AVT Guppy

Technical Manual

V5.0.1

09 May 2007

Allied Vision Technologies GmbH
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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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Contents

Introduction

Document history

Version	Date	Remarks
V2.0.0	06.04.2006	New Manual - RELEASE status
V2.0.1	28.06.2006	RoHS conformity; minor corrections
PRE_V3.0.0	30.10.2006	Minor corrections Input characteristics: Added description to input voltage (Table 55: Input characteristics on page 148) Added Guppy F-036B/C Correction in Chapter Multi-shot on page 178 New CAD drawing in Figure 28: Camera dimensions (new CS-/C-Mounting) on page 82. New CAD drawing in Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89. New CAD drawing in Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91. New CS-Mount and C-Mount adapter in Chapter Guppy types and highlights on page 18. Added Guppy F-33B/C BL (board level version) Changed camera status register (Table 118: Camera status register on page 247) Added Guppy F-146
PRE_V4.0.0	26.01.2007	Minor corrections Added Guppy F-080B/C BL (board level version) Added new features Guppy-F036B/C
V4.0.1	02.02.2007	Minor corrections Guppy F-146: new frame rates

Table 1: Document history

Version	Date	Remarks
PRE_V5.0.0	09.05.2007	Minor corrections Added interlaced GUPPYs F-038B/C, F038B/C NIR, F-044B/C, F-044B/C NIR Added **Value** field in Table 42: Shutter CSR on page 119 Added detailed description of BRIGHTNESS (800h) in Table 111: Feature control register on page 234 Added detailed description of WHITE-BALANCE (80Ch) in Table 111: Feature control register on page 234 et seq.
V5.0.1	09.05.2007	RELEASE status

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
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 avo

malfunctions.

Caution-ESD

This symbol highlights important ESD instructions. Only **qualified personnel** is allowed to install and operate components marked with this symbol.

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.

Note

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)	Guppy F-025B
	Guppy F-025C
	Guppy F-029B
	Guppy F-029C
	Guppy F-033B
	Guppy F-033C
	Guppy F-033B BL (board level)
	Guppy F-033C BL (board level)
	Guppy F-036B
	Guppy F-036C
	Guppy F-038B
	Guppy F-038C
	Guppy F-038B NIR
	Guppy F-038C NIR
	Guppy F-044B
	Guppy F-044C
	Guppy F-044B NIR
	Guppy F-044C NIR
	Guppy F-046B
	Guppy F-046C
	Guppy F-080B
	Guppy F-080C
	Guppy F-080B BL (board level)
	Guppy F-080C BL (board level)
	Guppy F-146B
	Guppy F-146C

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 (Guppy board level cameras: prepared for FCC Class B)
- CE (Guppy board level cameras do not have CE)
- DIN ISO 9022-3
- 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.

Note Customer samples may not comply with above regulations.

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 1394a 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 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

Safety instructions

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 1394a 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 bring the metal part, which is the shield of the IEEE 1394 cable, in contact with the housing of the camera (before plugging it into the camera) and, at the other end, in contact with metal parts of the computer, before plugging it into the port of the computer. This ensures that excessive charge can flow safely to ground.
- 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.

Safety instructions for board level cameras

Note

Read the Guppy Technical Manual and this safety instructions before use.

Abuse or misapplication of the camera may result in limited warranty or cancelation of warranty.

Caution-ESD

Board level cameras: ESD warnings

- Only **qualified personnel** is allowed to install and operate the Board level cameras.
- Board level camerass are delivered without housing. Handle the sensor board and main board with care. Do not bend the boards. Do not touch the components or contacts on a board. Hold a board by its edges.
- Sensor board and main board are sensitive to electrostatic discharge. To avoid possible damage, handle all static-sensitive boards and components in a static-safe work area. Follow the procedures below.
- ESD (electrostatic discharge): Static electricity can damage the sensor board or the main board of your Board level cameras. To prevent static damage, discharge static electricity from your body before you touch any of your Board level cameras’s electronic components, such as sensor board or main board. To do so, use a static-safe work area with static-dissipative mat and wear a static-dissipative wrist strap. Do not hold any components of your Board level cameras against your clothing. Even if you are wearing a wrist strap, your body is grounded but your clothes are not.
- Do not remove the sensor board and main board from its anti-static packaging unless your body is grounded.
- **ESD shielding**: To protect the boards from radiation of other modules or devices use a special ESD protective housing.

Caution	Board level cameras: General Warnings
	• Be sure that all power to your board level cameras is switched off, before mounting the sensor board or making connections to the camera. • Do not connect or disconnect any cables during an electrical storm. • Do not use your board level cameras during an electrical storm. • To help avoid possible damage to the sensor board or main board, wait 5 seconds after power is switched off, before connecting or disconnecting any cable to the board level cameras. • Ensure that nothing rests on the cables of your board level cameras. • Keep your board level cameras away from radiators and heat sources. • Do not spill food or liquids on your board level cameras.

Caution	Board level cameras: Loading
	• Avoid any mechanical forces to the board level cameras, the boards and its components, especially torsional, tensile and compressive forces. Any of these forces may result in damage of the board level cameras, the boards and its components. • To avoid damages of the boards, provide cables with an external pull relief so that no force is applied to the connectors itself.

Caution	Board level cameras: Dirty environments
	• Always use clean boards. • To protect the boards from dirt like dust, liquids or swarf always use the board level cameras only in clean room environment or use a protective housing.

Environmental conditions

Housing temperature (when camera in use) (Board level: operating temperature):	+ 5 °C ... + 50 °C
Ambient temperature during storage:	- 10 °C ... + 60 °C

Relative humidity:	20 % ... 80 % without condensation
Protection (for cased models):	IP 30
Protection (for board level):	IP 00

Guppy types and highlights

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

With the new GUPPY, Allied Vision Technologies presents a whole series of attractive digital camera entry-level models of the FireWire™ type.

These products offer an unequalled price-performance relationship and make the decision to switch from using analogue to digital technology easier than ever before.

The AVT Guppy family consists of 11 very compact IEEE 1394 C-Mount cameras, which are equipped with highly sensitive high-quality sensors (CCD, CMOS).

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

A large selection of different sensor sizes (type 1/2, type 1/3) and resolutions (VGA, WideVGA, SVGA, XGA, XGA-2, EIA/NTSC, CCIR/PAL) ensures the suitability of the cameras for all applications.

The Guppy family consists of the following models:

GUPPY type	Sensor	Picture size	Frame rates
GUPPY F-025B/C	Type 1/3 SONY ICX404AL/AK Interlaced EIA CCD imager	(NTSC) 508 (h) x 492 (v)	up to 30 fps (60 fields per second)
GUPPY F-029B/C	Type 1/3 SONY ICX405AL/AK Interlaced CCIR CCD imager	(PAL) 500 (h) x 582 (v)	up to 25 fps (50 fields per second)
GUPPY F-033B/C and board level version	Type 1/3 Sony ICX424AL/AQ Progressive Scan CCD imager	(VGA) 656 (h) x 494 (v)	up to 60 fps
GUPPY F-036B/C	Type 1/3 Micron Imaging MT9V022 Global Shutter CMOS imager	(WideVGA) 752 (h) x 480 (v)	up to 64 fps
GUPPY F-038B/C	Type 1/2 Sony ICX418ALL/AKL Interlaced EIA/NTSC CCD imager	(NTSC) 768 (h) x 492 (v)	up to 30 fps (60 fields per second)
GUPPY F-038B/C NIR	Type 1/2 Sony ICX428ALL/AKL Interlaced EIA/NTSC CCD imager EXview HAD CCD for near infrared light	(NTSC) 768 (h) x 492 (v)	up to 30 fps (60 fields per second)

Table 4: GUPPY camera types

GUPPY type	Sensor	Picture size	Frame rates
GUPPY F-044B/C	Type 1/2 Sony ICX419ALL/AKL Interlaced CCIR/PAL CCD imager	(PAL) 752 (h) x 580 (v)	up to 25 fps (50 fields per second)
GUPPY F-044B/C NIR	Type 1/2 Sony ICX429ALL/AKL Interlaced CCIR/PAL CCD imager EXview HAD CCD for near infrared light	(PAL) 752 (h) x 580 (v)	up to 25 fps (50 fields per second)
GUPPY F-046B/C	Type 1/2 Sony ICX415AL/AQ Progressive Scan CCD imager	(SVGA) 780 (h) x 582 (v)	up to 49 fps
GUPPY F-080B/C and board level version	Type 1/3 Sony ICX 204AL/AK Progressive Scan CCD imager	(XGA) 1032 (h) x 778 (v)	up to 30 fps
GUPPY F-146B/C	Type 1/2 Sony ICX 267AL/AK Progressive Scan CCD imager	1392 (h) x 1040 (v)	up to 17.7 fps

Table 4: GUPPY camera types

Operating in 8-bit mode (CCD b/w only), the cameras ensure very high quality images under almost all circumstances. The GUPPY is equipped with an asynchronous trigger shutter as well as true partial scan, and integrates numerous useful and intelligent smart features for image processing.

Old CS-/C-Mounting	New CS-/C-Mounting starting with serial no. 06/05-84312215
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.	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.
B/w models are delivered with sensor protection glass to ensure maximum sensitivity. In certain applications and depending on the lighting source and optics, the use of either IR blocking or passing filter may be required to improve the image quality.	B/w models are delivered with sensor protection glass to ensure maximum sensitivity. In certain applications and depending on the lighting source and optics, the use of either IR blocking or passing filter may be required to improve the image quality.

Table 5: Old and new CS-/C-Mounting of GUPPY cameras

Old CS-/C-Mounting	New CS-/C-Mounting starting with serial no. 06/05-84312215
CS-Mount models have the filter or protection glass mounted directly in front of the sensor. Taking out the filter or protection glass is not possible at customer site. Ask your dealer for a camera with the respective filter already installed.	All models have the filter or protection glass mounted directly in the CS-Mount adapter. (Standard delivery is a CS-Mount camera). Taking out the filter or protection glass is not possible at customer site. Ask your dealer for a camera with the respective filter already installed.
C-Mount models have the filter or protection glass mounted in the CS- to C-Mount extension adapter. Ask your dealer for an extension adapter with the intended filter already mounted.	In order to get a C-Mount camera, screw the 5 mm C-Mount adapter onto the CS-Mount camera. Unscrew the 5 mm C-Mount adapter to get again a CS-Mount camera.
Removing the C-Mount adapter opens the front section of the camera. This greatly enhances the risk for dust or particles to migrate on the sensor's protection glass. In order to remove the adapter: Hold the camera so that the adapter points downwards while changing the adapter. Use optical cleaning tissues for cleaning the sensor's protection glass if needed. **Never use compressed air** for cleaning purposes. Ask your dealer if you are not familiar with these procedures.	Removing the CS-Mount adapter opens the front section of the camera. This greatly enhances the risk for dust or particles to migrate on the sensor's protection glass. In order to remove the adapter: Hold the camera so that the adapter points downwards while changing the adapter. Use optical cleaning tissues for cleaning the sensor's protection glass if needed. **Never use compressed air** for cleaning purposes. Ask your dealer if you are not familiar with these procedures.

Table 5: Old and new CS-/C-Mounting of GUPPY cameras

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.

System components

Old CS-/C-Mounting

Each camera package consists of the following system components:

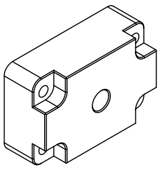
AVT Guppy C-Mount camera

4.5 m 1394 standard cable

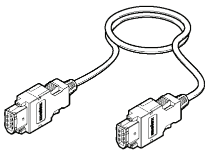
Color version:
Jenofilt 217 IR cut filter (built-in)

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

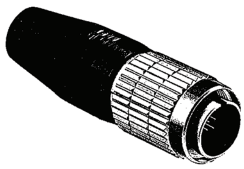
CD with driver and documentation



Optional: tripod adapter



Optional: 4.5 m latching cable



Optional: HIROSE connector for cable mount HR25 7TP-8S

Figure 1: System components

New CS-/C-Mounting

Each camera package consists of the following system components:

AVT Guppy CS-Mount camera

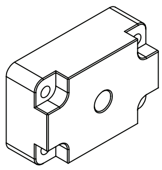
4.5 m 1394 standard cable

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

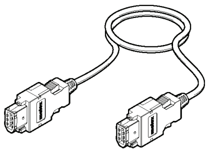
B/w version:
only protection glass (no filter)

5 mm C-Mount adapter

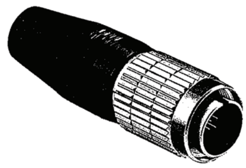
CD with driver and documentation



Optional: tripod adapter



Optional: 4.5 m latching cable



Optional: HIROSE connector for cable mount HR25 7TP-8S

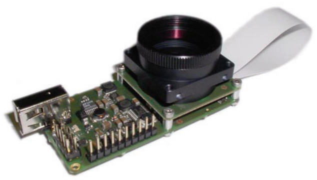
Figure 2: System components

Guppy board level cameras

Each camera package consists of the following system components:

AVT Guppy board level camera
without lens mount adapter

or

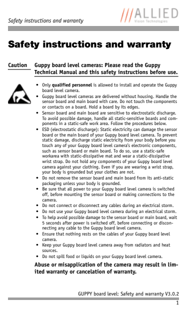


AVT Guppy board level camera
(C-Mount)

or

AVT Guppy board level camera
(M12-Mount)

CD with driver
and documentation
(only 1 per shipment)



Safety instructions and warranty

Safety instructions and warranty

Caution **Guppy board level cameras: Please read the Guppy Technical Manual and this safety instructions before use.**

- Only **qualified personnel** is allowed to install and operate the Guppy board level camera.
- Guppy board level cameras are delivered without housing. Handle the sensor board and main board with care. Do not touch the components or contacts on a board. Hold a board by its edges.
- Sensor board and main board are sensitive to electrostatic discharge. To avoid possible damage, handle all static-sensitive boards and components in a static-safe work area. Follow the procedures below.
- ESD (electrostatic discharge): Static electricity can damage the sensor board or the main board of your Guppy board level camera. To prevent static damage, discharge static electricity from your body before you touch any of your Guppy board level camera's electronic components, such as sensor board or main board. To do so, use a static-safe workarea with static-dissipative mat and wear a static-dissipative wrist strap. Do not hold any components of your Guppy board level camera against your clothing. Even if you are wearing a wrist strap, your body is grounded but your clothes are not.
- Do not remove the sensor board and main board from its anti-static packaging unless your body is grounded.
- Be sure that all power to your Guppy board level camera is switched off, before mounting the sensor board or making connections to the camera.
- Do not connect or disconnect any cables during an electrical storm.
- Do not use your Guppy board level camera during an electrical storm.
- To help avoid possible damage to the sensor board or main board, wait 5 seconds after power is switched off, before connecting or disconnecting any cable to the Guppy board level camera.
- Ensure that nothing rests on the cables of your Guppy board level camera.
- Keep your Guppy board level camera away from radiators and heat sources.
- Do not spill food or liquids on your Guppy board level camera.

Abuse or misapplication of the camera may result in limited warranty or cancelation of warranty.

GUPPY board level: Safety and warranty V3.0.2

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Safety instructions and warranty

Figure 3: System components: Guppy board level camera

IR cut filter

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

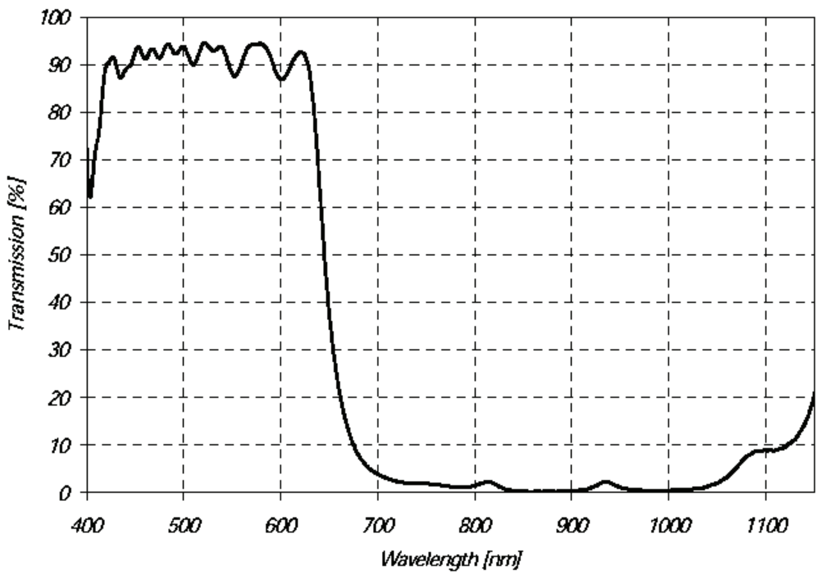


Figure 4: Spectral transmission of Jenofilt 217

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 width of the lens.

Focal Width for type 1/2 sensors Guppy F-038/044/046/146	Distance = 0.5 m	Distance = 1 m
4.8 mm	0.5 m x 0.67 m	1.0 m x 1.33 m
8 mm	0.3 m x 0.4 m	0.6 m x 0.8 m
12 mm	0.195 m x 0.26 m	0.39 m x 0.58 m
16 mm	0.145 m x 0.19 m	0.29 m x 0.38 m
25 mm	9.1 cm x 12.1 cm	18.2 cm x 24.2 cm
35 mm	6.4 cm x 8.51 cm	12.8 cm x 17.02 cm
50 mm	4.4 cm x 5.85 cm	8.8 cm x 11.7 cm

Table 6: Focal width vs. field of view (Guppy F-046)

Focal Width for type 1/3 sensors Guppy F-025/029/033/036/080	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 7: Focal width vs. field of view (Guppy F-025/029/033/036/080)

Specifications

Note

H-binning means horizontal binning.

V-binning means vertical binning.

Full binning means horizontal + vertical binning

2 x binning means: 2 neighboring pixels are combined.

4 x binning means: 4 neighboring pixels are combined.

Binning average means: signals form adjacent pixels are combined by averaging. Binning increases signal-to-noise ratio (SNR), but decreases resolution.

Guppy F-033B

Feature	Specification
Image device	ICX424AL (diag. 6 mm; type 1/3) progressive scan SONY IT CCD
Effective picture elements	658 (H) x 494 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	640 x 480 pixels (Format_0) 656 x 494 pixels (Format_7 Mode_0)
Cell size	7.4 µm x 7.4 µm
ADC	10 bit
Data path	8 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps variable frame rates in Format_7 up to 58 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain (select. AOI)
Shutter speed	20 … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, advanced feature: Trigger_Mode_15 (bulk); trigger delay

Table 8: Specification Guppy F-033B

Feature	Specification
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 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, EN61000, EN55024, FCC Class B, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options (old)	• C-Mount: IR cut filter / IR pass filter available as CS- to C-Mount adapter. • CS-Mount: Consult factory or your dealer for specific filters. • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)
Options (new)	• Board level OEM version • C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 8: Specification Guppy F-033B

Note

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

Guppy F-033C

Feature	Specification
Image device	ICX424AQ (diag. 6 mm; type 1/3) progressive scan SONY IT CCD
Effective picture elements	658 (H) x 494 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	640 x 480 pixels (Format_0) 656 x 494 pixels (Format_7 Mode_0)
Cell size	7.4 µm x 7.4 µm
ADC	10 bit
Color modes	Raw8
Data path	8 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps variable frame rates in Format_7 up to 58 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain (select. AOI)
Shutter speed	20 … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, advanced feature: Trigger_Mode_15 (bulk); trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), LUT (look-up table) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 g (without lens)

Table 9: Specification Guppy F-033C

Feature	Specification
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN61000, EN55024, FCC Class B, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options (old)	• Protection glass • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)
Options (new)	• Board level OEM version • C/CS-Mount: protection glass available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 9: Specification Guppy F-033C

Note

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

Guppy F-033B BL (board level)

Feature	Specification
Image device	ICX424AL (diag. 6 mm; type 1/3) progressive scan SONY IT CCD
Effective picture elements	658 (H) x 494 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	640 x 480 pixels (Format_0) 656 x 494 pixels (Format_7 Mode_0)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Data path	8 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps variable frame rates in Format_7 up to 58 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain (select. AOI)
Shutter speed	20 … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, advanced feature: Trigger_Mode_15 (bulk); trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) 4 free configurable inputs/outputs with pulse width modulation (PWM) for each, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, two ports (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 10-pin connector
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	35 mm x 35 mm (sensor board); 35 mm x 70 mm (main board); without lens
Mass	~30 g (without lens mount adapter, without lens)

Table 10: Specification Guppy F-033B BL (board level)

Feature	Specification
Operating temperature	+ 5 °C ... + 50 °C (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	Board level cameras are not tested for compliance with the regulations due to the fact that test results are strongly dependent on the housing.
Options	• C-Mount (built-in IR cut filter / protection glass) • M12-Mount (built-in IR cut filter / protection glass) • M12 lenses • 1394 adapter cable • I/O adapter cable • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 10: Specification Guppy F-033B BL (board level)

Note

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

Guppy F-033C BL (board level)

Feature	Specification
Image device	ICX424AQ (diag. 6 mm; type 1/3) progressive scan SONY IT CCD
Effective picture elements	658 (H) x 494 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	640 x 480 pixels (Format_0) 656 x 494 pixels (Format_7 Mode_0)
Cell size	7.4 µm x 7.4 µm
ADC	14 bit
Color modes	Raw8
Data path	8 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps variable frame rates in Format_7 up to 58 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain (select. AOI)
Shutter speed	20 … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, advanced feature: Trigger_Mode_15 (bulk); trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), LUT (look-up table) 4 free configurable inputs/outputs with pulse width modulation (PWM) for each, RS-232 port (serial port, IIDC V1.3.1)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, two ports (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 10-pin connector
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	35 mm x 35 mm (sensor board); 35 mm x 70 mm (main board); without lens

Table 11: Specification Guppy F-033C BL (board level)

Feature	Specification
Mass	~30 g (without lens mount adapter, without lens)
Operating temperature	+ 5 °C ... + 50 °C (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	Board level cameras are not tested for compliance with the regulations due to the fact that test results are strongly dependent on the housing.
Options	• C-Mount (built-in IR cut filter / protection glass) • M12-Mount (built-in IR cut filter / protection glass) • M12 lenses • 1394 adapter cable • I/O adapter cable • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 11: Specification Guppy F-033C BL (board level)

Note

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

Guppy F-036B

Feature	Specification
Image device	MT9V022 (diag. 5.35 mm; type 1/3) progressive scan Micron CMOS
Effective picture elements	752 (H) x 480 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	640 x 480 pixels (Format_0) 752 x 480 pixels (Format_7 Mode_0) 376 x 480 pixels (Format_7 Mode_1, 2 x H-binning average) 752 x 240 pixels (Format_7 Mode_2, 2 x V-binning average) 376 x 240 pixels (Format_7 Mode_3, 2 x full binning average) 188 x 480 pixels (Format_7 Mode_4, 4 x H-binning average) 752 x 120 pixels (Format_7 Mode_5, 4 x V-binning average) 188 x 120 pixels (Format_7 Mode_6, 4 x full binning average)
Cell size	6.0 µm x 6.0 µm
ADC	10 bit
Data path	8 bit
Frame rates	15 fps; 30 fps; 60 fps variable frame rates in Format_7 from 10 fps up to 64 fps
Gain control	Manual: 0-12 dB (average ~0.25 dB/step) for details see Chapter Manual gain on page 113
Shutter speed	20 µs … ~979 ms
External trigger shutter	Trigger_Mode_0, trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), LUT (look-up table), mirror, binning (average) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port

Table 12: Specification Guppy F-036B

Feature	Specification
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 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, EN61000, EN55024, FCC Class B, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options	• C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 12: Specification Guppy F-036B

Note

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

Guppy F-036C

Feature	Specification
Image device	MT9V022 (diag. 5.35 mm; type 1/3) progressive scan Micron CMOS
Effective picture elements	752 (H) x 480 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	640 x 480 pixels (Format_0) 752 x 480 pixels (Format_7 Mode_0)
Cell size	6.0 µm x 6.0 µm
ADC	10 bit
Data path	8 bit
Frame rates	15 fps; 30 fps; 60 fps variable frame rates in Format_7 from 10 fps up to 64 fps
Gain control	Manual: 0-12 dB (average ~0.25 dB/step) for details see Chapter Manual gain on page 113
Shutter speed	20 µs … ~979 ms
External trigger shutter	Trigger_Mode_0, trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AWB (auto white balance), LUT (look-up table), mirror one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 g (without lens)
Operating temperature	+ 5 °C … + 50 °C housing temperature (without condensation)

Table 13: Specification Guppy F-036C

Feature	Specification
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN61000, EN55024, FCC Class B, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options	• C/CS-Mount: protection glass available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 13: Specification Guppy F-036C

Guppy F-038B

Feature	Specification
Image device	ICX418ALL (diag. 8 mm; type 1/2) interlaced SONY EIA/NTSC CCD
Effective picture elements	768 (H) x 494 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	768 x 492 pixels (Format_7 Mode_0, 2 x V-binning), interlaced, field integration mode 768 x 492 pixels (Format_7 Mode_1, no binning), interlaced, frame integration mode 384 x 244 pixels (Format_7 Mode_2, 2 x 2 full binning), non-interlaced, progressive readout mode
Cell size	8.4 µm x 9.8 µm
ADC	12 bit
Data path	8 bit
Frame rates	Variable frame rates in Format_7 from 0.15 fps up to 30 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain
Shutter speed	20 … 67.108.864 µs (~67s); auto shutter
External trigger shutter	Trigger_Mode_0, Trigger_Mode_15, trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens

Table 14: Specification Guppy F-038B

Feature	Specification
Mass	50 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, EN61000, EN55024, FCC Class B, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options	• C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • Only on request: AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • Only on request: AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 14: Specification Guppy F-038B

Guppy F-038C

Feature	Specification
Image device	ICX418AKL (diag. 8 mm; type 1/2) interlaced SONY EIA/NTSC HAD CCD
Effective picture elements	768 (H) x 494 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	768 x 492 pixels (Format_7 Mode_0, 2 x V-binning), interlaced, field integration mode 768 x 492 pixels (Format_7 Mode_1, no binning), interlaced, frame integration mode
Cell size	8.4 µm x 9.8 µm
ADC	12 bit
Data path	8 bit
Frame rates	variable frame rates in Format_7 from 0.15 fps up to 30 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain
Shutter speed	20 … 67.108.864 µs (~67s); auto shutter
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), LUT (look-up table) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 g (without lens)

Table 15: Specification Guppy F-038C

Feature	Specification
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN61000, EN55024, FCC Class B, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options	• C/CS-Mount: protection glass available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • Only on request: AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • Only on request: AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 15: Specification Guppy F-038C

Note

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

Guppy F-038B NIR

Feature	Specification
Image device	ICX428ALL (diag. 8 mm; type 1/2) interlaced SONY EIA/NTSC EXview HAD CCD for enhanced near infrared light sensitivity
Effective picture elements	768 (H) x 494 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	768 x 492 pixels (Format_7 Mode_0, 2 x V-binning), interlaced, field integration mode 768 x 492 pixels (Format_7 Mode_1, no binning), interlaced, frame integration mode 384 x 244 pixels (Format_7 Mode_2, 2 x 2 full binning), non-interlaced, progressive readout mode
Cell size	8.4 µm x 9.8 µm
ADC	12 bit
Data path	8 bit
Frame rates	variable frame rates in Format_7 from 0.15 fps up to 30 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain
Shutter speed	20 … 67.108.864 µs (~67s); auto shutter
External trigger shutter	Trigger_Mode_0, Trigger_Mode_15, trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)

Table 16: Specification Guppy F-038B NIR

Feature	Specification
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 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, EN61000, EN55024, FCC Class B, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options	• C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • Only on request: AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • Only on request: AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 16: Specification Guppy F-038B NIR

Note

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

Guppy F-038C NIR

Feature	Specification
Image device	ICX428AKL (diag. 8 mm; type 1/2) interlaced SONY EIA/NTSC EXview HAD CCD for enhanced near infrared light sensitivity
Effective picture elements	768 (H) x 494 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	768 x 492 pixels (Format_7 Mode_0, 2 x V-binning), interlaced, field integration mode 768 x 492 pixels (Format_7 Mode_1, no binning), interlaced, frame integration mode
Cell size	8.4 µm x 9.8 µm
ADC	12 bit
Data path	8 bit
Frame rates	variable frame rates in Format_7 from 0.15 fps up to 30 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain
Shutter speed	20 … 67.108.864 µs (~67s); auto shutter
External trigger shutter	Trigger_Mode_0, Trigger_Mode_15, trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), LUT (look-up table) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens

Table 17: Specification Guppy F-038C NIR

Feature	Specification
Mass	50 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, EN61000, EN55024, FCC Class B, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options	• C/CS-Mount: protection glass available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • Only on request: AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • Only on request: AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 17: Specification Guppy F-038C NIR

Note

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

Guppy F-044B

Feature	Specification
Image device	ICX419ALL (diag. 8 mm; type 1/2) interlaced SONY CCIR/PAL HAD CCD
Effective picture elements	752 (H) x 582 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	752 x 580 (Format_7 Mode_0, 2 x V-binning), interlaced, field integration mode 752 x 580 (Format_7 Mode_1, no binning), interlaced, frame integration mode 376 x 288 (Format_7 Mode_2, 2 x 2 full binning), non-interlaced, progressive readout mode
Cell size	8.6 µm x 8.3 µm
ADC	12 bit
Data path	8 bit
Frame rates	Variable frame rates in Format_7 from 0.15 fps up to 25 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain
Shutter speed	20 … 67.108.864 µs (~67s); auto shutter
External trigger shutter	Trigger_Mode_0, Trigger_Mode_15, trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE

Table 18: Specification Guppy F-044B

Feature	Specification
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 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, EN61000, EN55024, FCC Class B, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options	• C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • Only on request: AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • Only on request: AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 18: Specification Guppy F-044B

