
<tr><td colspan="6">header_CRC</td></tr>
<tr><td colspan="6">Video data payload</td></tr>
<tr><td colspan="6">data_CRC</td></tr>
</table>

Table 40: Isochronous data block packet format. Source: IIDC V1.31

Field	**Description**
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

Table 41: Description of Data Block Packet Format

Field	Description
sy	**Synchronization value (sync bit)** This is one single bit. It indicates the start of a new frame. It shall be set to 0001h on the first isochronous data block of a frame, and shall be set to zero on all other isochronous blocks
Video data payload	Shall contain the digital video information

Table 41: Description of Data Block Packet Format

The video data for each pixel are output in either 8-bit or 14-bit format. Each pixel has a range of 256 or 16384 shades of gray. The digital value 0 is black and 255 or 16383 is white. In 16-bit mode the data output is MSB aligned.

The following table provides a description of the video data format for the different modes. (Source: IIDC V1.31)

<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)	Y-(K+6)	Y-(K+7)
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)

Figure 49: YUV 4:2:2 and YUV 4:1:1 format: Source: IIDC V1.31 specification

<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)	Y-(K+Pn-3)	Y-(K+Pn-2)	Y-(K+Pn-1)

< Y (Mono16) 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)
Y-(K+Pn-2)	Y-(K+Pn-1)

Figure 50: Y8 and Y16 format: Source: IIDC V1.31 specification

<Y, R, G, B>

Each component has 8bit 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 8bit 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
Highest (-)	-128	0x00

< Y(Mono16) >

Y component has 16bit 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

Figure 51: Data structure: Source: IIDC V1.31 specification

Description of the data path

Block diagrams of the cameras

The following diagrams illustrate the data flow and the bit resolution of image data after being read from the CCD sensor chip in the camera. The individual blocks are described in more detail in the following paragraphs.

Black and white cameras

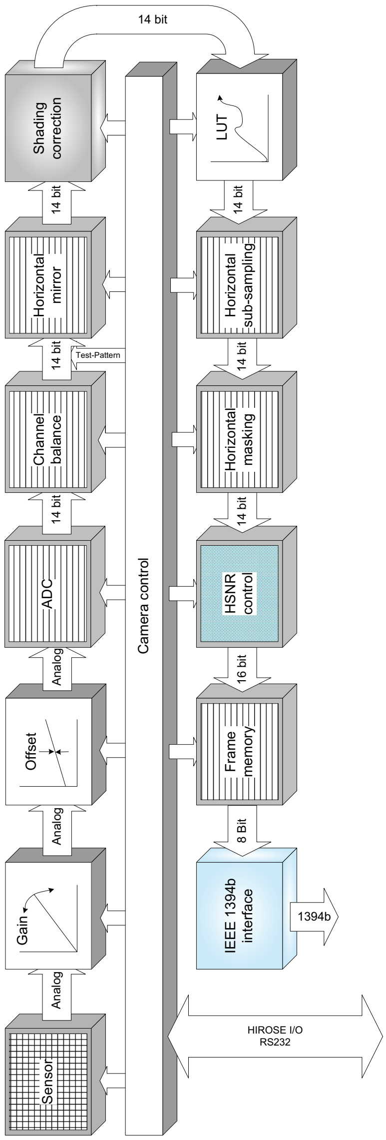


Figure 52: Block diagram b/w camera

Color cameras

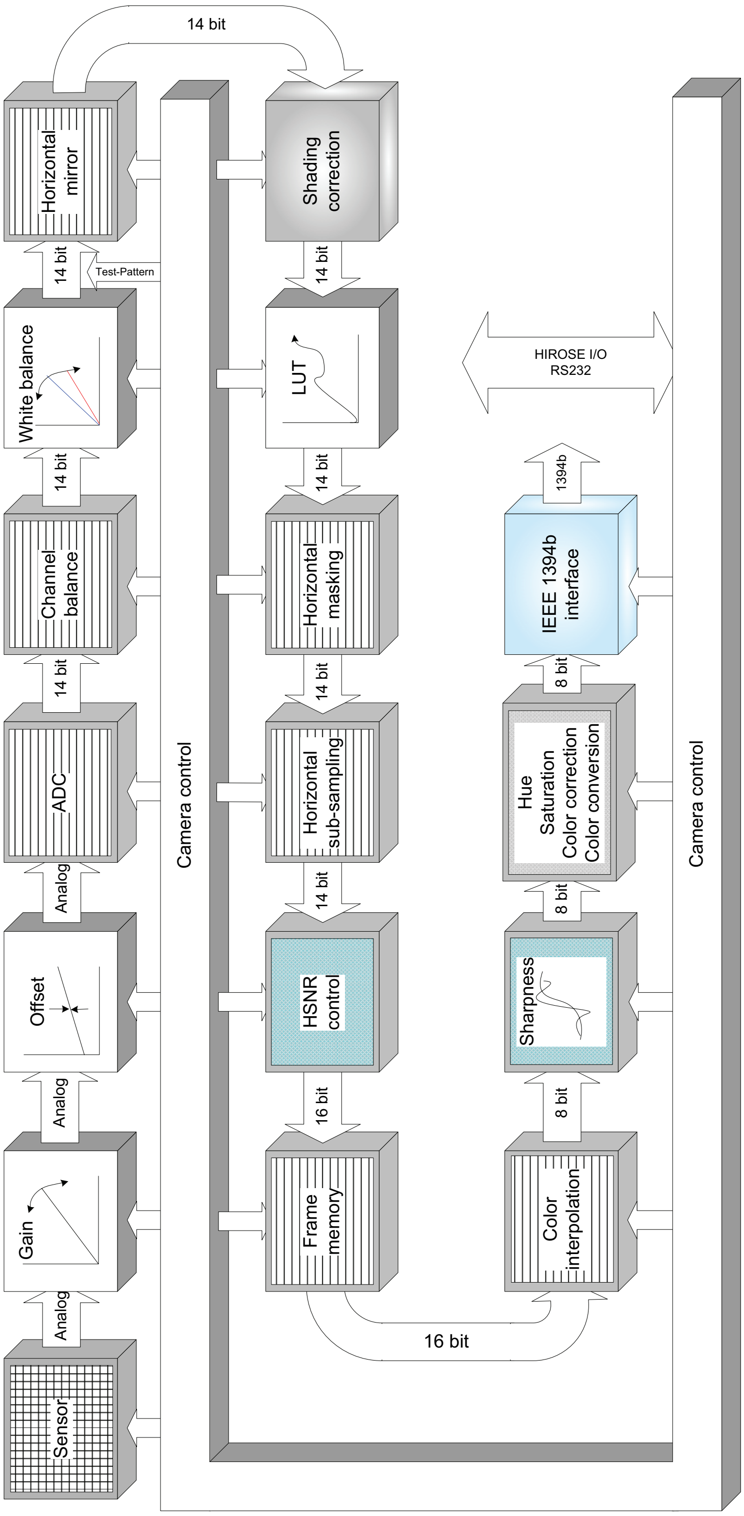


Figure 53: Block diagram color camera

Sensor

The PIKE family is equipped with various sensor types and resolutions. CCD types are available in color and monochrome.

The following table provides an overview (all models also with fiber):

Model	Techn	Manu-facturer	Sensor Type	Optical Format	Sensor diag.	Micro-lens	Chip Size [mm]	Pixel Size [µm]	Eff. Pixels
PIKE F-032B PIKE F-032C	CCD	KODAK	KAI-340	type 1/3	6 mm	Yes	4.74x3.55	7.4x7.4	648x488
PIKE F-100B PIKE F-100C	CCD	KODAK	KAI-1020	type 2/3	10.5 mm	Yes	7.4x7.4	7.4x7.4	1000x1000
PIKE F-145B PIKE F-145C	CCD	SONY	ICX285	type 2/3	11.2 mm	Yes EXview HAD	10.2x8.3	6.45 x 6.45	1392x1040
PIKE F-210B PIKE F-210C	CCD	KODAK	KAI-2093	type 1	15.3 mm	Yes	15.9x8.6	7.4x7.4	1928x1084
PIKE F-421B PIKE F-421C	CCD	KODAK	KAI-4021	type 1.2	21.4 mm	Yes	16.67x16.05	7.4x7.4	2056x2062

Table 42: Sensor data

Channel balance

All KODAK PIKE sensors are read out via two channels: the first channel for the left half of the image and the second channel for the right half of the image (divided by a central vertical line).

All KODAK equipped cameras come with a sensor-specific pre-adjusted channel balance.

However in some cases it may be advantageous to carry out a fine adjustment with the so-called channel balance.

To carry out an adjustment in an advanced register: see Table 130: Channel balance register on page 241.

Channel adjustment with SmartView 1.5

Prerequisites:

- Test sheet with continuous b/w gradient
- PIKE camera with defocused lens
- PIKE color cameras set to RAW8 and RAW16

- In case of using AOI, be aware that the middle vertical line (+/- 20 pixel) is part of the AOI.

To carry out an adjustment in SmartView, perform the following steps:

1. In SmartView click **Extras** → **Adjust channels...** or use **Alt+Ctrl+A**.

   The following window opens:

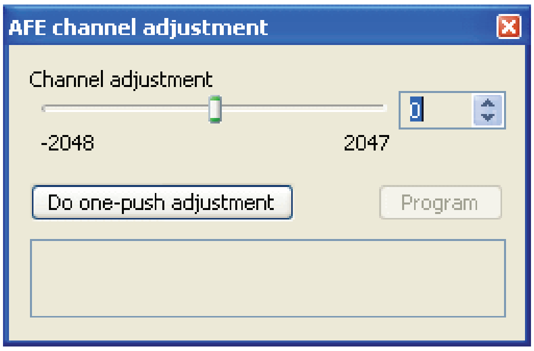


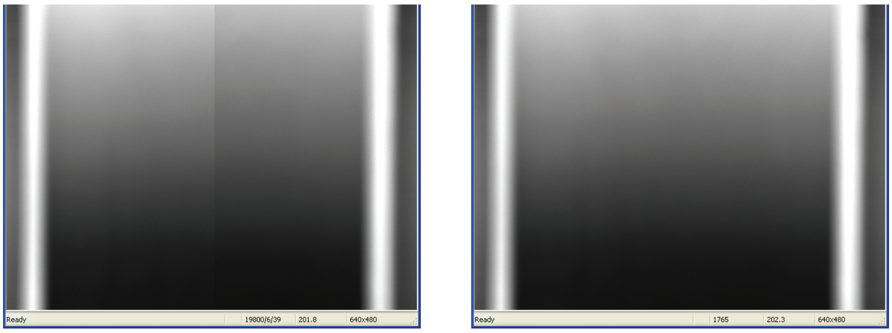
Figure 54: SmartView: channel adjustment

Note

Program button is only available for AVT factory.

2. To perform an automatic channel adjustment, click on **Do one-push adjustment**.
3. If the adjustment is not sufficient, repeat this step or adjust by clicking the arrow buttons.

The two channels are automatically adjusted. For the channel adjustment a region from +/- 20 pixel around the middle vertical is taken into account.



before after

Figure 55: Example of channel adjustment: PIKE F-032B

White balance

PIKE color cameras have both manual and automatic white balance. White balance is applied so that non-colored image parts are displayed non-colored. From the user's point, the white balance settings are made in register 80Ch of IIDC V1.31. This register is described in more detail below.

Register	Name	Field	Bit	Description
0xF0F0080C	WHITE_BALANCE	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the **Value** field 1: Control with value in the **Absolute** value CSR If this bit=1, the value in the **Value** field will be ignored.
		-	[2..4]	Reserved
		One_Push	[5]	Write 1: begin to work (self-cleared after operation) Read: 1: in operation 0: not in operation If A_M_Mode = 1, this bit will be ignored.
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF 1: ON
		A_M_MODE	[7]	Write: set mode Read: read current mode 0: MANUAL 1: AUTO
		U/B_Value	[8..19]	U/B value This field is ignored when writing the value in Auto or OFF mode. If readout capability is not available, reading this field has no meaning.
		V/R_Value	[20..31]	V/R Value This field is ignored when writing the value in Auto or OFF mode. If readout capability is not available, reading this field has no meaning.

Table 43: White balance register

The values in the U/B_Value field produce changes from green to blue; the V/R_Value field from green to red as illustrated below.

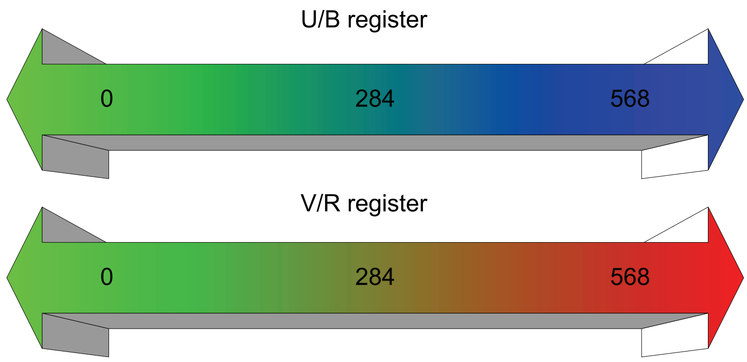


Figure 56: U/V slider range

Type	Range	Range in dB
PIKE color cameras	0 ... 568	± 10 dB

Table 44: Manual gain range of the various PIKE types

The increment length is ~0.0353 dB/step.

One-push automatic white balance

To configure this feature in control and status register (CSR): See Table 43: White balance register on page 105.

The camera automatically generates frames, based on the current settings of all registers (GAIN, OFFSET, SHUTTER, etc.).

For white balance, in total 9 frames are processed. For the white balance algorithm the whole image or a subset of it is used. The R-G-B component values of the samples are added and are used as actual values for both the one-push and the automatic white balance.

This feature uses the assumption that the R-G-B component sums of the samples shall be equal; i.e., it assumes that the average of the sampled grid pixels is to be monochrome.

Note

The following ancillary conditions should be observed for successful white balance:

- There are no stringent or special requirements on the image content, it requires only the presence of monochrome pixels in the image.
- Automatic white balance can be started both during active image capture and when the camera is in idle state.

If the image capture is active (e.g. **IsoEnable** set in register 614h), the frames used by the camera for white balance are also output on the 1394 bus. Any previously active image capture is restarted after the completion of white balance.

Automatic white balance can also be enabled by using an external trigger. However, if there is a pause of >10 seconds between capturing individual frames this process is aborted.

The following flow diagram illustrates the automatic white balance sequence.

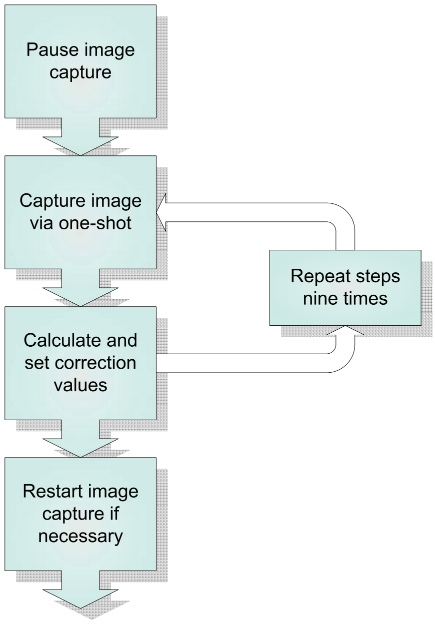


Figure 57: Automatic white balance sequence

Finally, the calculated correction values can be read from the WHITE_BALANCE register 80Ch.

Automatic white balance

The auto white balance feature continuously optimizes the color characteristics of the image.

For the white balance algorithm the whole image or a subset of it is used.

To set position and size of the control area (Auto_Function_AOI) in an advanced register: see Table 126: Advanced register for autofunction AOI on page 238.

AUTOFNC_AOI affects the auto shutter, auto gain and auto white balance features and is independent of the Format7 AOI settings. If this feature is switched off the work area position and size follow the current active image size.

Within this area, the R-G-B component values of the samples are added and used as actual values for the feedback.

The following drawing illustrates the AUTOFNC_AOI settings in greater detail.

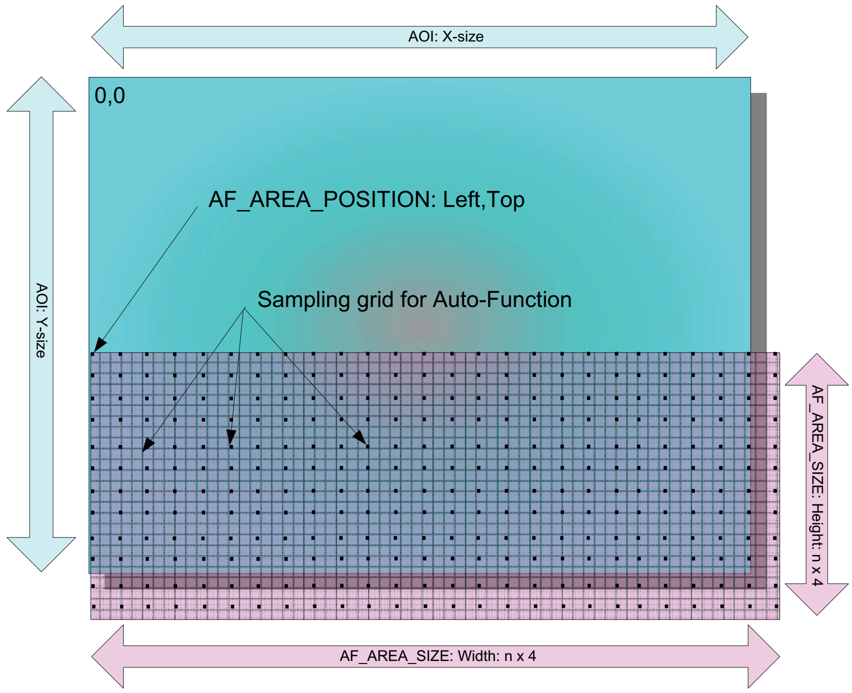


Figure 58: AUTOFNC_AOI positioning

The algorithm is based on the assumption that the R-G-B component sums of the samples are equal, i.e., it assumes that the mean of the sampled grid pixels is to be monochrome.

Auto shutter

In combination with auto white balance, PIKE cameras are equipped with auto-shutter feature.

When enabled, the auto shutter adjusts the shutter within the default shutter limits or within those set in advanced register F1000360h in order to reach the reference brightness set in auto exposure register. **Target grey level** parameter in SmartView corresponds to **Auto_exposure** register 0xF0F00804 (IIDC). Increasing the auto exposure value increases the average brightness in the image and vice versa.

The applied algorithm uses a proportional plus integral controller (PI controller) to achieve minimum delay with zero overshot.

To configure this feature in control and status register (CSR):

Register	Name	Field	Bit	Description
0xF0F0081C	SHUTTER	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the **Value** field 1: Control with value in the **Absolute** value CSR If this bit=1, the value in the **Value** field will be ignored.
		-	[2..4]	Reserved
		One_Push	[5]	Write 1: begin to work (self-cleared after operation) Read: 1: in operation 0: not in operation If A_M_Mode = 1, this bit will be ignored.
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF 1: ON
		A_M_MODE	[7]	Write: set mode Read: read current mode 0: MANUAL 1: AUTO
		-	[8..19]	reserved

Table 45: Shutter CSR

To configure **auto shutter control** in an advanced register: See Table 124: Auto shutter control advanced register on page 236.

Auto gain

All PIKE cameras are equipped with auto gain feature.

To configure this feature in an advanced register: See Table 125: Advanced register for auto gain control on page 237.

When enabled auto gain adjusts the gain within the default gain limits or within the limits set in advanced register F1000370h in order to reach the brightness set in auto exposure register as reference.

Increasing the auto exposure value increases the average brightness in the image and vice versa.

The applied algorithm uses a proportional plus integral controller (PI controller) to achieve minimum delay with zero overshot.

The following table shows both the gain and auto exposure CSR.

Register	Name	Field	Bit	Description
0xF0F00820	GAIN	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the value field 1: Control with value in the absolute value CSR If this bit=1 the value in the value field has to be ignored.
		-	[2..4]	Reserved
		One_Push	[5]	Write: Set bit high to start Read: Status of the feature: Bit high: WIP Bit low: Ready
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF 1: ON
		A_M_MODE	[7]	Write: set mode Read: read current mode 0: MANUAL 1: AUTO
		-	[8..19]	reserved
		Value	[20..31]	Read/Write Value This field is ignored when writing the value in Auto or OFF mode. If readout capability is not available, reading this field has no meaning.

Table 46: Gain

Register	Name	Field	Bit	Description
0xF0F00804	AUTO_EXPOSURE	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the value field 1: Control with value in the absolute value CSR If this bit=1 the value in the value field has to be ignored.
		-	[2..4]	Reserved
		One_Push	[5]	Write: Set bit high to star Read: Status of the feature: Bit high: WIP Bit low: Ready
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF 1: ON
		A_M_MODE	[7]	Write: set mode Read: read current mode 0: MANUAL 1: AUTO
		-	[8..19]	Reserved
		Value	[20..31]	Read/Write Value This field is ignored when writing the value in Auto or OFF mode. If readout capability is not available, reading this field has no meaning.

Table 47: Auto Exposure CSR

To configure auto gain control in an advanced register: See Table 125: Advanced register for auto gain control on page 237.

Note

- Values can only be changed within the limits of gain CSR.
- Changes in auto exposure register only have an effect when auto gain is active.
- Auto exposure limits are 50..205. (**SmartView→Ctrl1 tab: Target grey level**)

Manual gain

PIKE cameras are equipped with a gain setting, allowing the gain to be **manually** adjusted on the fly by means of a simple command register write.

The following ranges can be used when manually setting the gain for the analog video signal:

Type	Range	Range in dB
PIKE color cameras	0 … 565	0 … 20 dB
PIKE b/w cameras	1 … 630	0 … 22 dB
PIKE F-145B	0 … 900	0 … 32 dB
PIKE F-145C	0 … 900	0 … 32 dB

Table 48: Manual gain range of the various PIKE types

The increment length is ~0.0353 dB/step.

The increment length for the PIKE F-145B/C is ~0.0358 dB/step.

Note

- Setting the gain does not change the offset (black value)
- A higher gain produces greater image noise. This reduces image quality. For this reason, try first to increase the brightness, using the aperture of the camera optics and/or longer shutter settings.

Brightness (black level or offset)

It is possible to set the black level in the camera within the following ranges:

0 … +16 gray values (@ 8 bit)

Increments are in 1/16 LSB (@ 8 bit)

Note

- Setting the gain does not change the offset (black value).

The IIDC register brightness at offset 800h is used for this purpose.

The following table shows the BRIGHTNESS register.

Register	Name	Field	Bit	Description
0xF0F00800	BRIGHTNESS	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the value field 1: Control with value in the absolute value CSR If this bit= 1 the value in the value field has to be ignored
		-	[2..4]	Reserved
		One_Push	[5]	Write: Set bit high to start Read: Status of the feature: Bit high: WIP Bit low: Ready
		ON_OFF	[6]	Write ON or OFF this feature ON=1 Read: Status of the feature OFF=0
		A_M_MODE	[7]	Set bit high for Auto feature Read for Mode; 0= MANUAL; 1= AUTO
		-	[8..19]	Reserved
		Value	[20..31]	Read/Write Value; this field is ignored when writing the value in Auto or OFF mode; if readout capability is not available reading this field has no meaning

Table 49: Brightness

Horizontal mirror function

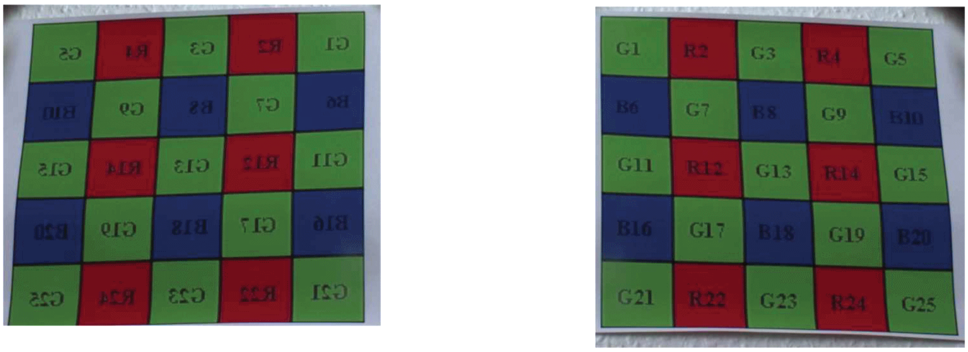
All PIKE cameras are equipped with an electronic mirror function, which mirrors pixels from the left side of the image to the right side and vice versa. The mirror is centered to the actual **FOV** center and can be combined with all image manipulation functions, like **binning**, **shading** and **DSNU**.

This function is especially useful when the camera is looking at objects with the help of a mirror or in certain microscopy applications.

To configure this feature in an advanced register: See Table 129: Mirror control register on page 241.

Note

The use of the mirror function with color cameras and image output in RAW format has implications on the BAYER-ordering of the colors.



Mirror OFF: R-G-G-B for Pike 145C

Mirror OFF: G-R-G-B for all other Pikes

Mirror ON: G-R-B-G Pike 145 C

Mirror ON: R-G-G-B for all other Pikes

Figure 59: Mirror and Bayer order

Note

During switchover one image may be temporarily corrupted.

Shading correction

Shading correction is used to compensate for non-homogeneities caused by lighting or optical characteristics within specified ranges.

To correct a frame, a multiplier from 1...2 is calculated for each pixel in 1/256 steps: this allows for shading to be compensated by up to 50%.

Besides generating shading data off-line and downloading it to the camera, the camera allows correction data to be generated automatically in the camera itself.

Note

- Shading correction does not support the mirror function.
- If you use shading correction, don't change the mirror function.
- Due to binning and sub-sampling in the Format_7 modes use only the modes from the following table to build the shading image.

If using the following mode...	... then build the shading image, using...
Format_7 Mode_0	Format_7 Mode_0
Format_7 Mode_1	Format_7 Mode_0
Format_7 Mode_2	Format_7 Mode_2
Format_7 Mode_3	Format_7 Mode_2
Format_7 Mode_4	Format_7 Mode_0
Format_7 Mode_5	Format_7 Mode_5
Format_7 Mode_6	Format_7 Mode_5

Table 50: Building shading image in Format_7 modes

There are two storing possibilities:

- After generating the shading image in the camera, it can be uploaded to the host computer for nonvolatile storage purposes.
- The shading image can be stored in the camera itself.

The following pictures describe the process of automatic generation of correction data (PIKE F-032C). Surface plots and histograms were created using the **ImageJ** program.

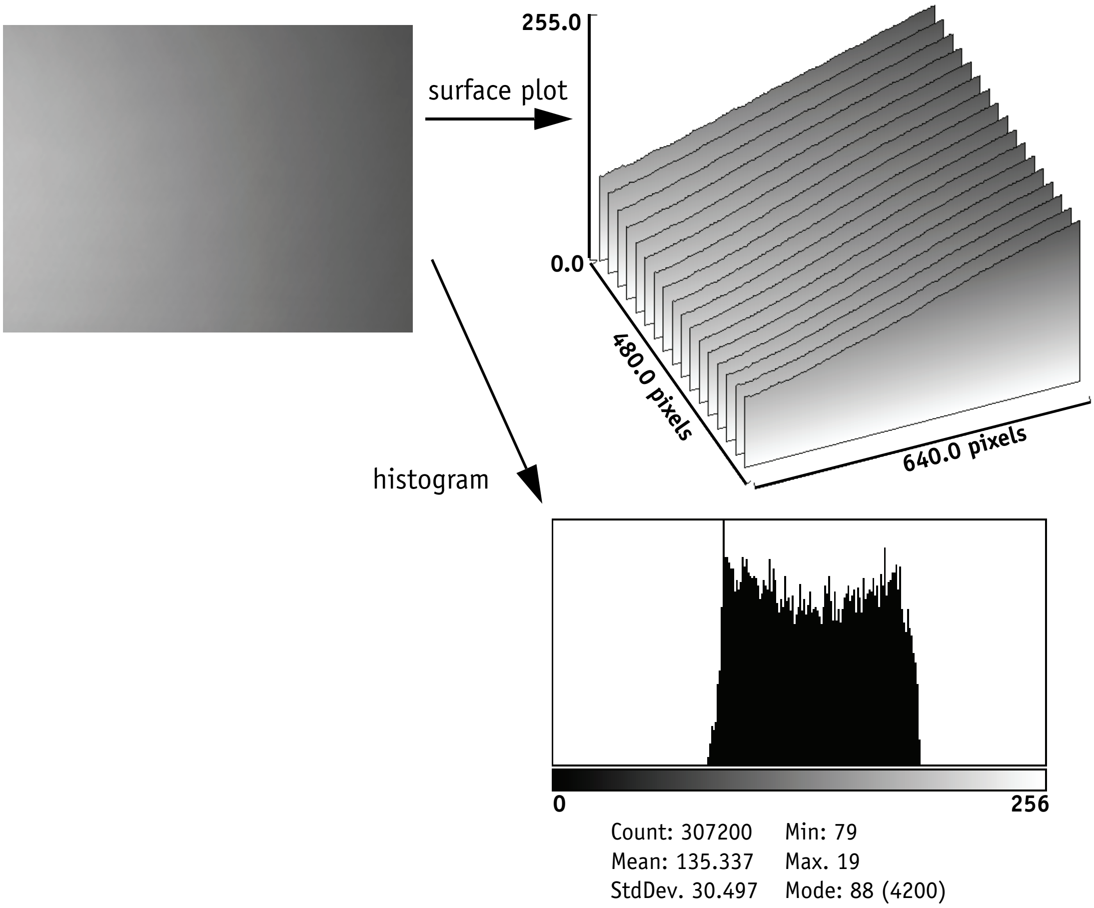


Figure 60: Shading correction: Source image with non-uniform illumination

- On the left you see the source image with non-uniform illumination.
- The surface plot on the right clearly shows a gradient of the brightness (0: brightest → 255: darkest pixels).
- The histogram shows a wide band of gray values.

By defocusing the lens, high-frequency image data is removed from the source image, therefore its not included in the shading image.

Automatic generation of correction data

Requirements

Shading correction compensates for non-homogeneities by giving all pixels the same gray value as the brightest pixel. This means that only the background must be visible and the brightest pixel has a gray value of less than 255 when automatic generation of shading data is started.

It may be necessary to use a neutral white reference, e.g. a piece of paper, instead of the real image.

Algorithm

After the start of automatic generation, the camera pulls in the number of frames set in the GRAB_COUNT register. Recommended values are 2, 4, 8, 16, 32, 64, 128 or 256. An arithmetic mean value is calculated from them (to reduce noise).

After this, a search is made for the brightest pixel in the mean value frame. The brightest pixel(s) remain unchanged. A factor is then calculated for each pixel to be multiplied by, giving it the gray value of the brightest pixel.

All of these multipliers are saved in a **shading reference image**. The time required for this process depends on the number of frames to be calculated and on the resolution of the image.

Correction alone can compensate for shading by up to 50% and relies on full resolution data to minimize the generation of missing codes.

How to proceed:

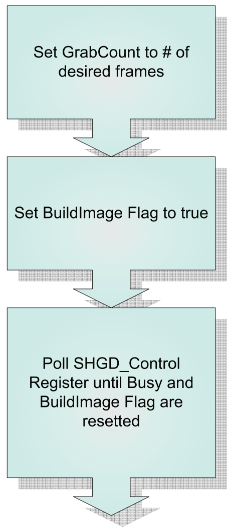


Figure 61: Automatic generation of a shading image

To configure this feature in an advanced register: See Table 119: Shading control register on page 230.