Note

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

Guppy F-044C

Feature	Specification
Image device	ICX419AKL (diag. 8 mm; type 1/2) interlaced SONY CCIR/PAL HAD CCD
Effective picture elements	752 (H) x 582 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	752 x 580 (Format_7 Mode_0, 2 x V-binning), interlaced, field integration mode 752 x 580 (Format_7 Mode_1, no binning), interlaced, frame integration mode
Cell size	8.6 µm x 8.3 µm
ADC	12 bit
Data path	8 bit
Frame rates	Variable frame rates in Format_7 from 0.15 fps up to 25 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain
Shutter speed	20 … 67.108.864 µs (~67s); auto shutter
External trigger shutter	Trigger_Mode_0, Trigger_Mode_15, trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), LUT (look-up table) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens

Table 19: Specification Guppy F-044C

Feature	Specification
Mass	50 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, EN61000, EN55024, FCC Class B, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options	• C/CS-Mount: protection glass available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • Only on request: AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • Only on request: AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 19: Specification Guppy F-044C

Note

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

Guppy F-044B NIR

Feature	Specification
Image device	ICX429ALL (diag. 8 mm; type 1/2) interlaced SONY CCIR/PAL EXview HAD CCD for enhanced near infrared light sensitivity
Effective picture elements	752 (H) x 582 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	752 x 580 (Format_7 Mode_0, 2 x V-binning), interlaced, field integration mode 752 x 580 (Format_7 Mode_1, no binning), interlaced, frame integration mode 376 x 288 (Format_7 Mode_2, 2 x 2 full binning), non-interlaced, progressive readout mode
Cell size	8.6 µm x 8.3 µm
ADC	12 bit
Data path	8 bit
Frame rates	Variable frame rates in Format_7 from 0.15 fps up to 25 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain
Shutter speed	20 … 67.108.864 µs (~67s); auto shutter
External trigger shutter	Trigger_Mode_0, Trigger_Mode_15, trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE

Table 20: Specification Guppy F-044B NIR

Feature	Specification
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 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, EN61000, EN55024, FCC Class B, CE, DDIN ISO 9022-3, RoHS (2002/95/EC)
Options	• C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • Only on request: AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • Only on request: AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 20: Specification Guppy F-044B NIR

Note

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

Guppy F-044C NIR

Feature	Specification
Image device	ICX429AKL (diag. 8 mm; type 1/2) interlaced SONY CCIR/PAL EXview HAD CCD for enhanced near infrared light sensitivity
Effective picture elements	752 (H) x 582 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	752 x 580 (Format_7 Mode_0, 2 x V-binning), interlaced, field integration mode 752 x 580 (Format_7 Mode_1, no binning), interlaced, frame integration mode
Cell size	8.6 µm x 8.3 µm
ADC	12 bit
Data path	8 bit
Frame rates	Variable frame rates in Format_7 from 0.15 fps up to 25 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain
Shutter speed	20 … 67.108.864 µs (~67s); auto shutter
External trigger shutter	Trigger_Mode_0, Trigger_Mode_15, trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), LUT (look-up table) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens

Table 21: Specification Guppy F-044C NIR

Feature	Specification
Mass	50 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, EN61000, EN55024, FCC Class B, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options	• C/CS-Mount: protection glass available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • Only on request: AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • Only on request: AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 21: Specification Guppy F-044C NIR

Note

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

Guppy F-046B

Feature	Specification
Image device	ICX415AL (diag. 8 mm; type 1/2) progressive scan SONY IT CCD
Effective picture elements	782 (H) x 582 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	640 x 480 pixels (Format_0) 780 x 582 pixels (Format_7 Mode_0)
Cell size	8.3 µm x 8.3 µm
ADC	12 bit
Data path	8 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps variable frame rates in Format_7 up to 49.4 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain (select. AOI)
Shutter speed	20 … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, advanced feature: Trigger_Mode_15 (bulk); trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 g (without lens)
Operating temperature	+ 5 °C … + 50 °C housing temperature (without condensation)

Table 22: Specification Guppy F-046B

Feature	Specification
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN61000, EN55024, FCC Class B, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options (old)	• Board level OEM version • C-Mount: IR cut filter / IR pass filter available as CS- to C-Mount adapter. • CS-Mount: Consult factory or your dealer for specific filters. • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)
Options (new)	• Board level OEM version • C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 22: Specification Guppy F-046B

Note

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

Guppy F-046C

Feature	Specification
Image device	ICX415AQ (diag. 8 mm; type 1/2) progressive scan SONY IT CCD
Effective picture elements	782 (H) x 582 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	640 x 480 pixels (Format_0) 780 x 582 pixels (Format_7 Mode_0)
Cell size	8.3 µm x 8.3 µm
ADC	12 bit
Color modes	Raw8
Data path	8 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps variable frame rates in Format_7 up to 49.4 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); Auto gain (select. AOI)
Shutter speed	20 … 67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, Advanced feature: Trigger_Mode_15 (bulk); trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), LUT (look-up table) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 g (without lens)

Table 23: Specification Guppy F-046C

Feature	Specification
Operating temperature	+ 5 °C ... + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN61000, EN55024, FCC Class B, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options (old)	• Board level OEM version • Protection glass • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)
Options (new)	• Board level OEM version • C/CS-Mount: protection glass available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 23: Specification Guppy F-046C

Note

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

Guppy F-080B

Feature	Specification
Image device	ICX204AL (diag. 6 mm; type 1/3) progressive scan SONY IT CCD
Effective picture elements	1034 (H) x 778 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	1024 x 768 pixels (Format_1) supporting all smaller fixed formats 1032 x 778 (Format_7 Mode_0)
Cell size	4.65 µm x 4.65 µm
ADC	12 bit
Data path	8 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps variable frame rates in Format_7 up to 30 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain (select. AOI)
Shutter speed	20 …67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, advanced feature: Trigger_Mode_15 (bulk); image transfer by command; trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); without tripod and lens
Mass	50 g (without lens)
Operating temperature	+ 5 °C … + 50 °C housing temperature (without condensation)

Table 24: Guppy F-080B

Feature	Specification
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options (old)	• C-Mount: IR cut filter / IR pass filter available as CS- to C-Mount adapter. • CS-Mount: Consult factory or your dealer for specific filters. • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)
Options (new)	• C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 24: Guppy F-080B

Note

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

Guppy F-080C

Feature	Specification
Image device	ICX204AK (diag. 6 mm; type 1/3) progressive scan SONY IT CCD
Effective picture elements	1034 (H) x 778 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	1024 x 768 pixels (Format_1) supporting all smaller fixed formats 1032 x 778 (Format_7 Mode_0)
Cell size	4.65 µm x 4.65 µm
ADC	12 bit
Color modes	Raw8
Data path	8 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps variable frame rates in Format_7 up to 30 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); Auto gain (select. AOI)
Shutter speed	20 …67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, Advanced feature: Trigger_Mode_15 (bulk); image transfer by command; trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), LUT (look-up table) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); without tripod and lens
Mass	50 g (without lens)

Table 25: Guppy F-080C

Feature	Specification
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, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options (old)	• Protection glass • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)
Options (new)	• C/CS-Mount: protection glass available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 25: Guppy F-080C

Note

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

Guppy F-080B BL (board level)

Feature	Specification
Image device	ICX204AL (diag. 6 mm; type 1/3) progressive scan SONY IT CCD
Effective picture elements	1034 (H) x 778 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 31: Guppy board level version: C-Mount on page 85) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 30: Guppy board level: CS-Mount on page 84)
Picture sizes	1024 x 768 pixels (Format_1) supporting all smaller fixed formats 1032 x 778 (Format_7 Mode_0)
Cell size	4.65 µm x 4.65 µm
ADC	14 bit
Data path	8 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps variable frame rates in Format_7 up to 30 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain (select. AOI)
Shutter speed	20 …67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, advanced feature: Trigger_Mode_15 (bulk); image transfer by command; trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) 4 free configurable inputs/outputs with pulse width modulation (PWM) for each, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, two ports (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 10-pin connector
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	35 mm x 35 mm (sensor board); 35 mm x 70 mm (main board); without lens
Mass	~30 g (without lens mount adapter, without lens)
Operating temperature	+ 5 °C … + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 60 °C ambient temperature (without condensation)

Table 26: Guppy F-080B BL (board level)

Feature	Specification
Regulations	Board level cameras are not tested for compliance with the regulations due to the fact that test results are strongly dependent on the housing.
Options	• C-Mount (built-in IR cut filter / protection glass) • M12-Mount (built-in IR cut filter / protection glass) • M12 lenses • 1394 adapter cable • I/O adapter cable • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 26: Guppy F-080B BL (board level)

Note

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

Guppy F-080C BL (board level)

Feature	Specification
Image device	ICX204AK (diag. 6 mm; type 1/3) progressive scan SONY IT CCD
Effective picture elements	1034 (H) x 778 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Chapter Guppy board level: C-Mount on page 85) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Chapter Guppy board level: C-Mount on page 85)
Picture sizes	1024 x 768 pixels (Format_1) supporting all smaller fixed formats 1032 x 778 (Format_7 Mode_0)
Cell size	4.65 µm x 4.65 µm
ADC	14 bit
Color modes	Raw8
Data path	8 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps variable frame rates in Format_7 up to 30 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); Auto gain (select. AOI)
Shutter speed	20 …67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, Advanced feature: Trigger_Mode_15 (bulk); image transfer by command; trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), LUT (look-up table) 4 free configurable inputs/outputs with pulse width modulation (PWM) for each, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	35 mm x 35 mm (sensor board); 35 mm x 70 mm (main board); without lens
Mass	~30 g (without lens mount adapter, without lens)
Operating temperature	+ 5 °C … + 50 °C (without condensation)

Table 27: Guppy F-080C BL (board level)

Feature	Specification
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	Board level cameras are not tested for compliance with the regulations due to the fact that test results are strongly dependent on the housing.
Options	• C-Mount (built-in IR cut filter / protection glass) • M12-Mount (built-in IR cut filter / protection glass) • M12 lenses • 1394 adapter cable • I/O adapter cable • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 27: Guppy F-080C BL (board level)

Note

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

Guppy F-146B

Feature	Specification
Image device	ICX267AL (diag. 8 mm; type 1/2) progressive scan SONY IT CCD
Effective picture elements	1392 (H) x 1040 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	1280 x 960 pixels (Format_1) supporting all smaller fixed formats 1392 x 1040 (Format_7 Mode_0)
Cell size	4.65 µm x 4.65 µm
ADC	12 bit
Data path	8 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps variable frame rates in Format_7 up to 17.7 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain (select. AOI)
Shutter speed	20 …67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, advanced feature: Trigger_Mode_15 (bulk); image transfer by command; trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); without tripod and lens
Mass	50 g (without lens)
Operating temperature	+ 5 °C … + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 60 °C ambient temperature (without condensation)

Table 28: Guppy F-146B

Feature	Specification
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options	• Board level OEM version • C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 28: Guppy F-146B

Note

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

Guppy F-146C

Feature	Specification
Image device	ICX267AK (diag. 8 mm; type 1/2) progressive scan SONY IT CCD
Effective picture elements	1392 (H) x 1040 (V)
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting) on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting) on page 91)
Picture sizes	1280 x 960 pixels (Format_1) supporting all smaller fixed formats 1392 x 1040 (Format_7 Mode_0)
Cell size	4.65 µm x 4.65 µm
ADC	12 bit
Color modes	Raw8
Data path	8 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps variable frame rates in Format_7 up to 17.7 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain (select. AOI)
Shutter speed	20 …67.108.864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, advanced feature: Trigger_Mode_15 (bulk); image transfer by command; trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	AGC (auto gain control), AEC (auto exposure control), AWB (auto white balance), LUT (look-up table) one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); without tripod and lens
Mass	50 g (without lens)
Operating temperature	+ 5 °C … + 50 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 60 °C ambient temperature (without condensation)

Table 29: Guppy F-146C

Feature	Specification
Regulations	EN 55022, EN 61000, EN 55024, FCC Class B, CE, DIN ISO 9022-3, RoHS (2002/95/EC)
Options	• Board level OEM version • C/CS-Mount: protection glass available as CS-Mount adapter. • AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 29: Guppy F-146C

Note

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

Spectral sensitivity

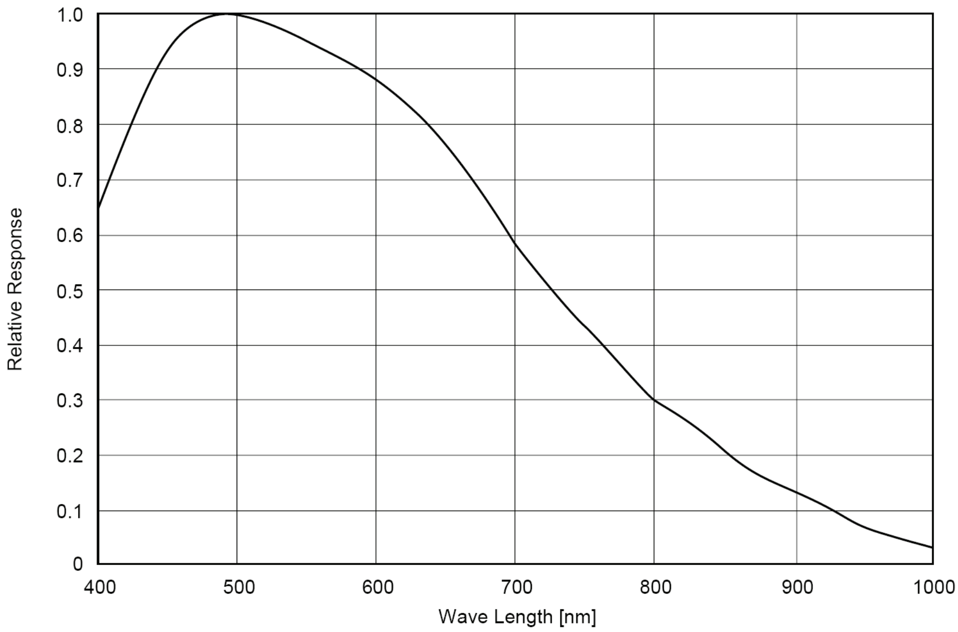


Figure 5: Spectral sensitivity of Guppy F-025B without cut filter and optics

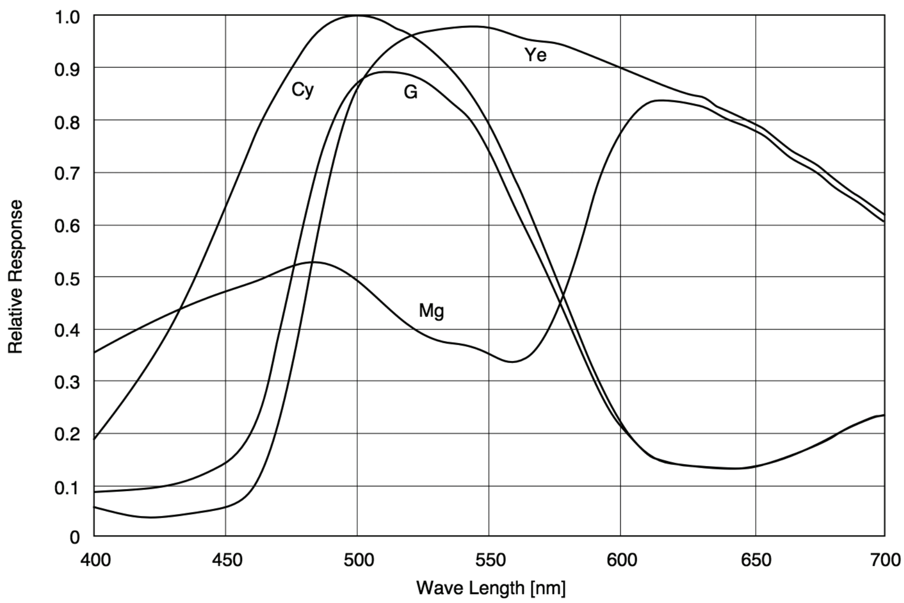


Figure 6: Spectral sensitivity of Guppy F-025C without cut filter and optics

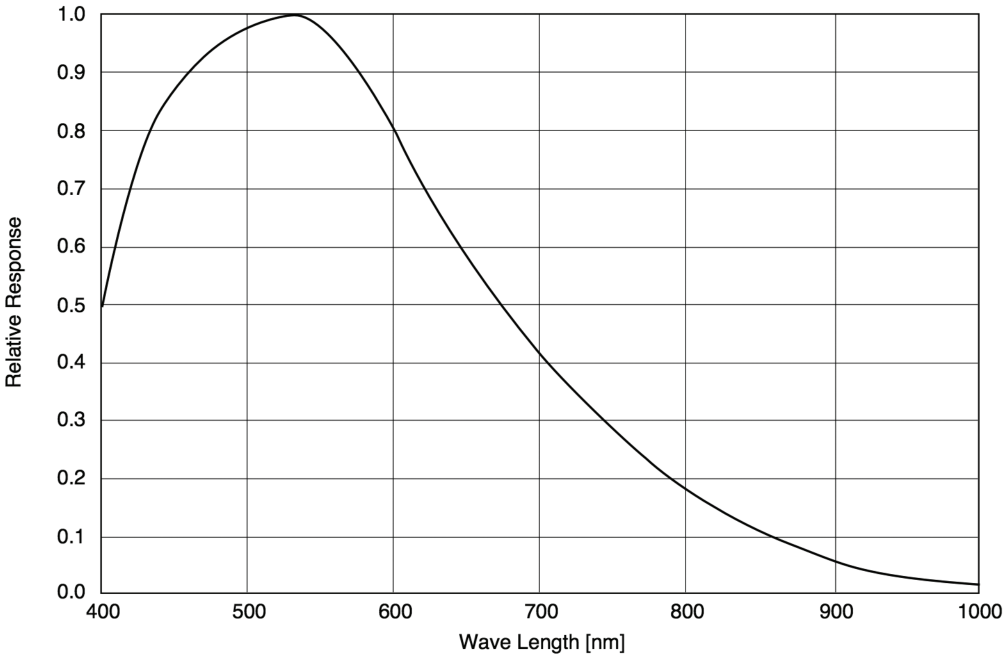


Figure 7: Spectral sensitivity of Guppy F-029B without cut filter and optics

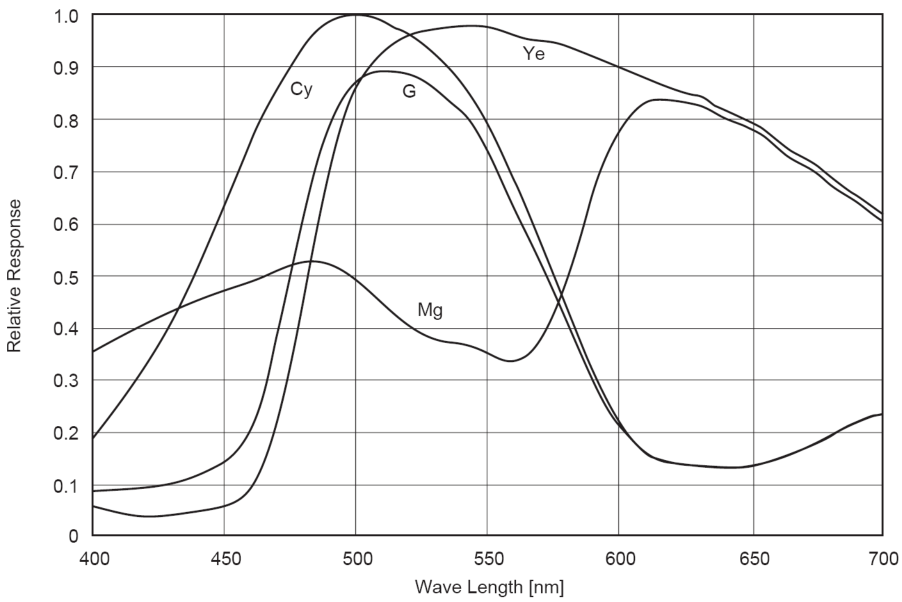


Figure 8: Spectral sensitivity of Guppy F-029C without cut filter and optics

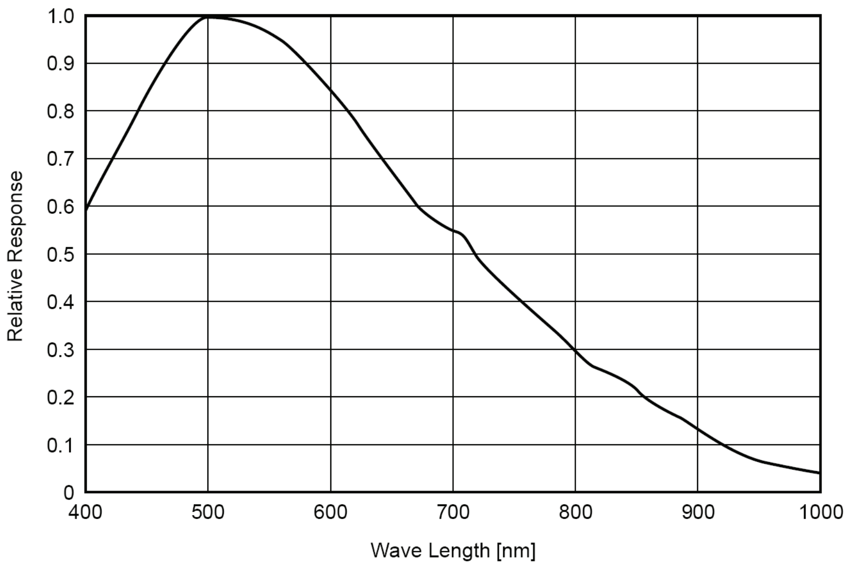


Figure 9: Spectral sensitivity of Guppy F-033B without cut filter and optics

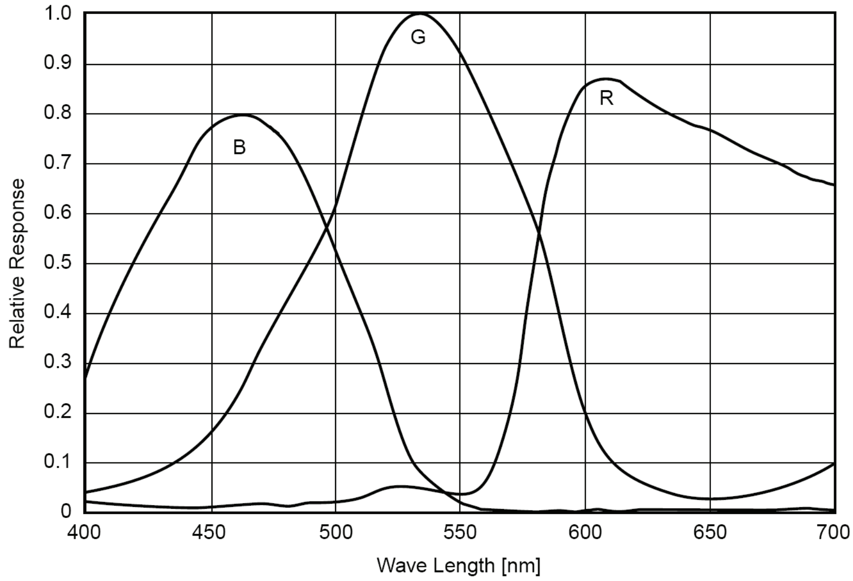


Figure 10: Spectral sensitivity of Guppy F-033C without cut filter and optics

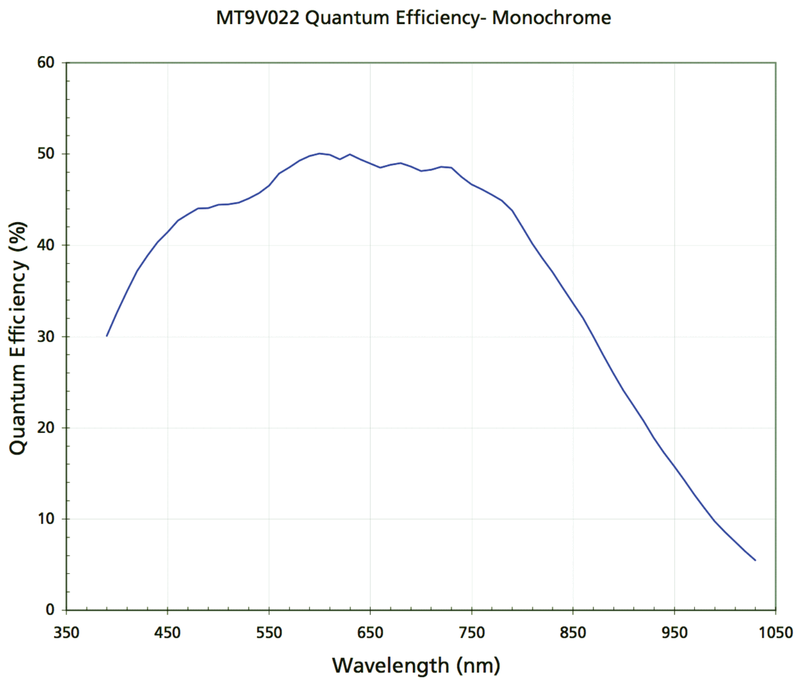


Figure 11: Spectral sensitivity of Guppy F-036B without cut filter and optics

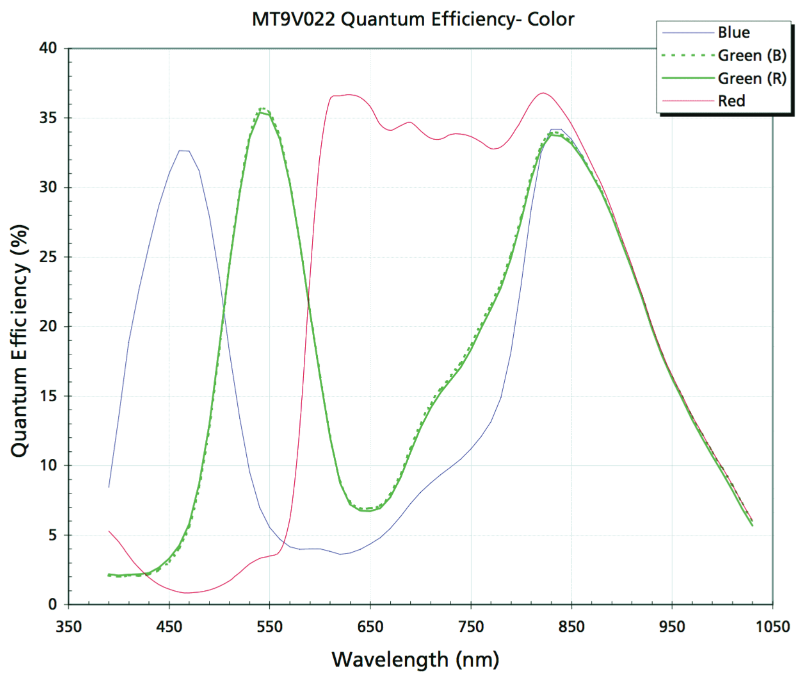


Figure 12: Spectral sensitivity of Guppy F-036C without cut filter and optics

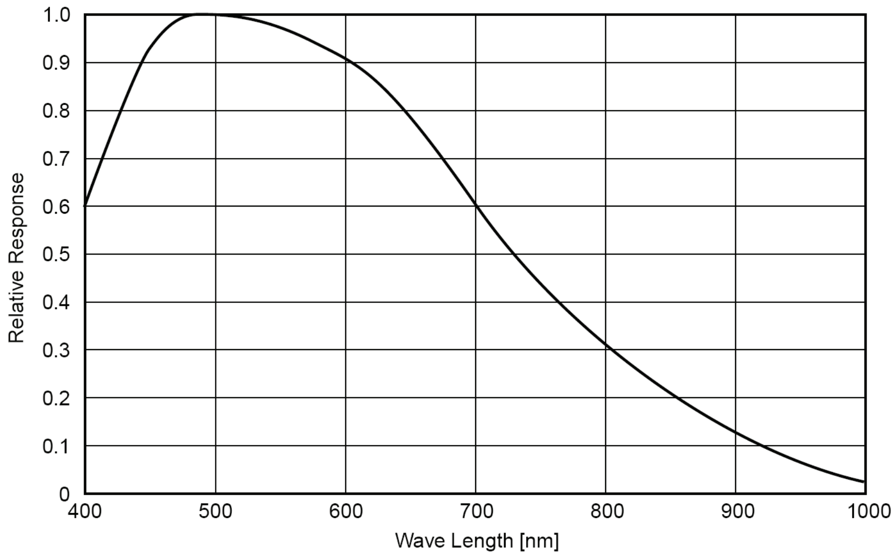


Figure 13: Spectral sensitivity of Guppy F-038B without cut filter and optics

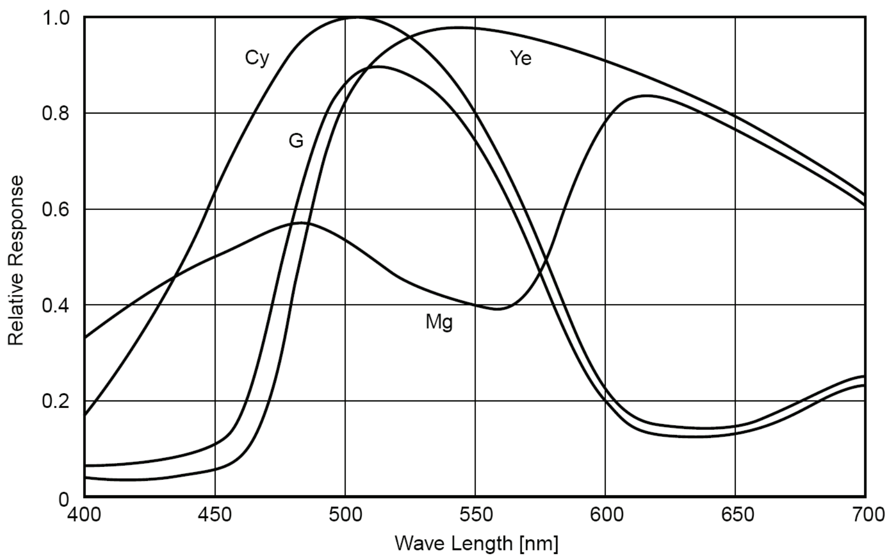


Figure 14: Spectral sensitivity of Guppy F-038C without cut filter and optics

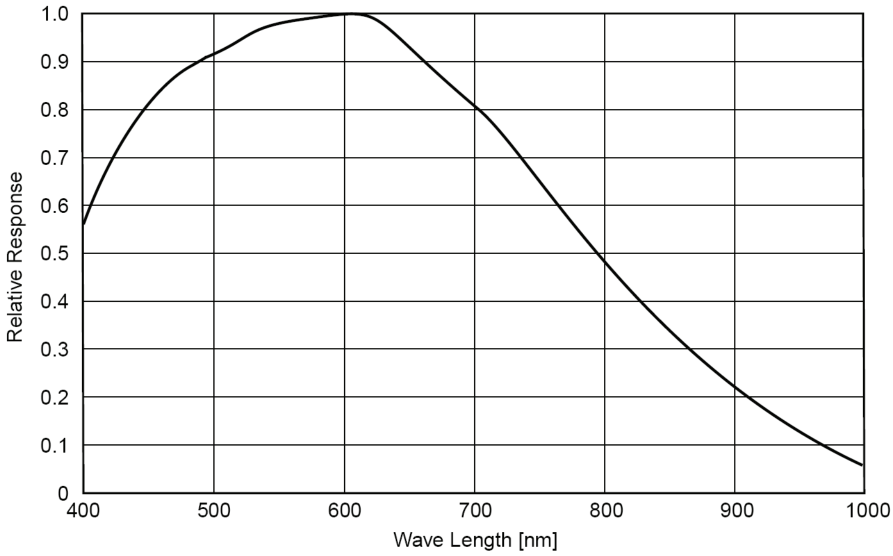


Figure 15: Spectral sensitivity of Guppy F-038B NIR without cut filter and optics

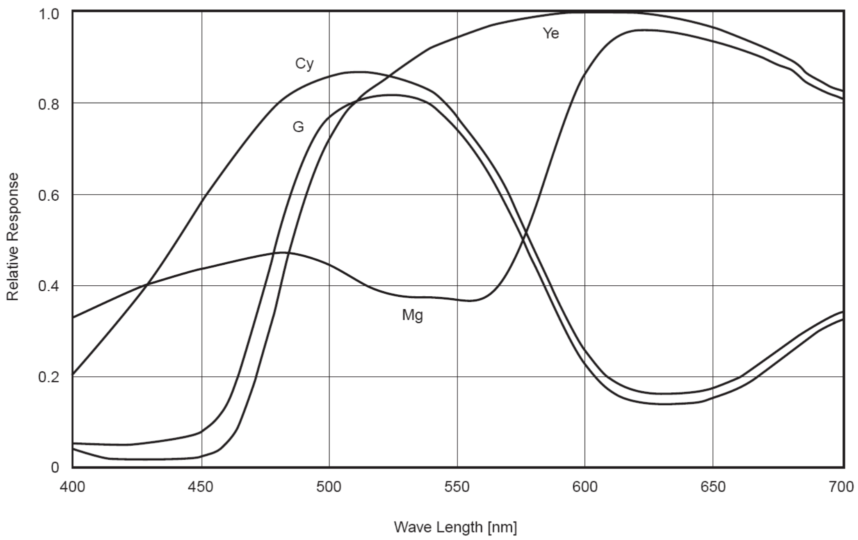


Figure 16: Spectral sensitivity of Guppy F-038C NIR without cut filter and optics

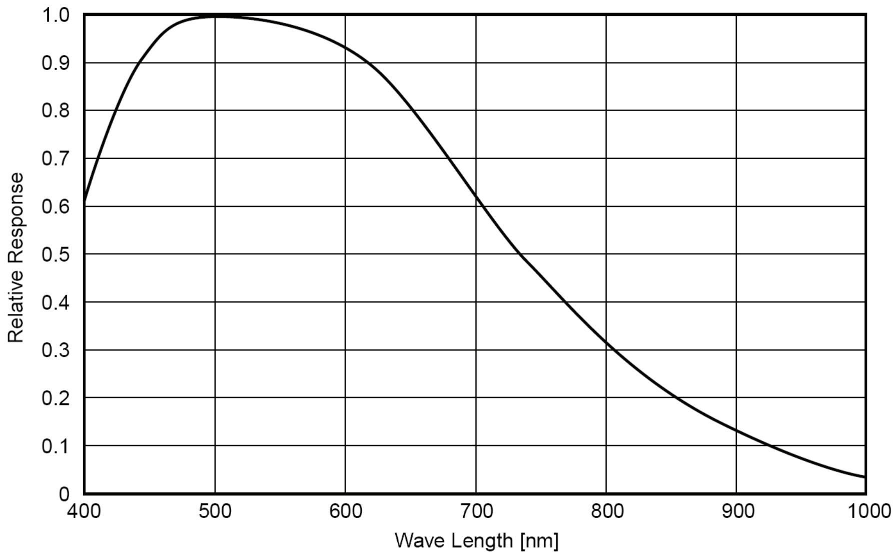


Figure 17: Spectral sensitivity of Guppy F-044B without cut filter and optics

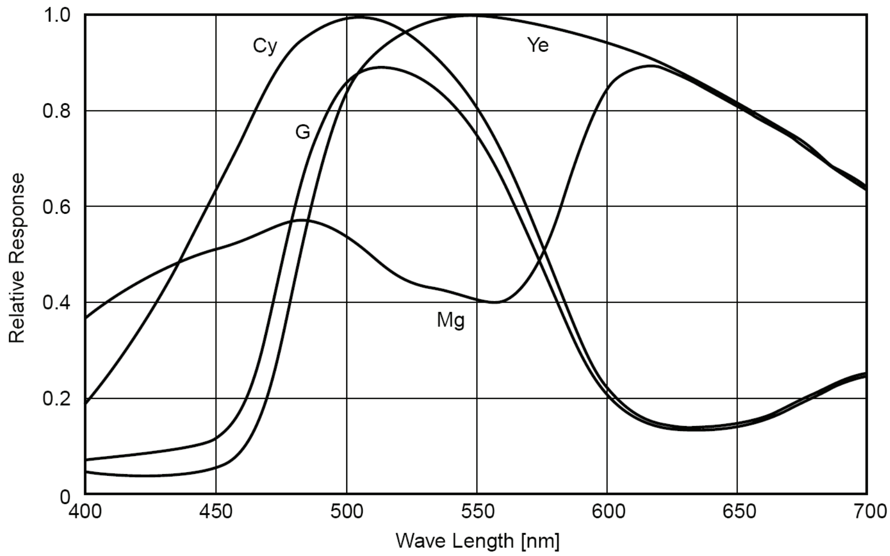


Figure 18: Spectral sensitivity of Guppy F-044C without cut filter and optics

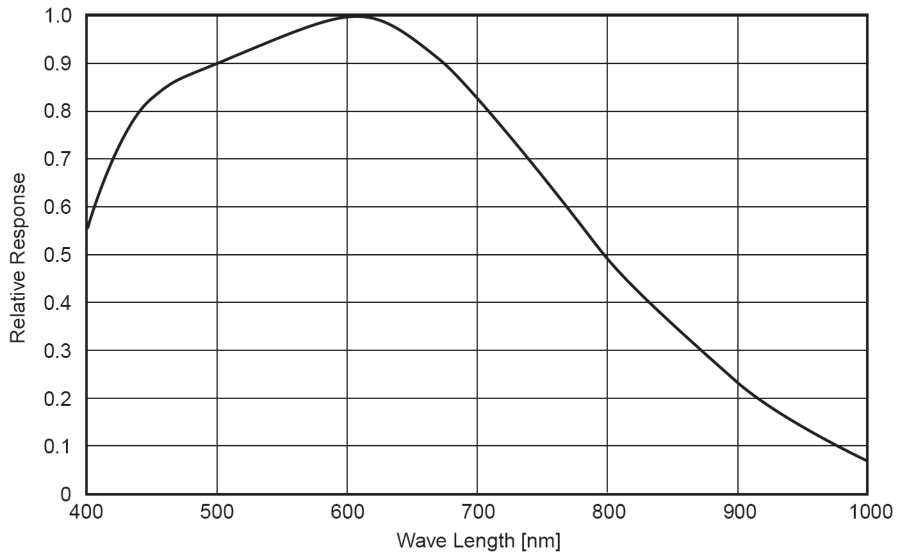


Figure 19: Spectral sensitivity of Guppy F-044B NIR without cut filter and optics

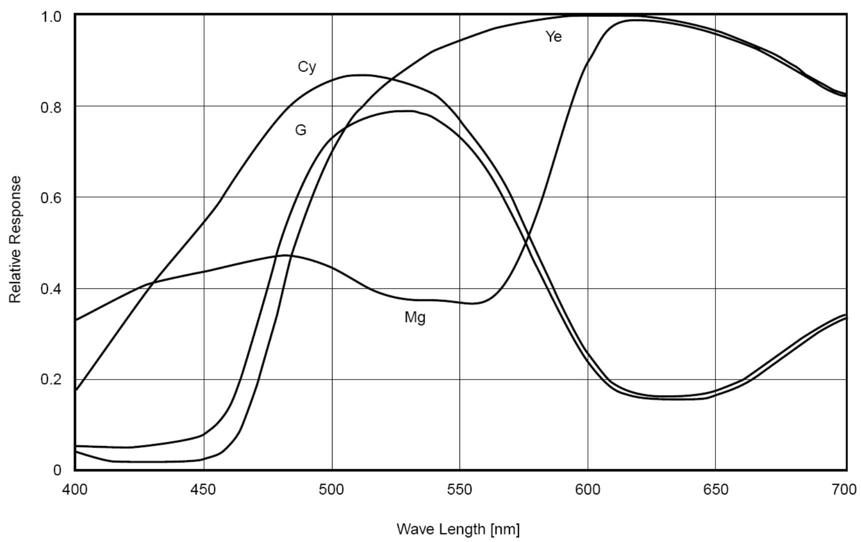


Figure 20: Spectral sensitivity of Guppy F-044C NIR without cut filter and optics

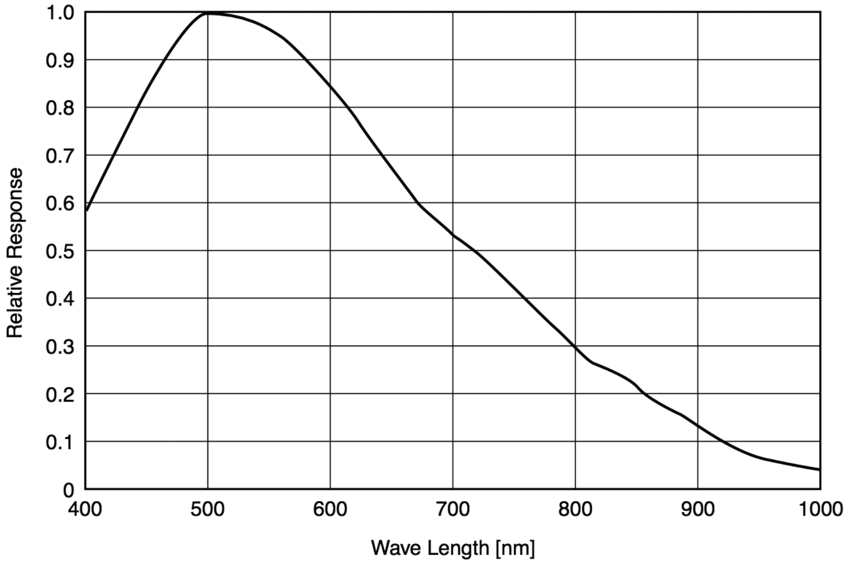


Figure 21: Spectral sensitivity of Guppy F-046B without cut filter and optics

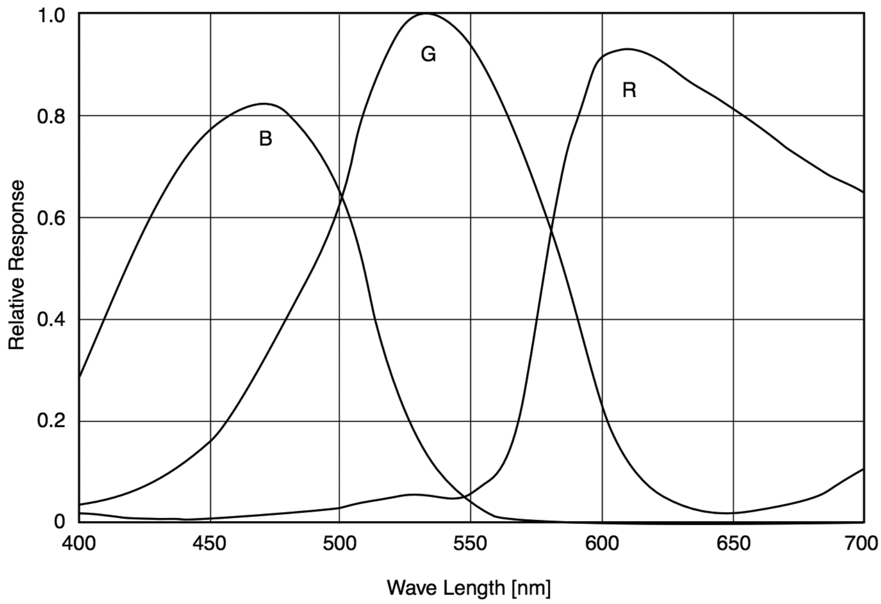


Figure 22: Spectral sensitivity of Guppy F-046C without cut filter and optics

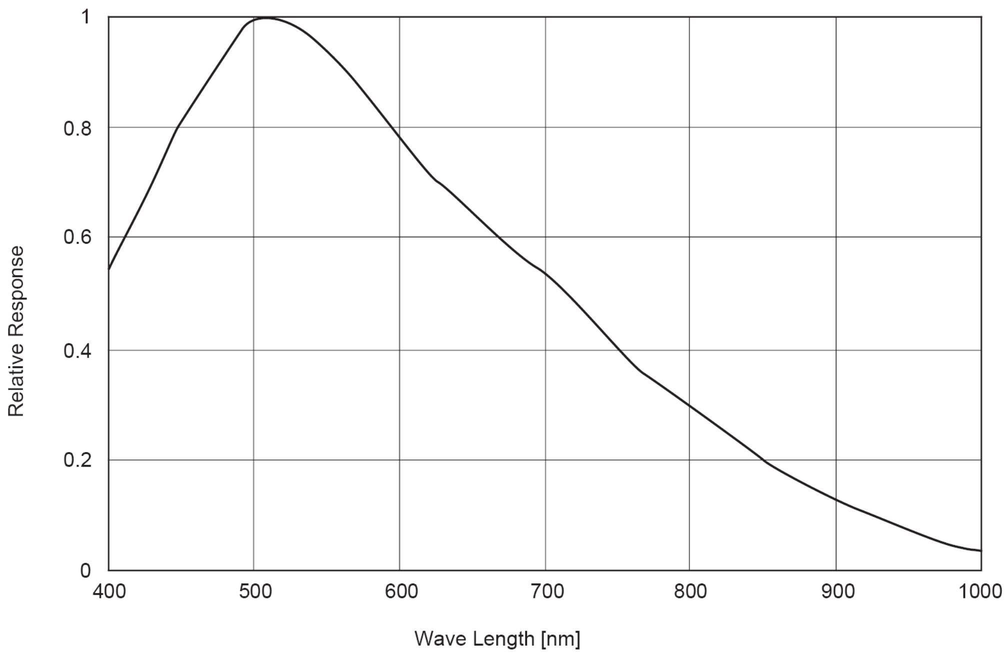


Figure 23: Spectral sensitivity of Guppy F-080B without cut filter and optics

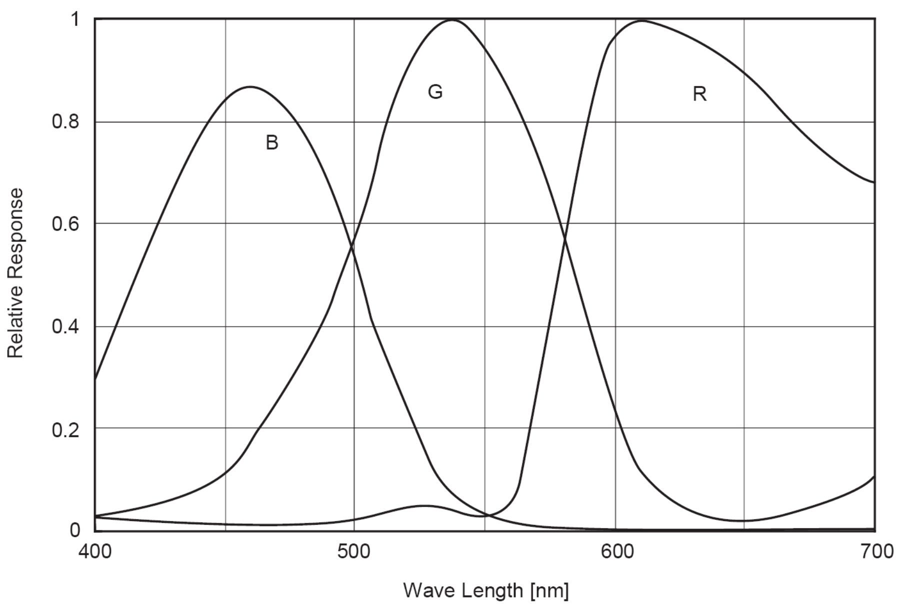


Figure 24: Spectral sensitivity of Guppy F-080C without cut filter and optics

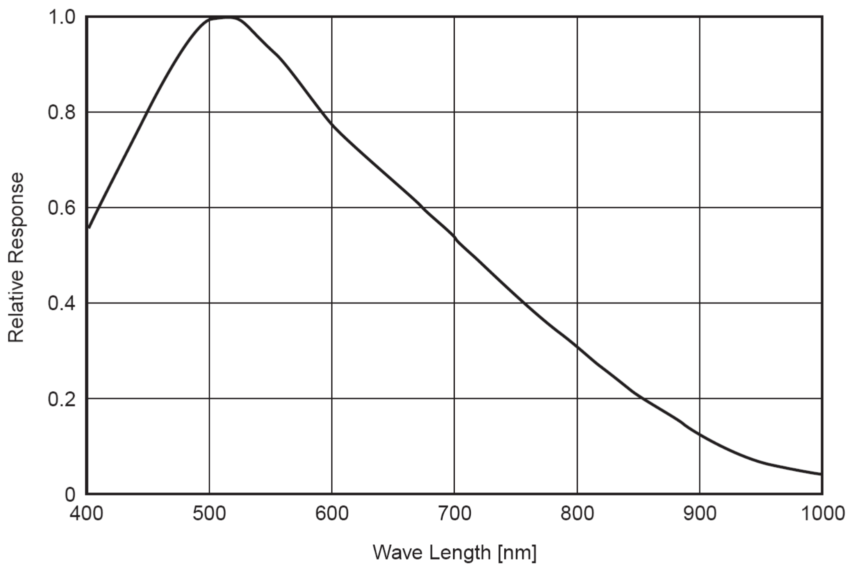


Figure 25: Spectral sensitivity of Guppy F-146B without cut filter and optics

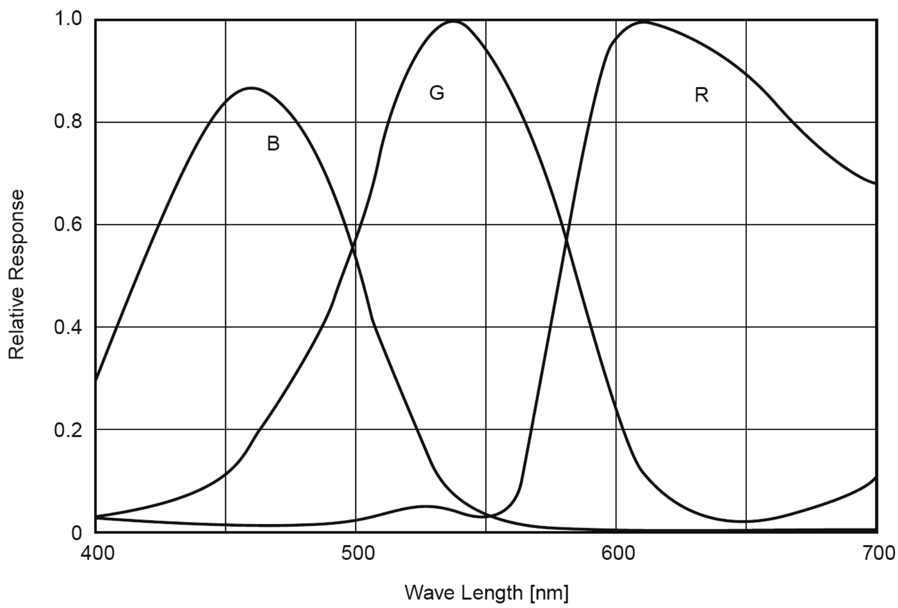
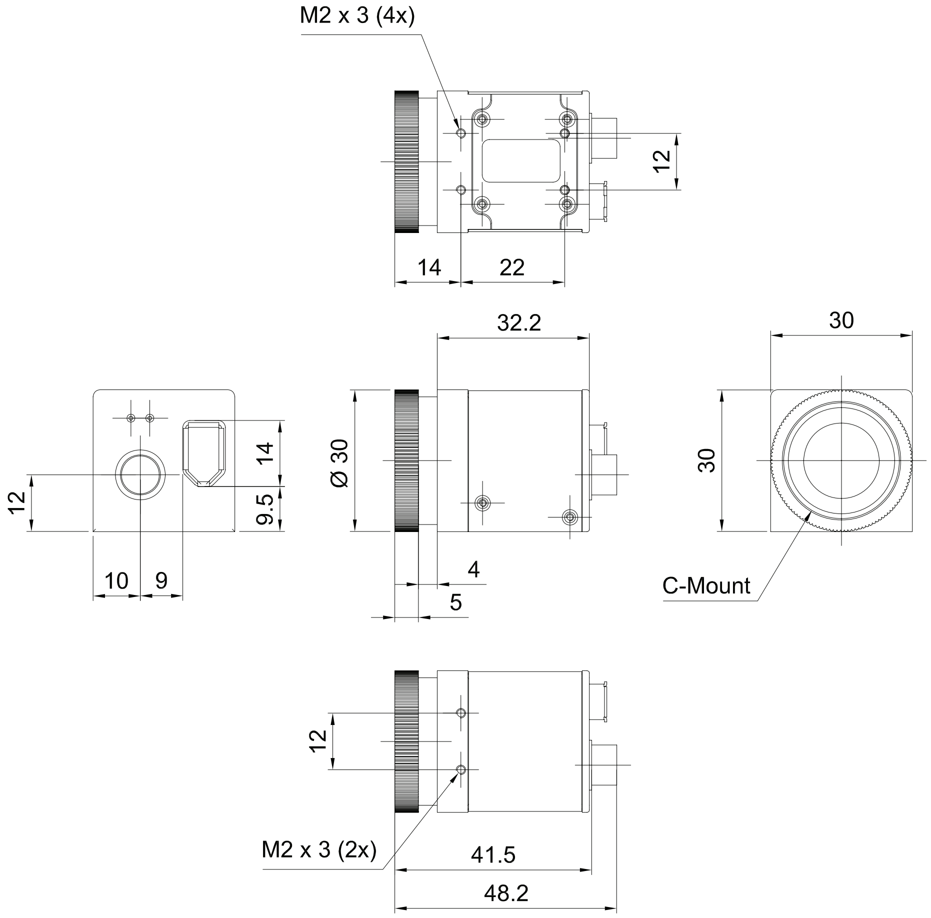


Figure 26: Spectral sensitivity of Guppy F-146C without cut filter and optics

Camera dimensions

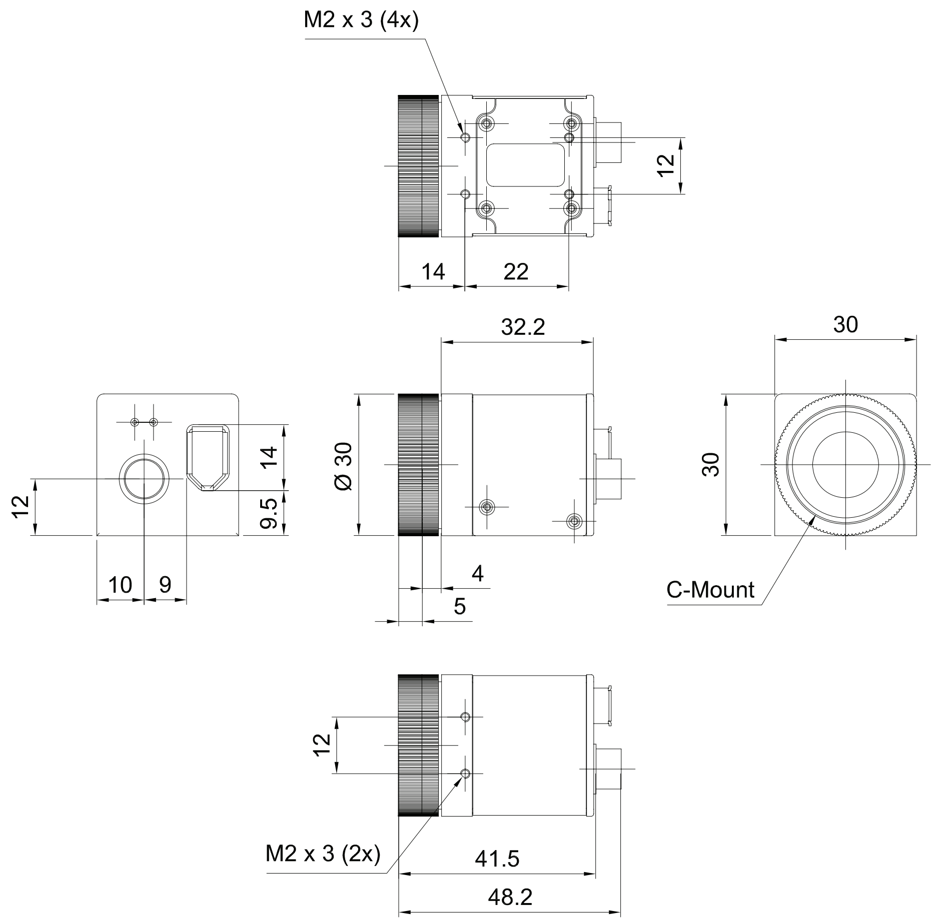
Guppy standard housing (old CS-/C-Mounting)



Body size: 48.2 mm x 30 mm x 30 mm (L x W x H)
Mass: 50 g (without lens)

Figure 27: Camera dimensions (old CS-/C-Mounting)

Guppy standard housing (new CS-/C-Mounting)



Body size: 48.2 mm x 30 mm x 30 mm (L x W x H)
Mass: 50 g (without lens)

Figure 28: Camera dimensions (new CS-/C-Mounting)

Guppy board level: dimensions

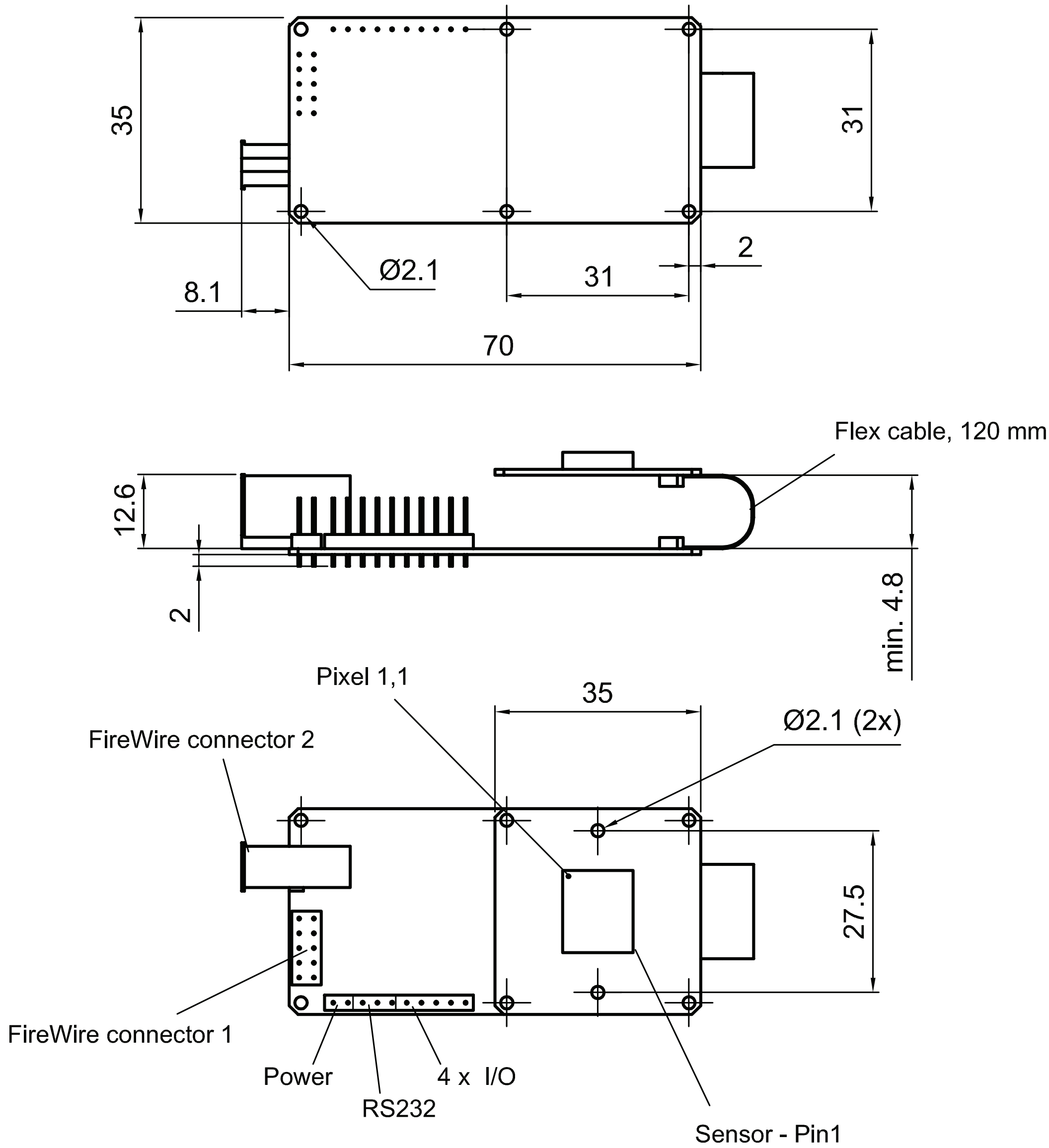


Figure 29: Guppy board level dimensions

Note

- **Pixel 1,1** on the sensor marks the pixel in the upper left corner in the image (incl. lens).
- **Sensor - Pin1** marks the first sensor pin.