Note

- The SHDG_CTRL register should not be queried at very short intervals. This is because each query delays the generation of the shading image. An optimal interval time is 500 ms.

Note

- The calculation of shading data is always carried out at the current resolution setting. If the AOI is later larger than the window in which correction data was calculated, none of the pixels lying outside are corrected.
- For Format_7 mode, it is advisable to generate the shading image in the largest displayable frame format. This ensures that any smaller AOIs are completely covered by the shading correction.
- The automatic generation of shading data can also be enabled when image capture is already running. The camera then pauses the running image capture for the time needed for generation and resumes after generation is completed.
- Shading correction can be combined with the image mirror and gamma functionality.
- Changing binning modes involves the generation of new shading reference images due to a change in the image size.

After the lens has been focused again the image below will be seen, but now with a considerably more uniform gradient.

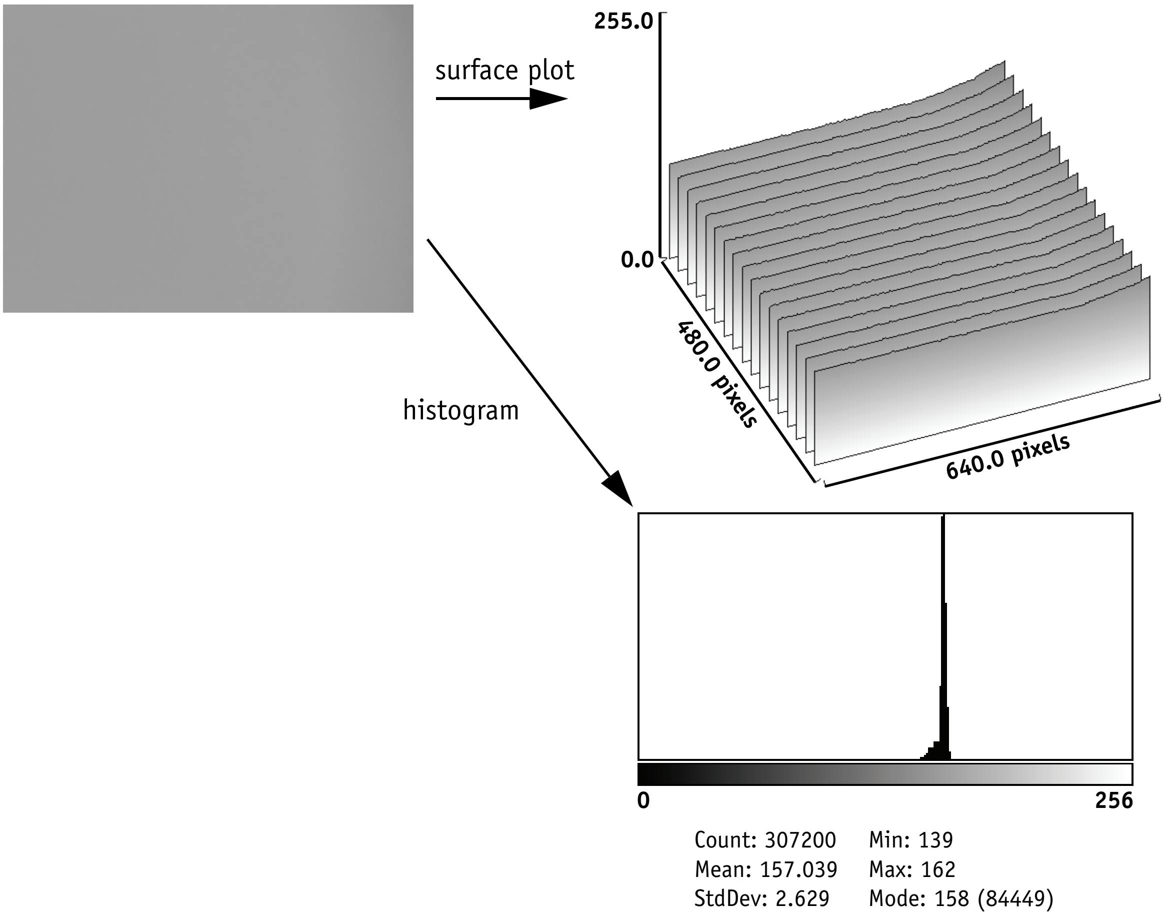


Figure 62: Example of shaded image

- On the left you see the image after shading correction.
- The surface plot on the right clearly shows nearly no more gradient of the brightness (0: brightest → 255: darkest pixels). The remaining gradient is related to the fact that the source image is lower than 50% on the right hand side.
- The histogram shows a peak with very few different gray values.

Loading a shading image out of the camera

GPDATA_BUFFER is used to load a shading image out of the camera. Because the size of a shading image is larger than GPDATA_BUFFER, input must be handled in several steps:

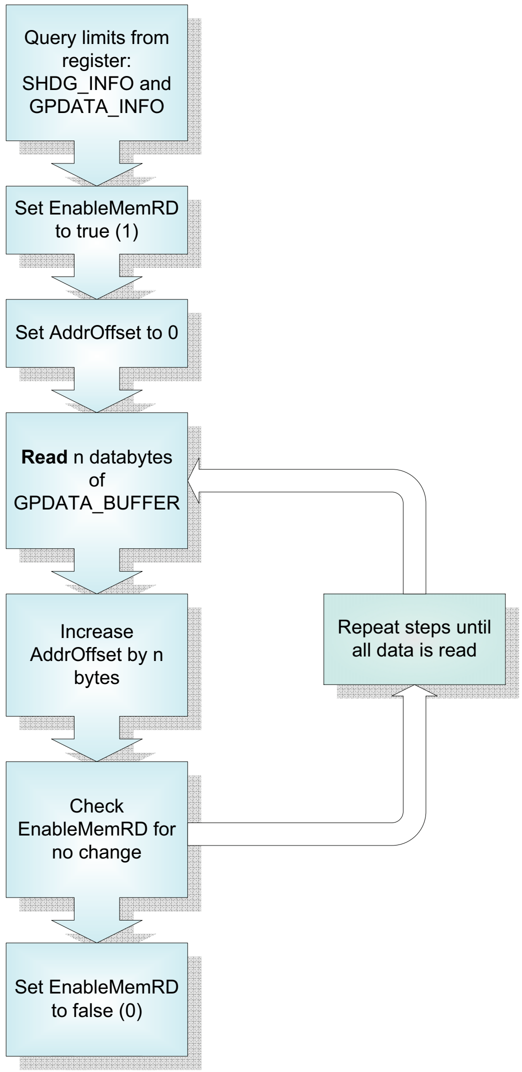


Figure 63: Uploading shading image to host

Loading a shading image into the camera

GPDATA_BUFFER is used to load a shading image into the camera. Because the size of a shading image is larger than GPDATA_BUFFER, input must be handled in several steps (see also Chapter Reading or writing shading image from/into the camera on page 231):

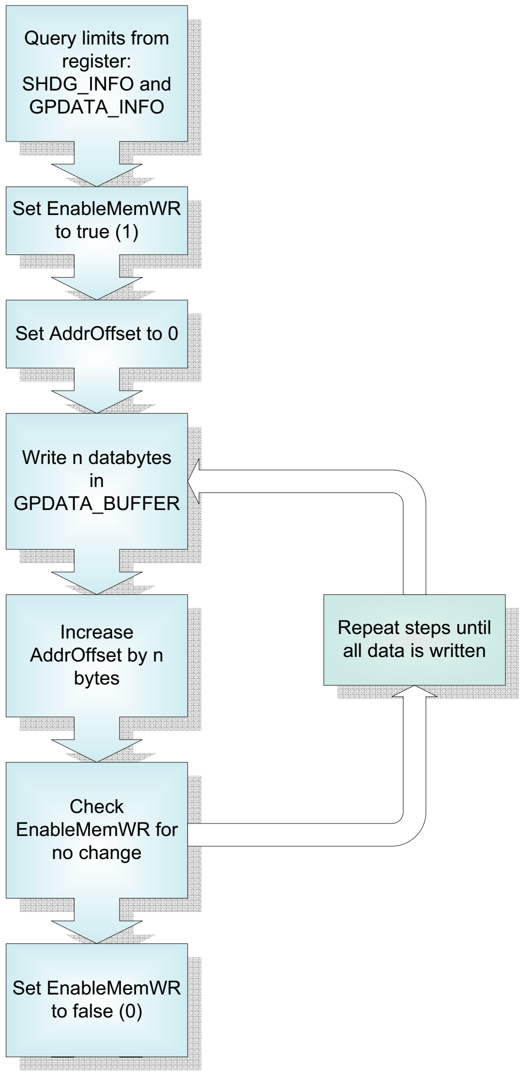


Figure 64: Loading the shading reference image

Look-up table (LUT) and gamma function

The AVT PIKE camera provides sixteen (0-15) user-defined look-up tables (LUT). The use of one LUT allows any function (in the form Output = F(Input)) to be stored in the camera's RAM and to be applied on the individual pixels of an image at run-time.

The address lines of the RAM are connected to the incoming digital data, these in turn point to the values of functions which are calculated offline, e.g. with a spreadsheet program.

This function needs to be loaded into the camera's RAM before use.

One example of using an LUT is the gamma LUT:

There are two gamma LUTs (gamma=0.7 and gamma=0.45)

Output = $(\text{Input})^{0.7}$ and Output = $(\text{Input})^{0.45}$

These two gamma LUTs are used with all PIKE models.

It is known as compensation for the nonlinear brightness response of many displays e.g. CRT monitors. The look-up table converts the incoming 14 bits from the digitizer to outgoing up to 14 bits.

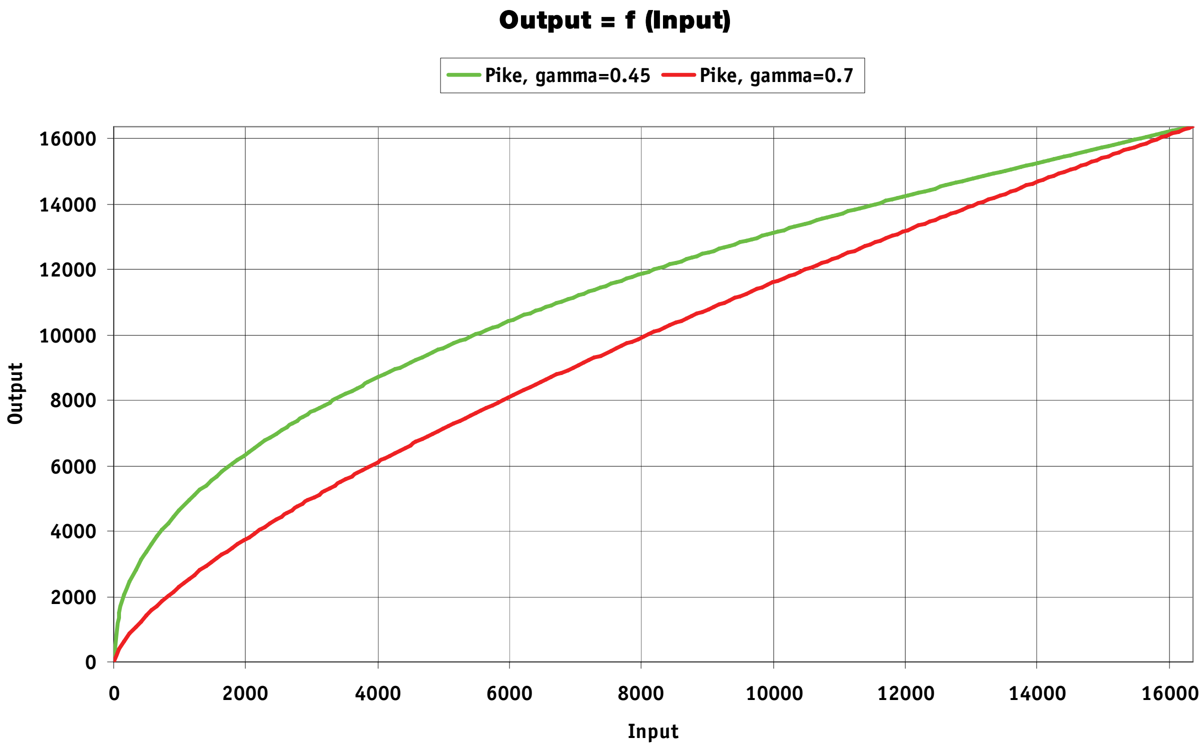


Figure 65: LUTs with gamma=0.45, gamma=0.7

Note

- The input value is the 14-bit value from the digitizer.
- The two gamma LUTs use LUT 14 and 15.
- Gamma 1 (gamma=0.7) switches on LUT 14, gamma 2 (gamma=0.45) switches on LUT 15. After overriding LUT 14 and 15 with a user defined content, gamma functionality is no longer available until the next full initialization of the camera.
- LUT content is volatile if you do not use the user profiles to save the LUT.

Loading an LUT into the camera

Loading the LUT is carried out through the data exchange buffer called GPDATA_BUFFER. As this buffer can hold a maximum of 2 kB, and a complete LUT at 16384 x 14 bit is 28 kByte, programming can not take place in a one block write step because the size of an LUT is larger than GPDATA_BUFFER. Therefore input must be handled in several steps. The flow diagram below shows the sequence required to load data into the camera.

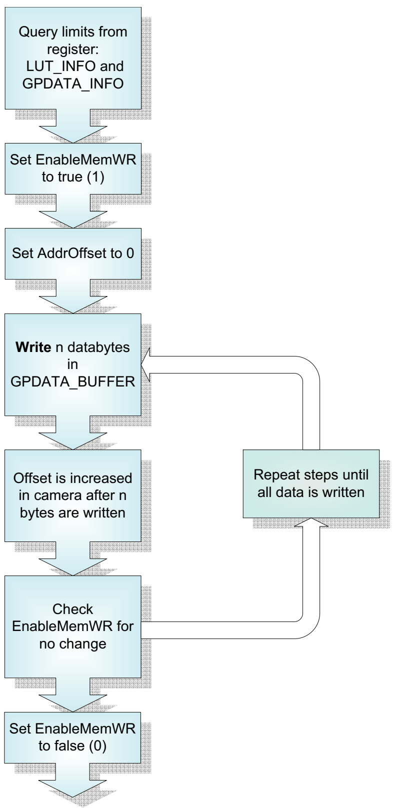


Figure 66: Loading an LUT

To configure this feature in an advanced register: See Table 118: LUT control register on page 227.

Binning (b/w models)

2 x 2 Binning

Binning is the process of combining neighboring pixels while being read out from the CCD chip.

PIKE b/w cameras have this feature.

Binning is used primarily for 3 reasons:

- a reduction in the number of pixels and thus the amount of data while retaining the original image area angle
- an increase in the frame rate (vertical binning only)
- a brighter image, also resulting in an improvement in the signal-to-noise ratio of the image

Signal-to-noise ratio (SNR) and **signal-to-noise separation** specify the quality of a signal with regard to its reproduction of intensities. The value signifies how high the ratio of noise is in regard to the maximum achievable signal intensity.

The higher this value, the better the signal quality. The unit of measurement used is generally known as the decibel (dB), a logarithmic power level. 6 dB is the signal level at approximately a factor of 2.

However, the advantages of increasing signal quality are accompanied by a reduction in resolution.

Binning is possible only in video Format_7. The type of binning used depends on the video mode.

Note

Changing binning modes involves the generation of new shading reference images due to a change in the image size.

In general, we distinguish between two types of binning — which can also be combined.

Vertical binning

Vertical binning increases the light sensitivity of the camera by a factor of two by adding together the values of two adjoining vertical pixels output as a single pixel. At the same time this normally improves signal-to-noise separation by about 3 dB.

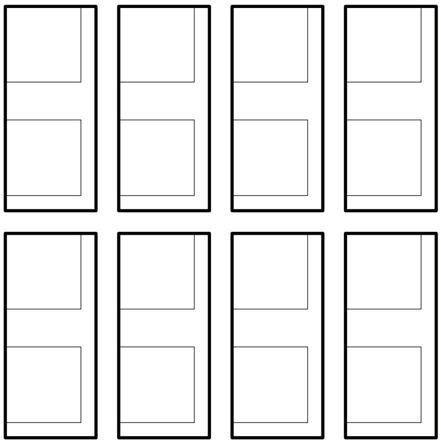


Figure 67: Vertical binning

This reduces vertical resolution, depending on the model.

Note

If **vertical binning** is activated the image may appear to be over-exposed and may require correction.

Use **Format_7 Mode_2** to activate vertical binning.

Note

The image appears **vertically** compressed in this mode and no longer exhibits a true aspect ratio.

Horizontal binning

In horizontal binning adjacent horizontal pixels in a line are combined in pairs.

This means that in horizontal binning the light sensitivity of the camera is also increased by a factor of two (6 dB). Signal-to-noise separation improves by approx. 3 dB. Horizontal resolution is lowered, depending on the model.

Use **Format_7 Mode_1** to activate horizontal binning.

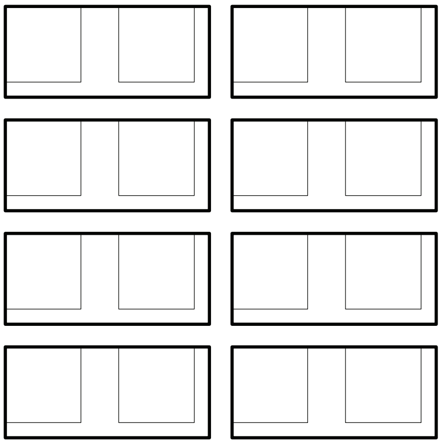


Figure 68: Horizontal binning

Note

The image appears **horizontally** compressed in this mode and does no longer show true aspect ratio.

If **horizontal binning** is activated the image may appear to be over-exposed and must eventually be corrected.

Full binning

If horizontal and vertical binning are combined, every 4 pixels are consolidated into a single pixel. At first two horizontal pixels are put together and then combined vertically.

This increases light sensitivity by a total of a factor of 4 and at the same time signal-to-noise separation is improved by about 6 dB. Resolution is reduced, depending on the model.

Use **Format_7 Mode_3** to activate full binning.

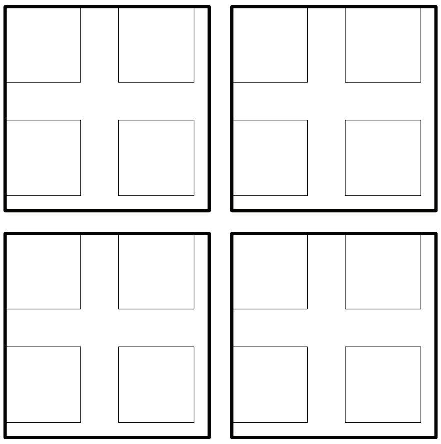


Figure 69: Full binning

Sub-sampling

Sub-sampling is the process of skipping neighboring pixels (with the same color) while being read out from the CCD chip.

All PIKE models, both color and b/w, have this feature.

Sub-sampling is used primarily for 2 reasons:

- A reduction in the number of pixels and thus the amount of data while retaining the original image area angle and image brightness

Similar to binning mode the cameras support horizontal, vertical and h+v sub-sampling mode.

Use **Format_7 Mode_4** to activate horizontal sub-sampling. The different sub-sampling patterns are shown below.

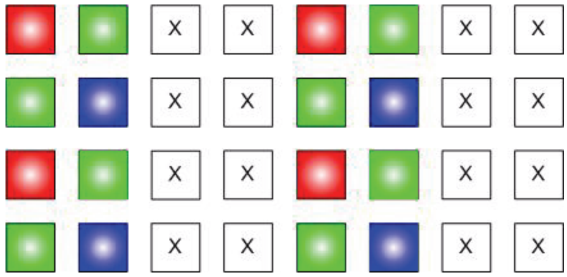


Figure 70: Horizontal sub-sampling (b/w and color)

Note

The image appears horizontally compressed in this mode and no longer exhibits a true aspect ratio.

Use **Format_7 Mode_5** to activate vertical sub-sampling.

The different sub-sampling patterns are shown below.

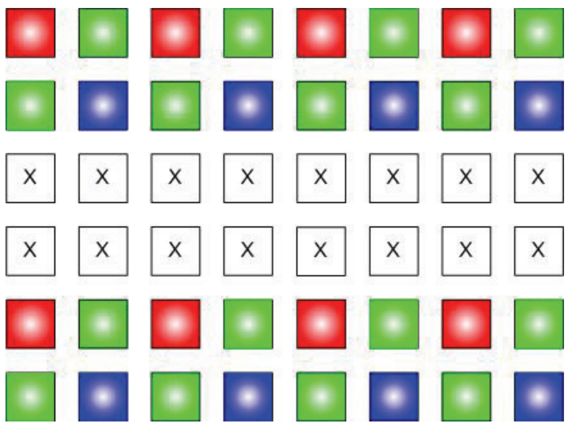


Figure 71: Vertical sub-sampling: (b/w and color)

Note

The image appears vertically compressed in this mode and no longer exhibits a true aspect ratio.

Use **Format_7 Mode_6** to activate h+v sub-sampling.

The different sub-sampling patterns are shown below.

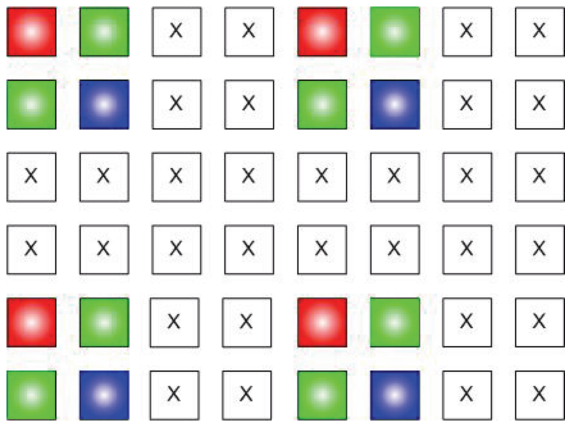


Figure 72: H+V sub-sampling: (b/w and color)

Note

Changing sub-sampling modes involves the generation of new shading reference images due to a change in the image size.

High SNR mode (High Signal Noise Ratio)

To configure this feature in an advanced register: See Table 132: High Signal Noise Ratio (HSNR) on page 242.

In this mode the camera grabs and averages a set number of images and outputs one image with the same bit depth and the same brightness. This means that the camera will output an 8-bit averaged image when an 8-bit image format is selected.

Because of the fact that normally uncorrelated (photon-, amplifier-) noise dominates over correlated noise (fixed pattern noise), adding two images will double (6 dB) the gray levels but only increase the noise levels by $\sqrt{2}$ (3 dB).

This enhances both the dynamic range as well as the signal-to-noise ratio.

Consequently adding 256 8-bit images will lead to a potential signal-to-noise enhancement of 24 dB or a resulting bit depth of 16 bit.

Note

- The averaged image is output at a lower frame rate being exactly the fraction: frame rate/number of images.
- The camera must be in idle before turning this feature on.
- The potential SNR enhancement may be lower when using more than 8-bit original bit depth.
- Select 16-bit image format in order to take advantage of the full potential SNR and DNR (**D**y**N**amic **R**ange) enhancements.

Frame memory and deferred image transport

An image is normally captured and transported in consecutive steps. The image is taken, read out from the sensor, digitized and sent over the 1394 bus.

Deferred image transport

As all PIKE cameras are equipped with built-in image memory, this order of events can be paused or delayed by using the **deferred image transport** feature.

PIKE cameras are equipped with 64 MB of RAM. The table below shows how many frames can be stored by each model. The memory operates according to the FIFO (first in, first out) principle. This makes addressing for individual images unnecessary.

Model	Memory size
PIKE F-032B/C PIKE F-032B/C fiber	105 frames
PIKE F-100B/C PIKE F-100B/C fiber	32 frames
PIKE F-145B/C PIKE F-145B/C fiber	22 frames
PIKE F-210B/C PIKE F-210B/C fiber	15 frames
PIKE F-421B/C PIKE F-421B/C fiber	6 frames

Table 51: FIFO memory size

Deferred image transport is especially useful for multi-camera applications:

Assuming several cameras acquire images concurrently. These are stored in the built-in image memory of every camera. Until this memory is full, the limiting factor of available bus bandwidth, DMA- or ISO-channel is overcome.

Image transfer is controlled from the host computer by addressing individual cameras one after the other and reading out the desired number of images.

To configure this feature in an advanced register: See Table 121: Deferred image configuration register on page 233.

HoldImg mode

By setting the **HoldImg** flag, transport of the image over the 1394 bus is stopped completely. All captured images are stored in the internal **ImageFiFo**. The camera reports the maximum possible number of images in the **FiFoSize** variable.

Note

- Pay attention to the maximum number of images that can be stored in **FiFo**. If you capture more images than the number in **FiFoSize**, the oldest images are overwritten.
- The extra **SendImage** flag is set to **true** to import the images from the camera. The camera sends the number of images set in the **NumOfImages** parameter.
- If **NumOfImages** is **0,** all images stored in FIFO will be sent.
- If **NumOfImages** is not **0**, the corresponding number of images will be sent.
- If the **HoldImg** field is set to **false**, all images in **ImageFIFO** will be deleted. No images will be sent.
- The last image in the FiFo will be corrupted, when simultaneously used as input buffer while being read out. In this case read out one image less than max. buffer size.
- **NumOfImages** is incremented after an image was read out of the sensor and therefore stored into the onboard image FIFO.
- **NumOfImages** is decremented after the last isochronous packet of an image was handed over to the IEEE1394 chipset of the camera.

The following screenshot shows the sequence of commands needed to work with deferred mode.

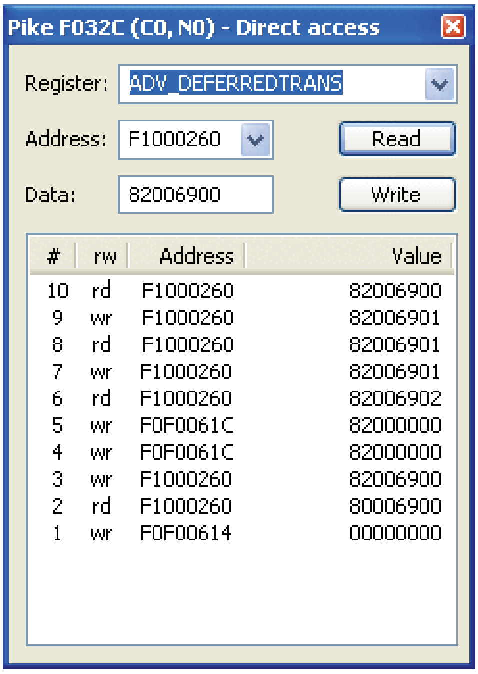


Figure 73: Example: Controlling deferred mode (SmartView - Direct Access; PIKE F-032C)

For a description of the commands see the following table:

#	rw	Address	Value	Description
10	rd	F1000260	82006900h	Check how many images are left in FiFo
9	wr	F1000260	86006901h	Read out the second image of FiFo
8	rd	F1000260	82006901h	Check how many images are left in FiFo
7	wr	F1000260	86006901h	Read out the first image of FiFo
6	rd	F1000260	82006902h	Check that two images are in FiFo
5	wr	F0F0061C	82000000h	Do second one-shot
4	wr	F0F0061C	82000000h	Do first one-shot
3	wr	F1000260	82006900h	Switch deferred mode on
2	rd	F1000260	80006900h	Check pres. of deferred mode and FiFo size (69h → 105 frames)
1	wr	F0F00614	00000000h	Stop continuous mode of camera

Table 52: Example: Controlling deferred mode (SmartView - Direct Access; PIKE F-032C)

FastCapture mode

Note This mode can be activated only in Format_7.

By setting **FastCapture** to **false**, the maximum frame rate both for image acquisition and read out is associated with the packet size set in the BYTE_PER_PACKET register. The lower this value is, the lower the attainable frame rate is.

By setting **FastCapture** to **true**, all images are recorded at the highest possible frame rate, i.e. the setting above does not affect the frame rate for the image intake but only the read out. The speed of the image transport over the 1394 bus can be defined via the **BytesPerPacket** register. This mode is ideal for applications where a burst of images need to be recorded at the highest sensor speed but the output can be at a lower frame frequency to save bandwidth.

Similar to the HoldImg mode, captured images will be stored in the internal image FIFO, if the transport over the 1394 bus is slower than images are captured.

Color interpolation (BAYER demosaicing)

The color sensors capture the color information via so called primary color (R-G-B) filters placed over the individual pixels in a **BAYER mosaic** layout. An effective BAYER → RGB color interpolation already takes place in all PIKE color version cameras.

In color interpolation a red, green or blue value is determined for each pixel. An AVT proprietary BAYER demosaicing algorithm is used for this interpolation (max. 3x3), optimized for both sharpness of contours as well as reduction of false edge coloring.

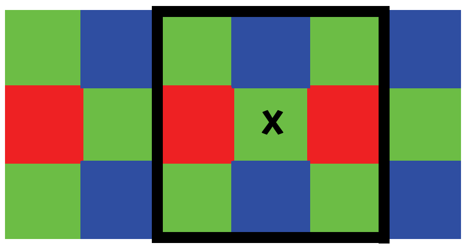


Figure 74: Bayer demosaicing (example of 3x3 matrix)

Color processing can be bypassed by using so-called RAW image transfer.

RAW-mode is primarily used to

- save bandwidths on the IEEE 1394 bus
- achieve higher frame rates
- use different BAYER demosaicing algorithms on the PC (for Pike F-145 the first pixel of the sensor is RED, for all other Pikes the first pixel is GREEN followed by RED).

Note

If the PC does not perform BAYER to RGB post-processing, the b/w image will be superimposed with a checkerboard pattern.

Sharpness

The PIKE color models are equipped with a two step sharpness control, applying a discreet horizontal high pass in the Y channel as shown in the next three line profiles.

Sharpness 0, 1 and 2 is calculated with the following scheme:

Sharpness value			
0	0	1	0
1	-0.25	+1.5	-0.25
2	-0.5	2	-0.5

Table 53: Sharpness scheme

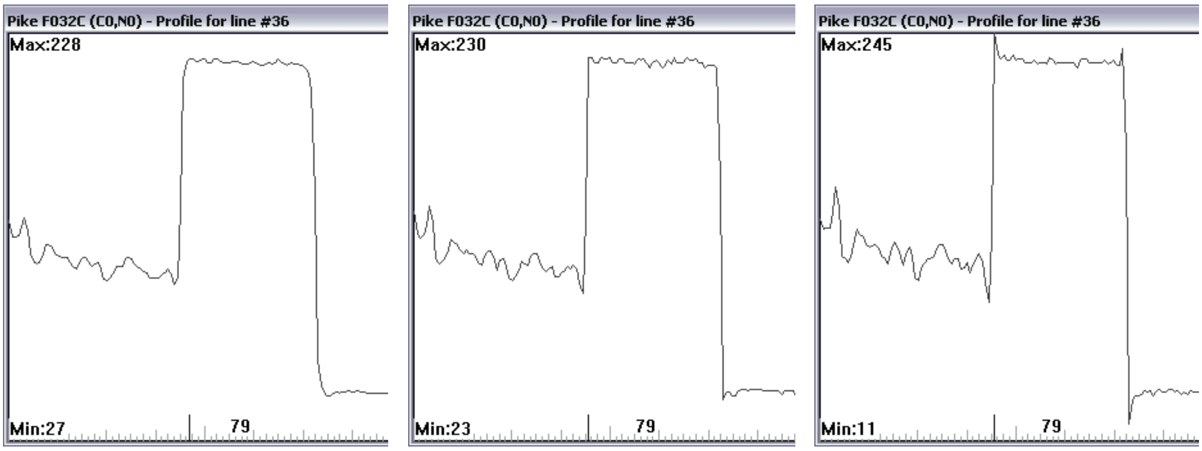


Figure 75: Sharpness: left: 0, middle: 1, right: 2

Note

Sharpness does not show any effect on PIKE color models in the Raw8 and Raw16 format, because color processing is put off in all Raw formats.

To configure this feature in feature control register: See Table 105: Feature control register on page 213.

Hue and saturation

PIKE CCD color models are equipped with hue and saturation registers.

The hue register at offset 810h allows the color of objects to be changed without altering the white balance, by +/- 40 steps (+/- 10°) from the nominal perception. Use this setting to manipulate the color appearance after having carried out the white balance.

The saturation register at offset 814h allows the intensity of the colors to be changed between 0 and 200% in steps of 1/256.

This means a setting of zero changes the image to black and white and a setting of 511 doubles the color intensity compared to the nominal one at 256.

To configure this feature in feature control register: See Table 105: Feature control register on page 213.

Note

Hue and saturation do not show any effect on PIKE color models in the Raw8 and Raw16 format, because color processing is switched off in all Raw formats.

Color correction

Before converting to the YUV format, color correction on all color models is carried out after BAYER demosaicing via a matrix as follows:

$$\begin{aligned} red^* &= Crr \times red + Cgr \times green + Cbr \times blue \\ green^* &= Crg \times red + Cgg \times green + Cbg \times blue \\ blue^* &= Crb \times red + Cgb \times green + Cbb \times blue \end{aligned}$$

Formula 1: Color correction

GretagMacbeth ColorChecker

Sensor-specific coefficients C_{xy} are scientifically generated to ensure that GretagMacbeth™ ColorChecker®-colors are displayed with highest color fidelity and color balance.

These coefficients are stored in user set 0 and can not be overwritten (factory setting).

Color correction coefficients

You can change the color-correction coefficients according to your own needs. Changes are stored in the user settings.

Note

If you need technical assistance, call the AVT support.

Note

- A number of 1000 equals a color correction coefficient of 1.
- Color correction values range -1000..+2000 and are signed 32 bit.
- In order for white balance to work properly ensure that the row sum equals 1000.
- The maximum row sum is limited to 2000.

To configure the color correction coefficients in an advanced register: See Table 127: Color correction on page 239.

To change the color-correction coefficients in **SmartView**, go to **Adv3** tab.

Switch color correction on/off

Color correction can also be switched off in YUV mode:

To configure this feature in an advanced register: See Table 127: Color correction on page 239.

Note

Color correction is deactivated in RAW mode.

Color conversion (RGB → YUV)

The conversion from RGB to YUV is made using the following formulae:

$$
\begin{aligned}
Y &= 0.3 \times R + 0.59 \times G + 0.11 \times B \\
U &= -0.169 \times R - 0.33 \times G + 0.498 \times B + 128 \\
V &= 0.498 \times R - 0.420 \times G - 0.082 \times B + 128
\end{aligned}
$$

Formula 2: RGB to YUV conversion

Note

- As mentioned above: Color processing can be bypassed by using so-called RAW image transfer.
- RGB → YUV conversion can be bypassed by using RGB8 format and mode. This is advantageous for edge color definition but needs more bandwidth (300% instead of 200% relative to b/w or RAW consumption) for the transmission, so that the maximal frame frequency will drop.

Bulk Trigger

See Chapter Trigger modi on page 145 and the following pages.

Level Trigger

See Trigger Mode 1 in Chapter Trigger modi on page 145.

Serial interface

All PIKE cameras are equipped with the SIO (serial input/output) feature as described in IIDC V1.31. This means that the PIKE's serial interface can be used as a general RS232 interface.

Data written to a specific address in the IEEE 1394 address range will be sent through the serial interface. Incoming data of the serial interface is put in a camera buffer and can be polled via simple read commands from this buffer. Controlling registers enable the settings of baud rates and the check of buffer sizes and serial interface errors.

Note

- Hardware handshaking is not supported.
- Typical PC hardware does not usually support 230400 bps or more.

Base address for the function is: F0F02100h.

To configure this feature in access control register (CSR):

Offset	Name	Field	Bit	Description
000h	SERIAL_MODE_REG	Baud_Rate	[0..7]	Baud rate setting WR: Set baud rate RD: Read baud rate 0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps 7: 38400 bps 8: 57600 bps 9: 115200 bps 10: 230400 bps Other values reserved
		Char_Length	[8..15]	Character length setting WR: Set data length (7 or 8 bit) RD: Get data length 7: 7 bits 8: 8 bits Other values reserved
		Parity	[16..17]	Parity setting WR: Set parity RD: Get parity setting 0: None 1: Odd 2: Even
		Stop_Bit	[18..19]	Stop bits WR: Set stop bit RD: Get stop bit setting 0: 1 1: 1.5 2: 2
		-	[20..23]	Reserved
		Buffer_Size_Inq	[24..31]	Buffer Size (RD only) This field indicates the maximum size of receive/transmit data buffer. If this value=1, Buffer_Status_Control and SIO_Data_Register Char 1-3 should be ignored.

Table 54: Serial input/output control and status register (SIO CSR)

Offset	Name	Field	Bit	Description
0004h	SERIAL_CONTROL_REG	RE	[0]	Receive enable RD: Current status WR: 0: Disable 1: Enable
		TE	[1]	Transmit enable RD: Current status WR: 0: disable 1: Enable
		-	[2..7]	Reserved
	SERIAL_STATUS_REG	TDRD	[8]	Transmit data buffer ready Read only 0: not ready 1: ready
		-	[9]	Reserved
		RDRD	[10]	Receive data buffer ready Read only 0: not ready 1: ready
		-	[11]	Reserved
		ORER	[12]	Receive data buffer overrun error Read: current status WR: 0: no error (to clear status) 1: Ignored
		FER	[13]	Receive data framing error Read: current status WR: 0: no error (to clear status) 1: Ignored
		PER	[14]	Receive data parity error Read: current status WR: 0: no error (to clear status) 1: Ignored
		-	[15..31]	Reserved

Table 54: Serial input/output control and status register (SIO CSR)

Offset	Name	Field	Bit	Description
008h	RECEIVE_BUFFER_ STATUS_CONTRL	RBUF_ST	[0..7]	SIO receive buffer status RD: Number of bytes pending in receive buffer WR: Ignored
		RBUF_CNT	[8..15]	SIO receive buffer control RD: Number of bytes to be read from the receive FiFo WR: Number of bytes left for readout from the receive FiFo
		-	[16..31]	Reserved
00Ch	TRANSMIT_BUFFER_ STATUS_CONTRL	TBUF_ST	[0..7]	SIO output buffer status RD: Space left in TX buffer WR: Ignored
		TBUF_CNT	[8..15]	SIO output buffer control RD: Number of bytes written to transmit FiFo WR: Number of bytes to transmit
		-	[16..31]	Reserved
010h .. 0FFh		-		Reserved
100h	SIO_DATA_REGISTER	CHAR_0	[0..7]	Character_0 RD: Read character from receive buffer WR: Write character to transmit buffer
	SIO_DATA_REGISTER	CHAR_1	[8..15]	Character_1 RD: Read character from receive buffer+1 WR: Write character to transmit buffer+1
	SIO_DATA_REGISTER	CHAR_2	[16..23]	Character_2 RD: Read character from receive buffer+2 WR: Write character to transmit buffer+2
	SIO_DATA_REGISTER	CHAR_3	[24..31]	Character_3 RD: Read character from receive buffer+3 WR: Write character to transmit buffer+3
104h .. 1FFH	SIO_DATA_REGISTER_ ALIAS		[0..31]	Alias SIO_Data_Register area for block transfer

Table 54: Serial input/output control and status register (SIO CSR)

To read data:

1. Query RDRD flag (buffer ready?) and write the number of bytes the host wants to read to RBUF_CNT.
2. Read the number of bytes pending in the receive buffer RBUF_ST (more data in the buffer than the host wanted to read?) and the number of bytes left for reading from the receive FiFo in RBUF_CNT (host wanted to read more data than were in the buffer?).
3. Read received characters from SIO_DATA_REGISTER, beginning at char 0.
4. To input more characters, repeat from step 1.

To write data:

1. Query TDRD flag (buffer ready?) and write the number of bytes to send (copied from SIO register to transmit FiFo) to TBUF_CNT.
2. Read the available data space left in TBUF_ST (if the buffer can hold more bytes than are to be transmitted) and number of bytes written to transmit buffer in TBUF_CNT (if more data is to be transmitted than fits in the buffer).
3. Write character to SIO_DATA_REGISTER, beginning at char 0.
4. To output more characters, repeat from step 1.

Note

- Contact your local dealer if you require further information or additional test programs or software.
- AVT recommends the use of Hyperterminal™ or other communication programs to test the functionality of this feature. Alternatively use SmartView to try out this feature.

Controlling image capture

The cameras support the SHUTTER_MODES specified in IIDC V1.31. For all models this shutter is a **global pipelined shutter**; meaning that all pixels are exposed to the light at the same moment and for the same time span.

Pipelined means that the shutter for a new image can already happen, while the preceding image is transmitted.

In continuous modes the shutter is opened shortly before the vertical reset happens, thus acting in a frame-synchronous way.

Combined with an external trigger, it becomes asynchronous in the sense that it occurs whenever the external trigger occurs. Individual images are recorded when an external trigger impulse is present. This ensures that even fast moving objects can be grabbed with no image lag and with minimal image blur.

The external trigger is fed as a TTL signal through Pin 4 of the camera I/O connector.

Trigger modi

The cameras support IIDC conforming Trigger_Mode_0 and Trigger_Mode_1 and special Trigger_Mode_15 (bulk trigger).

Trigger Mode	Description
Trigger_Mode_0	Sets the shutter time according to the value set in the shutter (or extended shutter) register
Trigger_Mode_1	Sets the shutter time according to the active low time of the pulse applied (or active high time in the case of an inverting input)
Trigger_Mode_15	Is a **bulk trigger**, combining one external trigger event with continuous or one-shot or multishot internal trigger

Table 55: Trigger modi

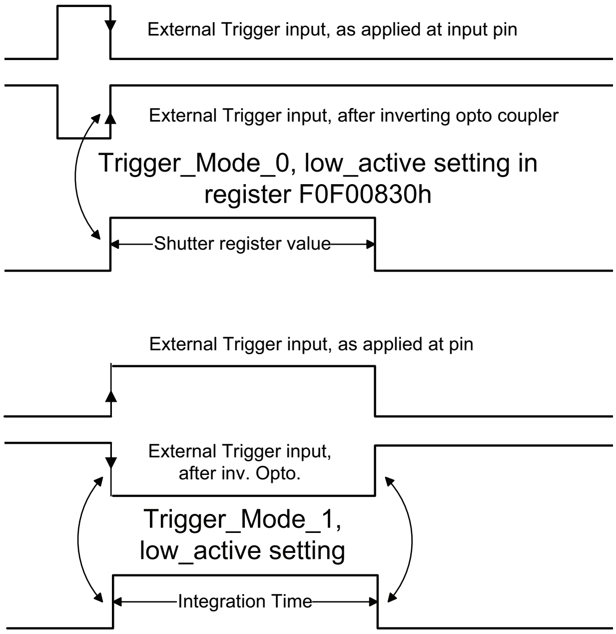


Figure 76: Trigger_mode_0 and 1

Bulk Trigger (Trigger_Mode_15)

Trigger_Mode_15 is an extension to the IIDC trigger modes. One external trigger event can be used to trigger a multitude of internal image intakes.

This is especially useful for:

- Grabbing exactly one image based on the first external trigger.
- Filling the camera's internal image buffer with one external trigger without overriding images.
- Grabbing an unlimited amount of images after one external trigger (surveillance)

The Figure below illustrates this mode.

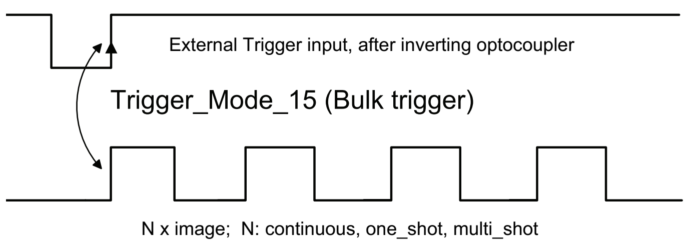


Figure 77: Trigger_Mode_15

The functionality is controlled via bit [6] and bitgroup [12-15] of the following register:

Register	Name	Field	Bit	Description
0xF0F00830	TRIGGER_MODE	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the **Value** field 1: Control with value in the **Absolute** value CSR If this bit = 1 the value in the **Value** field has to be ignored
		-	[2..5]	Reserved
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF 1: ON In this bit = 0, other fields will be read only.
		Trigger_Polarity	[7]	Select trigger polarity (Except for software trigger) If Polarity_Inq is 1: Write to change polarity of the trigger input. Read to get polarity of the trigger input. If Polarity_Inq is 0: Read only. 0: Low active input 1: High active input
		Trigger_Source	[8..10]	Select trigger source Set trigger source ID from trigger source ID_Inq
		Trigger_Value	[11]	Trigger input raw signal value read only 0: Low 1: High
		Trigger_Mode	[12..15]	Trigger_Mode (Trigger_Mode_0..15)
		-	[16..19]	Reserved
		Parameter	[20..31]	Parameter for trigger function, if required (optional)

Table 56: Trigger_Mode_15 (Bulk Trigger)

The screenshots below illustrate the use of Trigger_Mode_15 on a register level:

- Line #1switches continuous mode off, leaving viewer in listen mode.
- Line #2 prepares 830h register for external trigger and Mode_15.

Left = continuous	Middle = one shot	Right = multi shot
Line #3 switches camera back to continuous mode. Only one image is grabbed precisely with the first external trigger. To repeat rewrite line three.	Line #3 toggles One_Shot bit [0] of the One_Shot register 61C so that only one image is grabbed, based on the first external trigger. To repeat rewrite line three.	Line #3 toggles Multi_Shot bit [1] of the One_Shot register 61C so that Ah images are grabbed, starting with the first external trigger. To repeat rewrite line three.

Table 57: Description: Using Trigger_Mode_15: Continuous, oneshot, multishot

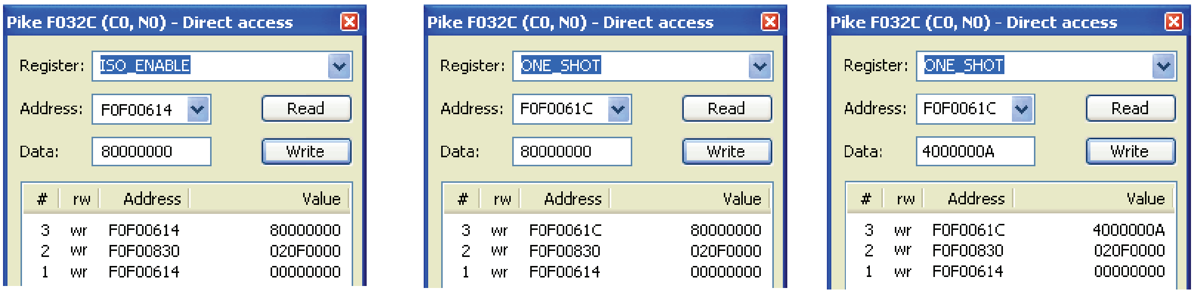


Figure 78: Using Trigger_Mode_15: Continuous, oneshot, multishot

Note

Shutter for the images is controlled by shutter register.

Trigger delay

As already mentioned earlier the cameras feature various ways to delay image capture based on external trigger.

With IIDC V1.31 there is a standard CSR at Register F0F00534/834h to control a delay up to FFFh x time base value. The following table explains the Inquiry register and the meaning of the various bits.

Register	Name	Field	Bit	Description
0xF0F00534	TRIGGER_DLY_INQUIRY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One Push auto mode (controlled automatically by the camera once)
		ReadOut_Inq	[4]	Capability of reading out 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 the camera)
		Manual_Inq	[7]	Manual Mode (controlled by user)
		Min_Value	[8..19]	Minimum value for this feature
		Max_Value	[20..31]	Maximum value for this feature

Table 58: Trigger Delay Inquiry register

	Name	Field	Bit	Description
0xF0F00834	TRIGGER_DELAY	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the **Value** field 1: Control with value in the **Absolute** value CSR If this bit = 1, the value in the **Value** field has to be ignored
		-	[2..5]	Reserved
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF 1: ON In this bit = 0, other fields will be read only.
		-	[7..19]	Reserved
		Value	[20..31]	Value If you write the value in OFF mode, this field will be ignored. If **ReadOut** capability is not available, then the read value will have no meaning.

Table 59: Trigger Delay CSR

Trigger delay advanced register

In addition, the cameras have an advanced register which allows even more precise image capture delay after receiving a hardware trigger.

Register	Name	Field	Bit	Description
0xF1000400	TRIGGER_DELAY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	-
		ON_OFF	[6]	Trigger delay on/off
		---	[7..10]	-
		DelayTime	[11..31]	Delay time in µs

Table 60: Trigger Delay Advanced CSR

The advanced register allows start of the integration to be delayed by max. 2^{21} µs, which is max. 2.1 s after a trigger edge was detected.

Note

- Switching trigger delay to ON also switches external Trigger_Mode_0 to ON.
- This feature works with external Trigger_Mode_0 only.

Exposure time

The exposure (shutter) time for continuous mode and Trigger_Mode_0 is based on the following formula:

Shutter register value x time base + offset

The register value is the value set in the corresponding IIDC 1.31 register (SHUTTER [81Ch]). This number is in the range between 1 and 4095.

The shutter register value is multiplied by the time base register value (see Table 115: Time base ID on page 224). The default value here is set to 20 µs.

A camera-specific offset is also added to this value. It is different for the camera models:

Exposure time offset

Camera model	Exposure time offset
PIKE F-032	15 µs
PIKE F-100	42 µs
PIKE F-145	32 µs
PIKE F-210	38 µs
PIKE F-421	65 µs

Table 61: Camera-specific exposure time offset

Minimum exposure time

Camera model	Minimum exposure time	Effective min. exp. time = Min. exp. time + offset
PIKE F-032	11 µs	26 µs
PIKE F-100	43 µs	85 µs

Table 62: Camera-specific minimum exposure time

Camera model	Minimum exposure time	Effective min. exp. time = Min. exp. time + offset
PIKE F-145	4 µs	36 µs
PIKE F-210	39 µs	77 µs
PIKE F-421	28 µs	93 µs

Table 62: Camera-specific minimum exposure time

Example: PIKE F-032

Camera	Register value	Time base (default)
PIKE F-032	100	20 µs

Table 63: Register value and time base for PIKE F-032

register value x time base = exposure time

100 x 20 µs + 15 µs = 2015 µs exposure time

The minimum adjustable exposure time set by register is 11 µs. → The real minimum exposure time of PIKE F-032 is then 11 µs + 15 µs = 26 µs.

Extended shutter

The exposure time for long-term integration of up to 67 seconds can be extended via the advanced register: EXTENDED_SHUTTER

Register	Name	Field	Bit	Description
0xF100020C	EXTD_SHUTTER	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1.. 5]	
		ExpTime	[6..31]	Exposure time in µs

Table 64: Extended shutter configuration

The longest exposure time, 3FFFFFFh, corresponds to 67.11 sec.

The lowest possible value of **ExpTime** is camera-specific (see Table 62: Camera-specific minimum exposure time on page 152).

Note

- Exposure times entered via the 81Ch register are mirrored in the extended register, but not vice versa.
- Longer integration times not only increase sensitivity, but may also increase some unwanted effects such as noise and pixel-to-pixel non-uniformity. Depending on the application, these effects may limit the longest usable integration time.
- Changes in this register have immediate effect, even when the camera is transmitting.
- Extended shutter becomes inactive after writing to a format/mode/frame rate register.

One-Shot

The camera can record an image by setting the **OneShot bit** in the 61Ch register. This bit is automatically cleared after the image is captured. If the camera is placed in Iso_Enable mode (see Chapter ISO_Enable / Free-Run on page 157), this flag is ignored.

If **OneShot mode** is combined with the external trigger, the **OneShot** command is used to arm it. The following screenshot shows the sequence of commands needed to put the camera into this mode. It enables the camera to grab exactly one image with an external trigger edge.

If there is no trigger impulse after the camera has been armed, **OneShot** can be cancelled by clearing the bit.

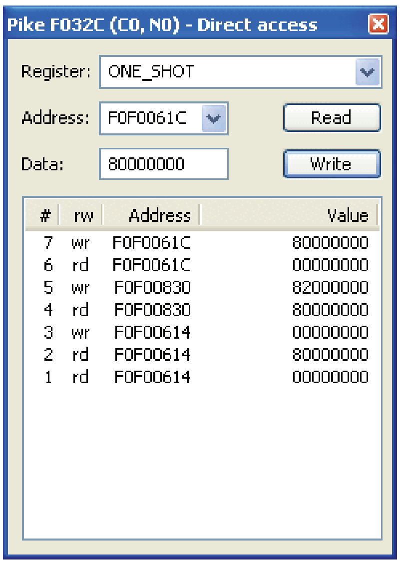


Figure 79: One-shot control (SmartView)

#	Read/ Write	Address	Value	Description
7	wr	F0F0061C	80000000	Do one-shot.
6	rd	F0F0061C	00000000	Read out one-shot register.
5	wr	F0F00830	82000000	Switch on external trigger mode 0.
4	rd	F0F00830	80000000	Check trigger status.
3	wr	F0F00614	00000000	Stop Free-run.
2	rd	F0F00614	80000000	Check Iso_Enable mode (→Free-run).
1	rd	F0F00614	00000000	This line is produced by SmartView.

Table 65: One-shot control: descriptions

One-Shot command on the bus to start of exposure

The following sections describe the time response of the camera using a single frame (OneShot) command. As set out in the IIDC specification, this is a software command that causes the camera to record and transmit a single frame.

The following values apply only when the camera is idle and ready for use. Full resolution must also be set.

Feature	Value
OneShot → Microcontroller-Sync	≤ 150 µs (processing time in the microcontroller)
µC-Sync/ExSync → Integration-Start	8 µs

Table 66: Values for one-shot

Microcontroller-Sync is an internal signal. It is generated by the microcontroller to initiate a trigger. This can either be a direct trigger or a release for ExSync if the camera is externally triggered.

End of exposure to first packet on the bus

After the exposure, the CCD sensor is read out; some data is written into the FRAME_BUFFER before being transmitted to the bus.

The time from the end of exposure to the start of transport on the bus is:

710 µs ± 62.5 µs

This time 'jitters' with the cycle time of the bus (125 µs).

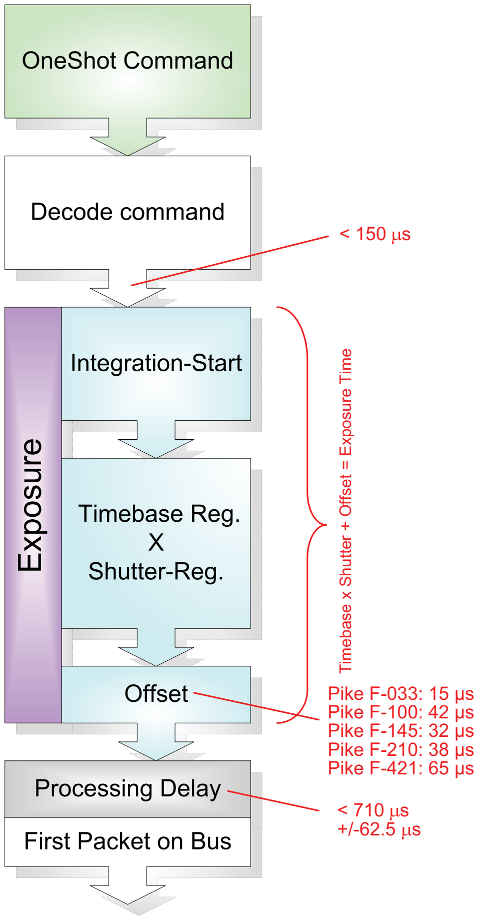


Figure 80: Data flow and timing after end of exposure

Multi-shot

Setting **multi-shot** and entering a quantity of images in **Count_Number** in the 61Ch register enables the camera to record a specified number of images.

The number is indicated in bits 16 to 31. If the camera is put into **Iso_Enable** mode (see Chapter ISO_Enable / Free-Run on page 157), this flag is ignored and deleted automatically once all the images have been recorded.

If **multi-shot** mode is activated and the images have not yet all been captured, it can be cancelled by resetting the flag. The same result can be achieved by setting the number of images to **0**.

Multi-shot can also be combined with the external trigger in order to grab a certain number of images based on an external trigger. This is especially helpful in combination with the so called **Deferred_Mode** to limit the number of grabbed images to the FIFO size.

ISO_Enable / Free-Run

Setting the MSB (bit 0) in the 614h register (ISO_ENA) puts the camera into ISO_Enable mode or Continuous_Shot. The camera captures an infinite series of images. This operation can be quit by deleting the **0** bit.

Asynchronous broadcast

The camera accepts asynchronous broadcasts. This involves asynchronous write requests that use node number 63 as the target node with no acknowledge.

This makes it possible for all cameras on a bus to be triggered by software simultaneously - e.g. by broadcasting a **One_Shot**. All cameras receive the **One_Shot** command in the same IEEE 1394 bus cycle. This creates uncertainty for all cameras in the range of 125 µs.

Inter-camera latency is described in Chapter Jitter at start of exposure on page 158.

The following screenshot shows an example of broadcast commands sent with the Firedemo example of FirePackage:

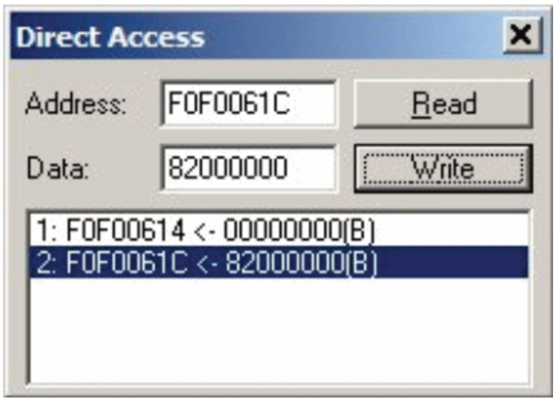


Figure 81: Broadcast one-shot

- Line 1 shows the broadcast command, which stops all cameras connected to the same IEEE 1394 bus. It is generated by holding the <shift> key down while clicking on <Write>.
- Line 2 generates a **broadcast One_Shot** in the same way, which forces all connected cameras to simultaneously grab one image.

Jitter at start of exposure

The following chapter discusses the latency time which exists for all CCD models when either a hardware or software trigger is generated, until the actual image exposure starts.

Owing to the well-known fact that an Interline Transfer CCD sensor has both a light sensitive area and a separate storage area, it is common to interleave image exposure of a new frame and output that of the previous one. It makes continuous image flow possible, even with an external trigger.

The uncertain time delay before the start of exposure depends on the state of the sensor. A distinction is made as follows:

FVal is active → the sensor is reading out, the camera is busy

In this case the camera must not change horizontal timing so that the trigger event is synchronized with the current horizontal clock. This introduces a max. uncertainty which is equivalent to the line time. The line time depends on the sensor used and therefore can vary from model to model.

FVal is inactive → the sensor is ready, the camera is idle

In this case the camera can resynchronize the horizontal clock to the new trigger event, leaving only a very short uncertainty time of the master clock period.

Model	Camera (while FVal)	Camera idle
Pike F-032	± 4.9 µs	± 8.3 ns
Pike F-100	± 8.2 µs	± 8.3 ns
Pike F-145	± 16 µs	± 8.3 ns
Pike F-210	± 14.25 µs	± 8.3 ns
Pike F-421	± 15 µs	± 8.3 ns

Table 67: Jitter at exposure start

Note

- Jitter at the beginning of an exposure has no effect on the length of exposure, i.e. it is always constant.

Video formats, modes and bandwidth

The different PIKE models support different video formats, modes and frame rates.

These formats and modes are standardized in the IIDC (formerly DCAM) specification.

Resolutions smaller than the generic sensor resolution are generated from the center of the sensor and without binning.

Note

- The maximum frame rates can only be achieved with shutter settings lower than 1/framerate. This means that with default shutter time of 40 ms, a camera will not achieve frame rates higher than 25 frames/s. In order to achieve higher frame rates, please reduce the shutter time proportionally.
- The following tables assume that bus speed is 800 Mbit/s. With lower bus speeds (e.g. 400, 200 or 100 Mbit/s) not all frame rates may be achieved.

PIKE F-032B / PIKE F-032C

Format	Mode	Resolution	Color mode	240 fps	120 fps	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120	YUV444								
	1	320 x 240	YUV422		x	x	x	x	x	x	x
	2	640 x 480	YUV411		x	x	x	x	x	x	x
	3	640 x 480	YUV422			x	x	x	x	x	x
	4	640 x 480	RGB8			x	x	x	x	x	x
	5	640 x 480	Mono8		x x*	x x*	x x*	x x*	x x*	x x*	x x*
	6	640 x 480	Mono16			x	x	x	x	x	x

Table 68: Video fixed formats PIKE F-032B / PIKE F-032C

*: Color camera outputs RAW image, which needs to be converted outside of camera.

Frame rates with shading are only achievable with 1394b (S800).

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes
7	0	640 x 480	Mono8 Mono16	202.53 fps (Mono8) 105.96 fps (Mono16)
		640 x 480	YUV411 YUV422 Raw16 Mono8 Raw8 RGB8	139.13 fps (YUV411) 105.96 fps (YUV422,Raw16) 202.53 fps (Mono8,Raw8) 70.48 fps (RGB8)
	1	320 x 480	Mono8 Mono16	202.53 fps (Mono8), 2x H-binning 202.53 fps (Mono16), 2x H-binning
	2	640 x 240	Mono8 Mono16	372.09 fps (Mono8), 2x V-binning 207.79 fps (Mono16), 2x V-binning
	3	320 x 240	Mono8 Mono16	372.09 fps (Mono8), 2x H+V binning 372.09 fps (Mono16), 2x H+V binning
	4	320 x 480	Mono8 Mono16	202.53 fps (Mono8), 2x H-sub-sampling 202.53 fps (Mono16), 2x H-sub-sampling
		320 x 480	YUV411 YUV422 Raw16 Mono8 Raw8 RGB8	202.53 fps (YUV411), 2x/4x H-sub-sampling 202.53 fps (YUV422,Raw16), 2x/4x H-sub-sampling 202.53 fps (Mono8,Raw8), 2x/4x H-sub-sampling 139.13 fps (RGB8), 2x/4x H-sub-sampling
	5	640 x 240	Mono8 Mono16	372.09 fps (Mono8), 2x V-sub-sampling 207.79 fps (Mono16), 2x V-sub-sampling
		640 x 240	YUV411 YUV422 Raw16 Mono8 Raw8 RGB8	271.19 fps (YUV411), 2x/4x V-sub-sampling 207.79 fps (YUV422,Raw16), 2x/4x V-sub-sampling 372.09 fps (Mono8,Raw8), 2x/4x V-sub-sampling 139.13 fps (RGB8), 2x/4x V-sub-sampling
	6	320 x 240	Mono8 Mono16	372.09 fps (Mono8), 2x H+V sub-sampling 372.09 fps (Mono16), 2x H+V sub-sampling
		320 x 240	YUV411 YUV422 Raw16 Mono8 Raw8 RGB8	372.09 fps (YUV411), 2x/4x H+V sub-sampling 372.09 fps (YUV422,Raw16), 2x/4x H+V sub-sampling 372.09 fps (Mono8,Raw8), 2x/4x H+V sub-sampling 271.19 fps (RGB8), 2x/4x H+V sub-sampling

Table 69: Video Format_7 modes PIKE F-032B / PIKE F-032C

PIKE F-100B / PIKE F-100C

Format	Mode	Resolution	Color mode	240 fps	120 fps	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120	YUV444								
	1	320 x 240	YUV422		x	x	x	x	x	x	x
	2	640 x 480	YUV411			x	x	x	x	x	x
	3	640 x 480	YUV422			x	x	x	x	x	x
	4	640 x 480	RGB8			x	x	x	x	x	x
	5	640 x 480	Mono8			xx*	x x*	x x*	x x*	x x*	x x*
	6	640 x 480	Mono16			x	x	x	x	x	x
1	0	800 x 600	YUV422			x	x	x	x	x	
	1	800 x 600	RGB8				x	x	x	x	
	2	800 x 600	Mono8			x x*	x x*	x x*	x x*		
	3	1024 x 768	YUV422								
	4	1024 x 768	RGB8								
	5	1024 x 768	Mono8								
	6	800 x 600	Mono16			x	x	x	x	x	
	7	1024 x 768	Mono16								

Table 70: Video fixed formats PIKE F-100B / F-100C

*: Color camera outputs RAW image, which needs to be converted outside of camera.