Guppy board level: CS-Mount

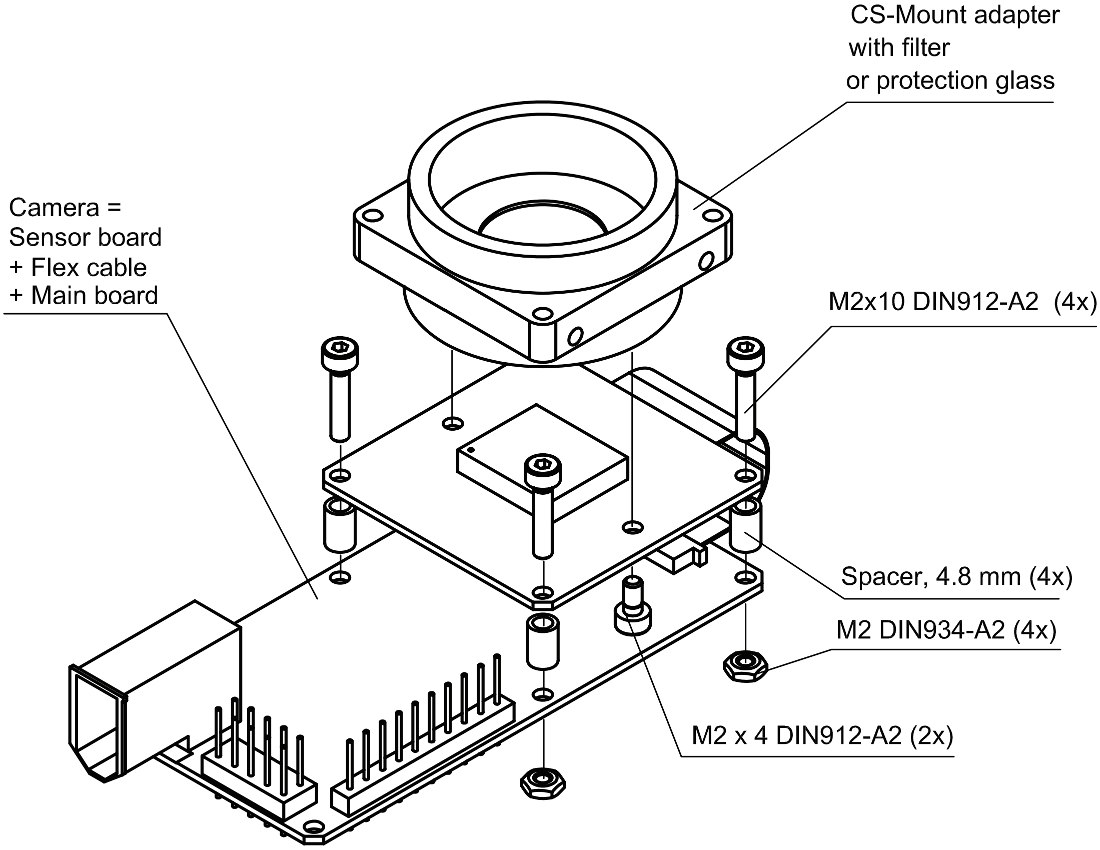


Figure 30: Guppy board level: CS-Mount

Guppy board level: C-Mount

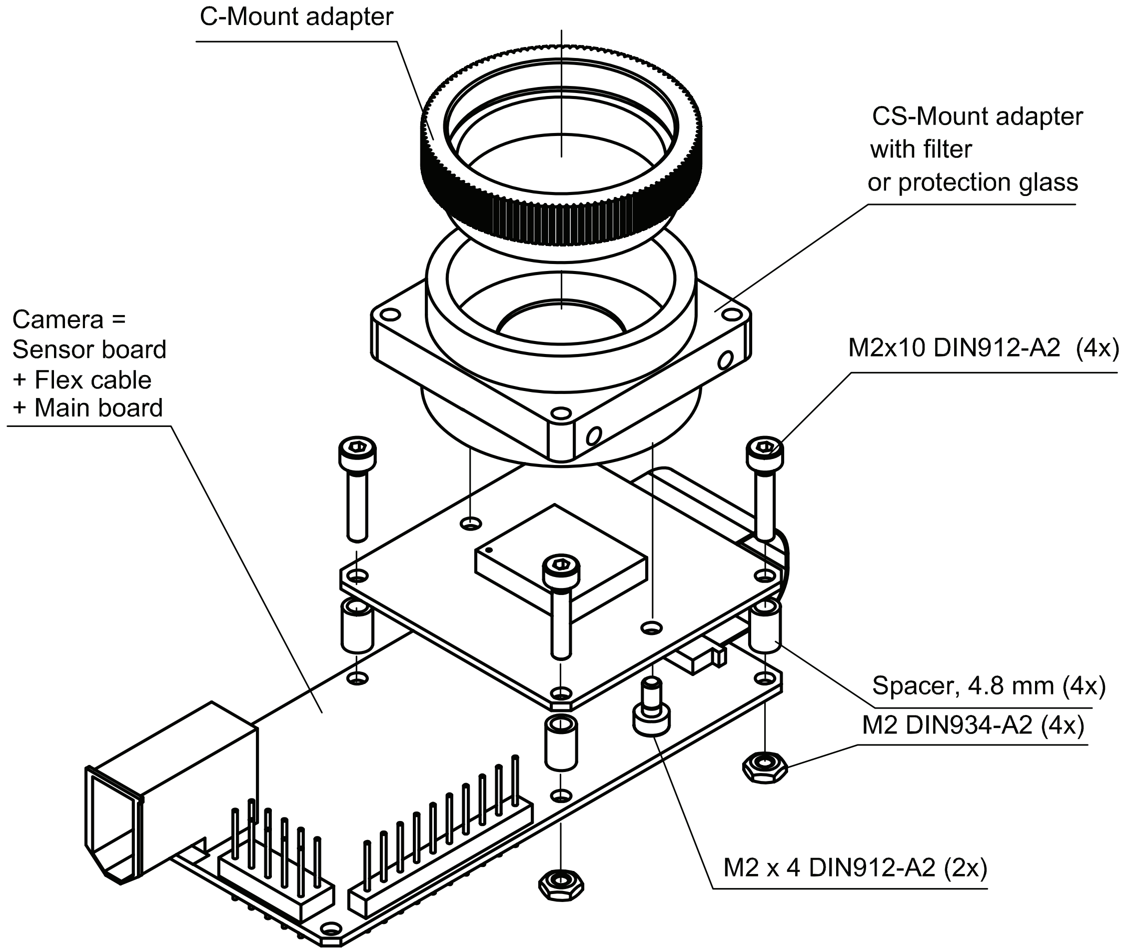


Figure 31: Guppy board level version: C-Mount

Guppy board level: M12-Mount

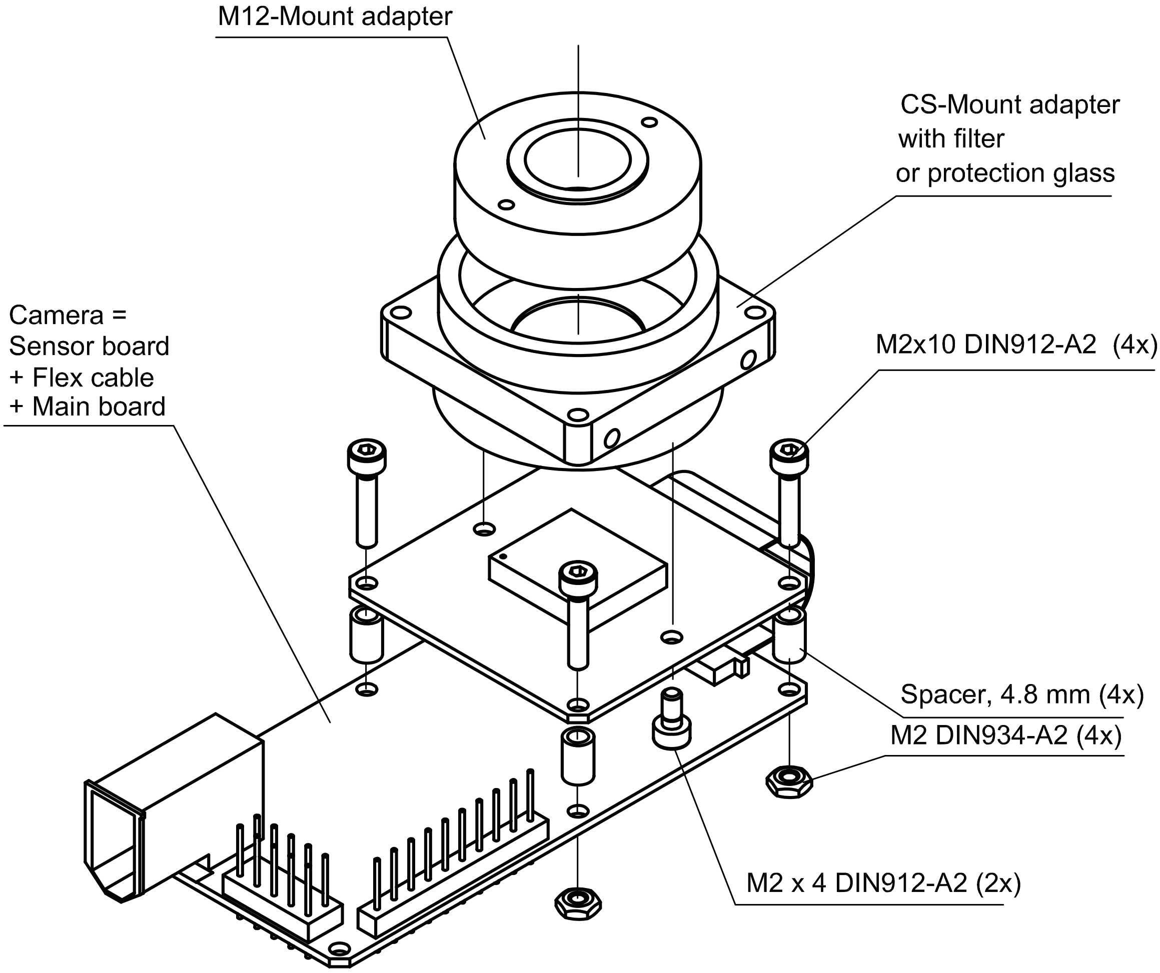


Figure 32: Guppy board level version: M12-Mount

Tripod adapter

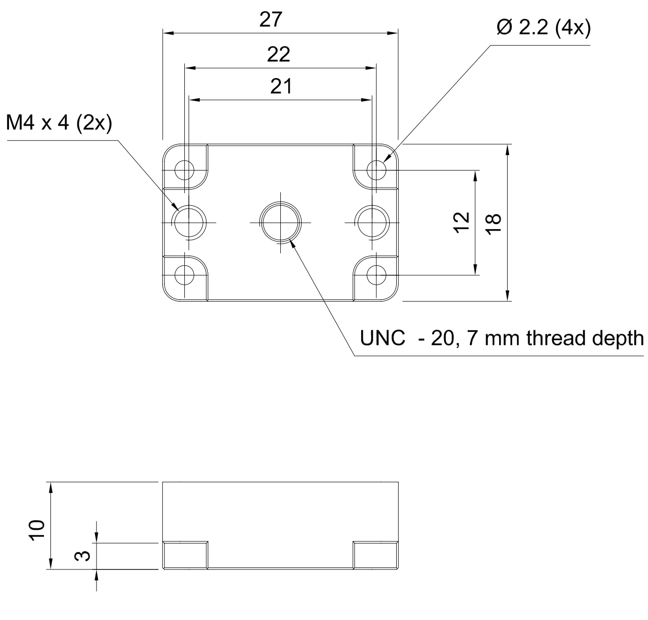


Figure 33: Tripod dimensions

Cross section: C-Mount (old CS-/C-Mounting)

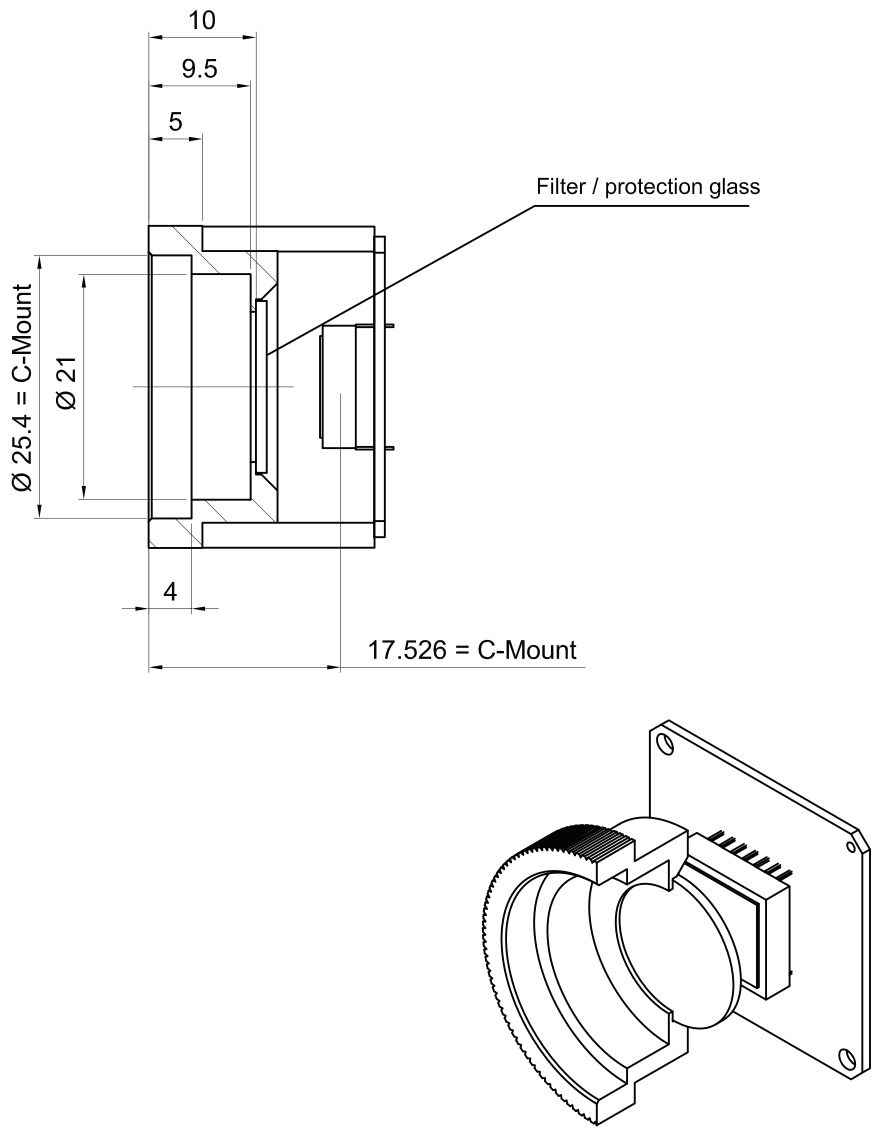
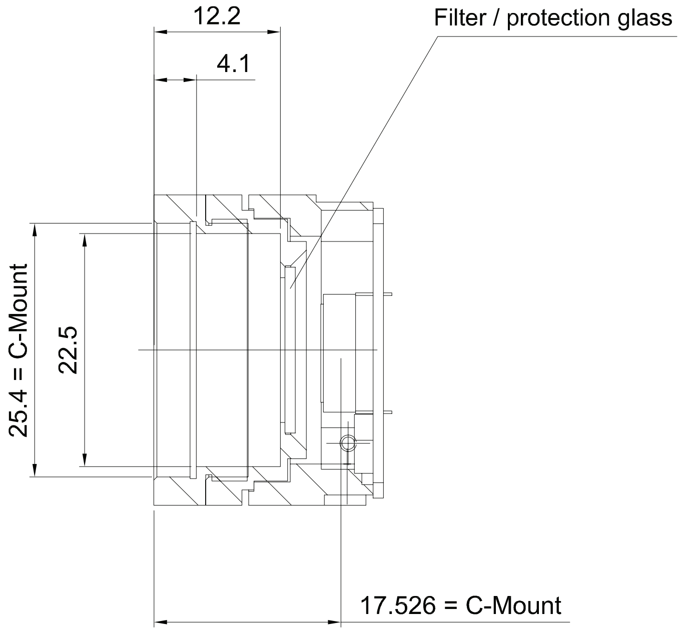


Figure 34: Guppy C-Mount dimensions (old CS-/C-Mounting)

Cross section: C-Mount (new CS-/C-Mounting)



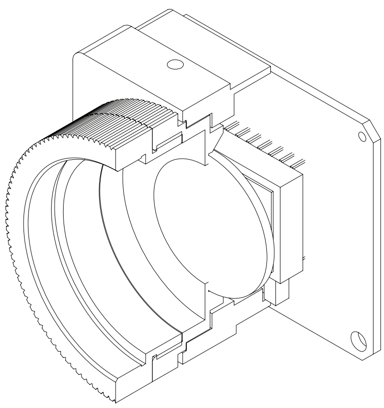


Figure 35: Guppy C-Mount dimensions (new CS-/C-Mounting)

Cross section: CS-Mount (old CS-/C-Mounting)

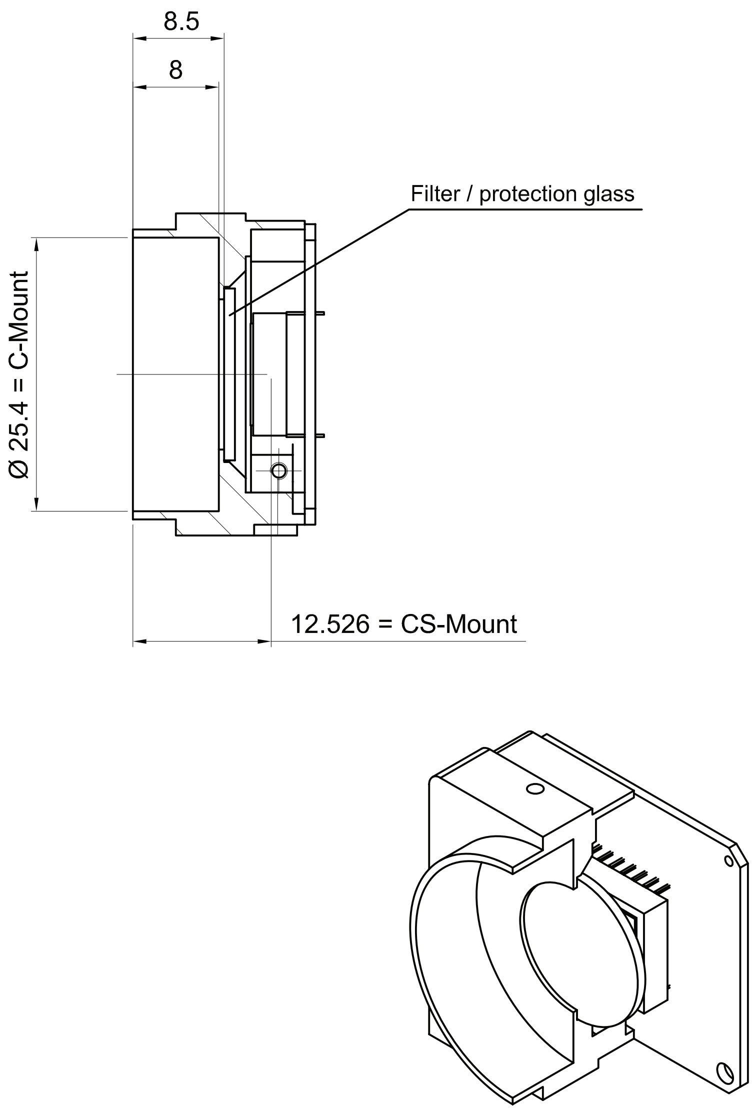


Figure 36: Guppy CS-Mount dimensions (old CS-/C-Mounting)

Cross section: CS-Mount (new CS-/C-Mounting)

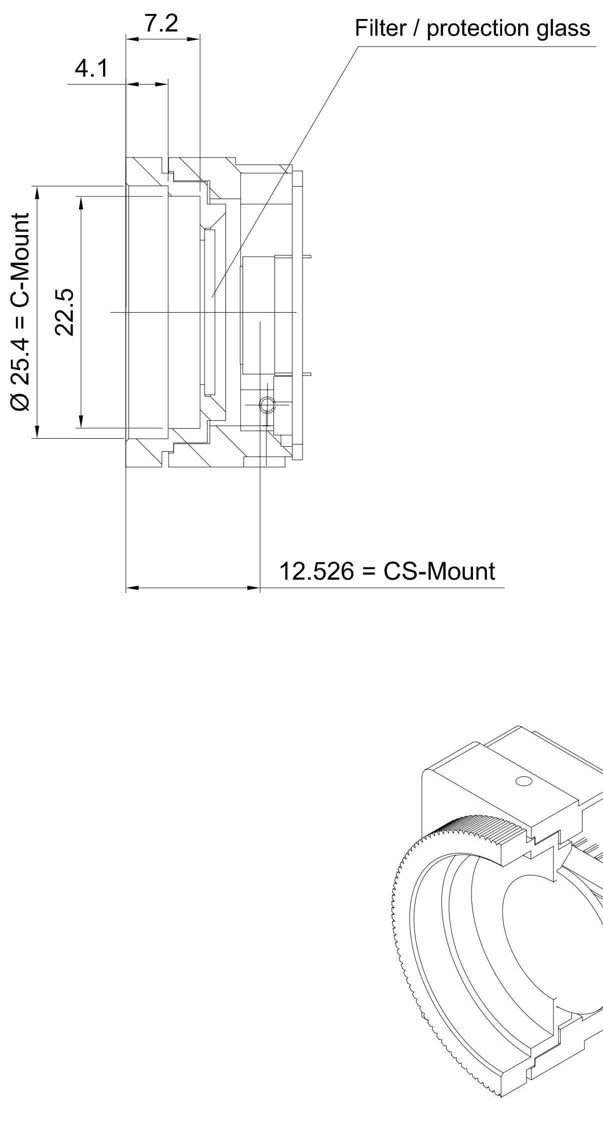


Figure 37: Guppy CS-Mount dimensions (new CS-/C-Mounting)

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 sensor chip in the camera. The individual blocks are described in more detail in the following paragraphs.

Black and white cameras (CCD and CMOS)

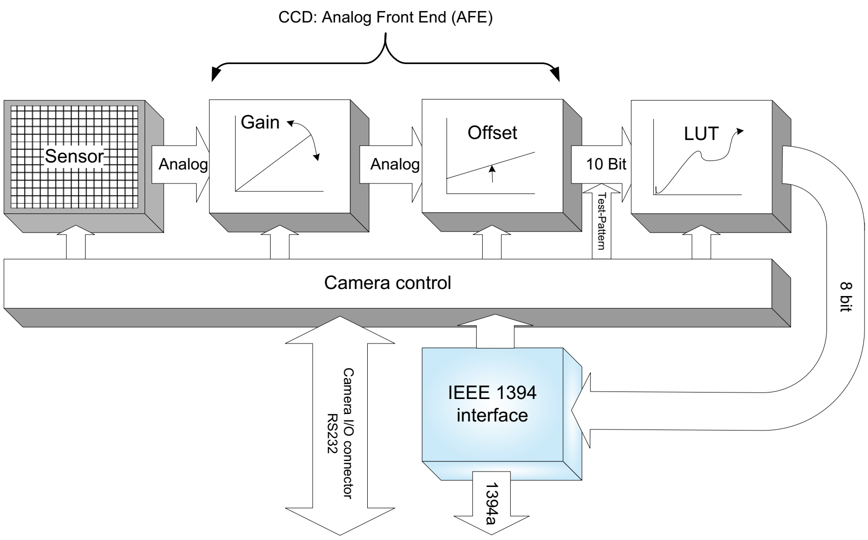


Figure 38: Block diagram b/w camera (CCD)

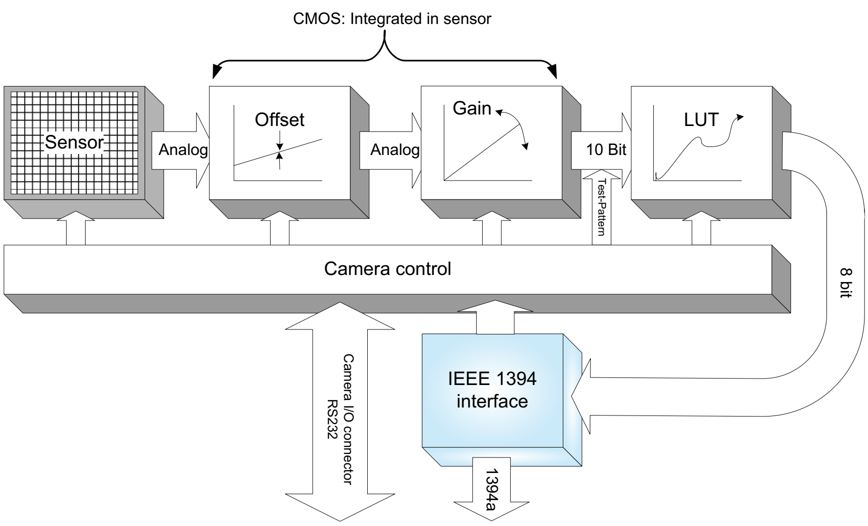


Figure 39: Block diagram b/w camera (CMOS)

Color cameras (CCD and CMOS)

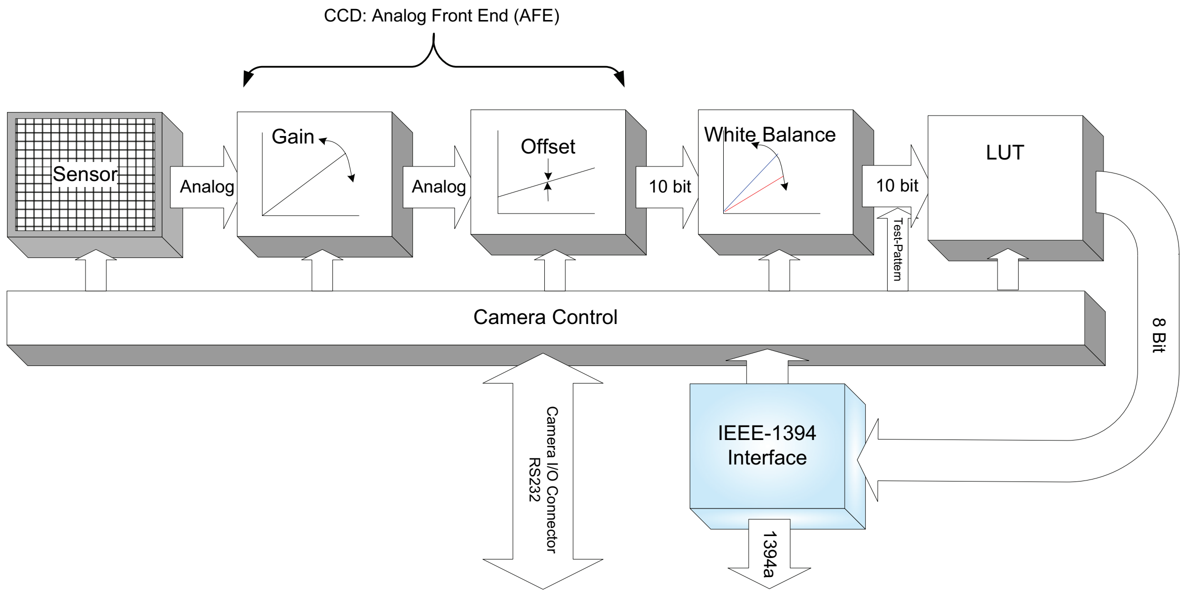


Figure 40: Block diagram color camera (CCD)

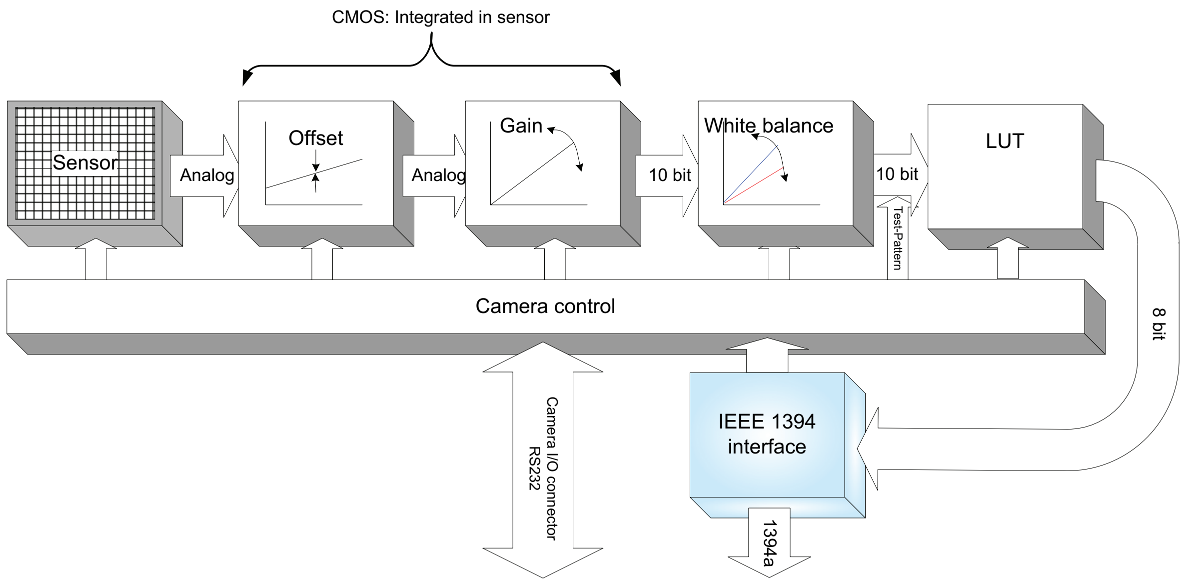


Figure 41: Block diagram color camera (CMOS)

Sensor

The GUPPY cameras are equipped with various sensor types and resolutions. Both CCD and CMOS types are available in monochrome (B) and color (C).

The following table provides an overview:

Model	Techn.	Manu-facturer	Sensor type	Optical format	Diag. [mm]	Micro-lens	Chip size [mm]	Pixel size [µm]	Eff. Pixels
GUPPY F-025B	CCD interlaced	SONY	ICX404AL	Type 1/3	6	Yes, HAD	5.59×4.68	9.6x7.5	510×492
GUPPY F-025C			ICX404AK						
GUPPY F-029B	CCD interlaced	SONY	ICX405AL	Type 1/3	6	Yes, HAD	5.59×4.68	9.8x6.3	500×582
GUPPY F-029C			ICX405AK						
GUPPY F-033B	CCD	SONY	ICX424AL	Type 1/3	6	Yes, HAD	5.79×4.89	7.4x7.4	658×494
GUPPY F-033C			ICX424AQ						
GUPPY F-036B	CMOS	Micron	MT9V022	Type 1/3	5.35	Yes	4.51x2.88	6.0x6.0	752x480
GUPPY F-036C									
GUPPY F-038B	CCD interlaced	SONY	ICX418ALL	Type 1/2	8	Yes, HAD	7.40x5.95	8.4x9.8	768x492
GUPPY F-038C			ICX418AKL						
GUPPY F-038B NIR	CCD interlaced	SONY	ICX428ALL	Type 1/2	8	Yes, EXview HAD	7.40x5.95	8.4x9.8	768x492
GUPPY F-038C NIR			ICX428AKL						
GUPPY F-044B	CCD interlaced	SONY	ICX419ALL	Type 1/2	8	Yes, HAD	7.40x5.95	8.6x8.3	752x580
GUPPY F-044C			ICX419AKL						
GUPPY F-044B NIR	CCD interlaced	SONY	ICX429ALL	Type 1/2	8	Yes, EXview HAD	7.40x5.95	8.6x8.3	752x580
GUPPY F-044C NIR			ICX429AKL						
GUPPY F-046B	CCD	SONY	ICX415AL	Type 1/2	8	Yes, HAD	7.48×6.15	8.3x8.3	782×582
GUPPY F-046C			ICX415AQ						
GUPPY F-080B	CCD	SONY	ICX 204AL	Type 1/3	6	Yes, HAD	5.80x4.92	4.65x4.65	1034x778
GUPPY F-080C			ICX 204AK						
GUPPY F-146B	CCD	SONY	ICX 267AL	Type 1/2	8	Yes, HAD	7.60x6.20	4.65x4.65	1392x1040
GUPPY F-146C			ICX 267AK						

Table 30: Sensor data

Readout schemes: GUPPY interlaced models (F-038, F-038 NIR, F-044, F-044 NIR)

The GUPPY F-038/038 NIR/044/044 NIR cameras use so-called interline scan interlaced CCDs.

Interlaced means: one complete image is scanned or reconstructed by a temporal succession of odd lines and interleaved even lines.

NIR means: near infrared. These sensors are equipped with the SONY EXview HAD technology improving sensitivity (also in the near infrared light region: 700 nm to 1000 nm).

Advantages of interlaced CCDs compared to progressive CCDs:

- More simple shift register (2-phase shift register per pixel element compared to progressive CCDs with 3-phase shift register per pixel element) and higher fill factor of pixels
- Vertical binning (aka field integration) increases sensitivity by a factor of two
- Very sensitive EX-View HAD sensors available (PAL/NTSC resolution)

In the following chapters the 3 different readout modes of the GUPPY interlaced models are explained:

- Format_7 Mode_0: interlaced, field integration (vertical binning)
- Format_7 Mode_2: non-interlaced, field integration (horizontal + vertical binning), so-called progressive readout mode
- Format_7 Mode_1: interlaced, frame integration

Note

For demosaicing process outside of the camera, see Chapter BAYER pattern (raw data output) on page 133.

4-phase vertical shift register

The interline interlaced CCDs use 4-phase vertical shift register and two gates for two vertical pixels. The gates are used to control field or frame integration:

- Field integration: the two gates are activated at the same time
  - see Figure 43: Format_7 Mode_0: 4-phase vertical shift register pre-charging (interlaced, field) on page 96 and
  - Figure 46: Format_7 Mode_2: 4-phase vertical shift register pre-charging (non-interlaced, field) on page 98
- Frame integration: the two gates are activated every other field
  - see Figure 49: Format_7 Mode_1: 4-phase vertical shift register pre-charging (interlaced, frame) on page 100
- Pre-charging of the phases defines interlaced or non-interlaced.

Interlaced and field integration (Format_7 Mode_0)

First field: Binning line 1+2, 3+4, ...

Second field: Binning line 2+3, 4+5, ...

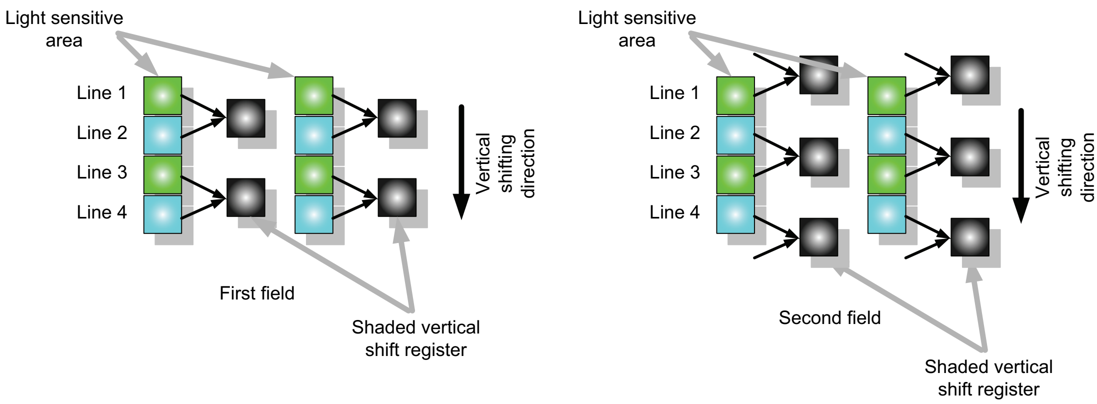


Figure 42: Format_7 Mode_0: field integration readout mode (interlaced)

- The first field and the second field have two different lines binned (vertical binning).
- The temporal vertical resolution is about 70% of progressive scan.
- One complete image is read out during one field. Therefore an electronic shutter is possible.

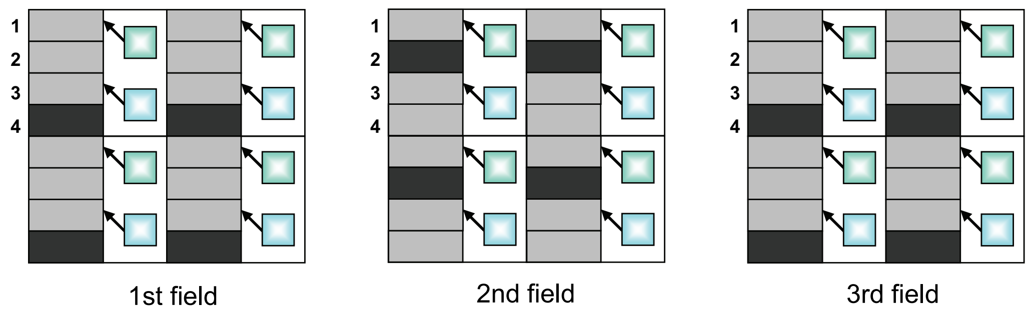


Figure 43: Format_7 Mode_0: 4-phase vertical shift register precharging (interlaced, field)

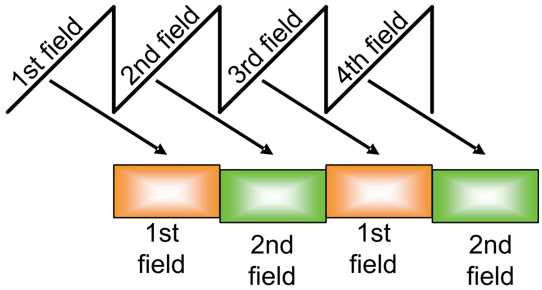


Figure 44: Format_7 Mode_0: output (interlaced, field)

Parameter	Description
Output during first field	Line 1+2, 3+4, ... are output as line 1, 3, ...
Output during second field	Line 2+3, 4+5, ... are output as line 2, 4, ...
Sensitivity	Doubled by field integration
Vertical resolution	About 70% (due to interlaced) compared to progressive scan
Temporal resolution	High (reason: one field contains the full sensor information).
Electronic shutter	Possible
Color reproduction	Possible, has to be done digitally in viewer (e.g. SmartView or by separate UniTransform.dll)

Table 31: Format_7 Mode_0: output parameters (interlaced, field)

Non-interlaced and field integration (Format_7 Mode_2) only b/w cameras

This mode emulates a progressive scan mode.

First field: Binning line 1+2, 3+4, ...

Second field: Binning line 1+2, 3+4, ...

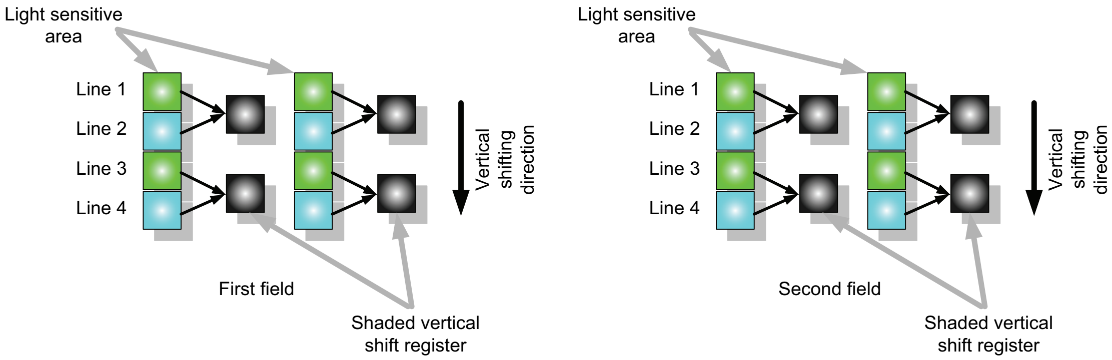


Figure 45: Format_7 Mode_2: field integration readout mode (non-interlaced)

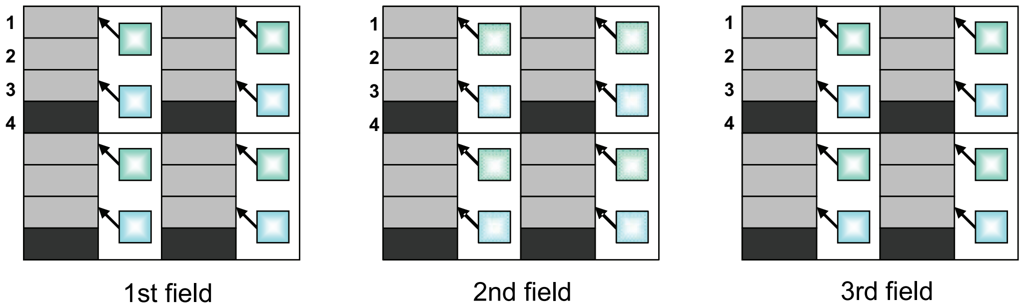


Figure 46: Format_7 Mode_2: 4-phase vertical shift register precharging (non-interlaced, field)

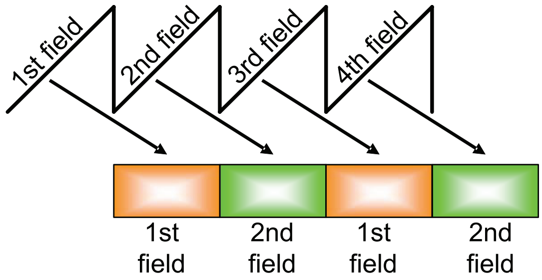


Figure 47: Format_7 Mode_2: output (non-interlaced, field)

Parameter	Description
Output during first field	Line 1+2, 3+4, ... are output as line 1, 3, ...
Output during second field	Line 1+2, 3+4, ... are output as line 1, 3, ...
Sensitivity	Vertically doubled by field integration Horizontally doubled by digital binning
Vertical resolution	About 50% compared to progressive scan (due to non-interlaced)
Temporal resolution	High (reason: one field contains the full sensor information).
Electronic shutter	Possible
Image	Shrunk in both dimensions. Color mode not possible.

Table 32: Format_7 Mode_2: output parameters (non-interlaced, field)

Interlaced and frame integration (Format_7 Mode_1)

Note

Always run the sensor at full speed due to specification of sensor.

First field: Reading out line 1, 3, 5, ...

Second field: Reading out line 2, 4, 6, ...

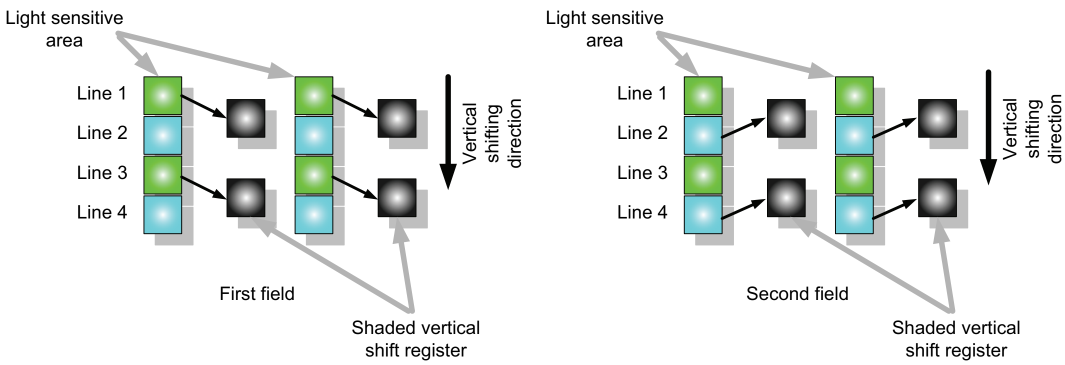


Figure 48: Format_7 Mode_1: frame integration readout mode (interlaced)

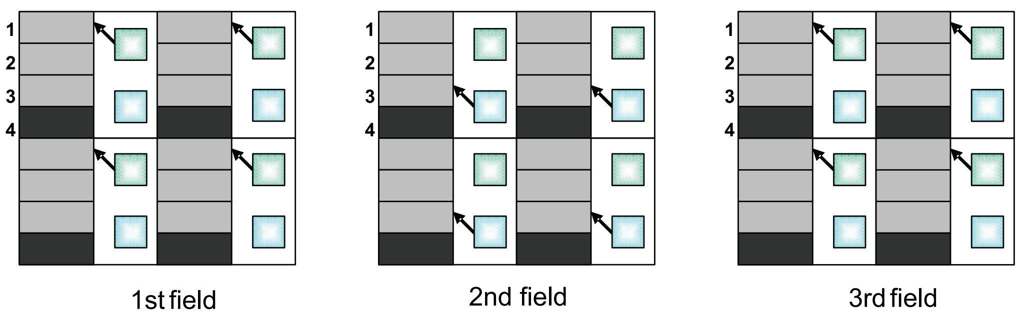


Figure 49: Format_7 Mode_1: 4-phase vertical shift register precharging (interlaced, frame)

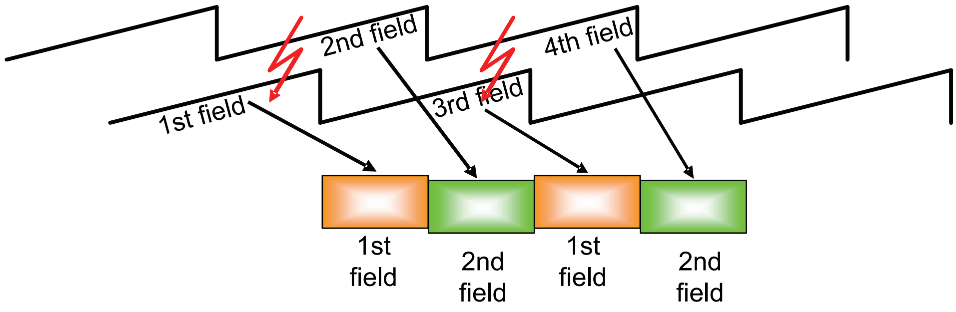


Figure 50: Format_7 Mode_1: output (interlaced, frame)

Parameter	Description
Output during first field	Line 1, 3, ... are output as line 1, 3, ...
Output during second field	Line 2, 4, ... are output as line 2, 4, ...
Sensitivity	Half compared to field integration
Vertical resolution	About 100% compared to progressive scan
Temporal resolution	Lower (reason: two fields contain the full sensor information).
Electronic shutter	Not possible due to overlap of integration time
Flashing	Gives full resolution IntEna can be used to synchronize the flash
Shutter (integration)	Can only be set larger than one field, not shorter.
Color reproduction	Possible, has to be done digitally in viewer (e.g. SmartView or by separate UniTransform.dll)

Table 33: Format_7 Mode_1: output parameters (interlaced, frame)

Complementary colors and demosaicing

Note

Color correction: see Chapter Color correction (only interlaced GUPPYs) on page 104.

BAYER pattern: see Figure 65: BAYER pattern of SONY complementary sensors: 1st line: G - Mg, 2nd line: Cy - Ye on page 134

The interlaced SONY CCDs use the four complementary colors Ye (=yellow), Cy (=cyan), Mg (=magenta) and G (=green) instead of R, G, B (red, green, blue).

Advantage of using complementary colors:

- Less energy needs to be filtered out. That means an increase of sensitivity (compare the spectral sensitivity diagrams in Chapter Spectral sensitivity on page 70)

Disadvantage of complementary colors:

- Fully saturated primary colors (e.g. red or blue) cannot be displayed as well as with primary (RGB) color filters

Using Red, Green, Blue	Using Yellow, Cyan, Magenta, Green
+ increases color resolution	- decreases color resolution
- decreases sensitivity	+ increases sensitivity

Table 34: Comparison RGB and CMYG

How demosaicing works

The generation of the output signal luma (Y) and the two chrominance (C) signals (R-Y) and (B-Y) can be done relatively easy by vertically averaging the charges of two adjacent lines in the analog domain (by field readout of the CCD) or by a digital representation..

It is now important that due to the changed ordering of Mg and G in every second line, the vertical averaging of the first two adjacent lines gives:

(Cy + Mg) and (Ye + G),

and the second two lines give:

(Cy + G) and (Ye + Mg).

As an approximation by SONY, the Y signal is created by adding horizontally adjacent pixels, and the chroma signal is generated by subtracting these adjacent pixel signals.

This is for the second line pair:

$$Y = \frac{1}{2} \times (2 \times B + 3 \times G + 2 \times R) = \frac{1}{2} \times ((G + Cy) + (Mg + Ye))$$

with the assumption:

$$(R + G) = Ye$$
$$(R + B) = Mg$$
$$(G + B) = Cy$$

Formula 1: Y signal expressed via RGB and CyMgYeG

The second chroma signal R-Y is created by subtracting the averaged pixels:

$$R - Y = (2 \times R - G) = ((Mg + Ye) - (G + Cy))$$

Formula 2: Second chroma signal V

Formula 2 is used for the **second chroma** (color difference) **signal V**.

For the first line pair, the Y signal is formed from these signals as follows:

$$Y = \frac{1}{2} \times ((G + Ye) + (Mg + Cy)) = \frac{1}{2} \times (2 \times B + 3 \times G + 2 \times R)$$

Formula 3: Y signal for first line pair

This is balanced since it is formed in the same way as for the first line pair.

In a like manner, the **first chroma** (color difference) **signal U** is approximated as follows:

$$-(B - Y) = -(2 \times B - G) = ((G + Ye) - (Mg + Cy))$$

Formula 4: First chroma signal U

In other words, the two chroma signals can be alternatingly retrieved from the sequence of lines from R – Y and – (B – Y).

This is also true for the second field. Complementary filtering is thus a way to achieve higher sensitivity at a slight expense of color resolution.

Color correction (only interlaced GUPPYs)

In order to further improve the color response of complementary color filter sensors, a color correction is built in in smartview as well as in UniTransform.dll library.

Color correction is done for daylight spectrum (about 5,000 K).

CyMgYeG is converted to YUV values according the given formulas from SONY (Chapter How demosaicing works on page 102).

The color correction RGBcor is done outside the camera by the viewer software SmartView via the following formula (color correction coefficients Cxy are fixed and can not be changed):

$$RGB_{cor} = R_{col} \times YUV2RGB \times YUV$$

$$YUV2RGB = \begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1.164 \times Y + 1.596 \times (V - 128) \\ 1.164 \times Y - 0.813 \times (V - 128) - 0.391 \times (U - 128) \\ 1.164 \times Y + 2.018 \times (U - 128) \end{bmatrix}$$

$$R_{col} = \begin{bmatrix} Crr & Cgr & Cbr \\ Crg & Cgg & Cbg \\ Crb & Cgb & Cbb \end{bmatrix} = \begin{bmatrix} 1.29948 & 0.0289296 & -0.934432 \\ -0.409754 & 1.31042 & -0.523692 \\ 0.110277 & -0.339351 & 2.45812 \end{bmatrix}$$

Formula 5: Color correction formula for interlaced GUPPYs

Note

The color correction coefficients can **not** be changed and can **not** be saved via the user profiles.

Horizontal and vertical mirror function (only Guppy F-036)

The Guppy F-036 CMOS cameras are equipped with a horizontal and vertical mirror function, which is built directly into the sensor. The mirror is centered to the actual **FOV** center and can be combined with all image manipulation functions, like **binning**.

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 130: Mirror control register on page 260.

Note

When using the mirror function, the starting color is maintained.

White balance

The color cameras have both manual and automatic white balance. White balance is applied so that non-colored image parts are displayed non-colored.

White balance does not use the so-called PxGA® (Pixel Gain Amplifier) of the analog front end (AFE) but a digital representation in the FPGA in order to modify the gain of the two channels with lower output by +9.5 dB (in 512 steps) relative to the channel with highest output.

The following screenshot is taken from the datasheet of the AFE and illustrates the details:

The analog color signal, coming in pulse amplitude modulation from the sensor, is in the form of the BAYER™ color pattern sequence. It is initially processed in the CDS (correlated double sampler) then bypasses the PxGA before further amplification and digitization.

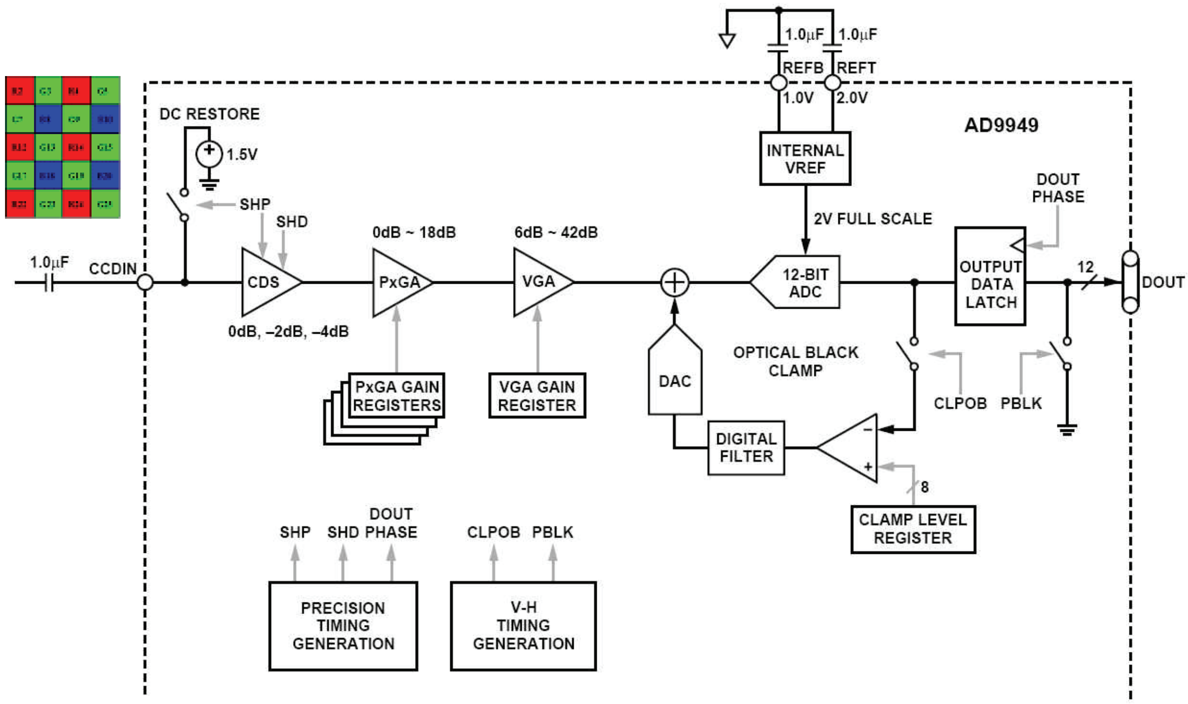


Figure 51: Block diagram of AFE (Source: Analog Devices)

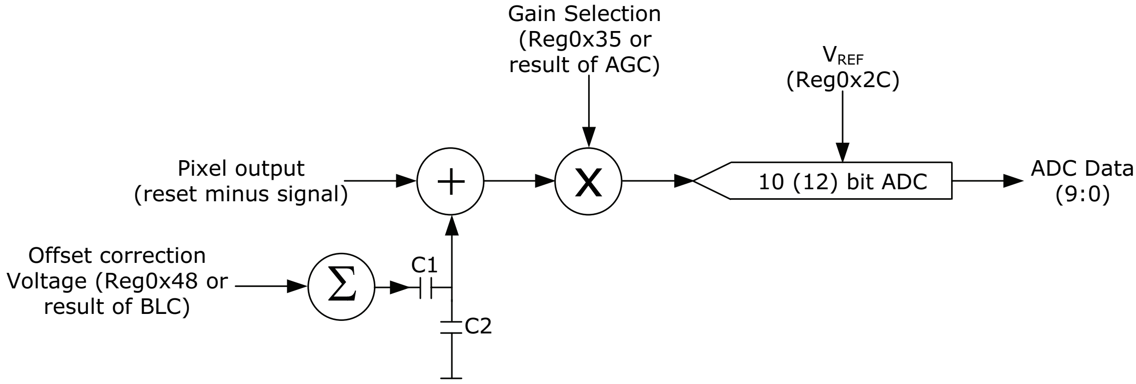


Figure 52: Signal path of MT9V022 (Guppy with CMOS sensor)

In CMOS cameras offset and gain are in reversed order compared to the CCD cameras. Therefore the offset is also amplified. So after changing gain, white balance may also be changed.

From the user's point of view, the white balance settings are made in register 80Ch of IIDC V1.3. This register is described in more detail on the next page.

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 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
		U/B_Value	[8..19]	U/B value; Write if not Auto; Read
		V/R_Value	[20..31]	V/R Value

Table 35: 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.

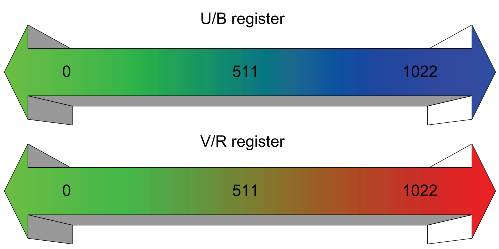


Figure 53: U/V slider range

White balance and interlaced GUPPYs

For the interlaced GUPPYs (GUPPY F-038/038 NIR/044/044 NIR) there is a non-standard (non-IIDC) register for white balance (0xF0F0080C4 and 0xF0F0080C8). This register is similar to the standard white balance CSR: here each of the four colors can be controlled independently. One-push white balance is not available.

Format_7 Mode_0: the binned 4 pixels have separate gains.

Format_7 Mode_1: Each of the complementary colors Cy, Ye, Mg and G have their own gain.