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes
7	0	1000 x 1000	Mono8 Mono16	59.93 fps (Mono8) 32.59 fps (Mono16)
		1000 x 1000	YUV411 YUV422 Raw16 Mono8 Raw8 RGB8	43.36 fps (YUV411) 32.59 fps (YUV422,Raw16) 59.93 fps (Mono8,Raw8) 21.77 fps (RGB8)
	1	500 x 1000	Mono8 Mono16	59.93 fps (Mono8), 2x H-binning 59.93 fps (Mono16), 2x H-binning
	2	1000 x 500	Mono8 Mono16	98.16 fps (Mono8), 2x V-binning 64.78 fps (Mono16), 2x V-binning
	3	500 x 500	Mono8 Mono16	98.16 fps (Mono8), 2x H+V binning 98.16 fps (Mono16), 2x H+V binning
	4	500 x 1000	Mono8 Mono16	59.93 fps (Mono8), 2x H-sub-sampling 59.93 fps (Mono16), 2x H-sub-sampling
		500 x 1000	YUV411 YUV422 Raw16 Mono8 Raw8 RGB8	59.93 fps (YUV411) 2x/4x H-sub-sampling 59.93 fps (YUV422,Raw16) 2x/4x H-sub-sampling 59.93 fps (Mono8,Raw8) 2x/4x H-sub-sampling 43.36 fps (RGB8) 2x/4x H-sub-sampling
	5	1000 x 500	Mono8 Mono16	98.16 fps (Mono8), 2x V-sub-sampling 64.78 fps (Mono16), 2x V-sub-sampling
		1000 x 500	YUV411 YUV422 Raw16 Mono8 Raw8 RGB8	86.49 fps (YUV411) 2x/4x V-sub-sampling 64.78 fps (YUV422,Raw16) 2x/4x V-sub-sampling 98.16 fps (Mono8,Raw8) 2x/4x V-sub-sampling 43.36 fps (RGB8) 2x/4x V-sub-sampling
	6	500 x 500	Mono8 Mono16	98.16 fps (Mono8), 2x H+V-sub-sampling 98.16 fps (Mono16), 2x H+V-sub-sampling
		500 x 500	YUV411 YUV422 Raw16 Mono8 Raw8 RGB8	98.16 fps (YUV411) 2x/4x H+V-sub-sampling 98.16 fps (YUV422,Raw16) 2x/4x H+V-sub-sampling 98.16 fps (Mono8,Raw8) 2x/4x H+V-sub-sampling 86.49 fps (RGB8) 2x/4x H+V-sub-sampling

Table 71: Video Format_7 modes PIKE F-100B / F-100C

PIKE F-145B / PIKE F-145C

Format	Mode	Resolution	Color mode	240 fps	120 fps	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
	0	160 x 120	YUV444								
	1	320 x 240	YUV422			x	x	x	x	x	x
	2	640 x 480	YUV411				x	x	x	x	x
0	3	640 x 480	YUV422				x	x	x	x	x
	4	640 x 480	RGB8				x	x	x	x	x
	5	640 x 480	Mono8				x x*	x x*	x x*	x x*	x x*
	6	640 x 480	Mono16				x	x	x	x	x
	0	800 x 600	YUV422				x	x	x	x	
	1	800 x 600	RGB8				x	x	x		
	2	800 x 600	Mono8				x x*	x x*	x x*		
1	3	1024 x 768	YUV422				x	x	x	x	x
	4	1024 x 768	RGB8					x	x	x	x
	5	1024 x 768	Mono8				x x*	x x*	x x*	x x*	x x*
	6	800 x 600	Mono16				x	x	x	x	
	7	1024 x 768	Mono16				x	x	x	x	x
	0	1280 x 960	YUV422					x	x	x	x
	1	1280 x 960	RGB8					x	x	x	x
	2	1280 x 960	Mono 8				x x*	x x*	x x*	x x*	x x*
2	3	1600 x 1200	YUV422								
	4	1600 x 1200	RGB8								
	5	1600 x 1200	Mono8								
	6	1280 x 960	Mono16					x	x	x	x
	7	1600 x 1200	Mono16								

Table 72: Video fixed formats PIKE F-145B / F-145C

*: Color camera outputs RAW image, which needs to be converted outside of camera.

Frame rates with shading are only achievable with 1394b (S800).

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes
7	0	1388 x 1038	Mono8 Mono16	30.02 fps (Mono8) 22.70 fps (Mono16)
		1388 x 1038	YUV411 YUV422 Raw16 Mono8 Raw8,RGB8	30.02 fps (YUV411) 22.70 fps (YUV422,Raw16) 30.02 fps (Mono8,Raw8) 15.14 fps (RGB8)
	1	692 x 1038	Mono8 Mono16	29.91 fps (Mono8), 2x H-binning 30.02 fps (Mono16), 2x H-binning
	2	1388 x 518	Mono8 Mono16	50.47 fps (Mono8), 2x V-binning 45.33 fps (Mono16), 2x V-binning
	3	692 x 518	Mono8 Mono16	50.47 fps (Mono8), 2x H+V binning 50.47 fps (Mono16), 2x H+V binning
	4	692 x 1038	Mono8 Mono16	29.91 fps (Mono8), 2x/4x H-sub-sampling 30.02 fps (Mono16), 2x/4x H-sub-sampling
		692 x 1038	YUV411 YUV422 Raw16 Mono8 Raw8,RGB8	30.02 fps (YUV411) 2x/4x H-sub-sampling 30.02 fps (YUV422,Raw16) 2x/4x H-sub-sampling 29.91 fps (Mono8) 2x/4x H-sub-sampling 30.02 fps (Raw8) 2x/4x H-sub-sampling 30.02 fps (RGB8) 2x/4x H-sub-sampling
	5#	1388 x 518	Mono8 Mono16	30.02 fps (Mono8), 2x/4x V-sub-sampling 30.02 fps (Mono16), 2x/4x V-sub-sampling
		1388 x 518	YUV411 YUV422 Raw16 Mono8 Raw8,RGB8	30.02 fps (YUV411) 2x/4x V-sub-sampling 30.02 fps (YUV422) 2x/4x V-sub-sampling 30.13 fps (Raw16) 2x/4x V-sub-sampling 30.02 fps (Mono8,Raw8) 2x/4x V-sub-sampling 30.02 fps (RGB8) 2x/4x V-sub-sampling
	6#	692 x 518	Mono8 Mono16	30.02 fps (Mono8), 2x/4x H+V-sub-sampling 30.02 fps (Mono16), 2x/4x H+V-sub-sampling
		692 x 518	YUV411 YUV422 Raw16 Mono8 Raw8,RGB8	30.02 fps (YUV411) 2x/4x H+V-sub-sampling 30.02 fps (YUV422) 2x/4x H+V-sub-sampling 30.13 fps (Raw16) 2x/4x H+V-sub-sampling 30.02 fps (Mono8,Raw8) 2x/4x H+V-sub-sampling 30.02 fps (RGB8) 2x/4x H+V-sub-sampling

Table 73: Video Format_7 modes PIKE F-145B / F-145C

#: Vertical sub-sampling is done via concealing certain lines, so the frame rate is not

frame rate = f (AOI height)
but
frame rate = f (2 x AOI height)

PIKE F-210B / PIKE F-210C

Format	Mode	Resolution	Color mode	240 fps	120 fps	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120	YUV444								
	1	320 x 240	YUV422			x	x	x	x	x	x
	2	640 x 480	YUV411				x	x	x	x	x
	3	640 x 480	YUV422				x	x	x	x	x
	4	640 x 480	RGB8				x	x	x	x	x
	5	640 x 480	Mono 8				x x*	x x*	x x*	x x*	x x*
	6	640 x 480	Mono 16				x	x	x	x	x
1	0	800 x 600	YUV422				x	x	x	x	
	1	800 x 600	RGB8				x	x	x		
	2	800 x 600	Mono8				x x*	x x*	x x*		
	3	1024 x 768	YUV422				x	x	x	x	x
	4	1024 x 768	RGB8					x	x	x	x
	5	1024 x 768	Mono 8				x x*	x x*	x x*	x x*	x x*
	6	800 x 600	Mono16				x	x	x	x	
	7	1024 x 768	Mono16				x	x	x	x	x
2	0	1280 x 960	YUV422					x	x	x	x
	1	1280 x 960	RGB8					x	x	x	x
	2	1280 x 960	Mono 8				x x*	x x*	x x*	x x*	x x*
	3	1600 x 1200	YUV422								
	4	1600 x 1200	RGB8								
	5	1600 x 1200	Mono8								
	6	1280 x 960	Mono16					x	x	x	x
	7	1600 x 1200	Mono16								

Table 74: Video fixed formats PIKE F-210B / F-210C

*: Color camera outputs RAW image, which needs to be converted outside of camera.

Frame rates with shading are only achievable with 1394b (S800).

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes
7	0	1920 x 1080 1920 x 1080	Mono8 Mono16 YUV411 YUV422 Raw16 Mono8 Raw8,RGB8	31.43 fps (Mono8) 15.76 fps (Mono16) 21.02 fps (YUV411) 15.76 fps (YUV422,Raw16) 31.43 fps (Mono8,Raw8) 10.52 fps (RGB8)
	1	960 x 1080	Mono8 Mono16	32.06 fps (Mono8), 2x H-binning 31.43 fps (Mono16), 2x H-binning
	2	1920 x 540	Mono8 Mono16	51.45 fps (Mono8), 2x V-binning 31.43 fps (Mono16), 2x V-binning
	3	960 x 540	Mono8 Mono16	51.45 fps (Mono8), 2x H+V binning 51.45 fps (Mono16), 2x H+V binning
	4	960 x 1080 960 x 1080 tbd	Mono8 Mono16 YUV411 YUV422 Raw16 Mono8 Raw8,RGB8	32.06 fps (Mono8), 2x H-sub-sampling 31.43 fps (Mono16), 2x H-sub-sampling 32.06 fps (YUV411) 2x/4x H-sub-sampling 31.43 fps (YUV422,Raw16) 2x/4x H-sub-sampling 32.06 fps (Mono8,Raw8) 2x/4x H-sub-sampling 21.02 fps (RGB8) 2x/4x H-sub-sampling
	5#	1920 x 540 1920 x 540	Mono8 Mono16 YUV411 YUV422 Raw16 Mono8 Raw8,RGB8	31.94 fps (Mono8), 2x V-sub-sampling 31.43 fps (Mono16), 2x V-sub-sampling 31.94 fps (YUV411) 2x/4x V-sub-sampling 31.43 fps (YUV422,Raw16) 2x/4x V-sub-sampling 31.94 fps (Mono8) 2x/4x V-sub-sampling 32.06 fps (Raw8) 2x/4x V-sub-sampling 21.02 fps (RGB8) 2x/4x V-sub-sampling
	6#	960 x 540 960 x 540	Mono8 Mono16 YUV411 YUV422 Raw16 Mono8 Raw8,RGB8	31.94 fps (Mono8), 2x H+V-sub-sampling 31.94 fps (Mono16), 2x H+V-sub-sampling 31.94 fps (YUV411) 2x/4x H+V-sub-sampling 31.94 fps (YUV422) 2x/4x H+V-sub-sampling 32.06 fps (Raw16) 2x/4x H+V-sub-sampling 31.94 fps (Mono8) 2x/4x H+V-sub-sampling 32.06 fps (Raw8) 2x/4x H+V-sub-sampling 31.94 fps (RGB8) 2x/4x H+V-sub-sampling

Table 75: Video Format_7 modes PIKE F-210B / F-210C

#: Vertical sub-sampling is done via concealing certain lines, so the frame rate is not

frame rate = f (AOI height)
but
frame rate = f (2 x AOI height)

PIKE F-421B / PIKE F-421C

Format	Mode	Resolution	Color Mode	240 fps	120 fps	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120	YUV444								
	1	320 x 240	YUV422				x	x	x	x	x
	2	640 x 480	YUV411				x	x	x	x	x
	3	640 x 480	YUV422				x	x	x	x	x
	4	640 x 480	RGB8				x	x	x	x	x
	5	640 x 480	Mono8				x x	x x*	x x*	x x*	x x*
	6	640 x 480	Mono16				x	x	x	x	x
1	0	800 x 600	YUV422				x	x	x	x	
	1	800 x 600	RGB8				x	x	x		
	2	800 x 600	Mono8				x x*	x x*	x x*		
	3	1024 x 768	YUV422				x	x	x	x	x
	4	1024 x 768	RGB8					x	x	x	x
	5	1024 x 768	Mono8				x x*	x x*	x x*	x x*	x x*
	6	800 x 600	Mono16				x	x	x	x	
	7	1024 x 768	Mono16				x	x	x	x	x
2	0	1280 x 960	YUV422					x	x	x	x
	1	1280 x 960	RGB8					x	x	x	x
	2	1280 x 960	Mono8					x x*	x x*	x x*	x x*
	3	1600 x 1200	YUV422					x	x	x	x
	4	1600 x 1200	RGB8						x	x	x
	5	1600 x 1200	Mono8					x x*	x x*	x x*	x x*
	6	1280 x 960	Mono16					x	x	x	x
	7	1600 x 1200	Mono16					x	x	x	x

Table 76: Video fixed formats PIKE F-421-B / PIKE F-421C

*: Color camera outputs RAW image, which needs to be converted outside of camera.

Frame rates with shading are only achievable with 1394b (S800).

Format	Mode	Resolution	Color Mode	Maximal S800 frame rates for Format_7 modes
7	0	2048 x 2048	Mono8 Mono16	15.61 fps (Mono8) 7.81 fps (Mono16)
		2048 x 2048	YUV411 YUV422 Raw16 Mono8 Raw8 RGB8	10.41 fps (YUV411) 7.81 fps (YUV422,Raw16) 15.61 fps (Mono8,Raw8) 5.21 fps (RGB8)
	1	1024 x 2048	Mono8 Mono16	16.11 fps (Mono8), 2x H-binning 15.61 fps (Mono16), 2x H-binning
	2	2048 x 1024	Mono8 Mono16	28.83 fps (Mono8), 2x V-binning 15.61 fps (Mono16), 2x V-binning
	3	1024 x 1024	Mono8 Mono16	28.83 fps (Mono8), 2x H+V binning 28.93 fps (Mono16), 2x H+V binning
	4	1024 x 2048	Mono8 Mono16	16.11 fps (Mono8), 2x H-sub-sampling 15.61 fps (Mono16), 2x H-sub-sampling
		1024 x 2048	YUV411 YUV422 Raw16 Mono8 Raw8 RGB8	16.11 fps (YUV411) 2x/4x H-sub-sampling 15.61 fps (YUV422,Raw16) 2x/4x H-sub-sampling 16.11 fps (Mono8) 2x/4x H-sub-sampling 16.15 fps (Raw8) 2x/4x H-sub-sampling 10.41 fps (RGB8) 2x/4x H-sub-sampling
	5	2048 x 1024	Mono8 Mono16	28.83 fps (Mono8), 2x/4x V-sub-sampling 15.61 fps (Mono16), 2x/4x V-sub-sampling
		2048 x 1024	YUV411 YUV422, Raw16 Mono8 Raw8 RGB8	20.81 fps (YUV411) 2x/4x V-sub-sampling 15.61 fps (YUV422,Raw16) 2x/4x V-sub-sampling 28.83 fps (Mono8) 2x/4x V-sub-sampling 28.93 fps (Raw8) 2x/4x V-sub-sampling 10.41 fps (RGB8) 2x/4x V-sub-sampling
	6	1024 x 1024	Mono8 Mono16	28.83 fps (Mono8), 2x/4x H+V-sub-sampling 28.93 fps (Mono16), 2x/4x H+V-sub-sampling
		1024 x 1024	YUV411 YUV422 Raw16 Mono8 Raw8 RGB8	28.83 fps (YUV411) 2x/4x H+V-sub-sampling 28.83 fps (YUV422) 2x/4x H+V-sub-sampling 28.93 fps (Raw16) 2x/4x H+V-sub-sampling 28.83 fps (Mono8) 2x/4x H+V-sub-sampling 28.93 fps (Raw8) 2x/4x H+V-sub-sampling 20.81 fps (RGB8) 2x/4x H+V-sub-sampling

Table 77: Video Format_7 modes PIKE F-421-B / PIKE F-421C

Area of interest (AOI)

The camera's image sensor has a defined resolution. This indicates the maximum number of lines and pixels per line that the recorded image may have.

However, often only a certain section of the entire image is of interest. The amount of data to be transferred can be decreased by limiting the image to a section when reading it out from the camera. At a lower vertical resolution the sensor can be read out faster and thus the frame rate is increased.

Note

The setting of AOIs is supported only in video Format_7.

While the size of the image read out for most other video formats and modes is fixed by the IIDC specification, thereby determining the highest possible frame rate, in Format_7 mode the user can set the **upper left corner** and **width and height** of the section (area of interest = AOI) he is interested in to determine the size and thus the highest possible frame rate.

Setting the AOI is done in the IMAGE_POSITION and IMAGE_SIZE registers.

Attention should be paid to the increments entered in the UNIT_SIZE_INQ and UNIT_POSITION_INQ registers when configuring IMAGE_POSITION and IMAGE_SIZE.

AF_AREA_POSITION and AF_AREA_SIZE contain in the respective bits values for the column and line of the upper left corner and values for the width and height.

Note

For more information see Table 107: Format_7 control and status register on page 214.

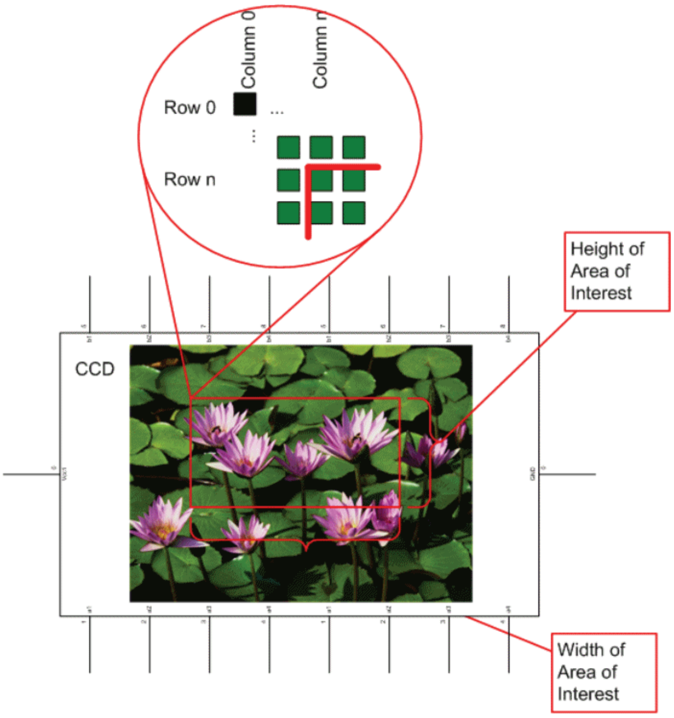


Figure 82: Area of interest (AOI)

Note

- The left position + width and the upper position + height may not exceed the maximum resolution of the sensor.
- The coordinates for width and height must be divisible by 4.

In addition to the AOI, some other parameters have an effect on the maximum frame rate:

- the time for reading the image from the sensor and transporting it into the FRAME_BUFFER
- the time for transferring the image over the FireWire™ bus
- the length of the exposure time.

Autofunction AOI

Use this feature to select the image area (work area) on which the following autofunctions work:

- auto shutter
- auto gain
- auto white balance

In the following screenshot you can see an example of the autofunction AOI:

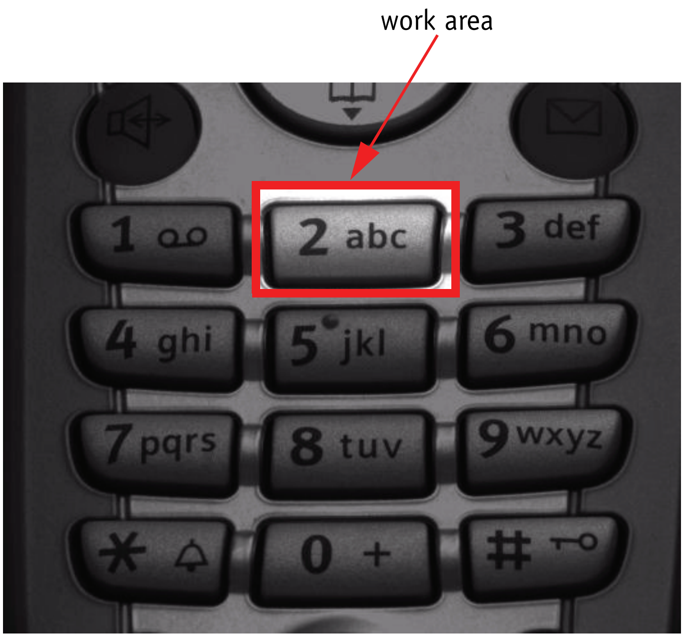


Figure 83: Example of autofunction AOI (Show work area is on)

Note

For more information see Chapter Autofunction AOI on page 238.

Frame rates

An IEEE 1394 camera requires bandwidth to transport images.

The IEEE 1394b bus has very large bandwidth of at least 62.5 MByte/s for transferring (isochronously) image data. Per cycle up to 8192 bytes (or around 2000 quadlets = 4 bytes@ 800 Mbit/s) can thus be transmitted.

Note

All bandwidth data is calculated with:

1 MByte = 1024 kByte

Depending on the video format settings and the configured frame rate, the camera requires a certain percentage of maximum available bandwidth. Clearly the bigger the image and the higher the frame rate, the more data is to be transmitted.

The following tables indicate the volume of data in various formats and modes to be sent within one cycle (125 µs) at 800 Mbit/s of bandwidth.

The tables are divided into three formats:

Format	Resolution	max. Video Format
Format_0	up to VGA	640 x 480
Format_1	up to XGA	1024 x 768
Format_2	up to UXGA	1600 x 1200

Table 78: Overview fixed formats

They enable you to calculate the required bandwidth and to ascertain the number of cameras that can be operated independently on a bus and in which mode.

Format	Mode	Resolution	240 fps	120 fps	60 fps	30 fps	15 fps	7.5 fps	3.75 fps
0	0	160 x 120 YUV (4:4:4) 24 bit/pixel	4H 640p 480q	2H 320p 240q	1H 160p 120q	1/2H 80p 60q	1/4H 40p 30q	1/8H 20p 15q	
	1	320 x 240 YUV (4:2:2) 16 bit/pixel	8H 2560p 1280q	4H 1280p 640q	2H 640p 320q	1H 320p 160q	1/2H 160p 80q	1/4H 80p 40q	1/8H 40p 20q
	2	640 x 480 YUV (4:1:1) 12 bit/pixel		8H 5120p 1920q	4H 2560p 960q	2H 1280p 480q	1H 640p 240q	1/2H 320p 120q	1/4H 160p 60q
	3	640 x 480 YUV (4:2:2) 16 bit/pixel			4H 2560p 1280q	2H 1280p 640q	1H 640p 320q	1/2H 320p 160q	1/4H 160p 80q
	4	640 x 480 RGB 24 bit/pixel			4H 2560p 1280q	2H 1280p 960q	1H 640p 480q	1/2H 320p 240q	1/4H 160p 120q
	5	640 x 480 (Mono8) 8 bit/pixel		8H 5120p 1280q	4H 2560p 640q	2H 1280p 320q	1H 640p 160q	1/2H 320p 80q	1/4H 160 p40q
	6	640 x 480 Y (Mono16) 16 Bit/pixel			4H 2560p 1280q	2H 1280p 640q	1H 640p 320q	1/2H 320p 160q	1/4H 160p 80q
	7	Reserved							

Table 79: Format_0

As an example, VGA Mono8 @ 60 fps requires four lines (640 x 4 = 2560 pixels/byte) to transmit every 125 µs: this is a consequence of the sensor's line time of about 30 µs, so that no data needs to be stored temporarily. It takes 120 cycles (120 x 125 µs = 15 ms) to transmit one frame, which arrives every 16.6 ms from the camera. Again no data need to be stored temporarily.

Thus around 64% of the available bandwidth (at S400) is used. Thus one camera can be connected to the bus at S400.

The same camera, run at S800 would require only 32% of the available bandwidth, due to the doubled speed. Thus up to three cameras can be connected to the bus at S800.

Format	Mode	Resolution	240 fps	120 fps	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
1	0	800 x 600 YUV (4:2:2) 16 bit/pixel			5H 4000p 2000q	5/2H 2000p 1000q	5/4H 1000p 500q	5/8H 500p 250q	6/16H 250p 125q	
	1	800 x 600 RGB 24 bit/pixel				5/2H 2000p 1500q	5/4H 1000p 750q	5/8H 500p 375q		
	2	800 x 600 Y (Mono8) 8 bit/pixel		10H 8000p 2000q	5H 4000p 1000q	5/2H 2000p 500q	5/4H 1000p 250q	5/8H 500p 125q		
	3	1024 x 768 YUV (4:2:2) 16 bit/pixel				3H 3072p 1536q	3/2H 1536p 768q	3/4H 768p 384q	3/8H 384p 192q	3/16H 192p 96q
	4	1024 x 768 RGB 24 bit/pixel					3/2H 1536p 384q	3/4H 768p 576q	3/8H 384p 288q	3/16H 192p 144q
	5	1024 x 768 Y (Mono) 8 bit/pixel			6H 6144p 1536q	3H 3072p 768q	3/2H 1536p 384q	3/4H 768p 192q	3/8H 384p 96q	3/16H 192p 48q
	6	800 x 600 (Mono16) 16 bit/pixel			5H 4000p 2000q	5/2H 2000p 1000q	5/4H 1000p 500q	5/8H 500p 250q	5/16H 250p 125q	
	7	1024 x 768 Y (Mono16) 16 bit/pixel				3H 3072p 1536q	3/2H 1536p 768q	3/4H 768p 384q	3/8H 384p 192q	3/16H 192p 96q

Table 80: Format_1

Format	Mode	Resolution	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
2	0	1280 x 960 YUV (4:2:2) 16 bit/pixel			2H 2560p 1280q	1H 1280p 640q	1/2H 640p 320q	1/4H 320p 160q
	1	1280 x 960 RGB 24 bit/pixel			2H 2560p 1920q	1H 1280p 960q	1/2H 640p 480q	1/4H 320p 240q
	2	1280 x 960 Y (Mono8) 8 bit/pixel		4H 5120p 1280q	2H 2560p 640q	1H 1280p 320q	1/2H 640p 160q	1/4H 320p 80q
	3	1600 x 1200 YUV(4:2:2) 16 bit/pixel			5/2H 4000p 2000q	5/4H 2000p 1000q	5/8H 1000p 500q	5/16H 500p 250q
	4	1600 x 1200 RGB 24 bit/pixel				5/4H 2000p 1500q	5/8H 1000p 750q	5/16 500p 375q
	5	1600 x 1200 Y (Mono) 8 bit/pixel		5H 8000p 2000q	5/2H 4000p 1000q	5/4H 2000p 500q	5/8H 1000p 250q	5/16H 500p 125q
	6	1280 x 960 Y (Mono16) 16 bit/pixel			2H 2560p 1280q	1H 1280p 640q	1/2H 640p 320q	1/4H 320p 160q
	7	1600 x 1200Y(Mono16) 16 bit/pixel			5/2H 4000p 2000q	5/4H 2000p 1000q	5/8H 1000p 500q	5/16H 500p 250q

Table 81: Format_2

As already mentioned, the recommended limit for transferring isochronous image data is 2000q (quadlets) per cycle or 8192 bytes (with 800 Mbit/s of bandwidth).

Note

- If the cameras are operated with an external trigger the maximum trigger frequency may not exceed the highest continuous frame rate, so preventing frames from being dropped or corrupted.
- IEEE 1394 adapter cards with PCILynx™ chipsets (pre-deccessor of OHCI) have a limit of 4000 bytes per cycle.

The frame rates in video modes 0 to 2 are specified and set fixed by IIDC V1.31.

Frame rates Format_7

In video Format_7 frame rates are no longer fixed.

For the different sensors, different values apply.

Frame rates may be further limited by bandwidth limitation from the IEEE 1394 bus.

Details are described in the next chapter.

PIKE F-032: AOI frame rates

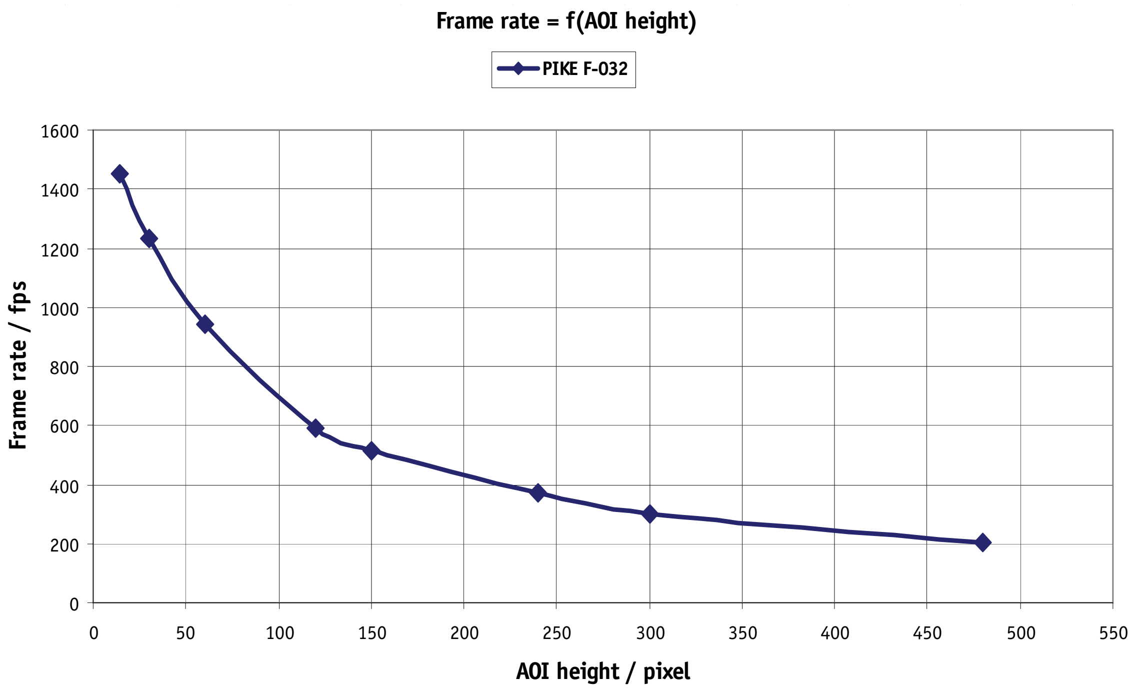


Figure 84: Frame rates PIKE F-032 as function of AOI height

AOI height / pixel	Frame rate / fps	T_{frame} / ms
480	202.53	4.93
300	301.89	3.31
240	372.09	2.68
150	516.13	1.93
120	592.59	1.68
60	941.18	1.06
30	1230.77	0.81
14	1454.55	0.68

Table 82: Frame rates PIKE F-032 as function of AOI height

Note

T_{frame} = 1 / frame rate

PIKE F-100: AOI frame rates

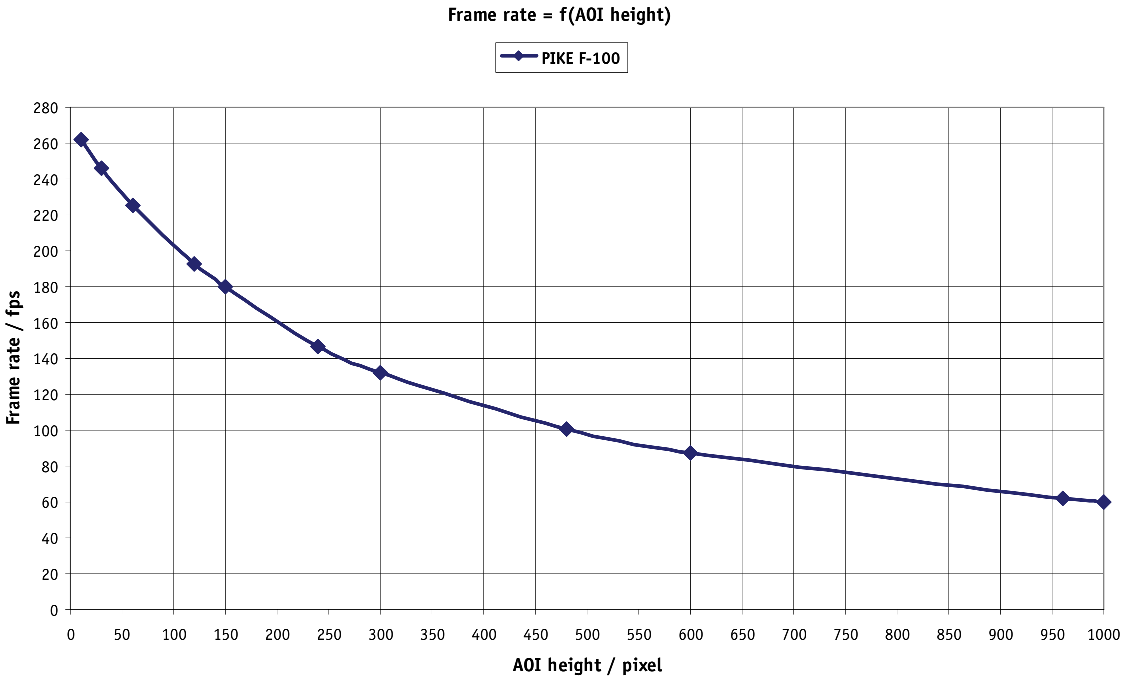


Figure 85: Frame rates PIKE F-100 as function of AOI height

AOI height / pixel	Frame rate / fps	T_{frame} / ms
1000	59.93	16.68
960	61.78	16.18
600	87.43	11.43
480	100.63	9.93
300	132.23	7.56
240	146.79	6.81
150	179.78	5.56
120	192.77	5.18
60	225.35	4.43
30	246.15	4.06
10	262.30	3.81

Table 83: Frame rates PIKE F-100 as function of AOI height

Note

T_{frame} = 1 / frame rate

PIKE F-145: AOI frame rates

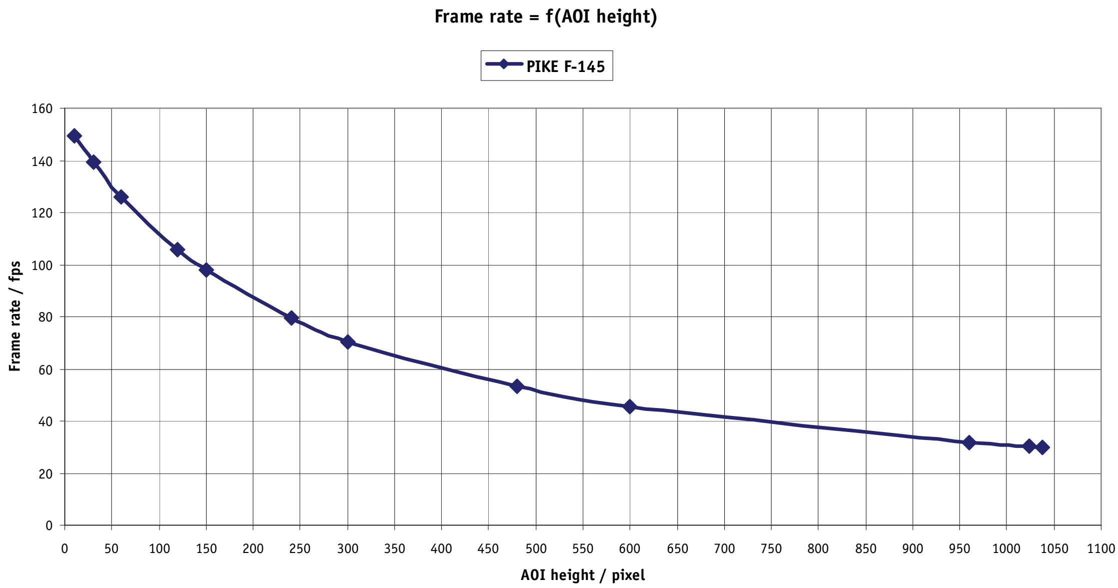


Figure 86: Frame rates PIKE F-145 as function of AOI height

AOI height / pixel	Frame rate / fps	T_{frame} / ms
1038	30.02	33.31
1024	30.36	32.94
960	31.94	31.31
600	45.58	21.94
480	53.16	18.81
300	70.48	14.19
240	79.60	12.56
150	98.16	10.19
120	105.96	9.44
60	125.98	7,94
30	139.13	7.19
10	149.53	6.69

Table 84: Frame rates PIKE F-145 as function of AOI height

Note

T_{frame} = 1 / frame rate

PIKE F-210: AOI frame rates

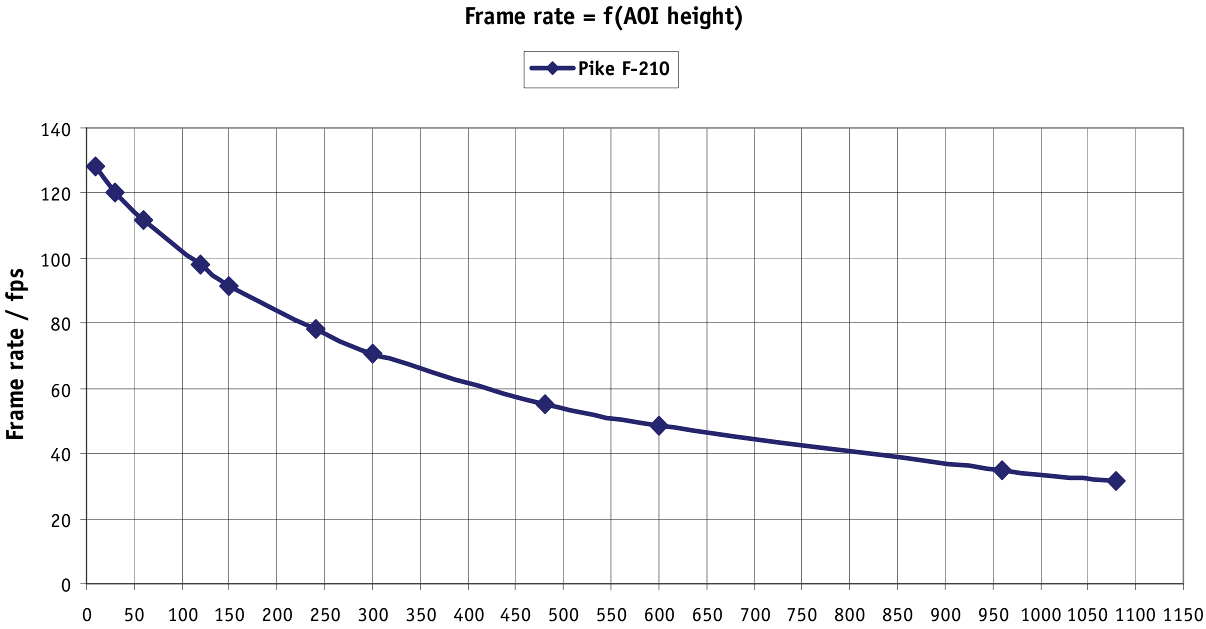


Figure 87: Frame rates PIKE F210 as function of AOI height

AOI height / pixel	Frame rate / fps	T_{frame} / ms
1080	31.43	31.82
960	35.01	28.56
600	48.34	20.69
480	55.36	18.06
300	70.48	14.19
240	78.05	12.81
150	91.43	10.94
120	98.16	10.19
60	111.89	8.94
30	120.30	8.31
10	128.00	7.81

Table 85: Frame rates PIKE F-210 as function of AOI height

Note

T_{frame} = 1 / frame rate

In Format_7 Mode_5 and Mode_6 the Pike F-210 has a frame rate of:

frame rate ~ f(2 x AOI height)

PIKE F-421: AOI frame rates

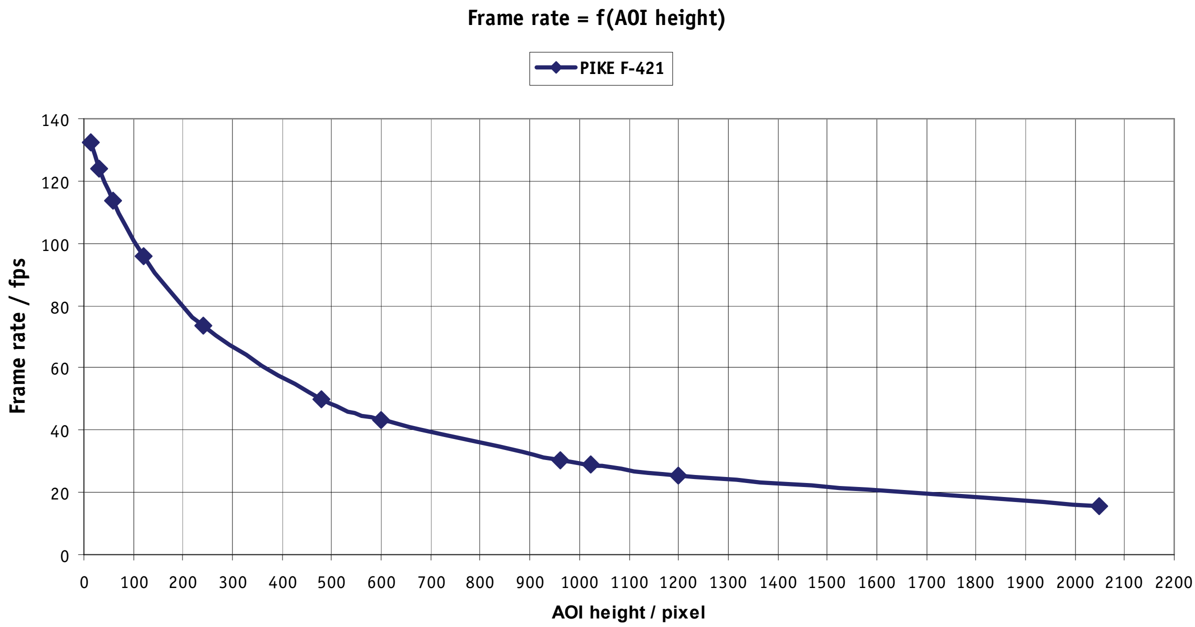


Figure 88: Frame rates PIKE F-421 as function of AOI height

AOI height / pixel	Frame rate / fps	T_{frame} / ms
2048	15.61	64.06
1200	25.44	39.30
1024	28.93	34.56
960	30.36	32.93
600	43.13	23.18
480	49.84	20.06
240	73.73	13.56
120	95.81	10.43
60	113.48	8.81
30	124.03	8.06
14	132.23	7.56

Table 86: Frame rates PIKE F-421 as function of AOI height

Note

T_{frame} = 1 / frame rate

How does bandwidth affect the frame rate?

In some modes the IEEE 1394b bus limits the attainable frame rate. According to the 1394b specification on isochronous transfer, the largest data payload size of 8192 bytes per 125 µs cycle is possible with bandwidth of 800 Mbit/s. In addition, there is a limitation, only a maximum number of 65535 (2^{16} -1) packets per frame are allowed.

The following formula establishes the relationship between the required Byte_Per_Packet size and certain variables for the image. It is valid only for Format_7.

$$\mathrm{BYTE\_PER\_PACKET} = \text{frame rate} \times \mathrm{AOI\_WIDTH} \times \mathrm{AOI\_HEIGHT} \times \mathrm{ByteDepth} \times 125\mu s$$

Formula 3: Byte_per_Packet calculation (only Format_7)

If the value for **BYTE_PER_PACKET** is greater than 8192 (the maximum data payload), the sought-after frame rate cannot be attained. The attainable frame rate can be calculated using this formula:

(Provision: **BYTE_PER_PACKET** is divisible by 4):

$$\text{frame rate} \approx \frac{\mathrm{BYTE\_PER\_PACKET}}{\mathrm{AOI\_WIDTH} \times \mathrm{AOI\_HEIGHT} \times \mathrm{ByteDepth} \times 125\mu s}$$

Formula 4: Maximum frame rate calculation

ByteDepth based on the following values:

Mode	bit/pixel	byte per pixel
Mono8, Raw8	8	1
Mono16, Raw16	16	2
YUV4:2:2	16	2
YUV4:1:1	12	1.5
RGB8	24	3

Table 87: ByteDepth

Example formula for the b/w camera

Mono16, 1392 x 1040, 30 fps desired

$$\text{BYTE\_PER\_PACKET} = 30 \times 1392 \times 1040 \times 2 \times 125\mu s = 10856 > 8192$$

$$\Rightarrow \quad \text{frame rate}_{\text{reachable}} \approx \frac{8192}{1392 \times 1040 \times 2 \times 125\mu s} = 22.64$$

Formula 5: Example maximum frame rate calculation

Test images

Loading test images

FirePackage	Direct FirePackage	Fire4Linux
1. Start **SmartView**. 2. Click the **Edit settings** button. 3. Click **Adv1** tab. 4. In combo box **Test images** choose **Image 1** or another test image.	1. Start **SmartView for WDM**. 2. In **Camera** menu click **Settings**. 3. Click **Adv1** tab. 4. In combo box **Test images** choose **Image 1** or another test image.	1. Start **cc1394** viewer. 2. In **Adjustments** menu click on **Picture Control**. 3. Click **Main** tab. 4. Activate Test image check box **on**. 5. In combo box **Test images** choose **Image 1** or another test image.

Table 88: Loading test images in different viewers

Test images for b/w cameras

The b/w cameras have two test images that look the same. Both images show a gray bar running diagonally (mirrored at the middle axis).

- **Image 1** is static.
- **Image 2** moves upwards by 1 pixel/frame.

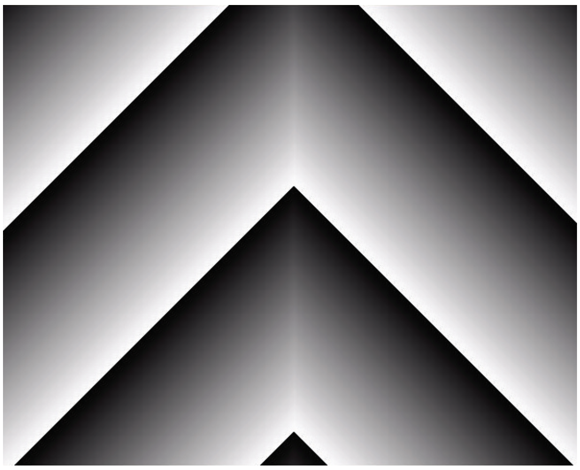


Figure 89: Gray bar test image

Test images for color cameras

The color cameras have 1 test image:

YUV4:2:2 mode

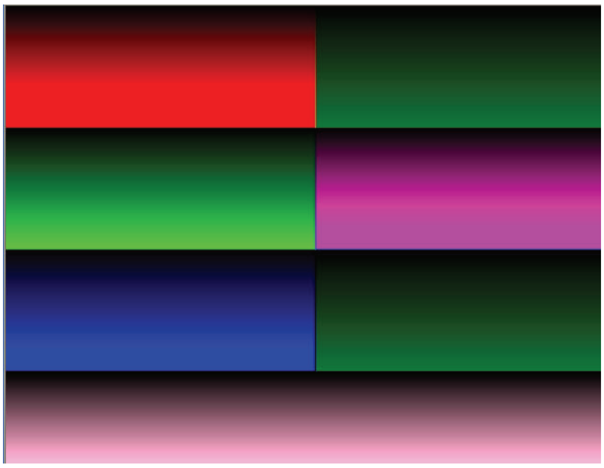


Figure 90: Color test image

Mono8 (raw data)

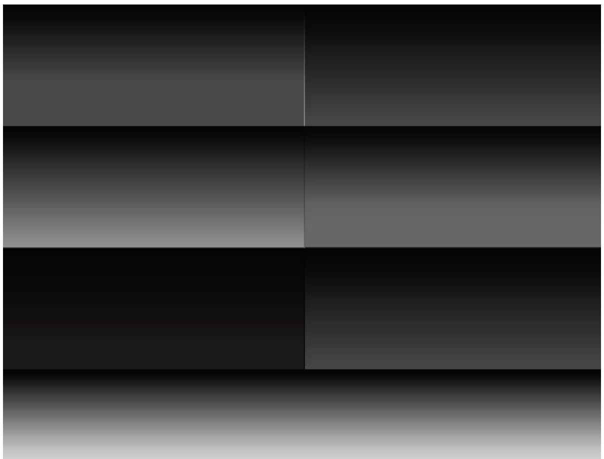


Figure 91: Bayer-coded test image

The color camera outputs Bayer-coded raw data in Mono8 instead of - as described in IIDC V1.31 - a real Y signal. The first pixel of the image is always the red pixel from the sensor. (Mirror must be switched off.)

Configuration of the camera

All camera settings are made by writing specific values into the corresponding registers.

This applies to:

- values for general operating states such as video formats and modes, exposure times, etc.
- extended features of the camera that are turned on and off and controlled via corresponding registers (so-called advanced registers).

Camera_Status_Register

The interoperability of cameras from different manufacturers is ensured by IIDC, formerly DCAM (Digital Camera Specification), published by the IEEE 1394 Trade Association.

IIDC is primarily concerned with setting memory addresses (e.g. CSR: Camera_Status_Register) and their meaning.

In principle all addresses in IEEE 1394 networks are 64 bits long.

The first 10 bits describe the Bus_Id, the next 6 bits the Node_Id.

Of the subsequent 48 bits, the first 16 bits are always FFFFh, leaving the description for the Camera_Status_Register in the last 32 bits.

If in the following, mention is made of a CSR F0F00600h, this means in full:

Bus_Id, Node_Id, FFFF F0F00600h

Writing and reading to and from the register can be done with programs such as **FireView** or by other programs developed using an API library (e.g. **FirePackage**).

Every register is 32 bit (big endian) and implemented as follows (MSB = Most Significant Bit; LSB = Least Significant Bit):

Far left

Bit 0	Bit 1	Bit 2	...	Bit 30	Bit 31
MSB					LSB

Table 89: 32-bit register

Example

This requires, for example, that to enable **ISO_Enabled mode** (see Chapter ISO_Enable / Free-Run on page 157), (bit 0 in register 614h), the value 80000000 h must be written in the corresponding register.

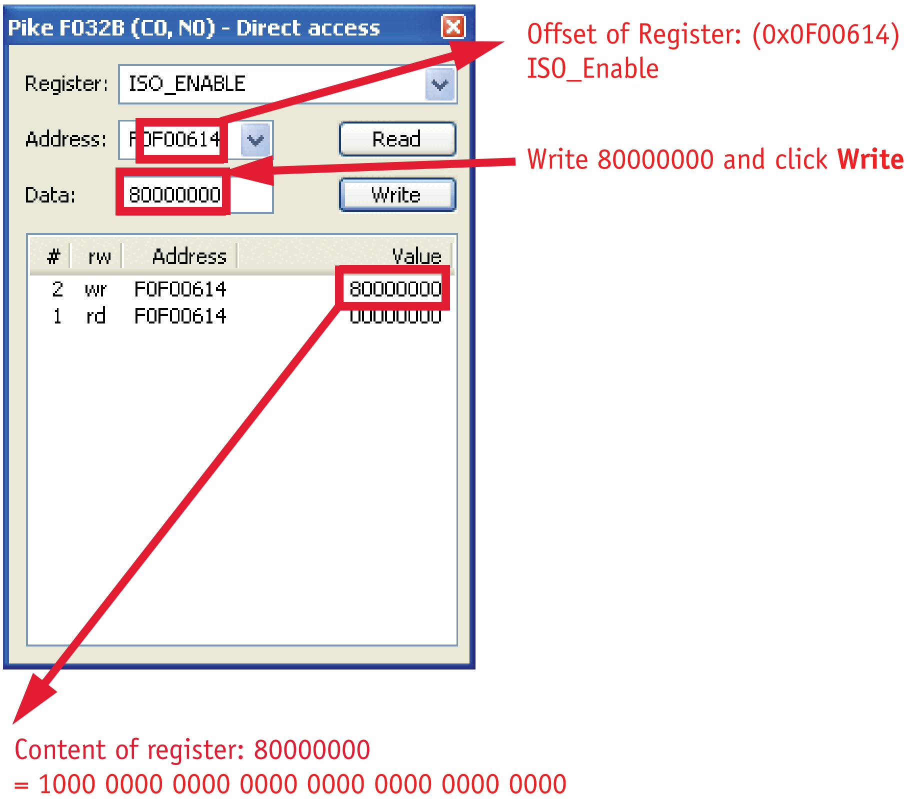


Figure 92: Enabling ISO_Enable

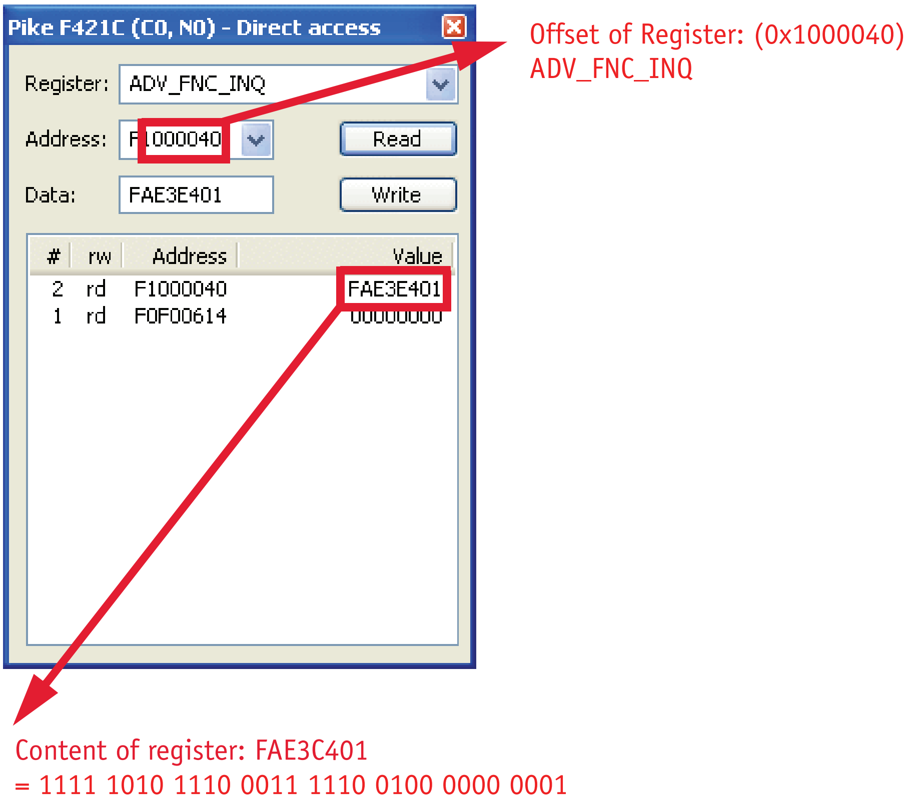


Table 90: Configuring the camera (PIKE F-421C)

	MaxResolution	TimeBase	ExtdShutter	Testimage			VersionInfo		Look-up tables	Shading	DeferredTrans				Trigger Delay	Misc. features
Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	1	1	1	1	1	0	1	0	1	1	1	0	0	0	1	1

	SoftReset	High SNR	ColorCorr			UserProfiles										GP_Buffer
Bit	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	1

Table 91: Configuring the camera: registers

Sample program

The following sample code in C/C++ shows how the register is set for video mode/format, trigger mode etc. using the **FireGrab** and **FireStack API**.

Example FireGrab

```
…
// Set Videoformat
  if(Result==FCE_NOERROR)
  Result= Camera.SetParameter(FGP_IMAGEFORMAT,MAKEIMAGEFORMAT(RES_640_480,
CM_Y8, FR_15));

  // Set external Trigger
  if(Result==FCE_NOERROR)
  Result= Camera.SetParameter(FGP_TRIGGER,MAKETRIGGER(1,0,0,0,0));

  // Start DMA logic
  if(Result==FCE_NOERROR)
   Result=Camera.OpenCapture();

  // Start image device
  if(Result==FCE_NOERROR)
   Result=Camera.StartDevice();

…
```

Example FireStack API

```
…
// Set framerate

Result=WriteQuad(HIGHOFFSET,m_Props.CmdRegBase+CCR_FRAMERATE,(UINT32)m_Parms.F
rameRate<<29);

  // Set mode
  if(Result)

Result=WriteQuad(HIGHOFFSET,m_Props.CmdRegBase+CCR_VMODE,(UINT32)m_Parms.Video
Mode<<29);

  // Set format
  if(Result)

Result=WriteQuad(HIGHOFFSET,m_Props.CmdRegBase+CCR_VFORMAT,(UINT32)m_Parms.Vid
eoFormat<<29);

  // Set trigger
  if(Result)
  {
    Mode=0;
    if(m_Parms.TriggerMode==TM_EXTERN)
     Mode=0x82000000;
    if(m_Parms.TriggerMode==TM_MODE15)
     Mode=0x820F0000;
    WriteQuad(HIGHOFFSET,m_Props.CmdRegBase+CCR_TRGMODE,Mode);
  }

  // Start continous ISO if not oneshot triggermode
  if(Result && m_Parms.TriggerMode!=TM_ONESHOT)
   Result=WriteQuad(HIGHOFFSET,m_Props.CmdRegBase+CCR_ISOENABLE,0x80000000);


…
```

Configuration ROM

The information in the Configuration ROM is needed to identify the node, its capabilities and which drivers are required.

The base address for the **configuration ROM** for all registers is FFFF F0000000h.

Note

If you want to use the **DirectControl** program to read or write to a register, enter the following value in the Address field:

F0F00000h + Offset

The ConfigRom is divided into

- Bus info block: providing critical information about the bus-related capabilities
- Root directory: specifying the rest of the content and organization, such as:
  - Node unique ID leaf
  - Unit directory and
  - Unit dependant info

The base address of the camera control register is calculated as follows based on the camera-specific base address:

	Offset	0-7	8-15	16-23	24-31	
Bus info block	400h	04	29	0C	C0	
	404h	31	33	39	34	.... ASCII for 1394
	408h	20	00	B2	03	.... Bus capabilities
	40Ch	00	0A	47	01	.... Node_Vendor_Id, Chip_id_hi
	410h	Serial number				.... Chip_id_lo
Root directory	414h	00	04	B7	85	According to IEEE1212, the root directory may have another length. The keys (e.g. 8D) point to the offset factors rather than the offset (e.g. 420h) itself.
	418h	03	00	0A	47	
	41Ch	0C	00	83	C0	
	420h	8D	00	00	02	
	424h	D1	00	00	04	

Table 92: Config ROM

The entry with key 8D in the root directory (420h in this case) provides the offset for the Node unique ID leaf.

To compute the effective start address of the node unique ID leaf:

To compute the effective start address of the node unique ID leaf	
currAddr	= node unique ID leaf address
destAddr	= address of directory entry
addrOffset	= value of directory entry
destAddr	= currAddr + (4 * addrOffset)
	= 420h + (4 * 000002h)
	= 428h

Table 93: Computing effective start address

420h + 000002 * 4 = 428h

	Offset	0-7	8-15	16-23	24-31	
→	428h	00	02	5E	9E	....CRC
Node unique ID leaf	42Ch	00	0A	47	01	....Node_Vendor_Id,Chip_id_hi
	430h	00	00	Serial number		

Table 94: Config ROM

The entry with key D1 in the root directory (424h in this case) provides the offset for the unit directory as follows:

424h + 000004 * 4 = 434h

	Offset	0-7	8-15	16-23	24-31
→	434h	00	03	93	7D
Unit directory	438h	12	00	A0	2D
	43Ch	13	00	01	02
	440h	D4	00	00	01

Table 95: Config ROM

The entry with key D4 in the unit directory (440h in this case) provides the offset for unit dependent info:

440h + 000001 * 4 = 444h

	Offset	0-7	8-15	16-23	24-31	
Unit dependent info	444h	00	0B	A9	6E	....unit_dep_info_length, CRC
	448h	40	3C	00	00	....command_regs_base
	44Ch	81	00	00	02	....vender_name_leaf
	450h	82	00	00	06	....model_name_leaf
	454h	38	00	00	10	....unit_sub_sw_version
	458h	39	00	00	00	....Reserved
	45Ch	3A	00	00	00	....Reserved
	460h	3B	00	00	00	....Reserved
	464h	3C	00	01	00	....vendor_unique_info_0
	468h	3D	00	92	00	....vendor_unique_info_1
	46Ch	3E	00	00	65	....vendor_unique_info_2
	470h	3F	00	00	00	....vendor_unique_info_3

Table 96: Config ROM

And finally, the entry with key 40 (448h in this case) provides the offset for the camera control register:

FFFF F0000000h + 3C0000h * 4 = FFFF F0F00000h

The base address of the camera control register is thus:

FFFF F0F00000h

The offset entered in the table always refers to the base address of F0F00000h.

Implemented registers

The following tables show how standard registers from IIDC V1.31 are implemented in the camera. Base address is F0F00000h. Differences and explanations can be found in the third column.

Camera initialize register

Offset	Name	Notes
000h	INITIALIZE	Assert MSB = 1 for Init.