Register	Name	Field	Bit	Description
0xF0F0080C0	WHITE_BAL_INQ	Presence_Inq	[0]	Always 0
		-	[1..31]	Reserved
0xF0F0080C4	WHITE_BAL_12	Presence_Inq	[0]	Indicates presence of this feature (read only)
		-	[1..4]	Reserved
		OnePush	[5]	One-push white balance
		ON_OFF	[6]	Feature On/Off
		A_M_Mode	[7]	Auto white balance
		PXGA_2_Value	[8..19]	Green / red
		PXGA_1_Value	[20..31]	Magenta / green
0xF0F0080C8	WHITE_BAL_34	Presence_Inq	[0]	Indicates presence of this feature (read only)
		-	[1..7]	Reserved
		PXGA_4_Value	[8..19]	Cyan / green
		PXGA_3_Value	[20..31]	Yellow / blue

Table 36: White balance register for interlaced GUPPYs

One-push automatic white balance

Note

Interlaced GUPPYs (GUPPY F-038/038 NIR/044/044 NIR) do **not** have one-push automatic white balance.

It is activated by setting the **one-push** bit in the WHITE_BALANCE register (see Chapter Status and control register for feature on page 234). The camera automatically generates frames, based on the current settings of all registers (GAIN, OFFSET, SHUTTER, etc.).

For white balance, in total eight frames are processed and a grid of at least 65536 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.

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.

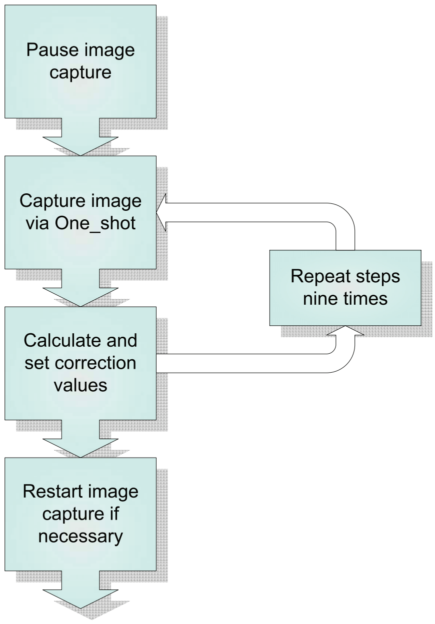


Figure 54: Automatic white balance sequence

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

Automatic white balance

There is also an auto white balance feature available which continuously optimizes the color characteristics of the image.

As a reference, it uses a grid of at least 65535 (2^{16}) samples equally spread over the area of interest or a fraction of it. The position and size of the control area (Auto_Function_AOI) can be set via an advanced register (see Chapter Autofunction AOI on page 257).

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 represent the current active image size.

The camera automatically adjusts the settings to the permitted values.

Due to the fact that the active image size might not be divisible by 4 without a remainder, the autofunction AOI work-area size might be greater.

This allows for the positioning of the work area to be at the bottom of the active image.

Another case is for outdoor applications: the sky will be excluded from the generation of the reference levels when the autofunction AOI is placed at the bottom of the image.

Note If the adjustment fails and the work area size and/or position becomes invalid, this feature is automatically switched off – make sure to read back the **ON_OFF** flag if this feature doesn't work as expected.

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.

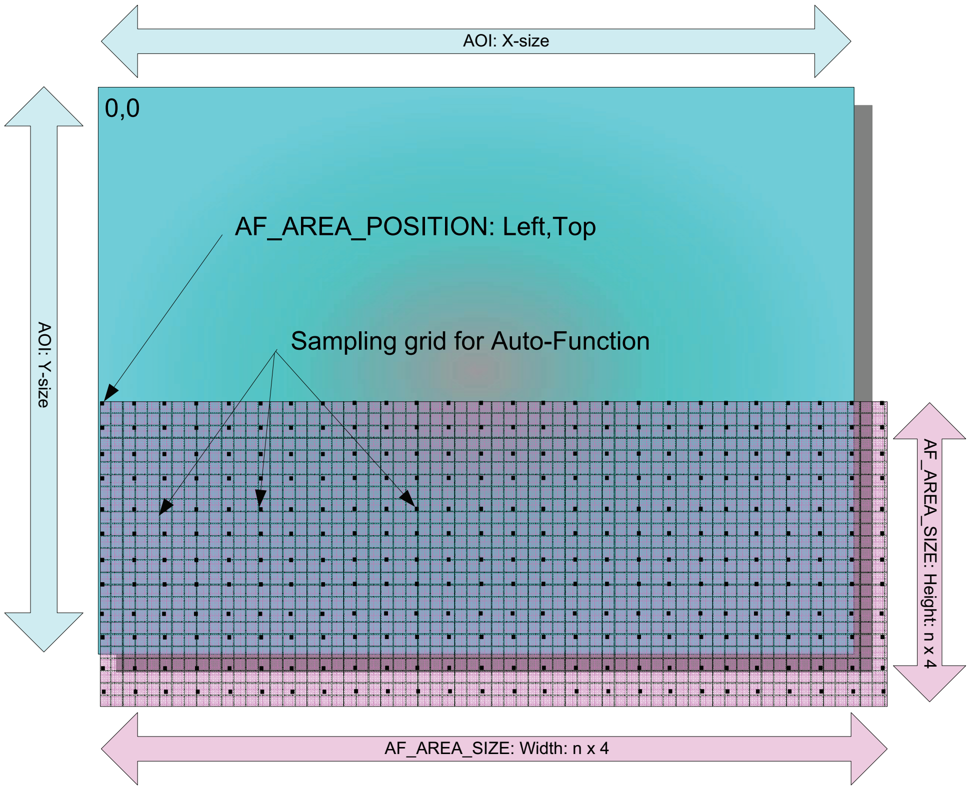


Figure 55: AUTOFNC_AOI positioning

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

Visualization of the AUTOFNC_AOI is carried out with the help of the graphics overlay (see: block diagram) function of the camera. This area is highlighted when the **Show work area** bit is set high.

Note The algorithm will try to create an uncolored image when looking at an area that is completely colored with automatic white balance **ON**.

Manual gain

As shown in Figure 51: Block diagram of AFE (Source: Analog Devices) on page 106 and Figure 52: Signal path of MT9V022 (Guppy with CMOS sensor) on page 107, all 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
CCD cameras	0 … 680	0 … 24 dB
CMOS camera	16 … 64	0 … 12 dB

Table 37: Manual gain range of the various GUPPY types

The increment length for CCD models is ~0.035 dB/step.

The increment length for the CMOS model is:

0..15: ~0.2 dB/step (1 step = 1 LSB)

16..64: ~0.25 dB/step (1 step = 2 LSB)

Note

- Setting the gain does not change the offset (black value) for CCD models.
- A higher gain also 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.

Auto gain

In combination with auto white balance, all CCD and CMOS models are equipped with auto gain feature.

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 (aka target grey 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 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 38: 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, 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 39: Auto_Exposure CSR

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**)
- **Auto gain of CMOS models** is directly controlled by the CMOS sensor (the target grey level is fixed to 125). Changes to this register have no effect in conjunction with auto gain. Auto exposure is working in conjunction with auto shutter only.

The table below illustrates the advanced auto gain control register.

Register	Name	Field	Bit	Description
0xF1000370	AUTOGAIN_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
			[1..3]	-
	MAXVALUE	Max Value	[4..15]	Max value
		-	[16..19]	-
	MINVALUE	Min value	[20..31]	Min value

Table 40: Advanced register for auto gain control

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.

Setting the brightness (black level or offset)

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

CCD models: 0...+16 gray values (@ 8 bit)

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

Board level versions: Increments are in 1/64 LSB (@ 8 bit)

CCD models: The formula for gain and offset setting is: Y`= G x Y + Offset

CMOS models: -127 .. 127 gray values

Increments are in 8/25 LSB

Note

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

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 41: Brightness CSR

Auto shutter

Note

Guppy interlaced cameras: due to the fact that electronic shutter is not possible in Format_7 Mode_1 consequently auto shutter is not useful in that mode.

Do not use auto shutter with Guppy interlaced cameras in Format_7 Mode_1.

In combination with auto white balance, all progressive CCD and CMOS models 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. 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 minimum overshot.

The following table shows the Shutter 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 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 42: Shutter CSR

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]	-

Table 43: Auto shutter ctrl. advanced register

Register	Name	Field	Bit	Description
0xF1000364	AUTOSHUTTER_LO	Min Value	[0..31]	Min value
0xF1000368	AUTOSHUTTER_HI	Max Value	[0..31]	Max value

Table 43: Auto shutter ctrl. 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

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.

Look-up table (LUT) and gamma function

The AVT GUPPY camera provides one user-defined look-up table (LUT). The use of this LUT allows any function (in the form Output = F(Input)) to be stored in the camera's RAM and applied to 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 a LUT is the gamma LUT:

Output = $(\text{Input})^{0.5}$

This is used with all CCD models. This is known as compensation for the non-linear brightness response of many displays e.g. CRT monitors. The look-up table converts the 10 bits from the digitizer to 8 bits.

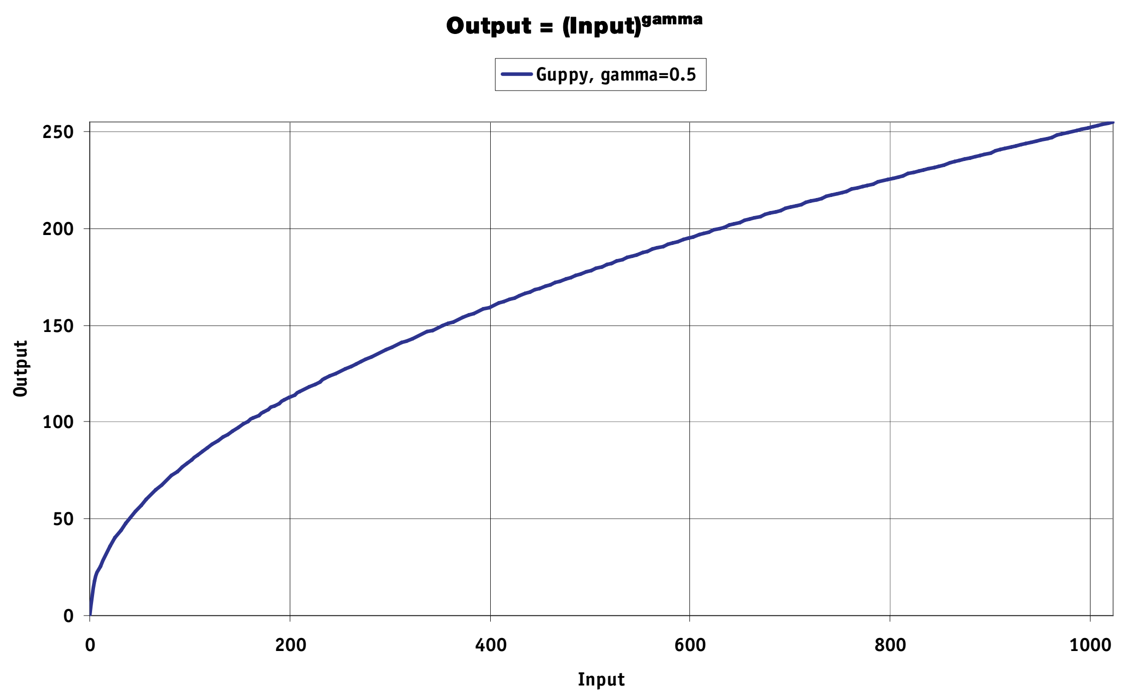


Figure 56: Gamma LUT

Note

- The input value is the 10-bit value from the digitizer. The gamma LUT of the CCD models outputs the most significant 8 bit as shown above.
- As gamma correction for the CCD models is also implemented via the look-up table, it is not possible to use a different LUT when gamma correction is enabled.
- With all CCD models, the user LUT will be overridden when gamma is enabled.
- CMOS models have the gamma function built in the sensor, so that it will not be overridden.
- LUT content is volatile.

Loading a 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 1024 x 8 bit is 1 kB, programming can take place in a one block write step. The flow diagram below shows the sequence required to load data into the camera.

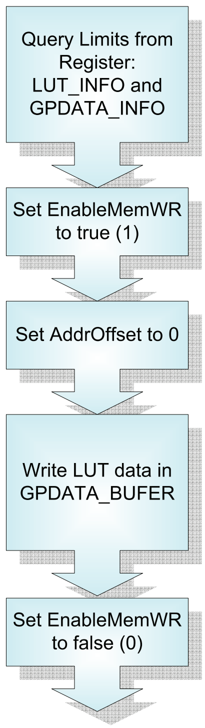


Figure 57: Loading a LUT

The table below describes the registers required:

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 44: LUT control register

Binning (b/w models)

2 x and 4 x binning

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

Note GUPPY F-036 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)
- 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 gain when binning two pixels, giving a theoretical SNR improvement of about 3 dB.

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.

In general, we distinguish between four types of binning:

- 2 x H-binning
- 2 x V-binning
- 4 x H-binning
- 4 x V-binning

and the full binning modes:

- 2 x full binning (a combination of 2 x H-binning and 2 x V-binning)
- 4 x full binning (a combination of 4 x H-binning and 4 x V-binning)

2 x vertical binning and 4 x vertical binning

2 x vertical binning: 2 pixel signals from 2 vertical neighboring pixels are combined and their signals are averaged.

4 x vertical binning: 4 pixel signals from 4 vertical neighboring pixels are combined and their signals are averaged.

Because the signal is averaged, the image will not be brighter as without binning.

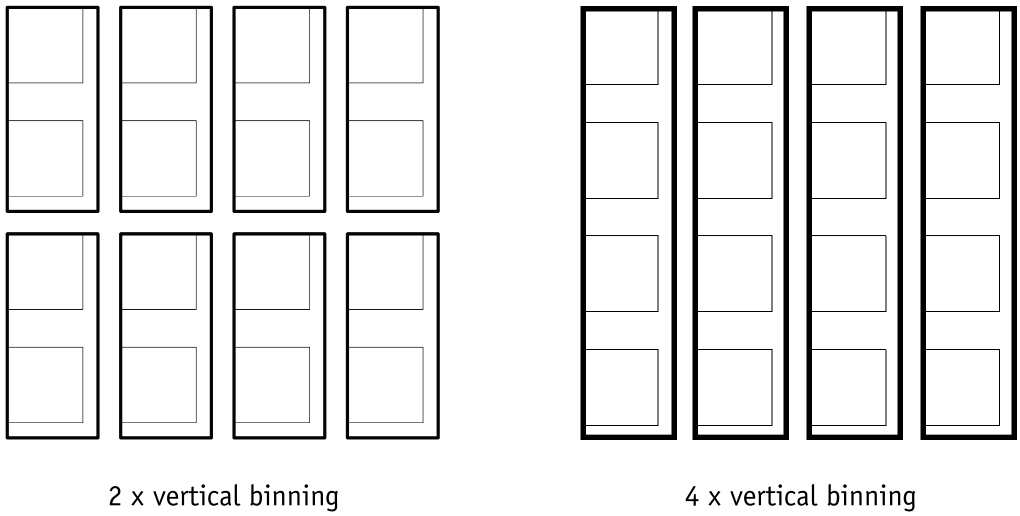


Figure 58: 2 x vertical binning and 4 x vertical binning

Note

Vertical resolution is reduced, but **signal-to noise ratio** (SNR) is increased by about 3 to 6 dB (2 x or 4 x binning).

Use **Format_7 Mode_2** to activate **2 x vertical binning**.

Use **Format_7 Mode_5** to activate **4 x vertical binning**.

Note

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

2 x horizontal binning and 4 x horizontal binning

2 x horizontal binning: 2 pixel signals from 2 horizontal neighboring pixels are combined and their signals are averaged.

4 x horizontal binning: 4 pixel signals from 4 horizontal neighboring pixels are combined and their signals are averaged.

Because the signal is averaged, the image will not be brighter as without binning.

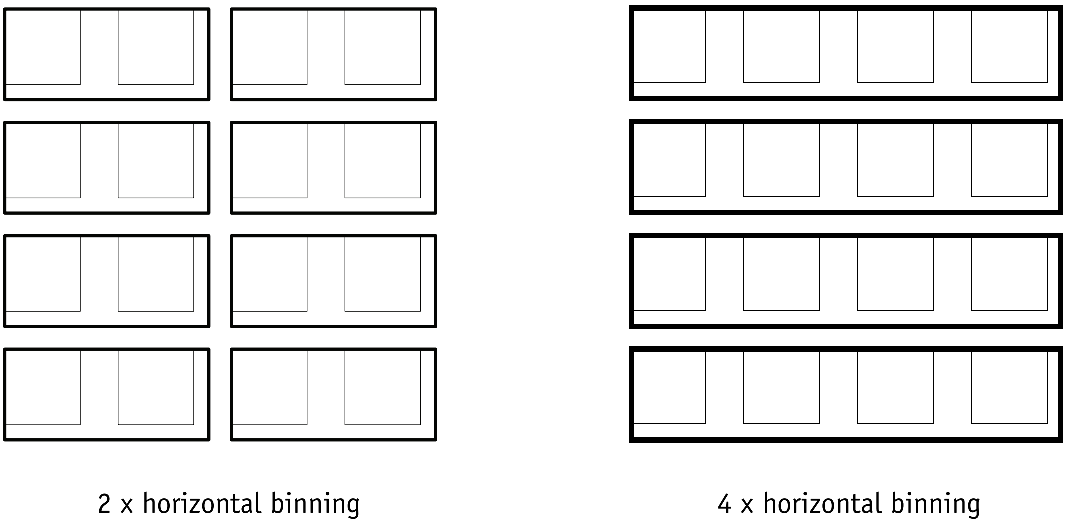


Figure 59: 2 x horizontal binning and 4 x horizontal binning

Note

Horizontal resolution is reduced, but **signal-to noise ratio** (SNR) is increased by about 3 or 6 dB (2 x or 4 x binning).

Use **Format_7 Mode_1** to activate **2 x horizontal binning**.

Use **Format_7 Mode_4** to activate **4 x horizontal binning**.

Note

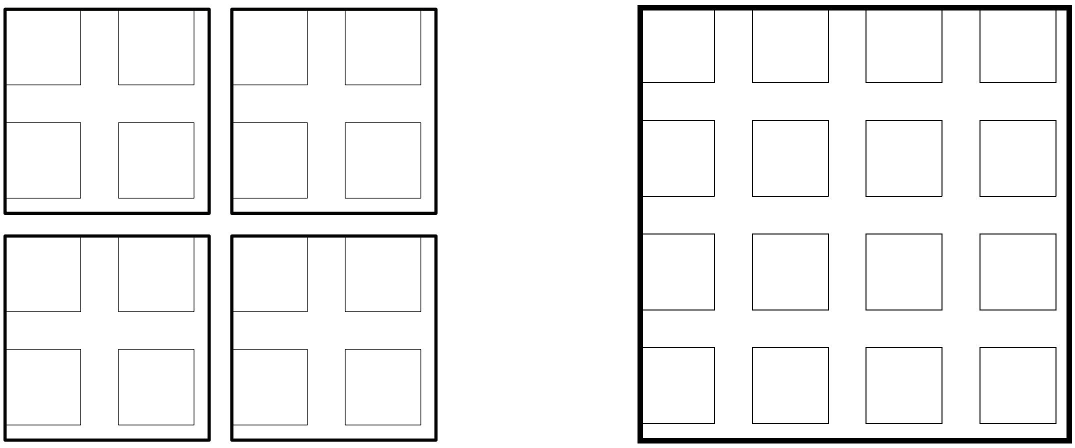
The image appears **horizontally** compressed in this mode and no longer exhibits a true aspect ratio.

2 x full binning and 4 x full binning

2 x full binning: 4 pixel signals from 2 adjacent rows and columns are combined and their signals are averaged.

4 x full binning: 16 pixel signals from 4 adjacent rows and columns are combined and their signals are averaged.

Because the signal is averaged, the image will not be brighter as without binning.



2 x full binning 4 x full binning

Figure 60: Full binning

Note

Signal-to noise ratio (SNR) is increased by about 6 or 12 dB (2 x full or 4 x full binning).

Use **Format_7 Mode_3** to activate **2 x full binning**.

Use **Format_7 Mode_6** to activate **4 x full binning**.

HDR (high dynamic range) (GUPPY F-036 only)

The HDR mode is available for the **GUPPY F-036** cameras with the Micron MT9V022 sensor. (**HDR** = **h**igh **d**ynamic **r**ange)

HDR enhances the range of illumination levels that can be distinguished. The MT9V022 sensor gives you an intrascene optical dynamic range exceeding 110 dB.

Thus the **GUPPY F-036** cameras are ideal for interior and exterior automotive, security and machine-vision imaging.

HDR overview (HiDy sensor)

With the MT9V022 sensor you achieve a **h**igh, **i**ntrascene-**dy**namic range the so-called **HiDy**. This is Micron's name for the HDR mode.

Analog signal chain and ADC are designed in a manner that saturation occurs only at extremely high levels of illumination. The pixel operation allows automatic exposure control of the pixel saturation level and manual adjustment of the knee points (one or two) during the exposure period. The automatic control creates a piece-wise linear response to the illumination. Exposure time ist controlloed automatically, whereas you adjust manually the maximum storage charge of the pixel knee points to get a response curve that is a combination of piece-wise linear segments of decreasing gradients.

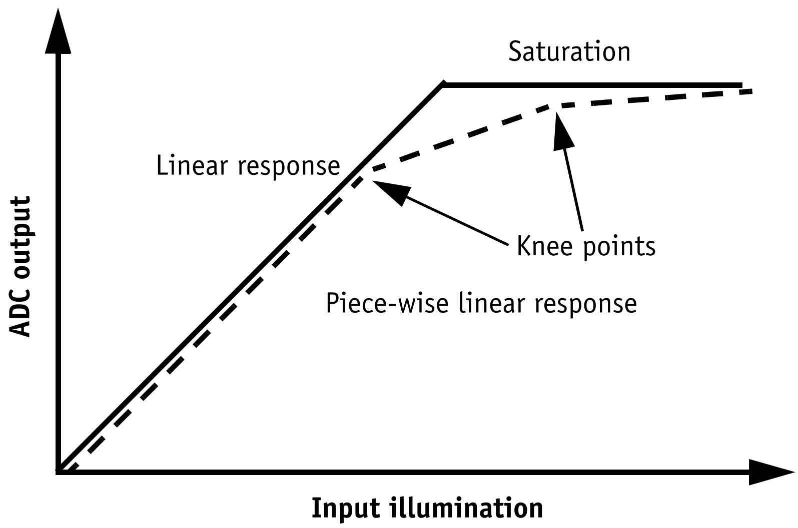


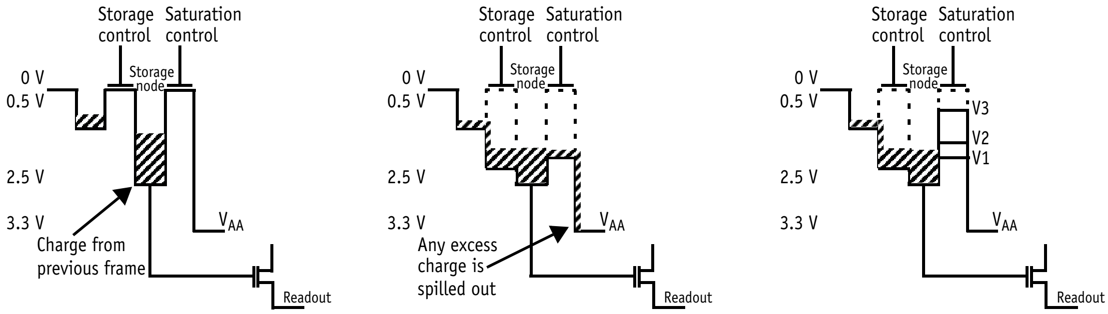
Figure 61: HDR response curves

Note

- Linear response causes loss of high-intensity detail in the saturation region.
- Piece-wise linear response causes compression of high-intensity detail (region after first and second knee point). But there is an increased scene dynamic.

Pixel operations in detail

The following diagrams show the principle of the pixel operations:



1. Exposure start 2. Storage control gate open 3. Final steps

Figure 62: Details of pixel operations

1. **Exposure start**: By starting the exposure the charge in the pixel is flushed through a reset mechanism. Exposure starts and charge accumulates in the pixel. At this time, the charge from the previous frame is on the storage node and is being read out. The storage control is at 0 V.
2. **Storage control gate open**: When the previous frame's charge is read out of the storage node, the storage control gate is opened and the saturation control gate is adjusted to level V1. Any charge that is already accumulated above this level is spilled out to V_{AA}.
3. **Final steps**: After time *Shutter Width 1*, the saturation control gate is adjusted to level V2, thus allowing further charge to accumulate or spill out if it exceeds the level set by V2. After time *Shutter Width 2*, the gate is further adjusted to voltage level V3. Finally after time *Total Shutter Width*, the storage control is closed. All the charge on the storage node is isolated. This will be read out during the following frame integration time.

Note

In the so-called **auto knee-adjust mode** *Shutter Width 1+2* and *Total Shutter* are controlled automatically.

Single knee point vs. two knee points

Single knee point operation means: Only one knee point can be controlled. The following diagram (left) shows the situation for a single knee saturation control in auto knee-adjust mode.

Two knee point operation means: Two knee points can be controlled. The following diagram (on the right) shows the situation for a two knee point control in auto knee-adjust mode.

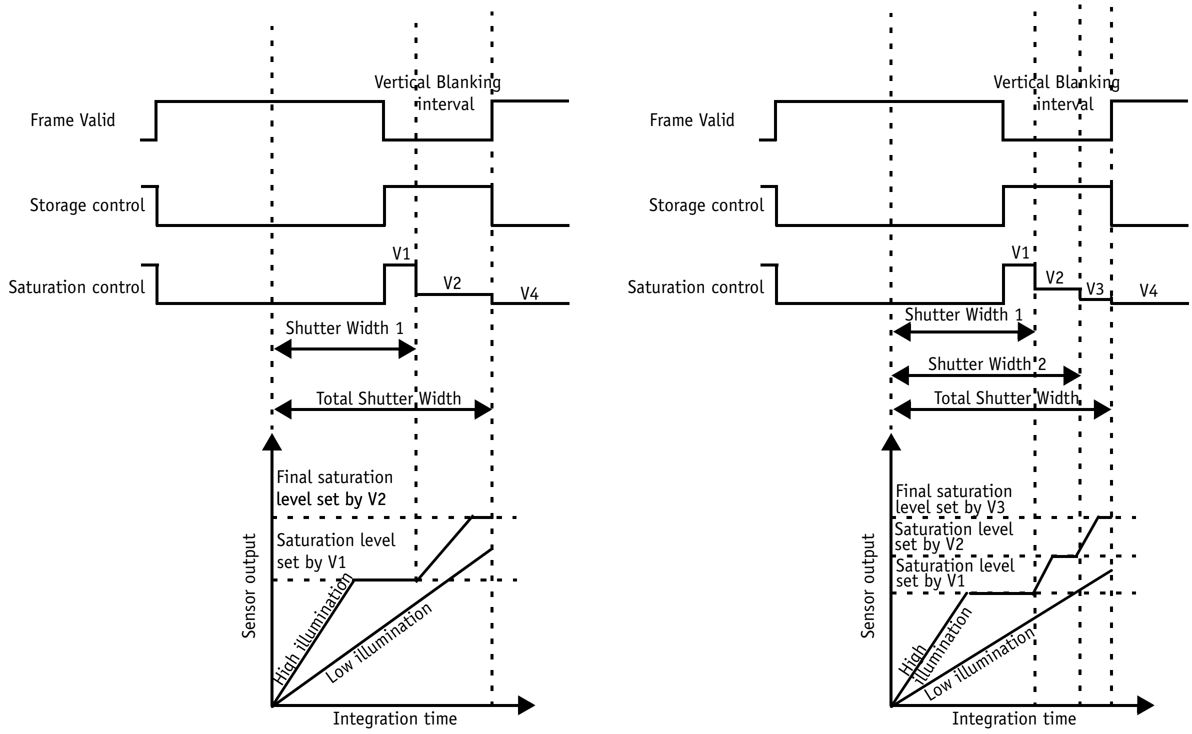


Figure 63: Single knee situation (left) and two knee point situation (right)

Note

The auto knee-adjust mode tries to keep the total shutter width to the maximum 480 rows in order to achieve the highest dynamic range.

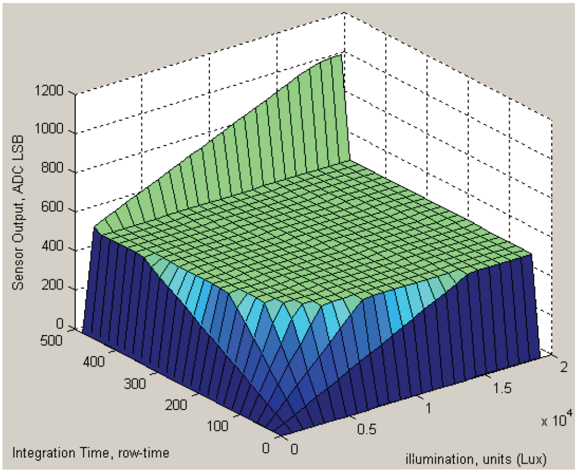
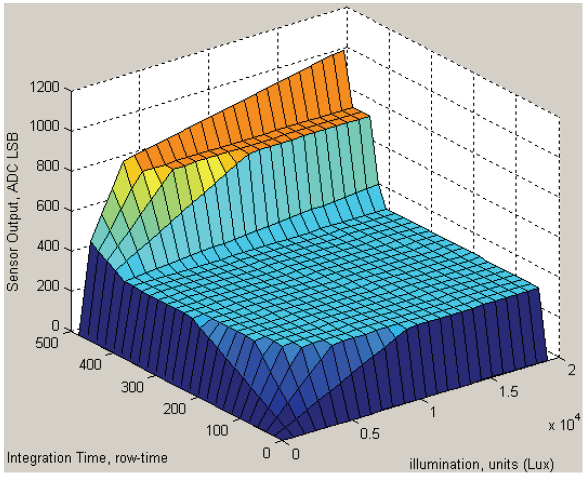
<table>
<tr><th>Setting one knee point</th><th>Setting two knee points</th></tr>
<tr><td>In single knee automatic exposure mode, the placement of a single knee point is set automatically.</td><td>In two knee automatic exposure mode, the placement of the two knee points is set automatically.</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Pixel output response for one knee operation</td><td>Pixel output response for two knee operation</td></tr>
</table>

Table 45: Setting knee points and pixel output response

Effects of a HiDy sensor

The Micron MT9V022 as a typical HiDy sensor shows a large decrease of FPN (fixed pattern noise) after crossing the knee-points. This leads to a very good image quality. Most of the signal range measures as low as 1.5 LSBs of temporal noise (compared to a normal linear sensor with ~4 LSBs of temporal noise).