Table 97: Camera initialize register

Inquiry register for video format

Offset	Name	Field	Bit	Description
100h	V_FORMAT_INQ	Format_0	[0]	Up to VGA (non compressed)
		Format_1	[1]	SVGA to XGA
		Format_2	[2]	SXGA to UXGA
		Format_3	[3..5]	Reserved
		Format_6	[6]	Still Image Format
		Format_7	[7]	Partial Image Format
		-	[8..31]	Reserved

Table 98: Format inquiry register

Inquiry register for video mode

Offset	Name	Field	Bit	Description
180h	V_MODE_INQ (Format_0)	Mode_0	[0]	160 x 120 YUV 4:4:4
		Mode_1	[1]	320 x 240 YUV 4:2:2
		Mode_2	[2]	640 x 480 YUV 4:1:1
		Mode_3	[3]	640 x 480 YUV 4:2:2
		Mode_4	[4]	640 x 480 RGB
		Mode_5	[5]	640 x 480 Mono8
		Mode_6	[6]	640 x 480 Mono16
		Mode_X	[7]	Reserved
		-	[8..31]	Reserved (zero)
184h	V_MODE_INQ (Format_1)	Mode_0	[0]	800 x 600 YUV 4:2:2
		Mode_1	[1]	800 x 600 RGB
		Mode_2	[2]	800 x 600 Mono8
		Mode_3	[3]	1024 x 768 YUV 4:2:2
		Mode_4	[4]	1024 x 768 RGB
		Mode_5	[5]	1024 x 768 Mono8
		Mode_6	[6]	800 x 600 Mono16
		Mode_7	[7]	1024 x 768 Mono16
		-	[8..31]	Reserved (zero)
188h	V_MODE_INQ (Format_2)	Mode_0	[0]	1280 x 960 YUV 4:2:2
		Mode_1	[1]	1280 x 960 RGB
		Mode_2	[2]	1280 x 960 Mono8
		Mode_3	[3]	1600 x 1200 YUV 4:2:2
		Mode_4	[4]	1600 x 1200 RGB
		Mode_5	[5]	1600 x 1200 Mono8
		Mode_6	[6]	1280 x 960 Mono16
		Mode_7	[7]	1600 x 1200 Mono16
		-	[8..31]	Reserved (zero)
18Ch … 197h	Reserved for other V_MODE_INQ_x for Format_x.			Always 0
198h	V_MODE_INQ_6 (Format_6)			Always 0

Table 99: Video mode inquiry register

Offset	Name	Field	Bit	Description
19Ch	V_MODE_INQ (Format_7)	Mode_0	[0]	Format_7 Mode_0
		Mode_1	[1]	Format_7 Mode_1
		Mode_2	[2]	Format_7 Mode_2
		Mode_3	[3]	Format_7 Mode_3
		Mode_4	[4]	Format_7 Mode_4
		Mode_5	[5]	Format_7 Mode_5
		Mode_6	[6]	Format_7 Mode_6
		Mode_7	[7]	Format_7 Mode_7
		-	[8..31]	Reserved (zero)

Table 99: Video mode inquiry register

Inquiry register for video frame rate and base address

Offset	Name	Field	Bit	Description
200h	V_RATE_INQ (Format_0, Mode_0)	FrameRate_0	[0]	Reserved
		FrameRate_1	[1]	Reserved
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
204h	V_RATE_INQ (Format_0, Mode_1)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)

Table 100: Frame rate inquiry register

Offset	Name	Field	Bit	Description
208h	V_RATE_INQ	FrameRate_0	[0]	1.875 fps
	(Format_0, Mode_2)	FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
20Ch	V_RATE_INQ	FrameRate_0	[0]	1.875 fps
	(Format_0, Mode_3)	FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
210h	V_RATE_INQ	FrameRate_0	[0]	1.875 fps
	(Format_0, Mode_4)	FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)

Table 100: Frame rate inquiry register

Offset	Name	Field	Bit	Description
214h	V_RATE_INQ (Format_0, Mode_5)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
218h	V_RATE_INQ	(Format_0, Mode_6) FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
21Ch … 21Fh	Reserved V_RATE_INQ_0_x (for other Mode_x of Format_0)			Always 0
220h	V_RATE_INQ (Format_1, Mode_0)	FrameRate_0	[0]	Reserved
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)

Table 100: Frame rate inquiry register

Offset	Name	Field	Bit	Description
224h	V_RATE_INQ (Format_1, Mode_1)	FrameRate_0	[0]	Reserved
		FrameRate_1	[1]	Reserved
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
228h	V_RATE_INQ (Format_1, Mode_2)	FrameRate_0	[0]	Reserved
		FrameRate_1	[1]	Reserved
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
22Ch	V_RATE_INQ (Format_1, Mode_3)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)

Table 100: Frame rate inquiry register

Offset	Name	Field	Bit	Description
230h	V_RATE_INQ (Format_1, Mode_4)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
234h	V_RATE_INQ (Format_1, Mode_5)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)
238h	V_RATE_INQ (Format_1, Mode_6)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		-	[8..31]	Reserved (zero)

Table 100: Frame rate inquiry register

Offset	Name	Field	Bit	Description
23Ch	V_RATE_INQ (Format_1, Mode_7)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved (zero)
240h	V_RATE_INQ (Format_2, Mode_0)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	Reserved
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved (zero)
244h	V_RATE_INQ (Format_2, Mode_1)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	Reserved
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved (zero)

Table 100: Frame rate inquiry register

Offset	Name	Field	Bit	Description
248h	V_RATE_INQ (Format_2, Mode_2)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved (zero)
24Ch	V_RATE_INQ (Format_2, Mode_3)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	Reserved
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved (zero)
250h	V_RATE_INQ (Format_2, Mode_4)	FrameRate_0	[0]	1.875 fps
		FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	Reserved
		FrameRate_6	[6]	Reserved
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved (zero)

Table 100: Frame rate inquiry register

Offset	Name	Field	Bit	Description
254h	V_RATE_INQ	FrameRate_0	[0]	1.875 fps
	(Format_2, Mode_5)	FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	Reserved
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved (zero)
258h	V_RATE_INQ	FrameRate_0	[0]	1.875 fps
	(Format_2, Mode_6)	FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	Reserved
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved (zero)
25Ch	V_RATE_INQ	FrameRate_0	[0]	1.875 fps
	(Format_2, Mode_7)	FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	Reserved
		FrameRate_7	[7]	Reserved
		-	[8..31]	Reserved
260h … 2BFh	Reserved V_RATE_INQ_y_x (for other Format_y, Mode_x)			
2C0h	V_REV_INQ_6_0 (Format_6, Mode0)			Always 0
2C4h .. 2DFh	Reserved V_REV_INQ_6_x (for other Mode_x of Format_6)			Always 0

Table 100: Frame rate inquiry register

Offset	Name	Field	Bit	Description
2E0h		V-CSR_INQ_7_0	[0..31]	CSR_quadlet offset for Format_7 Mode_0
2E4h		V-CSR_INQ_7_1	[0..31]	CSR_quadlet offset for Format_7 Mode_1
2E8h		V-CSR_INQ_7_2	[0..31]	CSR_quadlet offset for Format_7 Mode_2
2ECh		V-CSR_INQ_7_3	[0..31]	CSR_quadlet offset for Format_7 Mode_3
2F0h		V-CSR_INQ_7_4	[0..31]	CSR_quadlet offset for Format_7 Mode_4
2F4h		V-CSR_INQ_7_5	[0..31]	CSR_quadlet offset for Format_7 Mode_5
2F8h		V-CSR_INQ_7_6	[0..31]	CSR_quadlet offset for Format_7 Mode_6
2FCh		V-CSR_INQ_7_7	[0..31]	CSR_quadlet offset for Format_7 Mode_7

Table 100: Frame rate inquiry register

Inquiry register for basic function

Offset	Name	Field	Bit	Description
400h	BASIC_FUNC_INQ	Advanced_Feature_Inq	[0]	Inquiry for advanced features (Vendor unique Features)
		Vmode_Error_Status_Inq	[1]	Inquiry for existence of Vmode_Error_Status register
		Feature_Control_Error_Status_Inq	[2]	Inquiry for existence of Feature_Control_Error_Status
		Opt_Func_CSR_Inq	[3]	Inquiry for Opt_Func_CSR
		-	[4..7]	
		1394b_mode_Capability	[8]	Inquiry for 1394b_mode_Capability
		-	[9..15]	Reserved
		Cam_Power_Cntl	[16]	Camera process power ON/OFF capability
		-	[17..18]	Reserved
		One_Shot_Inq	[19]	One Shot transmission capability
		Multi_Shot_Inq	[20]	Multi Shot transmission capability
		-	[21..27]	Reserved
		Memory_Channel	[28..31]	Maximum memory channel number (N) If 0000, no user memory available

Table 101: Basic function inquiry register

Inquiry register for feature presence

Offset	Name	Field	Bit	Description
404h	FEATURE_HI_INQ	Brightness	[0]	Brightness Control
		Auto_Exposure	[1]	Auto_Exposure Control
		Sharpness	[2]	Sharpness Control
		White_Balance	[3]	White_Balance Control
		Hue	[4]	Hue Control
		Saturation	[5]	Saturation Control
		Gamma	[6]	Gamma Control
		Shutter	[7]	Shutter Control
		Gain	[8]	Gain Control
		Iris	[9]	Iris Control
		Focus	[10]	Focus Control
		Temperature	[11]	Temperature Control
		Trigger	[12]	Trigger Control
		Trigger_Delay	[13]	Trigger_Delay Control
		White_Shading	[14]	White_Shading Control
		Frame_Rate	[15]	Frame_Rate Control
			[16..31]	Reserved
408h	FEATURE_LO_INQ	Zoom	[0]	Zoom Control
		Pan	[1]	Pan Control
		Tilt	[2]	Tilt Control
		Optical_Filter	[3]	Optical_Filter Control
			[4..15]	Reserved
		Capture_Size	[16]	Capture_Size for Format_6
		Capture_Quality	[17]	Capture_Quality for Format_6
			[16..31]	Reserved
40Ch	OPT_FUNCTION_INQ	-	[0]	Reserved
		PIO	[1]	Parallel Input/Output control
		SIO	[2]	Serial Input/Output control
		Strobe_out	[4..31]	Strobe signal output

Table 102: Feature presence inquiry register

Offset	Name	Field	Bit	Description
410h .. 47Fh	Reserved			Address error on access
480h	Advanced_Feature_Inq	Advanced_Feature_Quadlet_Offset	[0..31]	Quadlet offset of the advanced feature CSR's from the base address of initial register space (Vendor unique) This register is the offset for the Access_Control_Register and thus the base address for Advanced Features. Access_Control_Register does not prevent access to advanced features. In some programs it should still always be activated first. **Advanced Feature Set Unique Value** is 7ACh and **CompanyID** is A47h.
484h	PIO_Control_CSR_Inq	PIO_Control_Quadlet_Offset	[0..31]	Quadlet offset of the PIO_Control CSR's from the base address of initial register space (Vendor unique)
488h	SIO_Control_CSR_Inq	SIO_Control_Quadlet_Offset	[0..31]	Quadlet offset of the SIO_Control CSR's from the base address of initial register space (Vendor unique)
48Ch	Strobe_Output_CSR_Inq	Strobe_Output_Quadlet_Offset	[0..31]	Quadlet offset of the Strobe_Output signal CSR's from the base address of initial register space (Vendor unique)

Table 102: Feature presence inquiry register

Inquiry register for feature elements

Register	Name	Field	Bit	Description
0xF0F00500	BRIGHTNESS_INQUIRY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One Push auto mode (Controlled automatically by the camera once)
		Readout_Inq	[4]	Capability of reading out the value of this feature
		ON_OFF	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto Mode (Controlled automatically by the camera)
		Manual_Inq	[7]	Manual Mode (Controlled by user)
		Min_Value	[8..19]	Min. value for this feature
		Max_Value	[20..31]	Max. value for this feature
504h	AUTO_EXPOSURE_INQ	Same definition as Brightness_inq.		
508h	SHARPNESS_INQ	Same definition as Brightness_inq.		
50Ch	WHITE_BAL_INQ	Same definition as Brightness_inq.		
510h	HUE_INQ	Same definition as Brightness_inq.		
514h	SATURATION_INQ	Same definition as Brightness_inq.		
518h	GAMMA_INQ	Same definition as Brightness_inq.		
51Ch	SHUTTER_INQ	Same definition as Brightness_inq.		
520h	GAIN_INQ	Same definition as Brightness_inq.		
524h	IRIS_INQ	Always 0		
528h	FOCUS_INQ	Always 0		
52Ch	TEMPERATURE_INQ	Same definition as Brightness_inq.		

Table 103: Feature elements inquiry register

Register	Name	Field	Bit	Description
530h	TRIGGER_INQ	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2..3	Reserved
		Readout_Inq	[4]	Capability of reading out the value of this feature
		ON_OFF	[5]	Capability of switching this feature ON and OFF
		Polarity_Inq	[6]	Capability of changing the polarity of the trigger input
			[7..15]	Reserved
		Trigger_Mode0_Inq	[16]	Presence of Trigger_Mode 0
		Trigger_Mode1_Inq	[17]	Presence of Trigger_Mode 1
		Trigger_Mode2_Inq	[18]	Presence of Trigger_Mode 2
		Trigger_Mode3_Inq	[19]	Presence of Trigger_Mode 3
			[20..31	Reserved
534h	TRIGGER_DELAY_INQUIRY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One Push auto mode Con-trolled automatically by the camera once)
		Readout_Inq	[4]	Capability of reading out the value of this feature
		ON_OFF	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto Mode (Controlled auto-matically by the camera)
		Manual_Inq	[7]	Manual Mode (Controlled by user)
		Min_Value	[8..19]	Min. value for this feature
		Max_Value	[20..31]	Max. value for this feature
538 .. 57Ch	Reserved for other FEATURE_HI_INQ			
580h	ZOOM_INQ	Always 0		
584h	PAN_INQ	Always 0		

Table 103: Feature elements inquiry register

Register	Name	Field	Bit	Description
588h	TILT_INQ	Always 0		
58Ch	OPTICAL_FILTER_INQ	Always 0		
590 .. 5BCh	Reserved for other FEATURE_LO_INQ	Always 0		
5C0h	CAPTURE_SIZE_INQ	Always 0		
5C4h	CAPTURE_QUALITY_INQ	Always 0		
5C8h .. 5FCh	Reserved for other FEATURE_LO_INQ	Always 0		
600h	CUR-V-Frm_RATE/Revision	Bits [0..2] for the frame rate		
604h	CUR-V-MODE	Bits [0..2] for the current video mode		
608h	CUR-V-FORMAT	Bits [0..2] for the current video format		
60Ch	ISO-Channel	Bits [0..3] for channel, [6..7] for ISO speed		
610h	Camera_Power	Always 0		
614h	ISO_EN/Continuous_Shot	Bit 0: 1 for start continuous shot; 0 for stop continuos shot		
618h	Memory_Save	Always 0		
61Ch	One_Shot, Multi_Shot, Count Number	See text		
620h	Mem_Save_Ch	Always 0		
624	Cur_Mem_Ch	Always 0		
628h	Vmode_Error_Status	Error in combination of Format/Mode/ISO Speed: Bit(0): No error; Bit(0)=1: error		

Table 103: Feature elements inquiry register

Inquiry register for absolute value CSR offset address

Offset	Name	Notes
700h	ABS_CSR_HI_INQ_0	Always 0
704h	ABS_CSR_HI_INQ_1	Always 0
708h	ABS_CSR_HI_INQ_2	Always 0
70Ch	ABS_CSR_HI_INQ_3	Always 0
710h	ABS_CSR_HI_INQ_4	Always 0
714h	ABS_CSR_HI_INQ_5	Always 0
718h	ABS_CSR_HI_INQ_6	Always 0
71Ch	ABS_CSR_HI_INQ_7	Always 0
720h	ABS_CSR_HI_INQ_8	Always 0
724h	ABS_CSR_HI_INQ_9	Always 0
728h	ABS_CSR_HI_INQ_10	Always 0
72Ch	ABS_CSR_HI_INQ_11	Always 0
730h	ABS_CSR_HI_INQ_12	Always 0
734 .. 77Fh	Reserved	Always 0
780h	ABS_CSR_LO_INQ_0	Always 0
784h	ABS_CSR_LO_INQ_1	Always 0
788h	ABS_CSR_LO_INQ_2	Always 0
78Ch	ABS_CSR_LO_INQ_3	Always 0
790h .. 7BFh	Reserved	Always 0
7C0h	ABS_CSR_LO_INQ_16	Always 0
7C4h	ABS_CSR_LO_INQ_17	Always 0
7C8h .. 7FFh	Reserved	Always 0

Table 104: Absolute value inquiry register

Status and control register for feature

The **OnePush** feature, WHITE_BALANCE, is currently implemented. If this flag is set, the feature becomes immediately active, even if no images are being input (see Chapter One-push automatic white balance on page 106).

Offset	Name	Notes
800h	BRIGHTNESS	See above
804h	AUTO-EXPOSURE	See above Note: **Target grey level** parameter in SmartView corresponds to Auto_exposure register 0xF0F00804 (IIDC).
808h	SHARPNESS	See above
80Ch	WHITE-BALANCE	See above Always 0 for Mono
810h	HUE	See above Always 0 for Mono
814h	SATURATION	See above Always 0 for Mono
818h	GAMMA	See above
81Ch	SHUTTER	see Advanced Feature time base see Table 45: Shutter CSR on page 109
820h	GAIN	See above
824h	IRIS	Always 0
828h	FOCUS	Always 0
82Ch	TEMPERATURE	Always 0
830h	TRIGGER-MODE	Can be effected via advanced feature IO_INP_CTRLx.
834h .. 87C	Reserved for other FEATURE_HI	Always 0
880h	Zoom	Always 0
884h	PAN	Always 0
888h	TILT	Always 0
88Ch	OPTICAL_FILTER	Always 0
890 .. 8BCh	Reserved for other FEATURE_LO	Always 0
8C0h	CAPTURE-SIZE	Always 0

Table 105: Feature control register

Offset	Name	Notes
8C4h	CAPTURE-QUALITY	Always 0
8C8h .. 8FCh	Reserved for other FEATURE_LO	Always 0

Table 105: Feature control register

Feature control error status register

Offset	Name	Notes
640h	Feature_Control_Error_Status_HI	Always 0
644h	Feature_Control_Error_Status_LO	Always 0

Table 106: Feature control error register

Video mode control and status registers for Format_7

Quadlet offset Format_7 Mode_0

The quadlet offset to the base address for **Format_7 Mode_0**, which can be read out at F0F002E0h (according to Table 100: Frame rate inquiry register on page 197) gives 003C2000h.

4 x 3C2000h = F08000h so that the base address for the latter (Table 107: Format_7 control and status register on page 214) equals F0000000h + F08000h = F0F08000h.

Quadlet offset Format_7 Mode_1

The quadlet offset to the base address for **Format_7 Mode_1**, which can be read out at F0F002E4h (according to Table 100: Frame rate inquiry register on page 197) gives 003C2400h.

4 x 003C2400h = F09000h so that the base address for the latter (Table 107: Format_7 control and status register on page 214) equals F0000000h + F09000h = F0F09000h.

Format_7 control and status register (CSR)

Offset	Name	Notes
000h	MAX_IMAGE_SIZE_INQ	According to IIDC V1.31
004h	UNIT_SIZE_INQ	According to IIDC V1.31

Table 107: Format_7 control and status register

Offset	Name	Notes
008h	IMAGE_POSITION	According to IIDC V1.31
00Ch	IMAGE_SIZE	According to IIDC V1.31
010h	COLOR_CODING_ID	See note
014h	COLOR_CODING_INQ	According to IIDC V1.31
034h	PIXEL_NUMER_INQ	According to IIDC V1.31
038h	TOTAL_BYTES_HI_INQ	According to IIDC V1.31
03Ch	TOTAL_BYTES_LO_INQ	According to IIDC V1.31
040h	PACKET_PARA_INQ	See note
044h	BYTE_PER_PACKET	According to IIDC V1.31

Table 107: Format_7 control and status register

Note

- For all modes in Format_7, **ErrorFlag_1** and **ErrorFlag_2** are refreshed on each access to the Format_7 Register.
- Contrary to IIDC DCAM V1.31, registers relevant to Format_7 are refreshed on each access. The **Setting_1** bit is automatically cleared after each access.
- When **ErrorFlag_1** or **ErrorFlag_2** are set and Format_7 is configured, no image capture is started.
- Contrary to IIDC V1.31, COLOR_CODING_ID is set to a default value after an INITIALIZE or **reset**.
- Contrary to IIDC V1.31, the **UnitBytePerPacket** field is already filled in with a fixed value in the PACKET_PARA_INQ register.

Advanced features

The camera has a variety of extended features going beyond the possibilities described in IIDC V1.31 The following chapter summarizes all available advanced features in ascending register order.

The following table gives an overview of all available registers:

Register	Register name	Remarks
0XF1000010	VERSION_INFO1	see Table 109: Version information register on page 218
0XF1000018	VERSION_INFO3	
0XF1000040	ADV_INQ_1	see Table 111: Advanced feature inquiry register on page 220
0XF1000044	ADV_INQ_2	
0XF1000048	ADV_INQ_3	
0XF100004C	ADV_INQ_4	
0xF1000100	CAMERA_STATUS	see Table 112: Camera status register on page 222
0XF1000200	MAX_RESOLUTION	see Table 113: Max. resolution inquiry register on page 223
0XF1000208	TIMEBASE	see Table 114: Time base configuration register on page 223
0XF100020C	EXTD_SHUTTER	see Table 116: Extended shutter configuration register on page 225
0XF1000210	TEST_IMAGE	see Table 117: Test image configuration register on page 226
0XF1000240	LUT_CTRL	see Table 118: LUT control register on page 227
0XF1000244	LUT_MEM_CTRL	
0XF1000248	LUT_INFO	
0XF1000250	SHDG_CTRL	see Table 119: Shading control register on page 230
0XF1000254	SHDG_MEM_CTRL	
0XF1000258	SHDG_INFO	
0XF1000260	DEFERRED_TRANS	see Table 121: Deferred image configuration register on page 233
0XF1000270	FRAMEINFO	see Table 122: Frame information configuration register on page 234
0XF1000274	FRAMECOUNTER	
0XF1000300	IO_INP_CTRL1	see Table 32: Input configuration register on page 85
0XF1000304	IO_INP_CTRL2	
0XF1000308	IO_INP_CTRL3	
0XF100030C	IO_INP_CTRL4	

Table 108: Advanced registers summary

Register	Register name	Remarks
0XF1000320	IO_OUTP_CTRL1	see Table 38: Output configuration register on page 93
0XF1000324	IO_OUTP_CTRL2	
0XF1000328	IO_OUTP_CTRL3	
0XF100032C	IO_OUTP_CTRL4	
0XF1000340	IO_INTENA_DELAY	see Table 123: Delayed integration enable configuration register on page 235
0XF1000360	AUTOSHUTTER_CTRL	see Table 124: Auto shutter control advanced register on page 236
0XF1000364	AUTOSHUTTER_LO	
0XF1000368	AUTOSHUTTER_HI	
0XF1000370	AUTOGAIN_CTRL	see Table 125: Advanced register for auto gain control on page 237
0XF1000390	AUTOFNC_AOI	see Table 126: Advanced register for autofunction AOI on page 238
0XF1000394	AF_AREA_POSITION	
0XF1000398	AF_AREA_SIZE	
0XF10003A0	COLOR_CORR	Pike color cameras only see Table 127: Color correction on page 239
0xF10003A4	COLOR_CORR_COEFFIC11 = Crr	Pike color camera only see Table 127: Color correction on page 239
0xF10003A8	COLOR_CORR_COEFFIC12 = Cgr	
0xF10003AC	COLOR_CORR_COEFFIC13 = Cbr	
0xF10003B0	COLOR_CORR_COEFFIC21 = Crg	
0xF10003B4	COLOR_CORR_COEFFIC22 = Cgg	
0xF10003B8	COLOR_CORR_COEFFIC23 = Cbg	
0xF10003BC	COLOR_CORR_COEFFIC31 = Crb	
0xF10003C0	COLOR_CORR_COEFFIC32 = Cgb	
0xF10003C4	COLOR_CORR_COEFFIC33 = Cbb	
0XF1000400	TRIGGER_DELAY	see Table 128: Trigger delay advanced CSR on page 240
0XF1000410	MIRROR_IMAGE	see Table 129: Mirror control register on page 241
0XF1000420	AFE_CHN_COMP	see Table 130: Channel balance register on page 241
0XF1000424		
0XF1000428		
0XF1000510	SOFT_RESET	see Table 131: Soft reset register on page 242
0XF1000520	HIGH_SNR	see Table 132: High Signal Noise Ratio (HSNR) on page 242
0X1000550	USER PROFILES	see Table 133: User profiles on page 243

Table 108: Advanced registers summary

Register	Register name	Remarks
0XF1000FFC	GPDATA_INFO	see Table 136: GPData buffer register on page 246
0XF1001000 ... 0XF100nnnn	GPDATA_BUFFER	

Table 108: Advanced registers summary

Note

Advanced features should always be activated before accessing them.

Note

- Currently all registers can be written without being activated. This makes it easier to operate the camera using **Directcontrol**.
- AVT reserves the right to require activation in future versions of the software.

Version information inquiry

The presence of each of the following features can be queried by the **0** bit of the corresponding register.

Register	Name	Field	Bit	Description
0xF1000010	VERSION_INFO1	µC type ID	[0..15]	Always 0
		µC version	[16..31]	Bcd-coded version number
0xF1000014			[0..31]	Reserved
0xF1000018	VERSION_INFO3	Camera type ID	[0..15]	See Table 110: Camera type ID list on page 219.
		FPGA version	[16..31]	Bcd-coded version number
0xF100001C			[0..31]	Reserved
0xF1000020		---	[0..31]	Reserved
0xF1000024		---	[0..31]	Reserved
0xF1000028		---	[0..31]	Reserved
0xF100002C		---	[0..31]	Reserved
0xF1000030		OrderIDHigh	[0..31]	8 Byte ASCII Order ID
0xF1000034		OrderIDLow	[0..31]	

Table 109: Version information register

The µC version and FPGA firmware version numbers are bcd-coded, which means that e.g. firmware version 0.85 is read as 0x0085 and version 1.10 is read as 0x0110.

The FPGA type ID (= camera type ID) identifies the camera type with the help of the following list:

ID	Camera type
101	PIKE F-032B
102	PIKE F-032C
103	PIKE F-100B
104	PIKE F-100C
105	PIKE F-145B
106	PIKE F-145C
107	PIKE F-210B
108	PIKE F-210C
109	-
110	-
111	PIKE F-421B
112	PIKE F-421C

Table 110: Camera type ID list

Advanced feature inquiry

This register indicates with a named bit if a feature is present or not. If a feature is marked as not present the associated register space might not be available and read/write errors may occur.

Note

Ignore unnamed bits in the following table: these bits might be set or not.

Register	Name	Field	Bit	Description
0xF1000040	ADV_INQ_1	MaxResolution	[0]	
		TimeBase	[1]	
		ExtdShutter	[2]	
		TestImage	[3]	
		FrameInfo	[4]	
		Sequences	[5]	
		VersionInfo	[6]	
		---	[7]	Reserved
		Look-up tables	[8]	
		Shading	[9]	
		DeferredTrans	[10]	
		HDR mode	[11]	
		---	[12]	Reserved
		---	[13]	Reserved
		TriggerDelay	[14]	
		Mirror image	[15]	
		Soft Reset	[16]	
		High SNR	[17]	
		Color Correction	[18]	
		---	[19..20]	Reserved
		User Sets	[21]	
		---	[22..30]	Reserved
		GP_Buffer	[31]	

Table 111: Advanced feature inquiry register

Register	Name	Field	Bit	Description
0xF1000044	ADV_INQ_2	Input_1	[0]	
		Input_2	[1]	
		---	[2..7]	Reserved
		Output_1	[8]	
		Output_2	[9]	
		Output_3	[10]	
		Output_4	[11]	
		---	[12..15]	Reserved
		IntEnaDelay	[16]	
		---	[17..31]	Reserved
0xF1000048	ADV_INQ_3	Camera Status	[0]	
		---	[1..3]	Reserved
		Auto Shutter	[4]	
		Auto Gain	[5]	
		Auto FNC AOI	[6]	
		---	[7..31]	Reserved
0xF100004C	ADV_INQ_4	HDR Pike	[0]	
		---	[18..31]	Reserved

Table 111: Advanced feature inquiry register

Camera status

This register allows to determine the current status of the camera. The most important flag is the **Idle** flag.

If the **Idle** flag is set the camera does not capture and does not send any images (but images might be present in the image FIFO).

The **ExSyncArmed** flag indicates that the camera is set up for external triggering. Even if the camera is waiting for an external trigger event the **Idle** flag might get set.

Other bits in this register might be set or toggled: just ignore these bits.

Note

- Excessive polling of this register may slow down the operation of the camera. Therefore the time between two polls of the status register should not be less than 5 milliseconds. If the time between two read accesses is lower than 5 milliseconds the response will be delayed.
- Depending on shutter and isochronous settings the status flags might be set for a very short time and thus will not be recognized by your application.

Register	Name	Field	Bit	Description
0xF1000100	CAMERA_STATUS	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..23]	Reserved
		ID	[24..31]	Implementation ID = 0x01
0xF1000104		---	[0..14]	Reserved
		ExSyncArmed	[15]	External trigger enabled
		---	[16..27]	Reserved
		ISO	[28]	Isochronous transmission
		---	[29..30]	Reserved
		Idle	[31]	Camera idle

Table 112: Camera status register

Maximum resolution

This register indicates the highest resolution for the sensor and is read-only.

This register normally outputs the MAX_IMAGE_SIZE_INQ Format_7 Mode_0 value.

Register	Name	Field	Bit	Description
0xF1000200	MAX_RESOLUTION	MaxHeight	[0..15]	Sensor height (read only)
		MaxWidth	[16..31]	Sensor width (read only)

Table 113: Max. resolution inquiry register

Time base

Corresponding to IIDC, exposure time is set via a 12-bit value in the corresponding register (SHUTTER_INQ [51Ch] and SHUTTER [81Ch]).

This means that a value in the range of 1 to 4095 can be entered.

PIKE cameras use a time base which is multiplied by the shutter register value. This multiplier is configured as the time base via the TIMEBASE register.

Register	Name	Field	Bit	Description
0xF1000208	TIMEBASE	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..7]	Reserved
		ExpOffset	[8..19]	Exposure offset in µs
		---	[20..27]	Reserved
		Timebase_ID	[28..31]	See Table 115: Time base ID on page 224.

Table 114: Time base configuration register

The time base IDs 0-9 are in bits 28 to 31. See Table 115: Time base ID on page 224.

Default time base is 20 µs: This means that the integration time can be changed in 20 µs increments with the shutter control.

Note

Time base can only be changed when the camera is in idle state and becomes active only after setting the shutter value.

The **ExpOffset** field specifies the camera specific exposure time offset in microseconds (µs). This time (which should be equivalent to Table 61: Camera-specific exposure time offset on page 152) has to be added to the exposure time (set by any shutter register) to compute the real exposure time.

If **ExpOffset** = zero: unknown exposure time offset.

ID	Time base in µs	
0	1	
1	2	
2	5	
3	10	
4	**20**	**Default value**
5	50	
6	100	
7	200	
8	500	
9	1000	

Table 115: Time base ID

Note

The ABSOLUTE VALUE CSR register, introduced in IIDC V1.3, is not implemented.

Extended shutter

The exposure time for long-term integration of up to 67 seconds can be entered with µs precision via the EXTENDED_SHUTTER register.

Register	Name	Field	Bit	Description
0xF100020C	EXTD_SHUTTER	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ExpTime	[6..31]	Exposure time in µs

Table 116: Extended shutter configuration register

The minimum allowed exposure time depends on the camera model. To determine this value write **1** to the **ExpTime** field and read back the minimum allowed exposure time.

The longest exposure time, 3FFFFFFh, corresponds to 67.11 sec.

Note

- Exposure times entered via the 81Ch register are mirrored in the extended register, but not vice versa.
- Changes in this register have immediate effect, even when camera is transmitting.
- Extended shutter becomes inactive after writing to a format / mode / frame rate register.
- Extended shutter setting will thus be overwritten by the normal time base/shutter setting after Stop/Start of FireView or FireDemo.

Test images

Bits **8-14** indicate which test images are saved. Setting bits **28-31** activates or deactivates existing test images.

By activating any test image the following auto features are automatically disabled:

- auto gain
- auto shutter
- auto white balance

Register	Name	Field	Bit	Description
0xF1000210	TEST_IMAGE	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..7]	Reserved
		Image_Inq_1	[8]	Presence of test image 1 0: N/A 1: Available
		Image_Inq_2	[9]	Presence of test image 2 0: N/A 1: Available
		Image_Inq_3	[10]	Presence of test image 3 0: N/A 1: Available
		Image_Inq_4	[11]	Presence of test image 4 0: N/A 1: Available
		Image_Inq_5	[12]	Presence of test image 5 0: N/A 1: Available
		Image_Inq_6	[13]	Presence of test image 6 0: N/A 1: Available
		Image_Inq_7	[14]	Presence of test image 7 0: N/A 1: Available
		---	[15..27]	Reserved
		TestImage_ID	[28..31]	0: No test image active 1: Image 1 active 2: Image 2 active …

Table 117: Test image configuration register

Look-up tables (LUT)

Load the look-up tables to be used into the camera and choose the look-up table number via the **LutNo** field. Now you can activate the chosen LUT via the LUT_CTRL register.

The LUT_INFO register indicates how many LUTs the camera can store and shows the maximum size of the individual LUTs.

The possible values for **LutNo** are 0..n-1, whereas n can be determined by reading the field **NumOfLuts** of the LUT_INFO register.

Register	Name	Field	Bit	Description
0xF1000240	LUT_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Enable/disable this feature
		---	[7..25]	Reserved
		LutNo	[26..31]	Use look-up table with **LutNo** number
0xF1000244	LUT_MEM_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	Reserved
		EnableMemWR	[5]	Enable write access
		---	[6..7]	Reserved
		AccessLutNo	[8..15]	Reserved
		AddrOffset	[16..31]	byte
0xF1000248	LUT_INFO	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..2]	Reserved
		BitsPerValue	[3..7]	Bits used per table item
		NumOfLuts	[8..15]	Maximum number of look-up tables
		MaxLutSize	[16..31]	Maximum look-up table size (bytes)

Table 118: LUT control register

Note

The **BitsPerValue** field indicates how many bits are read from the LUT for any gray-value read from the sensor. To determine the number of bytes occupied for each gray-value round-up the **BitsPerValue** field to the next byte boundary.

Examples:

- BitsPerValue = 8 → 1 byte per gray-value
- BitsPerValue = 14 → 2 byte per gray-value

Divide **MaxLutSize** by the number of bytes per gray-value in order to get the number of bits read from the sensor.

Note

Pike cameras have the gamma feature implemented via a built-in look-up table. Therefore you can not use gamma and your own look-up table at the same time. Nevertheless you may combine a gamma look-up table into your own look-up table.

Note

When using the LUT feature and the gamma feature pay attention to the following:

- gamma ON → look-up table is switched ON also
- gamma OFF → look-up table is switched OFF also
- look-up table OFF → gamma is switched OFF also
- look-up table ON → gamma is switched OFF

Loading a look-up table into the camera

Loading a look-up table into the camera is done through the GPDATA_BUFFER. Because the size of the GPDATA_BUFFER is smaller than a complete look-up table the data must be written in multiple steps.

To load a lookup table into the camera:

1. Query the limits and ranges by reading LUT_INFO and GPDATA_INFO.
2. Set **EnableMemWR** to true (1).
3. Set **AccessLutNo** to the desired number.
4. Set **AddrOffset** to 0.
5. Write n lookup table data bytes to GPDATA_BUFFER (n might be lower than the size of the GPDATA_BUFFER; AddrOffset is automatically adjusted inside the camera).
6. Repeat step 5 until all data is written into the camera.
7. Set **EnableMemWR** to false (0).

Shading correction

Owing to technical circumstances, the interaction of recorded objects with one another, optical effects and lighting non-homogeneities may occur in the images.

Because these effects are normally not desired, they should be eliminated as far as possible in subsequent image editing. The camera has automatic shading correction to do this.

Provided that a shading image is present in the camera, the **on/off** bit can be used to enable shading correction.

The **on/off** and **ShowImage** bits must be set for saved shading images to be displayed.

Note

- Always make sure that the shading image is saved at the highest resolution of the camera. If a lower resolution is chosen and ShowImage is set to **true**, the image will not be displayed correctly.
- The shading image is computed using the current video settings. On fixed video modes the selected frame rate also affects the computation time.
- The build process will not work, if a MONO16/RGB16 format is active.

Register	Name	Field	Bit	Description
0xF1000250	SHDG_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		BuildError	[1]	Could not built shading image
		---	[2..3]	Reserved
		ShowImage	[4]	Show shading data as image
		BuildImage	[5]	Build a new shading image
		ON_OFF	[6]	Shading on/off
		Busy	[7]	Build in progress
		MemChannelSave	[8]	Save shading data in flash memory
		MemChannelLoad	[9]	Load shading data from flash memory
		MemChannelClear	[10]	Erase flash memory
		---	[11..15]	Reserved
		MemChannelError	[16..19]	Indicates memory channel error. See Table 120: Memory channel error description on page 232.
		MemoryChannel	[20..23]	Set memory channel number for save and load operations
		GrabCount	[24..31]	Number of images
0xF1000254	SHDG_MEM_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	Reserved
		EnableMemWR	[5]	Enable write access
		EnableMemRD	[6]	Enable read access
		---	[7]	Reserved
		AddrOffset	[8..31]	In bytes
0xF1000258	SHDG_INFO	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..3]	Reserved
		MaxMemChannel	[4..7]	Maximum number of available memory channels to store shading images
		MaxImageSize	[8..31]	Maximum shading image size (in bytes)

Table 119: Shading control register

Reading or writing shading image from/into the camera

Accessing the shading image inside the camera is done through the GPDATA_BUFFER. Because the size of the GPDATA_BUFFER is smaller than a whole shading image the data must be written in multiple steps.

To read or write a shading image:

1. Query the limits and ranges by reading SHDG_INFO and GPDATA_INFO.
2. Set **EnableMemWR** or **EnableMemRD** to true (1).
3. Set **AddrOffset** to 0.
4. Write n shading data bytes to GPDATA_BUFFER (n might be lower than the size of the GPDATA_BUFFER; AddrOffset is automatically adjusted inside the camera).
5. Repeat step 4 until all data is written into the camera.
6. Set **EnableMemWR** and **EnableMemRD** to false.

Automatic generation of a shading image

Shading image data may also be generated by the camera. To use this feature make sure all settings affecting an image are set properly. The camera uses the current active resolution to generate the shading image.

To generate a shading image:

1. Set **GrabCount** to the number of the images to be averaged before the correction factors are calculated.
2. Set **BuildImage** to true.
3. Poll the SHDG_CTRL register until the **Busy** and **BuildImage** flags are reset automatically.

The maximum value of GrabCount depends on the camera type and the number of available image buffers. GrabCount is automatically adjusted to a power of two.

Do not poll the SHDG_CTRL register too often, while automatic generation is in progress. Each poll delays the process of generating the shading image. An optimal poll interval time is 500 ms.

Non-volatile memory operations

Pike cameras support storing shading image data into non-volatile memory. Once a shading image is stored it is automatically reloaded on each camera reset.

MaxMemChannel indicates the number of so-called memory channels/slots available for storing shading images.

To store a shading image into non-volatile memory:

1. Set **MemoryChannel** to the desired memory channel and **MemoryChannelSave** to true (1).
2. Read **MemoryChannelError** to check for errors.

To reload a shading image from non-volatile memory:

1. Set **MemoryChannel** to the desired memory channel and **MemChannelLoad** to true (1).
2. Read **MemChannelError** to check for errors.

To clear already stored shading image data in non-volatile memory (shading image data won't be loaded on camera resets):

1. Set **MemoryChannel** to the desired memory channel and **MemChannelClear** to true (1).
2. Read **MemChannelError** to check for errors.

Memory channel error codes

ID	Error description
0x00	No error
0x01	Memory detection error
0x02	Memory size error
0x03	Memory erase error
0x04	Memory write error
0x05	Memory header write error
0x0F	Memory channel out of range

Table 120: Memory channel error description

Deferred image transport

Using this register, the sequence of recording and the transfer of the images can be paused. Setting **HoldImg** prevents transfer of the image. The images are stored in **ImageFIFO**.

The images indicated by **NumOfImages** are sent by setting the **SendImage** bit.

When **FastCapture** is set (in Format_7 only), images are recorded at the highest possible frame rate.

Register	Name	Field	Bit	Description
0xF1000260	DEFERRED_TRANS	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	Reserved
		SendImage	[5]	Send NumOfImages now (auto reset)
		HoldImg	[6]	Enable/Disable deferred transport mode
		FastCapture	[7]	Enable/disable fast capture mode
		---	[8..15]	Reserved
		FiFoSize	[16..23]	Size of FiFo in number of images (read only)
		NumOfImages	[24..31]	Write: Number of images to send Read: Number of images in buffer

Table 121: Deferred image configuration register

Frame information

Register	Name	Field	Bit	Description
0xF1000270	FRAMEINFO	Presence_Inq	[0]	Indicates presence of this feature (read only)
		ResetFrameCnt	[1]	Reset frame counter
		---	[1..31]	Reserved
0xF1000274	FRAMECOUNTER	FrameCounter	[0..31]	Number of captured frames since last reset

Table 122: Frame information configuration register

The **FrameCounter** is incremented when an image is read out of the sensor.

The **FrameCounter** does not indicate whether an image was sent over the IEEE 1394 bus or not.

Input/output pin control

See Chapter Input/output pin control on page 85

Triggers

See Chapter Triggers on page 84

IO_INP_CTRL 1-2

See Chapter IO_INP_CTRL 1-2 on page 86

IO_OUTP_CTRL 1-4

See Chapter IO_OUTP_CTRL 1-4 on page 93

Output mode

See Chapter Output modes on page 94

Delayed Integration enable

A delay time between initiating exposure on the sensor and the activation edge of the **IntEna** signal can be set using this register. The **on/off** flag activates/deactivates integration delay. The time can be set in µs in **DelayTime**.

Note

- Please note that only one edge is delayed.
- If **IntEna_Out** is used to control an exposure, it is possible to have a variation in brightness or to precisely time a flash.

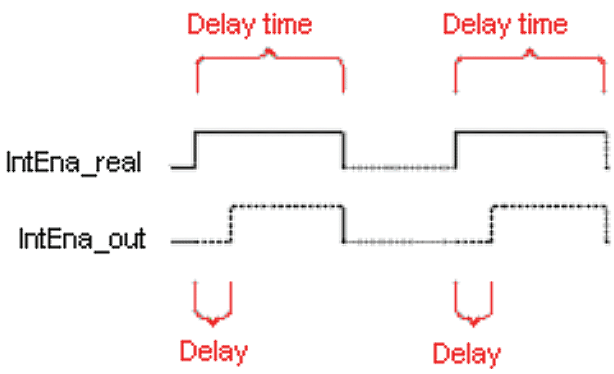


Figure 93: Delayed integration timing

Register	Name	Field	Bit	Description
0xF1000340	IO_INTENA_DELAY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Enable/disable integration enable delay
		---	[7..11]	Reserved
		DELAY_TIME	[12..31]	Delay time in µs

Table 123: Delayed integration enable configuration register

Auto shutter control

The table below illustrates the advanced register for **auto shutter control**. The purpose of this register is to limit the range within which auto shutter operates.

Register	Name	Field	Bit	Description
0xF1000360	AUTOSHUTTER_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..31]	Reserved
0xF1000364	AUTOSHUTTER_LO	---	[0..5]	Reserved
		MinValue	[6..31]	Minimum auto shutter value lowest possible value: 10 µs
0xF1000368	AUTOSHUTTER_HI	---	[0..5]	Reserved
		MaxValue	[0..31]	Maximum auto shutter value

Table 124: Auto shutter control advanced register

Note

- Values can only be changed within the limits of shutter CSR.
- Changes in auto exposure register only have an effect when auto shutter is enabled.
- Auto exposure limits are: 50..205 (**SmartView→Ctrl1 tab**: **Target grey level**)

When both auto shutter and auto gain are enabled, priority is given to increasing shutter when brightness decreases. This is done to achieve the best image quality with lowest noise.

For increasing brightness, priority is given to lowering gain first for the same purpose.

MinValue and **MaxValue** limits the range the auto shutter feature is allowed to use for the regulation process. Both values are initialized with the minimum and maximum value defined in the standard SHUTTER_INQ register (multiplied by the current active timebase).

If you change the **MinValue** and/or **MaxValue** and the new range exceeds the range defined by the SHUTTER_INQ register, the standard SHUTTER register will not show correct shutter values. In this case you should read the EXTENDED_SHUTTER register for the current active shutter time.

Changing the auto shutter range might not affect the regulation, if the regulation is in a stable condition and no other condition affecting the image brightness is changed.

If both auto gain and auto shutter are enabled and if the shutter is at its upper boundary and gain regulation is in progress, increasing the upper auto shutter boundary has no effect on auto gain/shutter regulation as long as auto gain regulation is active.

Note

As with the Extended Shutter the value of **MinValue** and **MaxValue** must not be set to a lower value than the minimum shutter time.

Auto gain control

The table below illustrates the advanced register for auto gain control.

Register	Name	Field	Bit	Description
0xF1000370	AUTOGAIN_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..3]	Reserved
		MaxValue	[4..15]	Maximum auto gain value
		---	[16..19]	Reserved
		MinValue	[20..31]	Minimum auto gain value

Table 125: Advanced register for auto gain control

MinValue and **MaxValue** limits the range the auto gain feature is allowed to use for the regulation process. Both values are initialized with the minimum and maximum value defined in the standard GAIN_INQ register.

Changing the auto gain range might not affect the regulation, if the regulation is in a stable condition and no other condition affecting the image brightness is changed.

If both auto gain and auto shutter are enabled and if the gain is at its lower boundary and shutter regulation is in progress, decreasing the lower auto gain boundary has no effect on auto gain/shutter regulation as long as auto shutter regulation is active.

Both values can only be changed within the range defined by the standard GAIN_INQ register.

Autofunction AOI

The table below illustrates the advanced register for autofunction AOI.

AOI means **area of interest.**

Use this feature to select the image area (work area) on which the following autofunctions work:

- auto shutter
- auto gain
- auto white balance

Note

Autofunction AOI is independent from Format_7 AOI settings.

If you switch off autofunction AOI, work area position and work area size follow the current active image size.

To switch off autofunctions, carry out following actions in the order shown:

1. Uncheck **Show AOI** check box (SmartView **Ctrl2** tab).
2. Uncheck **Enable** check box (SmartView **Ctrl2** tab).
Switch off Auto modi (e.g. **Shutter** and/or **Gain**) (SmartView **Ctrl2** tab).

As a reference it uses a grid of up to 65534 sample points equally spread over the AOI.

Register	Name	Field	Bit	Description
0xF1000390	AUTOFNC_AOI	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..3]	Reserved
		ShowWorkArea	[4]	Show work area
		---	[5]	Reserved
		ON_OFF	[6]	Enable/disable AOI (see note above)
		---	[7]	Reserved
		YUNITS	[8..19]	Y units of work area/pos. beginning with 0 (read only)
		XUNITS	[20..31]	X units of work area/pos. beginning with 0 (read only)
0xF1000394	AF_AREA_POSITION	Left	[0..15]	Work area position (left coordinate)
		Top	[16..31]	Work area position (top coordinate)

Table 126: Advanced register for autofunction AOI

Register	Name	Field	Bit	Description
0xF1000398	AF_AREA_SIZE	Width	[0..15]	Width of work area size
		Height	[16..31]	Height of work area size

Table 126: Advanced register for autofunction AOI

The possible increment of the work area position and size is defined by the YUNITS and XUNITS fields. The camera automatically adjusts your settings to permitted values.

Note

If the adjustment fails and the work area size and/or work area position becomes invalid, then this feature is automatically switched off.

Read back the ON_OFF flag, if this feature does not work as expected.

Color correction

To switch off color correction in YUV mode: see bit [6]

Register	Name	Field	Bit	Description
0xF10003A0	COLOR_CORR	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Color correction on/off default: on Write: 02000000h to switch color correction **OFF** Write: 00000000h to switch color correction **ON**
		Reset	[7]	Reset to defaults
		---	[8..31]	Reserved

Table 127: Color correction

Register	Name	Field	Bit	Description
0xF10003A4	COLOR_CORR_COEFFIC11 = Crr		[0..31]	A number of 1000 equals a color correction coefficient of 1. Color correction values range -1000..+2000 and are **signed 32 bit.** In order for white balance to work properly ensure that the row sum equals to 1000. The maximum row sum is limited to 2000.
0xF10003A8	COLOR_CORR_COEFFIC12 = Cgr		[0..31]	
0xF10003AC	COLOR_CORR_COEFFIC13 = Cbr		[0..31]	
0xF10003B0	COLOR_CORR_COEFFIC21 = Crg		[0..31]	
0xF10003B4	COLOR_CORR_COEFFIC22 = Cgg		[0..31]	
0xF10003B8	COLOR_CORR_COEFFIC23 = Cbg		[0..31]	
0xF10003BC	COLOR_CORR_COEFFIC31 = Crb		[0..31]	
0xF10003C0	COLOR_CORR_COEFFIC32 = Cgb		[0..31]	
0xF10003C4	COLOR_CORR_COEFFIC33 = Cbb		[0..31]	
0xF10003A4 ... 0xF10003FC				Reserved for testing purposes Don’t touch

Table 127: Color correction

For an explanation of the color correction matrix and for further information read Chapter Color correction on page 138.

Trigger delay

Register	Name	Field	Bit	Description
0xF1000400	TRIGGER_DELAY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Trigger delay on/off
		---	[7..10]	Reserved
		DelayTime	[11..31]	Delay time in µs

Table 128: Trigger delay advanced CSR

The advanced register allows start of the integration to be delayed via **DelayTime** by max. 2^{21} µs, which is max. 2.1 s after a trigger edge was detected.

Note Trigger delay works with external trigger modes only.

Mirror image

PIKE cameras are equipped with an electronic mirror function, which mirrors pixels from the left side of the image to the right side and vice versa. The mirror is centered to the actual **FOV** center and can be combined with all image manipulation functions, like **binning** and **shading**.

Register	Name	Field	Bit	Description
0xF1000410	MIRROR_IMAGE	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Mirror image on/off 1: on 0: off Default: off
		---	[7..31]	Reserved

Table 129: Mirror control register

AFE channel compensation (channel balance)

All KODAK PIKE sensors are read out via two channels: the first channel for the left half of the image and the second channel for the right half of the image.

Channel gain adjustment (PIKE color cameras only RAW8 and RAW16) can be done via the following two advanced registers:

Register	Name	Field	Bit	Description
0xF1000420	CHANNEL_ADJUST_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..7]	Reserved
		Save as default	[8]	Set to 1, if you want to save your own values.
		---	[9..31]	Reserved
0xF1000424	CHANNEL_ADJUST_VALUE	---	[0..15]	Reserved
		Balance_Value	[16..31]	Signed 16 bit value -8192...0...+8191 SmartView shows only: -2048...0...+2047

Table 130: Channel balance register

Soft Reset

Register	Name	Field	Bit	Description
0xF1000510	SOFT_RESET	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		Reset	[6]	Initiate reset
		---	[7..19]	Reserved
		Delay	[20..31]	Delay reset in 10 ms steps

Table 131: Soft reset register

The SOFT_RESET feature is similar to the INITIALIZE register, with the following differences:

- 1 or more bus resets will occur
- the FPGA will be rebooted

The reset can be delayed by setting the **Delay** to a value unequal to 0 - the delay is defined in 10 ms steps.

Note

When SOFT_RESET has been defined, the camera will respond to further read or write requests but will not process them.

High SNR mode (High Signal Noise Ratio)

With **High SNR** mode enabled the camera internally grabs **GrabCount** images and outputs a single averaged image.

Register	Name	Field	Bit	Description
0xF1000520	HIGH_SNR	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	High SNR mode on/off
		---	[7..22]	Reserved
		GrabCount	[23..31]	Number of images (min. 2) 2^n images with n=1..8 (automatically)

Table 132: High Signal Noise Ratio (HSNR)

Note

The camera must be idle to toggle this feature on/off.

User profiles

Within the IIDC specification user profiles are called memory channels. Often they are called user sets. In fact these are different expressions for the following: storing camera settings into a non-volatile memory inside the camera.

Offset	Name	Field	Bit	Description
0x1000550	USER_PROFILE	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Error	[1]	An error occurred
		---	[2..7]	Reserved
		SaveProfile	[8]	Save settings to profile
		RestoreProfile	[9]	Load settings from profile
		SetDefaultID	[10]	Set Profile ID as default
		---	[11..19]	Reserved
		ErrorCode	[20..23]	Error code See Table 134: User profiles: Error codes on page 244.
		---	[24..27]	Reserved
		ProfileID	[28..31]	ProfileID (memory channel)

Table 133: User profiles

In general this advanced register is a wrapper around the standard memory channel registers with some extensions. So to query the number of available user profiles you have to check the **Memory_Channel** field of the **BASIC_FUNC_INQ** register at offset **0x400** (see IIDC V1.31 for details).

The **ProfileID** is equivalent to the memory channel number and specifies the profile number to store settings to or to restore settings from. In any case profile #0 is the hard-coded factory profile and cannot be overwritten.

After an initialization command, startup or reset of the camera, the **ProfileID** also indicates which profile was loaded on startup, reset or initialization.

Note

- The default profile is the profile that ist loaded on power-up or an INITIALIZE comman.
- A save or load operation delays the response of the camera until the operation is completed. At a time only one operation can be performed.

To store the current camera settings into a profile:

1. Write the desired **ProfileID** with the **SaveProfile** flag set.
2. Read back the register and check the **ErrorCode** field.

To restore the settings from a previous stored profile:

1. Write the desired **ProfileID** with the **RestoreProfile** flag set.
2. Read back the register and check the **ErrorCode** field.

To set the default profile to be loaded on startup, reset or initialization

1. Write the desired **ProfileID** with the **SetDefaultID** flag set.
2. Read back the register and check the **ErrorCode** field.

Error codes

ErrorCode #	Description
0x00	No error
0x01	Profile data corrupted
0x02	Camera not idle during restore operation
0x03	Feature not available (feature not present)
0x04	Profile does not exist
0x05	ProfileID out of range
0x06	Restoring the default profile failed
0x07	Loading LUT data failed
0x08	Storing LUT data failed

Table 134: User profiles: Error codes

Reset of error codes

The **ErrorCode** field is set to zero on the next write access.

You may also reset the **ErrorCode**

- by writing to the **USER_PROFILE** register with the **SaveProfile**, **RestoreProfile** and **SetDefaultID** flag not set.
- by writing 00000000h to the **USER_PROFILE** register.

Stored settings

The following table shows the settings stored inside a profile:

Standard registers	Standard registers (Format_7)	Advanced registers
Cur_V_Frm_Rate Cur_V_Mode Cur_V_Format ISO_Channel ISO_Speed BRIGHTNESS AUTO_EXPOSURE (Target grey level) SHARPNESS WHITE_BALANCE (+ auto on/off) HUE (+ hue on) SATURATION (+ saturation on) GAMMA (+ gamma on) SHUTTER (+ auto on/off) GAIN TRIGGER_MODE TRIGGER_POLARITY TRIGGER_DELAY ABS_GAIN	IMAGE_POSITION (AOI) IMAGE_SIZE (AOI) COLOR_CODING_ID BYTES_PER_PACKET	TIMEBASE EXTD_SHUTTER IO_INP_CTRL IO_OUTP_CTRL IO_INTENA_DELAY AUTOSHUTTER_CTRL AUTOSHUTTER_LO AUTOSHUTTER_HI AUTOGAIN_CTRL AUTOFNC_AOI (+ on/off) COLOR_CORR (on/off + color correction coefficients) TRIGGER_DELAY MIRROR_IMAGE HIGH_SNR LUT_CTRL (LutNo; ON_OFF is not saved) SHDG_CTRL (on/off + ShowImage) DEFERRED_TRANS (HoldImg + NumOfImages) CHANNEL_ADJUST_CTRL CHANNEL_ADJUST_VALUE

Table 135: User profile: stored settings

The user can specify which user profile will be loaded upon startup of the camera.

This frees the user software from from having to restore camera settings, that differ from default, after every cold start. This can be especially helpful if third party software is used which may not give easy access to certain advanced features or may not provide efficient commands for quick writing of data blocks into the camera.

Note

- A profile save operation automatically disables capturing of images.
- A profile save or restore operation is an uninterruptable (atomic) operation. The write response (of the asynchronous write cycle) will be sent after completion of the operation.
- Restoring a profile will not overwrite other settings than listed above.
- If a restore operation fails or the specified profile does not exist, all registers will be overwritten with the hard-coded factory defaults (profile #0).
- Data written to this register will not be reflected in the standard memory channel registers.

GPDATA_BUFFER

GPDATA_BUFFER is a general purpose register that regulates the exchange of data between camera and host for:

- writing look-up tables (LUTs) into the camera
- uploading/downloading of the shading image

GPDATA_INFO Buffer size query

GPDATA_BUFFER indicates the actual storage range

Register	Name	Field	Bit	Description
0xF1000FFC	GPDATA_INFO	---	[0..15]	Reserved
		BufferSize	[16..31]	Size of GPDATA_BUFFER (byte)
0xF1001000 ... 0xF10017FC	GPDATA_BUFFER			

Table 136: GPData buffer register

Note

- Read the BufferSize before using
- GPDATA_BUFFER can be used by only one function at a time.

Firmware update

Firmware updates can be carried out via FireWire cable without opening the camera.

Note

For further information:

- Read the application note: **How to update Guppy/Pike firmware** at AVT website or
- Contact your local dealer.

Glossary

4:1:1

YUV4:1:1 is a color mode (see YUV).

Chroma subsampling means that a lower resolution for the color (chroma) information in an image is used than for the brightness (intensity or luma) information.

Because the human eye is less sensitive to color than intensity, the chroma components of an image need not be as well defined as the luma component, so many video systems sample the color difference channels at a lower definition (i.e., sample frequency) than the brightness. This reduces the overall bandwidth of the video signal without much apparent loss of picture quality. The missing values will be interpolated or repeated from the preceding sample for that channel.

Sampling systems and ratios: The subsampling in a video system is usually expressed as a three part ratio. The three terms of the ratio are: the number of brightness (luminance, luma or Y) samples, followed by the number of samples of the two color (chroma) components: U then V, for each complete sample area. For quality comparison, only the ratio between those values is important, so 4:4:4 could easily be called 1:1:1; however, traditionally the value for brightness is always 4, with the rest of the values scaled accordingly.

YUV4:1:1 means: chroma subsampling, the horizontal color resolution is quartered. This is still acceptable for lower-end and consumer applications. Uncompressed video in this format with 8-bit quantization uses 6 bytes for every macropixel (4 pixels in a row).

4:2:2

YUV4:2:2 is a color mode (see YUV).

For detailed explanation of chroma subsampling see 4:1:1.

In YUV4:2:2 color mode each of the two color-difference channels has half the sample rate of the brightness channel, so horizontal color resolution is only half that of 4:4:4.

ADC

ADC = **a**nalog **d**igital **c**onverter

An analog-to-digital converter (abbreviated ADC, A/D, or A to D) is a device that converts continuous signals to discrete digital numbers.

Typically, an ADC converts a voltage to a digital number. A digital-to-analog converter (DAC) performs the reverse operation.

AEC

AEC = **a**uto **e**xposure **c**ontrol

AFE

AFE = **a**nalog **f**ront **e**nd

The AFE conditions the analog signal received from the image sensor and performs the analog-to-digital (A/D) conversion.

AGC

AGC = **a**uto **g**ain **c**ontrol

AGC means that the electronic amplification of the video signal is automatically adjusted to compensate for varying levels of scene illumination.

Aliasing

Phenomenon of interference which occurs when a signal being sampled contains frequencies that are higher than half the sampling frequency. Typically can be seen as ragged edges on horizontal lines.

Analog front end

see AFE

AOI

AOI = **a**rea **o**f **i**nterest

see area of interest

Area of interest

Area of interest readout (AOI) refers to a camera function whereby only a portion of the available pixels are read out from the camera. For example, it is possible to read out a 10 x 20 pixel rectangular area of pixels from a camera that has a total resolution of 648 x 488. The result is a much faster frame rate and less data to be processed. This is also referred to as partial scan. Various autofunctions (auto shutter, auto gain, auto white balance) act on the AOI.

Asynchronous shutter

The camera CCD starts to accumulate electrons on receipt of an external trigger pulse.

Asynchronous transmission mode

Asynchronous transmission mode is a mode supported by IEEE 1394 (FireWire). IEEE 1394 supports asynchronous data transmission, which includes receipt datagrams that indicate that the data was transmitted reliably to the 1394 device. Asynchronous data transfers place emphasis on delivery rather than timing. The data transmission is guaranteed, and retries are supported. An example for an asynchronous transmission mode is the one-shot comand. All cameras receive the one-shot command in the same IEEE 1394 bus cycle. This creates uncertainty for all cameras in the range of 125 µs.

AWB

AWB = **a**uto **w**hite **b**alance

A system for automatically setting the white balance in digital cameras.

see white balance

Bayer, Dr. Bryce E.

Dr. Bryce E. Bayer (Eastman Kodak) is the inventor of the so-called BAYER patent (20 July 1976).

BAYER

Patent of Dr. Bryce E. Bayer of Eastman Kodak. This patent refers to a particular arrangement of color filters used in most single-chip digital image sensors used in digital cameras to create a color image. The filter pattern is 50% green, 25% red and 25% blue, hence is also called RGBG or GRGB

BAYER demosaicing

BAYER demosaicing is the process of transforming the BAYER mosaic back to RGB.

BAYER filter

see BAYER mosaic

BAYER mosaic

A Bayer filter mosaic is a color filter array (CFA) for arranging RGB color filters on a square grid of photo sensors. The term derives from the name of its inventor, Bryce Bayer of Eastman Kodak, and refers to a particular arrangement of color filters used in most single-chip digital cameras.

Bryce Bayer's patent called the green photo sensors luminance-sensitive elements and the red and blue ones chrominance-sensitive elements. He used twice as many green elements as red or blue to mimic the human eye's greater resolving power with green light. These elements are referred to as samples and after interpolation become pixels.

The raw output of Bayer-filter cameras is referred to as a Bayer Pattern image. Since each pixel is filtered to record only one of the three colors, two-thirds of the color data is missing from each. A demosaicing algorithm is used to interpolate a set of complete red, green, and blue values for each point, to make an RGB image. Many different algorithms exist.