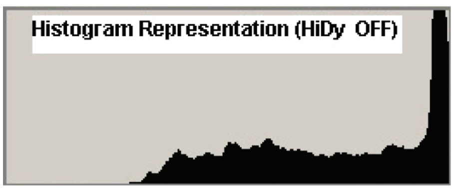
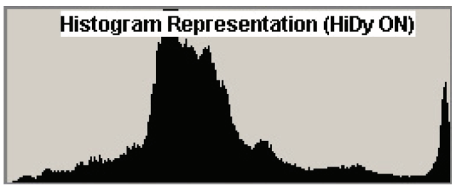
<table>
<tr><th>Histogram (HiDy off)</th><th>Histogram (HiDy on)</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td colspan="2">This is a histogram example from an outdoor scene taken with HiDy off (left) and HiDy on (right). The HiDy mode is able to show details in both the bright and dark areas to be resolved in a single image.</td></tr>
</table>

Table 46: Histogram with HiDy off (left) and HiDy on (right)

Advanced registers for high dynamic range mode (HDR) (GUPPY F-036 only)

The **GUPPY F-036** cameras offer the so-called **high dynamic range mode** (HDR mode) with one or two knee points.

Register	Name	Field	Bit	Description
0xF1000280	HDR_CONTROL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Enable/disable HDR mode
		---	[7..19]	Reserved
		MaxKneePoints	[20..23]	Read only Maximum number of knee points (2)
		---	[24..27]	Reserved
		KneePoints	[28..31]	Number of active knee points (max. 2)
0xF1000284	KNEEPOINT_1	KneeVoltage_1	[0..7]	Regulation of saturation level
		KneeVoltage_2	[8..15]	Regulation of saturation level
		KneeTime_1	[16..31]	Not implemented, but value must be greater 0
0xF1000288	KNEEPOINT_2	KneeVoltage_3	[0..7]	Regulation of saturation level
		KneeVoltage_4	[8..15]	Regulation of saturation level
		KneeTime_2	[16..31]	Not implemented, but value must be greater 0.
0xF100028C	KNEEPOINT_3	---	[0..31]	Reserved

Table 47: High dynamic range (HDR) configuration register

Note

The HDR mode of **GUPPY F-036** runs in **automatic knee point adjustment mode** only, which means: the knee times are calculated by the sensor automatically (calculated from the knee point's voltage values).

BAYER pattern (raw data output)

The color sensors capture the color information via so-called primary color (R, G, B) or complementary color (G, Mg, Cy, Ye) filters placed over the individual pixels in a **BAYER mosaic** layout.

Guppy color cameras have no color interpolation, so the BAYER demosaicing has to be done outside the camera in the PC (raw mode).

- For GUPPY cameras with SONY progressive scan sensors the first pixel of the sensor is **RED**. (GUPPY F-033C, GUPPY F-046C, GUPPY F-080C)
- For GUPPY F-036C the first pixel of the sensor is **BLUE**.
- Changes are possible: For interlaced GUPPY cameras (date: 01.03.07 LUL) the first pixel of the first line is **GREEN** followed by **MAGENTA** and the first pixel of the second line is **CYAN** followed by **YELLOW**.
  GREEN und **MAGENTA** change every second line.
  (GUPPY F-038C, GUPPY F-038C NIR, GUPPY F-044C, GUPPY F-044C NIR)

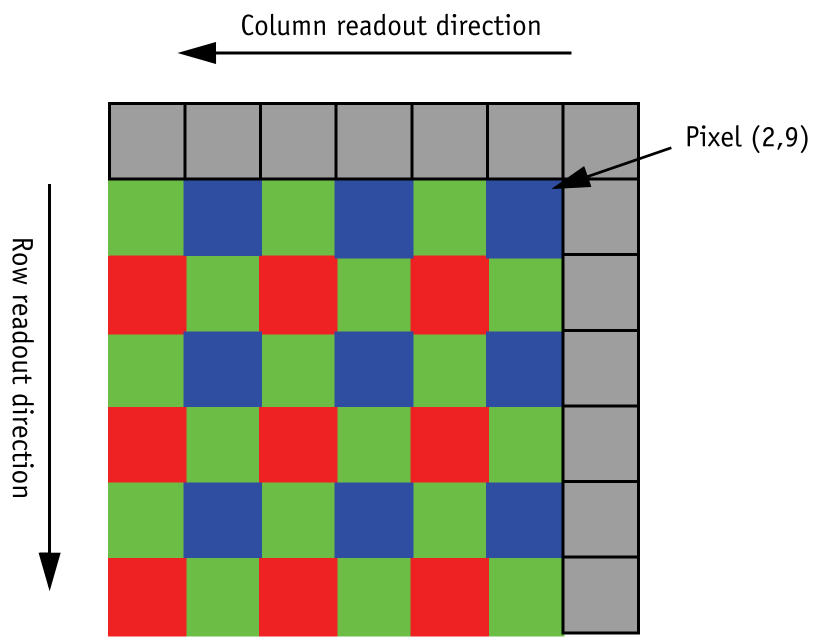


Figure 64: Bayer pattern of Guppy F-036C

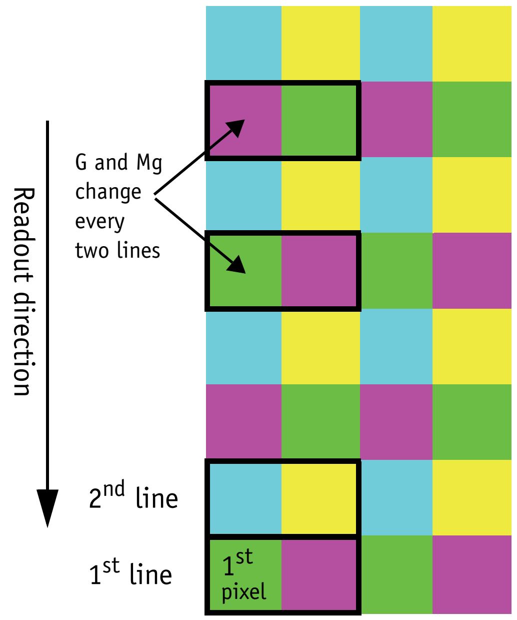


Figure 65: BAYER pattern of SONY complementary sensors: 1st line: G - Mg, 2nd line: Cy - Ye

Serial interface

All GUPPY cameras are equipped with the SIO (serial input/output) feature as described in IIDC V1.31. This means that the GUPPYs serial interface which is used for firmware upgrades can also 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 serial interface data is put in the camera buffer and can be polled from here via simple read commands . 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 support 230400 bps.

Base address for the function is: F0F02100h.

The following registers provide an overview:

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 field is 1, Buffer_Status_Control and SIO_Data_Reg. Char 1-3 should be ignored

Table 48: 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 0: no error WR: 0 to clear status (1: Ignored)
		FER	[13]	Receive data framing error Read: current status 0: no error WR: 0 to clear status (1: Ignored)
		PER	[14]	Receive data parity error Read: current status 0: no error WR: 0 to clear status (1: Ignored)
		-	[15..31]	Reserved

Table 48: 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 WR: Number of bytes to be read from the receive FIFO RD: 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 char. from receive buffer WR: Write char. to transmit buffer
	SIO_DATA_REGISTER	CHAR_1	[8..15]	Character_1 RD/WR
	SIO_DATA_REGISTER	CHAR_2	[16..23]	Character_2 RD/WR
	SIO_DATA_REGISTER	CHAR_3	[24..31]	Character_3 RD/WR

Table 48: SIO CSR

Reading data requires the following series of actions:

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 (the 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.

Writing data requires the following series of actions:

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 are to be transmitted than fit 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.

Camera interfaces

In addition to the two status LEDs (see Chapter Status LEDs on page 145), there are two jacks located at the rear of the camera.

- The 8-pin camera I/O connector provides a variety of control input and output lines.
- The IEEE 1394 connector with lock mechanism provides access to the IEEE 1394 bus and thus makes it possible to control the camera and output frames.

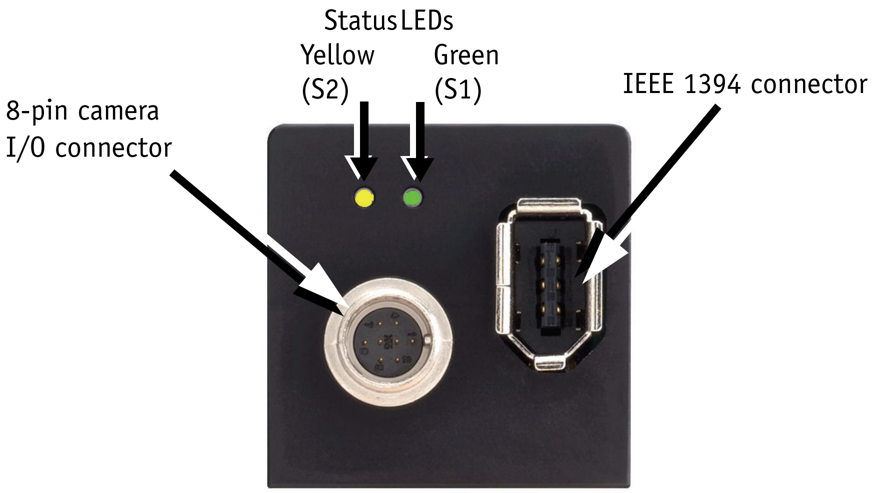


Figure 66: Rear view of camera

IEEE 1394 port pin assignment

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

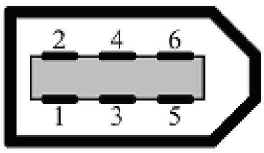


Figure 67: IEEE 1394 connector

Pin	Signal
1	Cable power
2	Cable GND
3	TPB-
4	TPB+
5	TPA-
6	TPA+

Table 49: IEEE 1394 pin assignment

Note

Cables with latching connectors on one or both sides can be used and are available with various lengths of 4.5 m or up to 17.5 m. Ask your local dealer for more details.

Board level camera: IEEE 1394 port pin assignment

Board level Guppies have two 1394 ports to allow daisy chaining of cameras.

The second IEEE 1394 pin header (2.54 mm connector) is designed for adding a 1394 adapter cable of e.g the following supplier:

http://www.frontx.com/

IEEE 1394 6 PIN - PANEL F TO 2X5 F (AVT#: K1200155)

It has the following pin assignment (see FireWire connector 1 in Figure 30: Guppy board level: CS-Mount on page 84):

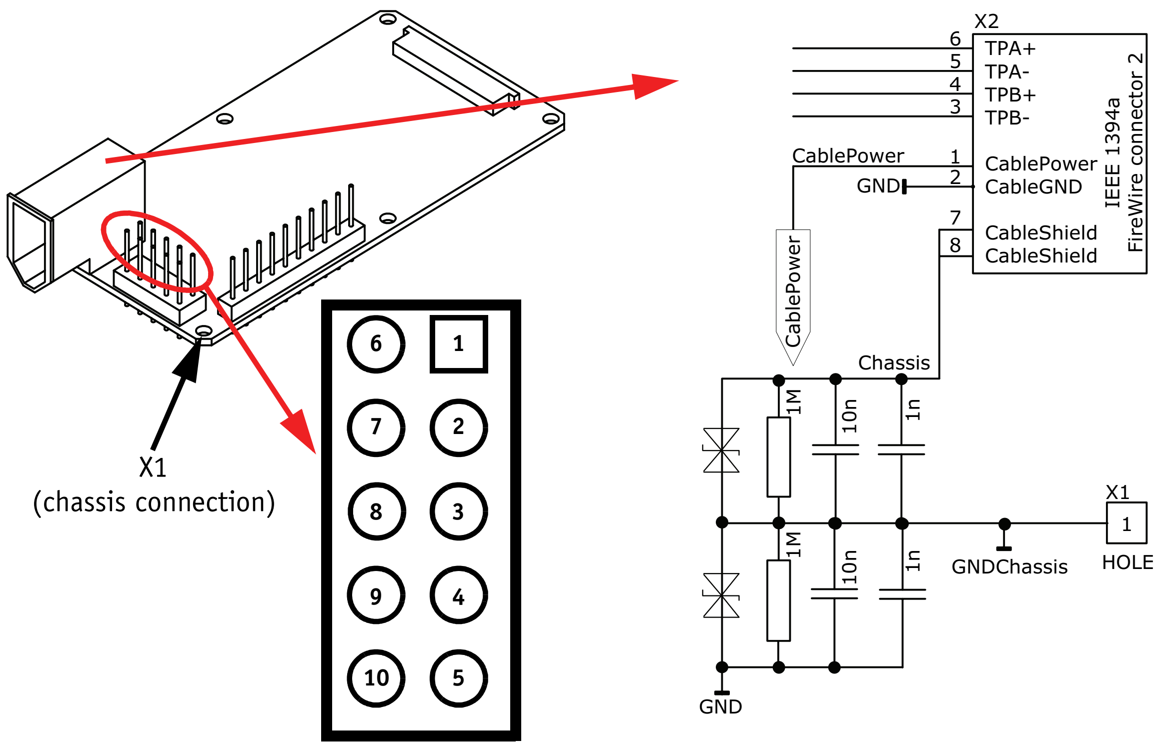


Figure 68: Board level camera: IEEE 1394 FireWire connector 1 (view on pins)

Signal	Pin
TPA+	6
-	7
TPB+	8
-	9
-	10

Pin	Signal
1	TPA-
2	GND
3	TPB-
4	Cable power
5	Cable shield

Table 50: Board level camera: IEEE 1394 pin assignment (FireWire connector 1)

Camera I/O pin assignment

The camera I/O connector is designed for industrial use.

It provides:

- access to the inputs and outputs on the camera
- a serial interface

The following diagram shows the pinning as viewed in pin direction.

Note

The part number of the appropriate straight I/O connector is:

- HIROSE HR25-7TP-8S, AVT article number K7600503

AVT also supplies various I/O cables of different lengths, a selection is listed below:

I/O cable, open 8-pin HIROSE female to open end, 2.0 m	E1000842
I/O cable, open 8-pin HIROSE female to open end, 5 m	E1000843

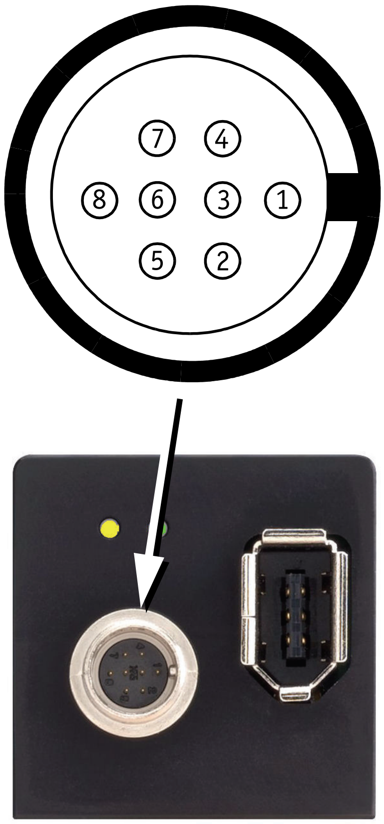


Figure 69: Camera I/O connector pin assignment

Pin	Signal	Direction	Level	Description
1	CameraOut1	Out	TTL	Camera Output 1
2	CameraOut2	Out	TTL	Camera Output 2
3	CameraOut3	Out	TTL	Camera Output 3
4	CameraIn	In	TTL	Camera Input
5	RxD_RS232	In	RS232	Terminal Receive Data
6	TxD_RS232	Out	RS232	Terminal Transmit Data
7	ExtPower		+8 … 36V	Power Supply
8	GND		GND	Ground

Table 51: Camera I/O pin assignment

Board level camera: I/O pin assignment

The following diagram shows the I/O pin header (2.54 mm connector) of a board level camera as viewed in pin direction:

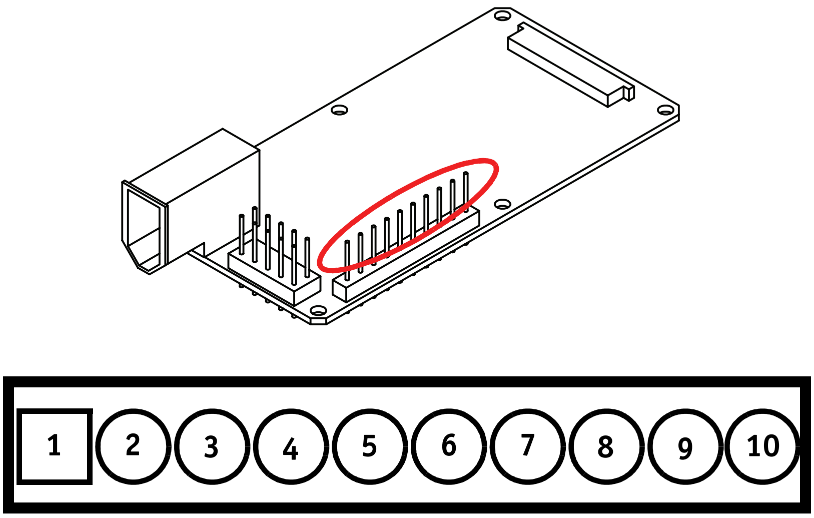


Figure 70: Board level camera: I/O pin assignment (view on pins)

Pin	Signal	Direction	Level	Description	
1	GND		GND	Ground	Power
2	ExtPower		+8 … 36V	Power Supply	

Table 52: Board level camera: Camera I/O pin assignment

Pin	Signal	Direction	Level	Description	
3	GND		GND	Ground	RS232
4	TxD_RS232	Out	RS232	Terminal Transmit Data	
5	RxD_RS232	In	RS232	Terminal Receive Data	
6	GND		GND	Ground	4 x I/O
7	UserInOut4	In/Out	TTL	User Input/Output 4	
8	UserInOut3	In/Out	TTL	User Input/Output 3	
9	UserInOut2	In/Out	TTL	User Input/Output 2	
10	UserInOut1	In/Out	TTL	User Input/Output 1	

Table 52: Board level camera: Camera I/O pin assignment

Status LEDs

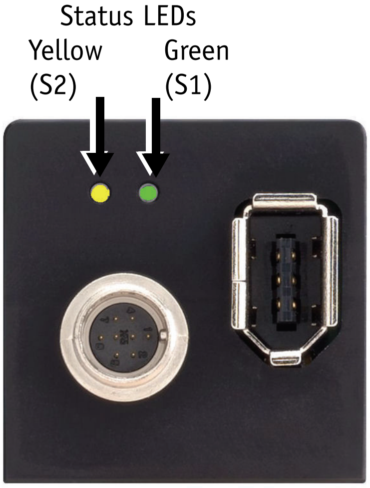


Figure 71: Status LEDs

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
S1 (green)	LED on - power on LED off - power off
S2 (yellow)	Asynchronous and isochronous data transmission active (indicated asynchronously to transmission over the 1394 bus)

Table 53: LED indication

Blink codes are used to signal warnings or error states:

Class S1 → Error codes 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 54: Error codes

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

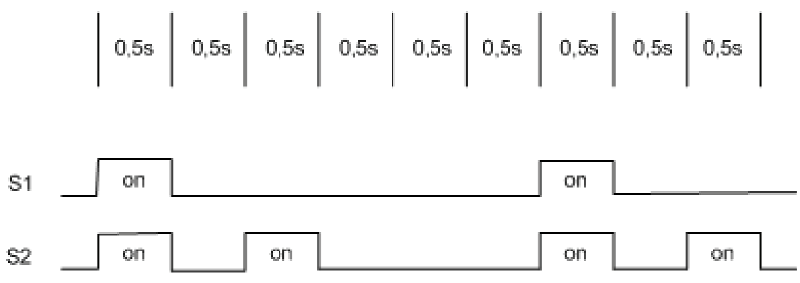


Figure 72: Warning and error states

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 7.

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 connector supplies power to the camera via a diode. This means that there is no power out at pin 7 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

Guppy cameras have 1 input and 3 outputs. These can be configured by software. The different modes are described below.

Note

Guppy **board level** cameras have **4 bidirectional inputs/ outputs**: Outputs can be disabled via the Output Control Register.

For further details, read Chapter Board level cameras: inputs and outputs on page 158 and Chapter Board level cameras: pulse-width modulation on page 159.

Warning

The Guppy outputs are not short-circuit-proof.

If there occurs a short-circuit at the outputs, the **output driver will be damaged**.

Input

	Absolute maximum ratings	Recommended operating conditions	Description
Input voltage	-0.5 V ... +7.0 V	0 V ... + 5.5 V	5 V CMOS
Input rise and fall time			Schmitt trigger implemented
Input clamping voltage	24 V		
Input pulse width (min.)		> 1µs	Digital input filter

Table 55: Input characteristics

The inputs can be connected directly to +5 V.

Warning

If using voltages higher than + 5 V the input of the camera will be damaged.

To avoid damage of the input, **use an external resistor in series (outside of the camera).**

Recommendations for resistors by voltages higher than + 5 V:

- Use at +12 V a 18 kΩ resistor.
- Use at +24 V a 47 kΩ resistor.

For details see Figure 73: Input block diagram on page 148.

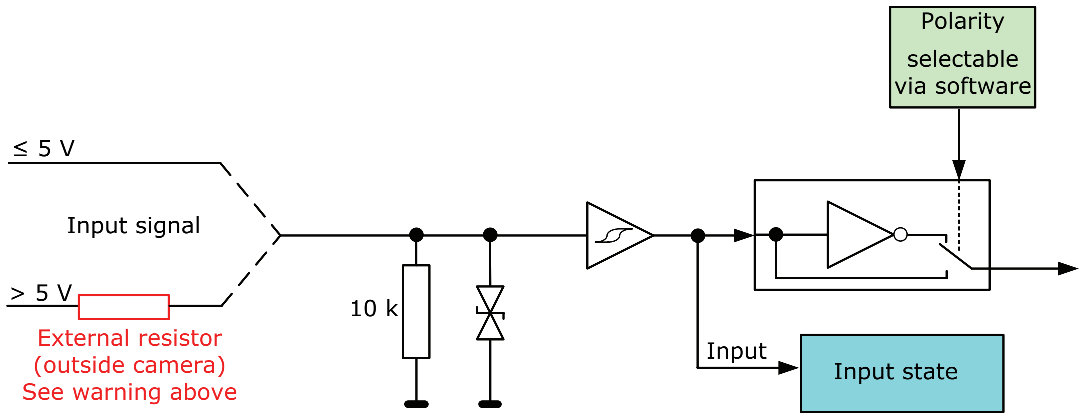


Figure 73: Input block diagram

Trigger

The signal can be inverted. The camera must be set to **external triggering** to trigger image capture by the trigger signal.

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)
		TiedToOutput	[1]	only board level Guppy: Tied to output pin x (read only)
		---	[2..6]	Reserved
		Polarity	[7]	0: Signal not inverted 1: Signal inverted
		---	[8..10]	Reserved
		InputMode	[11..15]	Mode see Table 57: Input routing on page 150
		---	[16..30]	Reserved
		PinState	[31]	RD: Current state of pin
0xF1000304	IO_INP_CTRL2	Same as IO_INP_CTRL1		Only Guppy board level cameras
0xF1000308	IO_INP_CTRL3	Same as IO_INP_CTRL1		Only Guppy board level cameras
0xF100030C	IO_INP_CTRL4	Same as IO_INP_CTRL1		Only Guppy board level cameras

Table 56: Input configuration register

The **TiedToOutput** field indicates that an output and the corresponding input share the same physical connector pin. Pins with **TiedToOutput** set to 1 can be used as an output or input.

Note

Make sure that output and input are not enabled at the same time. In order to use a pin as an input (e.g. for external trigger), its output driver (e.g. IntEna) needs to be switched off.

IO_INP_CTRL 1

The **Polarity** field determines whether the input is inverted (0) or not (1). See Table 56: Input configuration register on page 149.

The **InputMode** field can be seen in the following table.

The **PinState** field is used to query the current status of the input.

Input modes

ID	Mode	Default
0x00	Off	
0x01	Reserved	
0x02	Trigger input	Input 1
0x03	Reserved	
0x04	Reserved	
0x05	Reserved	
0x06..0x0F	Reserved	
0x10..0x1F	Reserved	

Table 57: Input routing

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 timebase 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]	Min. value for this feature
		Max_Value	[20..31]	Max. value for this feature

Table 58: Trigger_Delay_Inquiry register

Register	Name	Field	Bit	Description
0xF0F00834	TRIGGER_DELAY	Presence_Inq	[0]	Presence of this feature: 0: Not available 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 59: Trigger Delay CSR

In addition, the cameras have an advanced register which allows even more precise delay of image capture 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 60: 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

- This feature works with external Trigger_Mode_0 only.

Outputs

The standard Guppy camera has 3 inverting outputs.

Outputs	Operating Conditions
Output voltage	0 ... 5.5 V
Output current	Max. ± 20 mA

Table 61: Output characteristics

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 up to 1.05 seconds.
Fval (Frame valid) signal	This feature signals readout from the sensor. This signal Fval follows IntEna.
Busy signal	This signal appears when: • the exposure is being made or • the sensor is being read out or • data transmission is active.

Table 62: Output signals

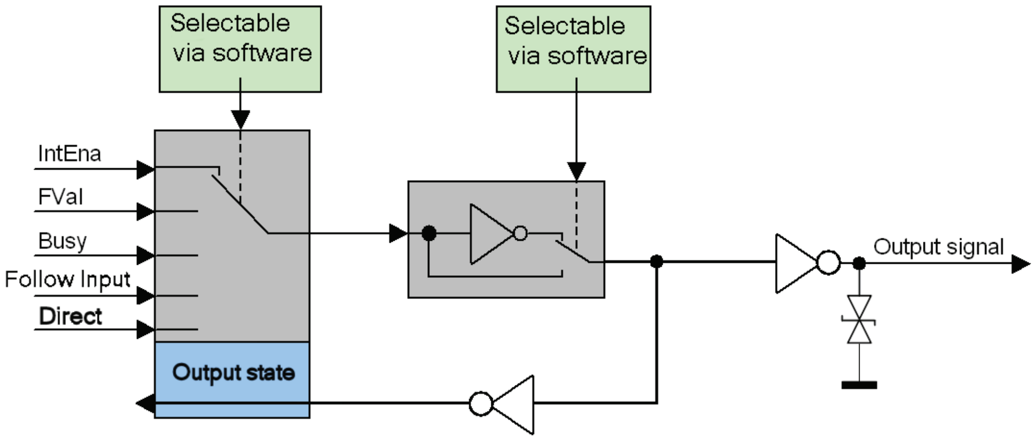


Figure 74: Output block diagram

Note

The following signals are high active: IntEna, FVal, Busy, Follow Input, Direct.

IO_OUTP_CTRL 1-3

The outputs are controlled via 3 advanced feature registers.

Only board level cameras: The outputs are controlled via 4 advanced feature registers.

The **Polarity** field determines whether the output is inverted (1) or not (0). 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)
		PWMCapable	[1]	Only Guppy board level cameras: Indicates if an output pin supports the PWM feature. See Table 66: PWM configuration registers on page 159.
		---	[2..6]	Reserved
		Polarity	[7]	0: Signal not inverted 1: Signal inverted
		---	[8..10]	Reserved
		Output mode	[11..15]	Mode See Table 64: Output routing on page 156.
		---	[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		Only Guppy board level cameras

Table 63: Output configuration register

Output modes

ID	Mode	Default
0x00	Off	
0x01	Output state follows **PinState** bit	
0x02	Integration enable	Output 1
0x03	Reserved	
0x04	Reserved	
0x05	Reserved	
0x06	FrameValid	
0x07	Busy	Output 2
0x08	Follow corresponding input (Inp1 → Out1)	
0x09	PWM (=pulse-width modulation)	Only Guppy board level cameras
0x0A..0x1F	Reserved	

Table 64: Output routing

Note

The output mode 0x08 is not available for output pins directly tied to an input pin.

The **Polarity** setting refers to the input side of the inverting driver.