Big endian

Byte order: big units first (compare: little endian)

Binning

Binning is the process of combining neighboring pixels while being read out from the CCD chip.

Binning factor

Binning factor is the number of pixels to be combined on a CCD during binning. A binning factor of 2x2 means that the pixels in two rows and two columns (a total of four pixels) are combined for CCD readout.

Bit depth

Bit depth is the number of bits that are digitized by the A/D converter.

Bitmap

A raster graphics image, digital image, or bitmap, is a data file or structure representing a generally rectangular grid of pixels, or points of color, on a computer monitor, paper, or other display device.

Blooming

A pixel on a digital camera sensor collects photons which are converted into an electrical charge by its photo diode. Once the full well capacity of the pixel is full, the charge caused by additional photons will overflow and have no effect on the pixel value, resulting in a clipped or overexposed pixel value. Blooming occurs when this charge flows over to surrounding pixels, brightening or overexposing them in the process. As a result detail is lost. Blooming can also increase the visibility of purple fringing.

BMP bitmap

The BMP (bit mapped) format is used internally in the Microsoft Windows operating system to handle graphics images. These files are typically not compressed resulting in large files. The main advantage of BMP files is their wide acceptance and use in Windows programs. Their large size makes them unsuitable for file transfer. Desktop backgrounds and images from scanners are usually stored in BMP files.

CCD

charge-**c**oupled **d**evice

CCD readout

CCDs are analog devices. In order to obtain a digital signal that is appropriate for doing quantitative analysis, it is necessary to convert the analog signal to a digital format. When light is gathered on a CCD and is ready to be read out, a series of serial shifts and parallel shifts occurs. First, the rows are shifted in the serial direction towards the serial register. Once in the serial register, the data is shifted in the parallel direction out of the serial register, into the output node, and then into the A/D converter where the analog data is converted into a digital signal.

CDS

CDS = **c**orrelated **d**ouble **s**ampling

Charge-coupled device

A charge-coupled device (CCD) is a sensor for recording images, consisting of an integrated circuit containing an array of linked, or coupled, capacitors. Under the control of an external circuit, each capacitor can transfer its electric charge to one or other of its neighbors. CCDs are used in digital cameras and are manufactured in a wide variety of formats, architectures, and grades.

CMOS

CMOS (pronounced *see-moss*) stands for **c**omplementary **m**etal-**o**xide **s**emiconductor

CMOS is a major class of integrated circuits. CMOS chips include microprocessor, microcontroller, static RAM, and other digital logic circuits. The central characteristic of the technology is that it only uses significant power when its transistors are switching between on and off states. Consequently, CMOS devices use little power and do not produce as much heat as other forms of logic. CMOS also allows a high density of logic functions on a chip.

CMOS image sensors also allow processing circuits to be included on the same chip, an advantage not possible with CCD sensors, which are also much more expensive to produce.

C-Mount

A standard lens interface used on digital cameras. It is a 1 inch diameter, 32 tpi (=threads per inch) interface with a flange-to-image plane distance of 17.526 mm.

Color aliasing

Color aliasing is caused by the color filters on a single CCD camera. A small white line on a black background that registers on individual pixels in a CCD will be interpreted as a line containing single pixels of each of the primary colors registered.

Color reproduction

Color reproduction is the process to reproduce colors on different devices. Two common methods used for reproducing color are additive color mixtures and subtractive color mixtures.

Correlated double sampling

abbr. CDS

Correlated double sampling is a sampling technique used to achieve higher precision in CCD readout. The sampling circuit is reset to a predetermined reference level and then the actual pixel voltage is sampled in order to find the difference between the two. Using the resulting correlation minimizes read noise, especially in ultra-low-noise cameras.

CS-Mount

A relatively new industry standard used on digital cameras. It is a 1 inch diameter, 32 tpi (=threads per inch) interface with a flange-to-image plane distance of 12.526 mm.

CSR

CSR = **C**amera_**S**tatus_**R**egister

CSR architecture

A convenient abbreviation of the following reference:

ISO/IEC 13213 : 1994 [ANSI/IEEE Std 1212, 1994 Edition], Information Technology — Microprocessor systems — Control and Status Register (CSR) Architecture for Microcomputer Buses.

Dark current

Dark current is the accumulation of electrons within a CCD or CMOS image sensor that are generated thermally rather than by light. This is a form of noise that is most problematic in low light applications requiring long exposure times.

Dark noise

Dark noise is the statistical variation of the dark current, equal to the square root of the dark current. Dark current can be subtracted from an image, while dark noise remains. Also called dark current noise.

dB

abbr. of decibel

see decibel

DCAM

DCAM = **d**igital **cam**era **s**pecification

DCAM or IIDC is a software interface standard for communicating with cameras over FireWire. It is a standardized set of registers etc. If a camera is DCAM compliant then its control registers and data structures comply with the DCAM spec. Such a camera can be truly plug & play in a way that other cameras are not. Recent specifications are IIDC V1.30 and IIDC V1.31.

Decibel

Decibel (abbr. dB) is a measurement unit of dynamic range.

Depth of field

Depth of field refers to the in-focus region of an imaging system. When using a lens, especially in close proximity, objects at and near a certain distance will be in focus whereas other objects in the field of view that are closer or farther away will appear fuzzy, or out of focus. The depth of the region that appears in focus is called the depth of field. Generally speaking, the depth of field will be large if the lens aperture is small (large f-number), and the depth of field will be small with a wide aperture (small f-number).

Digital camera

A digital camera is an electronic device to transform images into electronic data. Modern digital cameras are typically multifunctional and the same device can take photographs, video, and/or sound.

Digital photography

Digital photography uses an electronic sensor to record the image as a piece of electronic data.

There are two main types of sensors:

- charge-coupled device (CCD)
- CMOS semiconductor

There are also two main types of sensor mechanisms:

- Area array
- Linear array (very rare, only limited to the highest-end)

An area array sensor reads the entire image plane at once, whereas a linear array sensor works more like a flatbed scanner.

Dynamic range

The ratio of the maximum signal relative to the minimum measurable signal often measured in decibels or dBs.

The largest possible signal is directly proportional to the full well capacity of the pixel. The lowest signal is the noise level when the sensor is not exposed to any light, also called the noise floor.

Practically, cameras with a large dynamic range are able to capture shadow detail and highlight detail at the same time. Dynamic range should not be confused with tonal range.

Exposure time

Exposure time is the amount of time that the sensor is exposed to the light and thus accumulates charge. This is the control that is used first (before gain and offset) to adjust the camera.

Field of view

Field of view (FOV) is the area covered by the lens' angle of view.

FireWire

FireWire (also known as i.Link or IEEE 1394) is a personal computer (and digital audio/video) serial bus interface standard, offering high-speed communications. It is often used as an interface for industrial cameras.

Fixed pattern noise

abbr. **FPN**

If the output of an image sensor under no illumination is viewed at high gain a distinct non-uniform pattern, or fixed pattern noise, can be seen. This fixed pattern can be removed from the video by subtracting the dark value of each pixel from the pixel values read out in all subsequent frames.

Dark fixed pattern noise is usually caused by variations in dark current across an imager, but can also be caused by input clocking signals abruptly starting or stopping or if the CCD clocks do not closely match one another.

Mismatched CCD clocks can result in high instantaneous substrate currents, which, when combined with the fact that the silicon substrate has some non-zero resistance, can cause in the substrate potential bouncing.

The pattern noise can also be seen when the imager is under uniform illumination. An imager which exhibits a fixed pattern noise under uniform illumination and shows no pattern in the dark is said to have **light pattern noise** or **photosensitivity pattern noise**. In addition to the reasons mentioned above, light pattern noise can be caused by the imager becoming saturated, the non-uniform clipping effect of the anti-blooming circuit, and by non-uniform, photosensitive pixel areas often caused by debris covering portions of some pixels.

FOV

FOV = **f**ield **o**f **v**iew

see field of view

FPN

FPN = **f**ixed **p**attern **n**oise

Related with the dark current is its electrical behavior to be regionally different on the sensor. This introduces a structural spatial noise component, called fixed pattern noise, although it's not meant temporal, visible with low illumination conditions.

FPN is typically more dominant with CMOS sensors than with CCD, where it can be ignored mostly.

This noise nfpn [%] is usually quantified in % of the mean dark level.

Frame

An individual picture image taken by a digital camera. Using an interlaced camera, a frame consists of 2 interlaces fields.

Frame grabber

A component of a computer system designed for digitizing analog video signals.

Frame rate

Frame rate is the measure of camera speed. The unit of this measurement is **frames per second** (fps) and is the number of images a camera can capture in a second of time. Using area of interest (AOI) readout, the frame rate can be increased.

Full binning

If horizontal and vertical binning are combined, every 4 pixels are consolidated into a single pixel. At first, two horizontal pixels are put together and then combined vertically.

This increases light sensitivity by a total of a factor of 4 and at the same time signal-to-noise separation is improved by about 6 dB. Resolution is reduced, depending on the model.

See also: horizontal binning and vertical binning

Gain

Gain is the same as the contrast control on your TV. It is a multiplication of the signal. In math terms, it controls the slope of the exposure/time curve. The camera should normally be operated at the lowest gain possible, because gain not only multiplies the signal, but also multiplies the noise. Gain comes in very handy when you require a short exposure (say, because the object is moving and you do not want any blur), but do not have adequate lighting. In this situation the gain can be increased so that the image signal is strong.

Gamma

Gamma is the exponent in a power-law relationship between video or pixel values and the displayed brightness.

Each pixel in a digital image has a certain level of brightness ranging from black (0) to white (1). These pixel values serve as the input for your computer monitor. Due to technical limitations, CRT monitors output these values in a nonlinear way:

Output = $\text{Input}^{\text{gamma}}$

When unadjusted, most CRT monitors have a gamma of 2.5 which means that pixels with a brightness of 0.5, will be displayed with a brightness of only $0.5^{2.5}$= 0.18 in non-colormanaged applications. LCDs, in particular those on notebooks, tend to have rather irregularly shaped output curves. Calibration via software and/or hardware ensures that the monitor outputs the image based on a predetermined gamma curve, typically 2.2 for Windows, which is approximately the inverse of the response of the human vision. The sRGB and Adobe RGB color spaces are also based on a gamma of 2.2.

A monitor with a gamma equal to 1.0 would respond in a linear way (Output = Input) and images created on a system with a gamma of 2.2 would appear flat and overly bright in non-color managed applications.

GIF

GIF = **G**raphics **I**nterchange **F**ormat

GIF is one of the most common file formats used for images in web pages. There are two versions of the format, 87a and 89a. Version 89a supports animations, i.e. a short sequence of images within a single GIF file. A GIF89a can also be specified for interlaced presentation.

Gigabit Ethernet

Gigabit Ethernet is an industry standard interface used for high-speed computer networks that is now being adapted as a camera interface. This generalized networking interface is being adapted for use as a standard interface for high-performance machine vision cameras that is called GigE Vision.

GigE Vision

GigE Vision is a new interface standard, published by the AIA, for high-performance machine vision cameras. GigE (Gigabit Ethernet), on the other hand, is simply the network structure on which GiGE Vision is built. The GigE Vision standard includes both a hardware interface standard (Gigabit Ethernet), communications protocols, and standardized camera control registers. The camera control registers are based on a command structure called GenICam. GenICam seeks to establish a common software interface so that third party software can communicate with cameras from various manufacturers without customization. GenICam is incorporated as part of the GigE Vision standard. GigE Vision is analogous to FireWire's DCAM, or IIDC interface standard and has great value for reducing camera system integration costs and for improving ease of use.

Global pipelined shutter

A global pipelined shutter assures that the integration for all pixels starts and stops at the same moment in time. The integration of the next image is possible during the readout of the previously captured image.

Global shutter

All pixels are exposed to the light at the same moment and for the same time span.

HDR mode

HDR = **h**igh **d**ynamic **r**ange

High dynamic range

In the high dynamic range mode various nonlinearity points, the so-called knee-points (and integration time as a second parameter) can be freely adjusted, leading to increased dynamic range. This enables the high dynamic range of the sensor to be compressed into 8 bit, preserving interesting details of the image. This mode is also known as multiple slope.

Horizontal binning

In **horizontal binning** adjacent horizontal pixels in a line are combined in pairs.

This means that in horizontal binning the light sensitivity of the camera is also increased by a factor of two (6 dB). Signal-to-noise separation improves by approx. 3 dB. Horizontal resolution is lowered, depending on the model.

See also: vertical binning and full binning

Host computer

Host computer is the primary or controlling computer for a digital camera.

HSV color space

The HSV (hue, saturation, value) model, also called HSB (hue, saturation, brightness), defines a color space in terms of three constituent components:

- Hue, the color type (such as red, blue, or yellow)
- Saturation, the vibrancy of the color and colorimetric purity
- Value, the brightness of the color

Hue

A hue refers to the gradation of color within the optical spectrum, or visible spectrum, of light. Hue may also refer to a particular color within this spectrum, as defined by its dominant wavelength, or the central tendency of its combined wavelengths. For example, a light wave with a central tendency within 565-590 nm will be yellow.

In an RGB color space, hue can be thought of as an angle φ in standard position. The other coordinates are saturation and brightness.

IEEE

The **I**nstitute of **E**lectrical and **E**lectronics **E**ngineers, Inc.

IEEE 1394 Trade Association

IEEE 1394 Trade Association is a non-profit industry association devoted to the promotion of and growth of the market for IEEE 1394-compliant products.

Participants in working groups serve voluntarily and without compensation from the Trade Association. Most participants represent member organizations of the 1394 Trade Association. The specifications developed within the working groups represent a consensus of the expertise represented by the participants.

Background of the Trade Association and IEEE 1394

The 1394 Trade Association was founded in 1994 to support the development of computer and consumer electronics systems that can be easily connected with each other via a single serial multimedia link. The IEEE 1394 multimedia connection enables simple, low cost, high bandwidth isochronous (real time) data interfacing between computers, peripherals, and consumer electronics products such as camcorders, VCRs, printers, PCs, TVs, and digital cameras. With IEEE 1394 compatible products and systems, users can transfer video or still images from a camera or camcorder to a printer, PC, or television, with no image degradation. The 1394 Trade Association includes more than 170 companies and continues to grow.

Members of the 1394 Trade Association

The 1394 Trade Association is comprised of more than 170 member companies. Membership is still in a rapid growth phase, with approximately one company a week joining the 1394 TA. The membership consists of a number of companies of every size in almost every sector of the electronics industry. Some of the best known names in the 1394 TA membership are Sony, Intel, Microsoft, JVC, Matsushita, Compaq, NEC, Philips, Samsung, among other well respected electronics institutions.

Organization of the 1394 Trade Association

The 1394 TA is incorporated as a nonprofit trade organization. Its Board of Directors and Chair are volunteers elected from the membership of the association. The 1394 TA maintains an office in Southlake, Texas, with paid staff that execute the programs organized by the 1394 TA membership.

IIDC

The 1394 Trade Association **I**nstrumentation and **I**ndustrial Control Working Group, **D**igital **C**amera Sub Working Group

IIDC V1.3

IIDC V1.3

IIDC 1394-based Digital Camera Specification Version 1.30 July 25, 2000

The purpose of this document is to act as a design guide for digital camera makers that wish to use IEEE 1394 as the camera-to-PC interconnect. Adherence to the design specifications contained herein do not guarantee, but will promote interoperability for this class of device. The camera registers, fields within those registers, video formats, modes of operation, and controls for each are specified. Area has been left for growth. To make application for additional specification, contact the 1394 Trade Association Instrumentation and Industrial Control Working Group, Digital Camera Sub Working Group (II-WG DC-SWG).

http://www.1394ta.org/Technology/Specifications/

IIDC V1.31

IIDC V1.31 was published in January 2004, evolving the industry standards for digital imaging communications to include I/O and RS232 handling, and adding additional formats.

Image processing

In the broadest sense, image processing includes any form of information processing in which the input is an image. Many image processing techniques derive from the application of signal processing techniques to the domain of images — two-dimensional signals such as photographs or video.

Typical problems are:

- Geometric transformations such as enlargement, reduction, and rotation
- Color corrections such as brightness and contrast adjustments, quantization, or conversion to a different color space
- Combination of two or more images, e.g. into an average, blend, difference, or image composite
- Interpolation, demosaicing, and recovery of a full image from a mosaic image (e.g. a Bayer pattern, etc.)
- Noise reduction and other types of filtering, and signal averaging
- Edge detection and other local operators
- Segmentation of the image into regions

Infrared

Infrared (abbr. IR) is the region beyond the visible spectrum at the red end, typically greater than 770 nm.

see IR cut filter

Interline transfer CCD

Interline transfer CCD or just interline CCD is a type of CCD in which the parallel register is subdivided so that, like a Venetian blind, opaque strips span and mask the columns of pixels. The masks act as storage areas. When the CCD is exposed to light, the image accumulates in the exposed areas (photosites) of the parallel register. In the serial register, the entire image is under the interline mask when it shifts for CCD readout. It is possible to shift the integrated charge quickly (200 ns) under the storage areas. Since these devices function as a fast shutter (or gate), they are also sometimes referred to as gated interline CCDs.

See microlens

IR

IR = infrared

IR cut filter

As color cameras can see infrared radiation as well as visible light, these cameras are usually equipped with an IR cut filter, to prevent distortion of the colors the human eye can see. To use the camera in very dark locations or at night, this filter can be removed, to allow infrared radiation to hit the image sensor and thus produce images.

Isochronous transmission mode

Isochronous transmission mode is a mode supported by IEEE 1394 (FireWire). IEEE 1394 supports a guaranteed data path bandwidth and allows for real-time transmission of data to/from 1394 devices. Isochronous data transfers operate in a broadcast manner, where one or many 1394 devices can listen to the data being transmitted. The emphasis of isochronous data transfers is placed on guaranteed data timing rather than guaranteed delivery. Multiple channels (up to 16) of isochronous data can be transferred simultaneously on the 1394 bus. Since isochronous transfers can only take up a maximum of 80 percent of the 1394 bus bandwidth, there is enough bandwidth left over for additional asynchronous transfers.

(See also Asynchronous transmission mode).

Jitter

Small, rapid variations in a waveform due to mechanical disturbances or to changes in the characteristic of components. They are caused by variations in supply voltages, imperfect synchronizing signals, circuits, etc.

JPEG, JPG

The JPEG (**J**oint **P**hotographic **E**xperts **G**roup) image files are files in a lossy format. The DOS filename extension is JPG, although other operating systems may use JPEG. Nearly all digital cameras have the option to save images in JPEG format, some at different compression levels, such as fine and standard. The JPEG format supports full color and produces relatively small file sizes. Fortunately, the compression in most cases does not detract noticeably from the image. But JPEG files do suffer generational degradation when repeatedly edited and saved. Photographic images are best stored in a lossless non-JPEG format if they will be re-edited in future, or if the presence of small artifacts (blemishes), due to the nature of the JPEG compression algorithm, is unacceptable. JPEG is also used as the image compression algorithm in many Adobe PDF files.

Linux

Linux is an open source operating system within the Unix family. Because of its robustness and availability, Linux has won popularity in the open source community and among commercial application developers.

Little endian

Byte order: little units first (compare: big endian)

Lux

The **lux** (symbol: lx) is the SI unit of illuminance. It is used in photometry as a measure of the intensity of light, with wavelengths weighted according to the luminosity function, a standardized model of human brightness perception. In English, **lux** is used in both singular and plural.

Machine vision

Machine vision is the application of cameras and computers to cause some automated action based on images received by the camera(s) in a manufacturing process. Generally, the term **machine vision** applies specifically to manufacturing applications and has an automated aspect related to the vision sensors. However, it is common to use machine vision equipment and algorithm outside of the manufacturing realm.

Megapixel

Megapixel refers to one million pixels - relating to the spatial resolution of a camera. Any camera that is roughly 1000 x 1000 or higher resolution would be called a megapixel camera.

Microlens

Microlens is a type of technology used in some interline transfer CCDs whereby each pixel is covered by a small lens which channels light directly into the sensitive portion of the CCD.

OCR

OCR = **O**ptical **C**haracter **R**ecognition

Offset

Offset is just the same as the brightness control on your TV. It is a positive DC offset of the image signal. It is used primarily to set the level of black. Generally speaking, for the best signal, the black level should be set so that it is near zero (but not below zero) on the histogram. Increasing the brightness beyond this point just lightens the image but without improving the image data.

OHCI	OHCI = **O**pen **H**ost **C**ontroller **I**nterface
One-push autofocus	Focus hold mode that can be automatically readjusted as required by the user (one-push autofocus trigger) assuming that the required subject is within the focusing limits of the camera lens.
One-push white balance	AVT color cameras have not only manual but also one-push white balance. For white balance, in total a number of frames are processed and a grid of a number of samples is equally spread over the whole image area. The R-G-B component values of the samples are added and are used as actual values for both the one-push and the automatic white balance. This feature uses the assumption that the R-G-B component sums of the samples are equal; i.e., it assumes that the average of the sampled grid pixels is to be monochrome.
Opaque mask	In CCD imaging technology, a light-impenetrable material that is used to shield selected parts of a photosensitive surface. Opaque masks are used in interline transfer CCDs and frame transfer CCDs.
Open Host Controller Interface	Open Host Controller Interface (OHCI) describes the standards created by software and hardware industry leaders (including Microsoft, Apple, Compaq, Intel, Sun Microsystems, National Semiconductor, and Texas Instruments) to assure that software (operating systems, drivers, applications) works properly with any compliant hardware.
Optical Character Recognition	Optical Character Recognition (OCR) refers to the use of machine vision cameras and computers to read and analyze human-readable alphanumeric characters to recognize them.
Optocoupler	An optocoupler is a device that uses a short optical transmission path to transfer a signal between elements of a circuit, typically a transmitter and a receiver, while keeping them electrically isolated. Advantage: Since the signal goes from an electrical signal to an optical signal back to an electrical signal, electrical contact along the path is broken.
PCI-Express	PCI-Express (PCIE) is the next generation bus architecture and is compatible with the current PCI software environment while offering low-cost with scalable performance for the next generation of computing and communications platforms. PCIE is a serial technology with point-to-point connection to provide 2.5 Gbit/s per lane which is 2 times faster than current PCI technology. PCIE is scalable to form multiple lanes like x1, x2, x4, x8, x16, and x32.
PDF	**P**ortable **D**ocument **F**ormat

PxGA

Pix**el** **G**ain **A**mplifier

Pixel

Pixels are generally thought of as the smallest complete sample of an image. The definition is highly context sensitive. For example, we can speak of pixels in a visible image (e.g. a printed page) or pixels carried by one or more electronic signal(s), or represented by one or more digital value(s), or pixels on a display device, or pixels in a digital camera (photosensor elements). This list is not exhaustive and depending on context there are several synonyms which are accurate in particular contexts, e.g. pel, sample, bytes, bits, dots, spots, superset, triad, stripe set, window, etc. We can also speak of pixels in the abstract, in particular when using pixels as a measure of resolution, e.g. 2400 pixels per inch or 640 pixels per line. Dots is often used to mean pixels, especially by computer sales and marketing people, and gives rise to the abbreviation DPI or dots per inch.

The more pixels used to represent an image, the closer the result can resemble the original. The number of pixels in an image is sometimes called the resolution, though resolution has a more specific definition. Pixels can be expressed as a single number, as in a *three-megapixel* digital camera, which has a nominal three million pixels, or as a pair of numbers, as in a *640 by 480 display*, which has 640 pixels from side to side and 480 from top to bottom (as in a VGA display), and therefore has a total number of 640 × 480 = 307,200 pixels.

The color samples that form a digitized image (such as a JPG file used on a web page) are also called pixels. Depending on how a computer displays an image, these may not be in one-to-one correspondence with screen pixels. In areas where the distinction is important, the dots in the image file may be called texels.

In computer programming, an image composed of pixels is known as a bitmapped image or a raster image. The word raster originates from analogue television technology. Bitmapped images are used to encode digital video and to produce computer-generated art.

QE

QE = **q**uantum **e**fficiency

Quadlet

Four bytes of data

Quantum efficiency

Quantum efficiency (abbr. QE) is the measure of the effectiveness of an imager to produce electronic charge from incident photons. Especially important to perform low-light-level imaging.

RAW

RAW is a file option available on some digital cameras. It usually uses a lossless compression and produces file sizes much smaller than the TIFF format. Unfortunately, the RAW format is not standard among all camera manufacturers and some graphic programs and image editors may not accept the RAW format. The better graphic editors can read some manufacturer's RAW formats, and some (mostly higher-end) digital cameras also support saving images in the TIFF format directly. There are also separate tools available for converting digital camera raw image format files into other formats.

Readout

Readout refers to how data is transferred from the CCD or CMOS sensor to the host computer. Readout rate is an important specification for high-resolution digital cameras. Higher readout rates mean that more images can be captured in a given length of time.

RGB

The RGB color model utilizes the additive model in which red, green, and blue light are combined in various ways to create other colors. The very idea for the model itself and the abbreviation **RGB** come from the three primary colors in additive light models.

Note that the RGB color model itself does not define what exactly is meant by **red**, **green** and **blue**, so that the same RGB values can describe noticeably different colors on different devices employing this color model. While they share a common color model, their actual color spaces can vary considerably.

Rolling shutter

Some CMOS sensors operate in **rolling shutter** mode only so that the rows start, and stop, exposing at different times. This type of shutter is not suitable for moving subjects except when using flash lighting because this time difference causes the image to smear. (see global shutter)

RS-232

RS-232 is a long-established standard that describes the physical interface and protocol for low-speed serial data communication between devices. This is the interface that e.g. a computer uses to talk to and exchange data with a digital camera.

Saturation

In color theory, saturation or purity is the intensity of a specific hue. It is based on the color's purity; a highly saturated hue has a vivid, intense color, while a less saturated hue appears more muted and grey. With no saturation at all, the hue becomes a shade of grey. Saturation is one of three coordinates in the HSL color space and the HSV color space.

The saturation of a color is determined by a combination of light intensity and how much it is distributed across the spectrum of different wavelengths. The purest color is achieved by using just one wavelength at a high intensity such as in laser light. If the intensity drops the saturation also drops.

Scalable mode

Scalable mode allows selection of an area within a full image for output.

Sensitivity

Sensitivity is a measure of how sensitive the camera sensor is to light input. Unfortunately there is no standardized method of describing sensitivity for digital CCD or CMOS cameras.

Shading

The variation of the brightness or relative illumination over the surface of an object, often caused by color variations or surface curvature.

Signal-to-noise ratio

also called **SNR**

Signal-to-noise ratio specifies the quality of a signal with regard to its reproduction of intensities. The value signifies how high the ratio of noise is in regard to the maximum wanted signal intensity expected.

The higher this value, the better the signal quality. The unit of measurement used is generally known as the decibel (dB), a logarithmic power level. 6 dB is the signal level at approximately a factor of 2.

However, the advantages of increasing signal quality are accompanied by a reduction in resolution.

Signal-to-noise separation

Signal-to-noise separation specifies the quality of a signal with regard to its reproduction of intensities. The value signifies how high the ratio of noise is in regard to the maximum wanted signal intensity expected.

The higher this value, the better the signal quality. The unit of measurement used is generally known as the decibel (dB), a logarithmic power level. 6 dB is the signal level at approximately a factor of 2.

However, the advantages of increasing signal quality are accompanied by a reduction in resolution.

Smart camera

A term for a complete vision system contained in the camera body itself, including imaging, image processing and decision making functions. While the common smart cameras are intended just for the dedicated systems, the latest PC technology enables development of devices fully compatible with desktop PCs. This category of smart cameras thus provides a standard API and thus much wider functionality.

Smear

Smear is an undesirable artifact of CCDs that appears in the picture as a vertical streak above and below a very bright object in the scene. Smear is caused by parasitic light getting into the vertical transfer registers. It is greatly reduced by the microlens-type of CCD used in Hyper HAD and Power HAD sensors. Almost suppressed in FIT CCDs.

SNR

SNR = **s**ignal-to-**n**oise **r**atio

Square pixel

Pixels of the same x and y dimensions (pixel aperture ratio PAR = 1). In the case of rectangular (non-square) pixels (usual in TV) one must maintain the aspect ratio when measuring objects, because the dimensions of stored frames aren't equal to true dimensions; resolutions along x and y axes aren't the same. Use of square pixels solves such problems - picture elements are equally arrayed in both directions, and allow easy addressing. Thus aspect ratio of the image does not require adjustment. This is needed in image processing tasks requiring accurate image measuring.

Aspect ratio: The ratio of horizontal to vertical dimension of the illuminated sensing area.

Pixel aperture dimension ratio: Defines the pixel dimension (the ratio of its width to height). This parameter describes the resolution (granularity) and the reproduction behavior of an image sensor area.

Aspect ratio deviation: Shows the ratio between frame store data and true dimensions of an image.

Sub-sampling

Sub-sampling is the process of skipping neighboring pixels (with the same color) while being read out from the CMOS or CCD chip.

CMOS equipped MARLIN models, both color and b/w have this feature (FW > 2.03).

E.g. the CCD model MARLIN F-146C is also equipped with this mode, acting as a preview mode. Because it is realized digitally there is no further speed increase.

Sub-sampling is used primarily for 2 reasons:

- A reduction in the number of pixels and thus the amount of data while retaining the original image area angle and image brightness
- CMOS: an increase in the frame rate.

Similar to binning mode the cameras support horizontal, vertical and h+v sub-sampling mode.

Trigger

Trigger is an input to an industrial digital camera than initiates the image capture sequence. Otherwise, an electrical signal or set of signals used to synchronize a camera, or cameras, to an external event.

The term **trigger** is sometimes used in the sense of a trigger shutter.

Trigger shutter

A trigger shutter is a shutter mode with random timing or even with random shutter speed. Such randomness is controlled by the trigger signal mentioned above.

USB

Universal **S**erial **B**us (USB) provides a serial bus standard for connecting devices, usually to computers such as PCs, but is also becoming commonplace on digital cameras.

Vertical binning

Vertical binning increases the light sensitivity of the camera by a factor of two by adding together the values of two adjoining vertical pixels output as a single pixel. At the same time this normally improves signal-to-noise separation by about 2 dB.

See also: full binning and horizontal binning

WDM

WDM = **W**indows **D**river **M**odel

In computing, the Windows Driver Model (WDM) - also known (somewhat misleadingly) at one point as the Win32 Driver Model - is a framework for device drivers that was introduced with Windows 98 and Windows 2000 to replace VxD, which was used on older versions of Windows such as Windows 95 and Windows 3.1 and the Windows NT Driver Model.

White balance

A function enabling adjustment of the image colors to make the white objects really appear as white. Thus one can avoid color shifts caused e.g. by differing illumination conditions.

YUV

The YUV model defines a color space in terms of one luminance and two chrominance components. YUV is used in the PAL and NTSC systems of television broadcasting, which are the standards in much of the world.

YUV models human perception of color more closely than the standard RGB model used in computer graphics hardware, but not as closely as the HSL color space and HSV color space.

Y stands for the luminance component (the brightness) and U and V are the chrominance (color) components.

YUV signals are created from an original RGB (red, green and blue) source. The weighted values of R, G and B are added together to produce a single Y signal, representing the overall brightness, or luminance, of that spot. The U signal is then created by subtracting the Y from the blue signal of the original RGB, and then scaling; and V by subtracting the Y from the red, and then scaling by a different factor.

An advantage of YUV is that some of the information can be discarded in order to reduce bandwidth. The human eye has fairly little color sensitivity: the accuracy of the brightness information of the luminance channel has far more impact on the image discerned than that of the other two.

(See also 4:2:2 and 4:1:1)

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