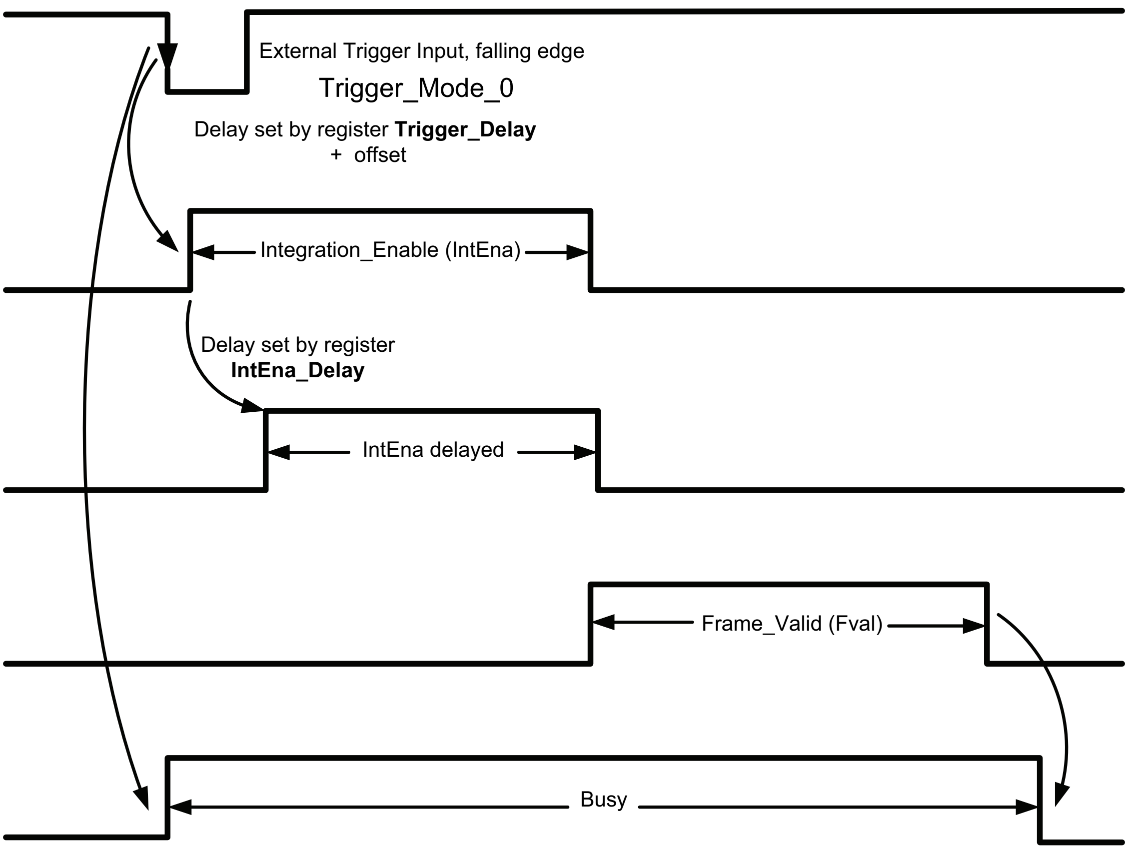


Figure 75: Output impulse diagram

See also Chapter Jitter at start of exposure on page 179.

Offsets are camera specific. For more information read Chapter Camera offsets on page 172.

Note

The signals can be inverted.

Caution

Firing a new trigger while **IntEna** is still active can result in **image corruption** due to double exposure occurring.

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.

Board level cameras: inputs and outputs

The following Guppy board level cameras are available:

Guppy board level camera	Description
Guppy F-033B BL	Board level version of Guppy F-033B
Guppy F-033C BL	Board level version of Guppy F-033C
Guppy F-080B BL	Board level version of Guppy F-080B
Guppy F-080B BL	Board level version of Guppy F-080C

Table 65: Guppy board level cameras

Guppy **board level** cameras have physically 4 I/Os and logically **4 inputs and 4 outputs**: Outputs can be disabled in the Output Control Register via 0x00 (register 0xF1000320 bit 11..15). Inputs are always enabled.

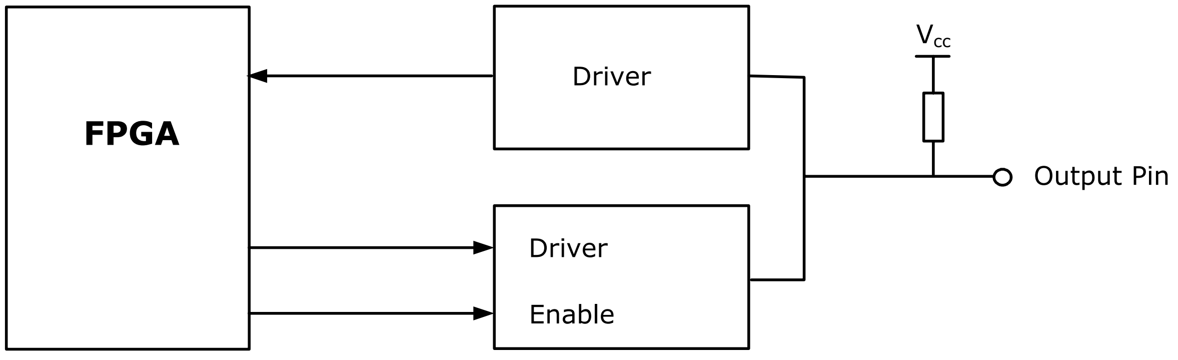


Figure 76: Input/output block diagram

Board level cameras: pulse-width modulation

The 4 inputs and 4 outputs are independent. Each output has pulse-width modulation (PWM) capabilities, which can be used (with additional external electronics) for motorized speed control or autofocus control.

Period (in µs) and pulse width (in µs) are adjustable via the following registers (see also examples in Chapter PWM: Examples in practice on page 160):

Register	Name	Field	Bit	Description
0xF1000800	IO_OUTP_PWM1	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1]	Reserved
		---	[2..3]	Reserved
		MinPeriod	[4..19]	Minimum PWM period in µs (read only)
		---	[20..27]	Reserved
		---	[28..31]	Reserved
0xF1000804		PulseWidth	[0..15]	PWM pulse width in µs
		Period	[16..31]	PWM period in µs
0xF1000808	IO_OUTP_PWM2	Same as IO_OUTP_PWM1		
0xF100080C	IO_OUTP_PWM3	Same as IO_OUTP_PWM1		
0xF1000810	IO_OUTP_PWM4	Same as IO_OUTP_PWM1		

Table 66: PWM configuration registers

To enable the PWM feature select output mode 0x09. Control the signal state via the **PulseWidth** and **Period** fields (all times in microseconds (µs)).

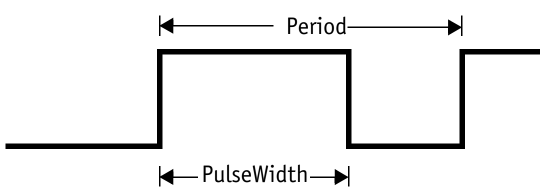


Figure 77: PulseWidth and Period definition

Note

Note the following conditions:

- PulseWidth < Period
- Period ≥ MinPeriod

PWM: minimal and maximal periods and frequencies

In the following formulas you find the minimal/maximal periods and frequencies for the pulse-width modulation (PWM).

$$\mathrm{period}_{min} = 3\mu s$$

$$\Rightarrow \mathrm{frequency}_{max} = \frac{1}{\mathrm{period}_{min}} = \frac{1}{3\mu s} = 333.33\mathrm{kHz}$$

$$\mathrm{frequency}_{min} = \frac{1}{2^{16} \times 10^{-6}\mathrm{s}} = 15.26\mathrm{Hz}$$

$$\Rightarrow \mathrm{period}_{max} = \frac{1}{\mathrm{frequency}_{min}} = 2^{16}\mu s$$

Formula 6: Minimal/maximal period and frequency

PWM: Examples in practice

In this chapter we give you two examples, how to write values in the PWM registers. All values have to be written in microseconds (µs) in the PWM registers, therefore remember always the factor 10^{-6}s.

Example 1:

Set PWM with 1kHz at 30% pulse width.

$$\mathrm{RegPeriod} = \frac{1}{\mathrm{frequency} \times 10^{-6}\mathrm{s}} = \frac{1}{1\mathrm{kHz} \times 10^{-6}\mathrm{s}} = 1000$$

$$\mathrm{RegPulseWidth} = \mathrm{RegPeriod} \times 30\% = 1000 \times 30\% = 300$$

Formula 7: PWM example 1

Example 2:

Set PWM with 250 Hz at 12% pulse width.

$$\text{RegPeriod} = \frac{1}{\text{frequency} \times 10^{-6}\text{s}} = \frac{1}{250\,\text{Hz} \times 10^{-6}\text{s}} = 4000$$

$$\text{RegPulseWidth} = \text{RegPeriod} \times 12\% = 4000 \times 12\% = 480$$

Formula 8: PWM example 2

Pixel data

Pixel data are transmitted as isochronous data packets in accordance with the 1394 interface described in IIDC V1.3. The first packet of a frame is identified by the **1** in the sync bit (sy) of the packet header.

0-7	8-15	16-23		24-31	
data_length		tg	channel	tCode	sy
header_CRC					
Video data payload					
data_CRC					

Isochronous Data Block Packet Format

Figure 78: Isochronous data block packet format: Source: IIDC V1.3

The video data for each pixel are output in 8-bit format. Each pixel has a range of 256 shades of gray. The digital value 0 is black and 255 is white.

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

<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 79: YUV 4:2:2 and YUV 4:1:1 format: Source: IIDC V1.3

<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 80: Y8 and Y16 format: Source: IIDC V1.3

<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 81: Data structure: Source: IIDC V1.3

Controlling image capture

Global shutter

The cameras support the SHUTTER_MODES specified in IIDC V1.3. For all models this shutter is a **global shutter**; meaning that all pixels are exposed to the light at the same moment and for the same time span.

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 comes in as a TTL signal through Pin 4 of the camera I/O connector.

Pipelined global shutter

The CMOS Guppy F-036 (Micron CMOS sensor MT9V022) has a **pipelined global shutter** with simultaneous integration and readout.

Trigger modi

The cameras support IIDC-conforming Trigger_Mode_0 and Trigger_Mode_1 and special Trigger_Mode_15.

Note

Interlaced cameras (GUPPY F-038 / F-038 NIR / F-044 / F-044 NIR) support only Trigger_Mode_0 and Trigger_Mode_15.

These models can only be triggered in Format_7 Mode_0 and Mode_2.

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).

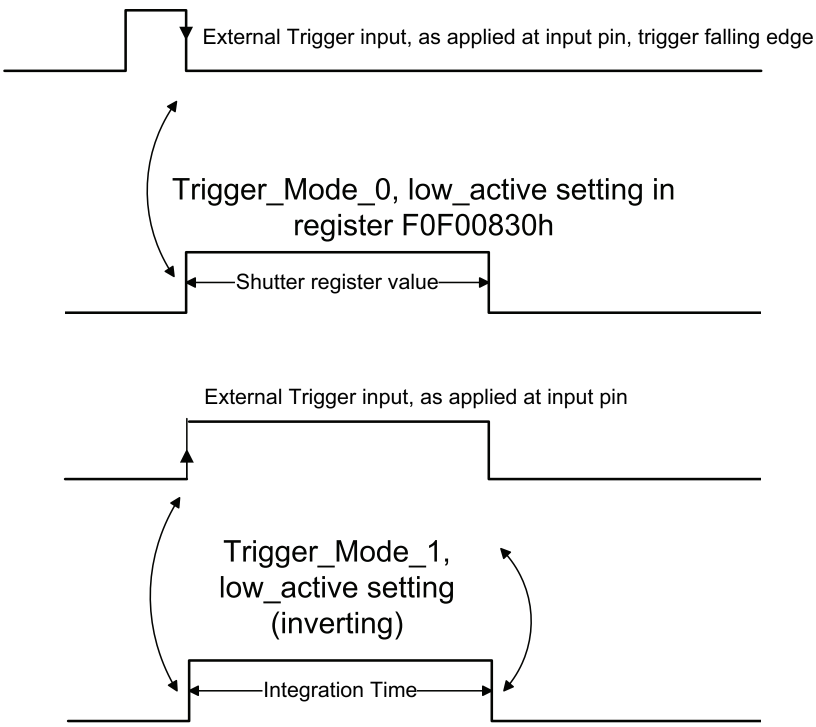


Figure 82: Trigger_Mode_0 and 1

Trigger_Mode_15 is a bulk trigger, combining one external trigger event with continuous or one-shot or multi-shot internal trigger.

It 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 number of images after one external trigger (surveillance)

The next diagram shows this mode in detail.

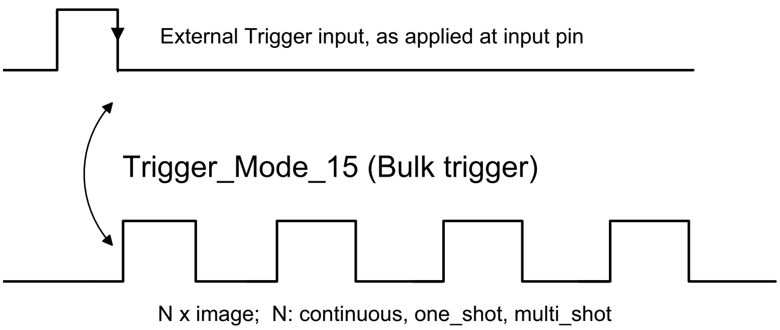


Figure 83: Trigger_Mode_15

The functionality is controlled via bit [6] and bitgroup [12-15] of the IIDC 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 ON=1 Read: Status of the feature OFF=0
		Trigger_Polarity	[7]	If Polarity_Inq = 1: W: 0 for low active (inverting) input 1 for high active input If Polarity_Inq = 0: Read only
		Trigger_Source	[8..10]	Select trigger source ID from trigger source ID_Inq.
		Trigger_Value	[11]	Trigger input raw signal value (read only)
		Trigger_Mode	[12..15]	Trigger_Mode (0-15)
		-	[16..19]	Reserved
		Parameter	[20..31]	Parameter for trigger function, if required

Table 67: Trigger_Mode_15

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

- The first line switches continuous mode off, leaving viewer in listen mode.
- The second line prepares 830h register for external trigger and Mode_15.

Left	Middle	Right
The last line switches camera back to continuous mode. Only one image is grabbed precisely with the first external trigger. To repeat rewrite line three.	Toggle 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.	Toggle 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 68: Description of screenshots

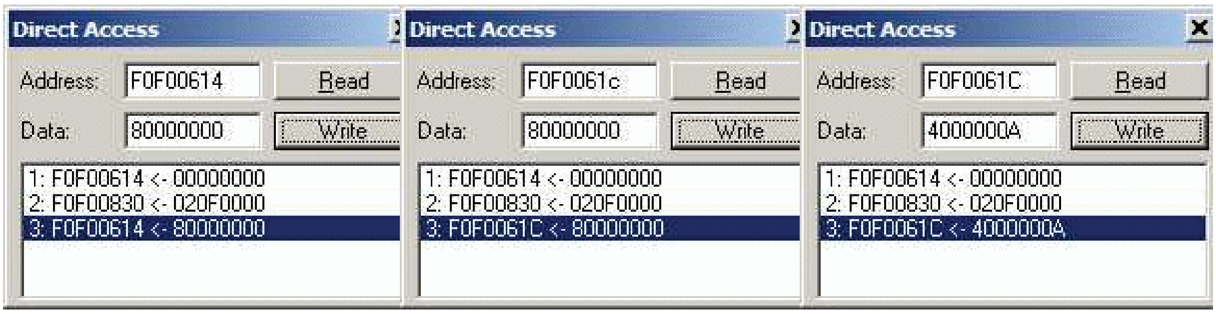


Figure 84: Using Trigger_Mode_15: Continuous, one-shot, multi-shot

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 timebase 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]	Min. value for this feature
		Max_Value	[20..31]	Max. value for this feature

Table 69: 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, ON=1 Read: Status of the feature OFF=0
		-	[7..19]	Reserved
		Value	[20..31]	Value

Table 70: Trigger Delay CSR

In addition, the cameras have an advanced register which allows even more precise delay of image capture 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 71: 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.

Exposure time (shutter) and offset

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

Shutter register value x timebase + offset

The register value is the value set in the corresponding IIDC 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 121: Time base ID on page 249). The default value here is set to 20 µs.

Exposure time of CMOS sensor (GUPPY F-036)

The CMOS sensor of GUPPY F-036 enables shutter times in integer multiples of the row time (29.89 µs).

Note Although you can enter shutter register values as usual, the camera will round down to integer multiples of the row time.

Example GUPPY F-036

Set Shutter register: 100

100 x 20 µs = 2000 µs

2000 µs/29.89 µs = 66.91

Effective shutter:

66 x 29.89 µs = 1972.74 µs (without offset)

Camera offsets

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

Camera model	Offset
GUPPY F-025	tbd µs
GUPPY F-029	tbd µs
GUPPY F-033	24.28 µs
GUPPY F-036	20.30 µs
GUPPY F-038	49.6 µs
GUPPY F-038 NIR	49.6 µs
GUPPY F-044	49.3 µs
GUPPY F-044 NIR	49.3 µs

Table 72: Camera-specific offset

Camera model	Offset
GUPPY F-046	23.90 µs
GUPPY F-080	35.64 µs
GUPPY F-146	19.96 µs

Table 72: Camera-specific offset

Example GUPPY F-033

Camera	Register value	Timebase
GUPPY F-033	100	20 µs

Table 73: Register value and Timebase for GUPPY F-033

100 x 20 µs + 24.28 µs = 2024.28 µs exposure time

The minimum adjustable exposure time set by register is 20 µs. → The real minimum exposure time of GUPPY F-033 is then 20 µs + 24.28 µs = 44.28 µs.

Extended shutter

The exposure time for long-term integration of up to 67 seconds for the CCD-models and up to 979 ms for the CMOS models can be extended 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]	
		ExpTime	[6..31]	Exposure time in µs

Table 74: Extended shutter configuration

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.
- 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 **one-shot 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 178), this flag is ignored.

If **one-shot mode** is combined with the external trigger, the **one-shot** 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, **one-shot** can be cancelled by clearing the bit.

Note

One-shot and Interlaced and Format_7 Mode_1 produces an image, where the first field has different brightness due to principal reasons.

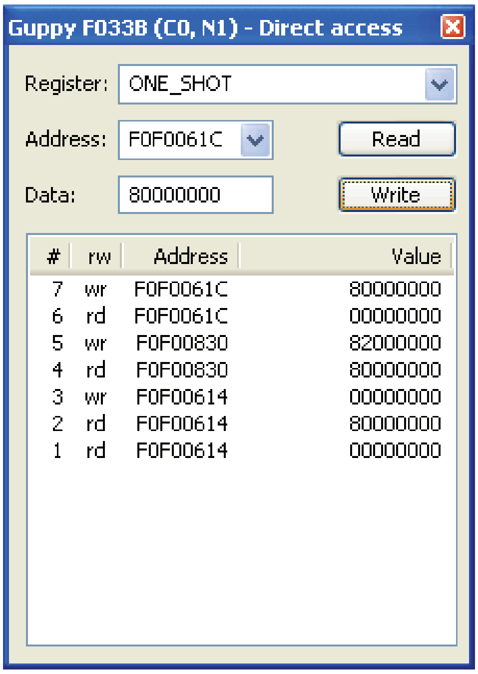


Figure 85: One-shot control (SmartView)

#	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 75: 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 (one-shot) 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
One-shot → Microcontroller-Sync	≤ 250 µs (processing time in the microcontroller)
µC-Sync/ExSync → Integration-Start	8 µs

Table 76: 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 or CMOS sensor is read out; some data is written into a small FIFO buffer before being transmitted to the bus.

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

500 µs ± 62.5 µs

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

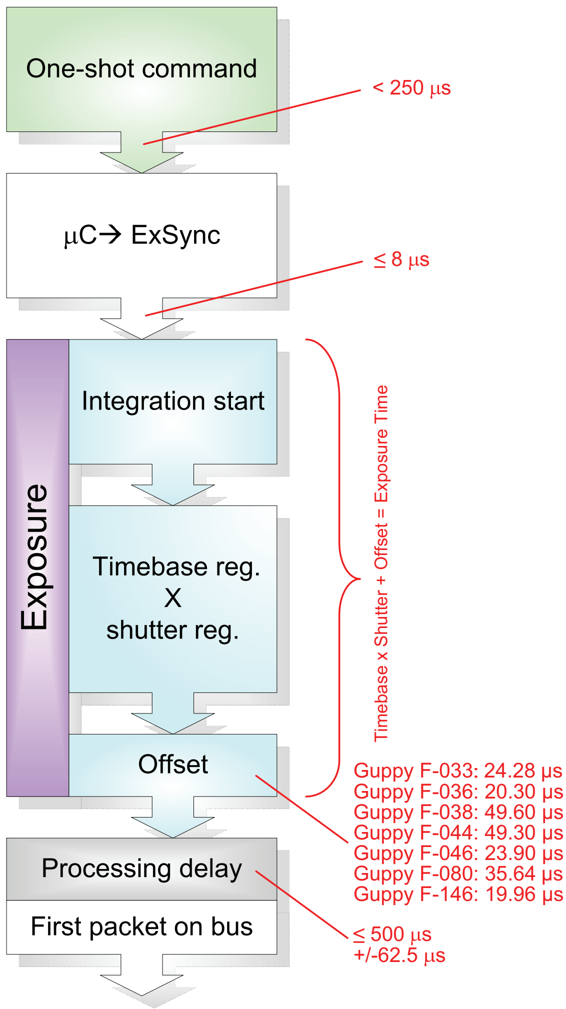


Figure 86: Data flow and timing after end of exposure

Camera	Offset	Description
GUPPY F-025	tbd	
GUPPY F-029	tbd	
GUPPY F-033	24.28 µs	
GUPPY F-036	20.30 µs	
GUPPY F-038	49.60 µs	
GUPPY F-038 NIR	49.60 µs	
GUPPY F-044	49.30 µs	
GUPPY F-044 NIR	49.30 µs	

Table 77: Timing after end of exposure

Camera	Offset	Description
GUPPY F-046	23.90 µs	
GUPPY F-080	35.64 µs	
GUPPY F-146	19.96 µs	

Table 77: 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 178), 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.

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 179.

The following screenshot shows an example of broadcast commands sent with the Firedemo example of FirePackage (version 1V51 or newer):

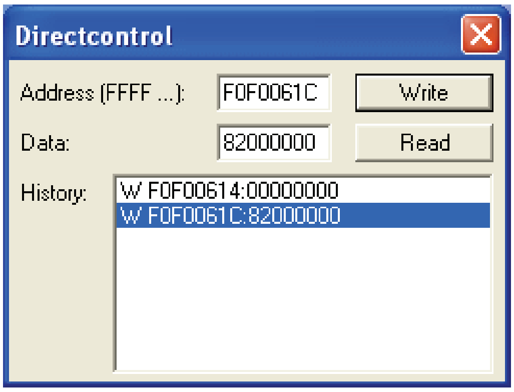


Figure 87: Broadcast one-shot

- 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 **Micron CMOS sensor** of the GUPPY F-036 uses a **pipelined global shutter**, thus imitating the separate light sensitive and storage area of a CCD.

For the CCDs the uncertainty 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 row 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 idle	Camera busy
Guppy F-025	tbd ns	tbd µs
Guppy F-029	tbd ns	tbd µs
Guppy F-033	40.69 ns	32.29 µs
Guppy F-036	29.89 µs	29.89 µs
Guppy F-038	8.77 µs	68.06 µs
Guppy F-038 NIR	8.77 µs	68.06 µs
Guppy F-044	8.77 µs	66.94 µs
Guppy F-044 NIR	8.77 µs	66.94 µs
Guppy F-046	33.34 ns	31.73 µs
Guppy F-080	30.30 ns	40.45 µs
Guppy F-146	30.30 ns	42.18 µs

Table 78: 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.

User profiles

User profiles are also known as memory channels from the IIDC specifications.

The feature is described in Chapter User profiles on page 262.

Video formats, modes and bandwidth

The different GUPPY 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.
- Tables assume that bus speed is 400 Mbit/s. With lower bus speeds (e.g. 200 or 100 Mbit/s) not all frame rates may be achieved.

GUPPY F-025B / GUPPY F-025C

tbd

GUPPY F-029B / GUPPY F-029C

tbd

GUPPY F-033B/ GUPPY F-033C and board level versions F-033B BL/F-033C BL

Format	Mode	Resolution	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						
	2	640 x 480 YUV411						
	3	640 x 480 YUV422						
	4	640 x 480 RGB8						
	5	640 x 480 MONO8	x x*	x x*	x x*	x x*	x x*	
	6	640 x 480 MONO16						
7	0	656 x 494 MONO8 656 x 494 Raw8	@58 fps @58 fps					
	1							
	2							
	3							

Table 79: Video formats Guppy F-033B / Guppy F-033C and board level versions

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

GUPPY F-036B/ GUPPY F-036C

Format	Mode	Resolution	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						
	2	640 x 480 YUV411						
	3	640 x 480 YUV422						
	4	640 x 480 RGB8						
	5	640 x 480 MONO8	x x*	x x*	x x*			
	6	640 x 480 MONO16						
7	0	752 x 480 MONO8 752 x 480 Raw8	@64 fps @64 fps					
	1	376 x 480 MONO8	@43 fps, 2 x H-binning average					
	2	752 x 240 MONO8	@119 fps, 2 x V-binning average					
	3	376 x 240 MONO8	@81 fps, 2 x full binning average					
	4	188 x 480 MONO8	@37 fps, 4 x H-binning average					
	5	752 x 120 MONO8	@209 fps, 4 x V-binning average					
	6	188 x 120 MONO8	@122 fps, 4 x full binning average					

Table 80: Video formats Guppy F-036B / Guppy F-036C

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

Note

The CMOS sensor does not support frame rates below 10 fps. Therefore 7.5 and 3.75 fps are not selectable in fixed formats. In Format_7 this implies that there is a minimum byte_per_packet setting.

GUPPY F-038B/ GUPPY F-038C

Format	Mode	Resolution	Max. frame rates in Format_7
7	0	768 x 492 MONO8 768 x 492 Raw8	@30 fps, 2 x V-binning, field integration mode @30 fps, 2 x V-binning, field integration mode (binned colors)
	1	768 x 492 MONO8 768 x 492 Raw8	@30 fps, no binning, frame integration mode @30 fps, no binning, frame integration mode
	2	384x244 MONO8	@59 fps, 2 x full binning for aspect ratio, progressive readout mode

Table 81: Video formats Guppy F-038B / Guppy F-038C

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

GUPPY F-038B NIR / GUPPY F-038C NIR

Format	Mode	Resolution	Max. frame rates in Format_7
7	0	768 x 492 MONO8 768 x 492 Raw8	@30 fps, 2 x V-binning, field integration mode @30 fps, 2 x V-binning, field integration mode (binned colors)
	1	768 x 492 MONO8 768 x 492 Raw8	@30 fps, no binning, frame integration mode @30 fps, no binning, frame integration mode
	2	384x244 MONO8	@59 fps, 2 x full binning for aspect ratio, progressive readout mode

Table 82: Video formats Guppy F-038B NIR / Guppy F-038C NIR

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

GUPPY F-044B / GUPPY F-044C

Format	Mode	Resolution	Max. frame rate in Format_7
7	0	752 x 580 MONO8 752 x 580 Raw8	@25 fps, 2 x V-binning, field readout mode @25 fps, 2 x V-binning, field readout mode
	1	752 x 580 MONO8 752 x 580 Raw8	@25 fps, no binning, frame integration mode @ 25 fps, no binning, frame integration mode
	2	376 x 288 MONO8	@52 fps, 2 x full binning for aspect ratio, progressive readout mode, only first field is read out

Table 83: Video formats Guppy F-044B / Guppy F-044C

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

GUPPY F-044B NIR / GUPPY F-044C NIR

Format	Mode	Resolution	Max. frame rate in Format_7
7	0	752 x 580 MONO8 752 x 580 Raw8	@25 fps, 2 x V-binning, field readout mode @25 fps, 2 x V-binning, field readout mode
	1	752 x 580 MONO8 752 x 580 Raw8	@25 fps, no binning, frame integration mode @ 25 fps, no binning, frame integration mode
	2	376 x 288 MONO8	@52 fps, 2 x full binning for aspect ratio, progressive readout mode, only first field is read out

Table 84: Video formats Guppy F-044B NIR / Guppy F-044C NIR

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

GUPPY F-046B / GUPPY F-046C

Format	Mode	Resolution	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						
	2	640 x 480 YUV411						
	3	640 x 480 YUV422						
	4	640 x 480 RGB8						
	5	640 x 480 MONO8	x x*	x x*	x x*	x x*	x x*	
	6	640 x 480 MONO16						
7	0	780 x 582 MONO8 780 x 582 Raw8	@49.4 fps @49.4 fps					
	1							
	2							
	3							

Table 85: Video formats Guppy F-046B / Guppy F-046C

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

GUPPY F-080B / GUPPY F-080C and board level versions F-080B BL/F-080C BL

Format	Mode	Resolution	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						
	2	640 x 480 YUV411						
	3	640 x 480 YUV422						
	4	640 x 480 RGB8						
	5	640 x 480 MONO8		x x*	x x*	x x*	x x*	
	6	640 x 480 MONO16						
1	0	800 x 600 YUV422						
	1	800 x 600 RGB8						
	2	800 x 600 MONO8		x x*	x x*	x x*		
	3	1024 x 768 YUV422						
	4	1024 x 768 RGB8						
	5	1024 x 768 MONO8		x x*	x x*	x x*	x x*	
	6	800 x 600 MONO16						
	7	1024 x 768 MONO16						
7	0	1032 x 778 MONO8 1032 x 778 Raw8	@30 fps @30 fps					
	1							
	2							
	3							

Table 86: Video formats Guppy F-080B / Guppy F-080C

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

GUPPY F-146B / GUPPY F-146C

Format	Mode	Resolution	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						
	2	640 x 480 YUV411						
	3	640 x 480 YUV422						
	4	640 x 480 RGB8						
	5	640 x 480 MONO8		x x*	x x*	x x*	x x*	
	6	640 x 480 MONO16						
1	0	800 x 600 YUV422						
	1	800 x 600 RGB8						
	2	800 x 600 MONO8			x x*	x x*		
	3	1024 x 768 YUV422						
	4	1024 x 768 RGB8						
	5	1024 x 768 MONO8			x x*	x x*	x x*	x x*
	6	800 x 600 MONO16						
	7	1024 x 768 MONO16						
2	0	1280 x 960 YUV422						
	1	1280 x 960 RGB8						
	2	1280 x 960 Mono 8			x x*	x x*	x x*	x x*
	3	1600 x1200 YUV422						
	4	1600 x1200 RGB8						
	5	1600 x1200 Mono8						
	6	1280 x 960 Mono16						
	7	1600 x1200 Mono16						
7	0	1392 x 1040 MONO8 1392 x 1040 Raw8	@17.7 fps @17.7 fps					
	1							
	2							
	3							

Table 87: Video formats Guppy F-146B / Guppy F-146C

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

Area of interest (AOI)

The cameras 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.

Note

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.

IMAGE_POSITION and IMAGE_SIZE contain the respective bits values for the column and line of the upper left corner and values for the width and height.

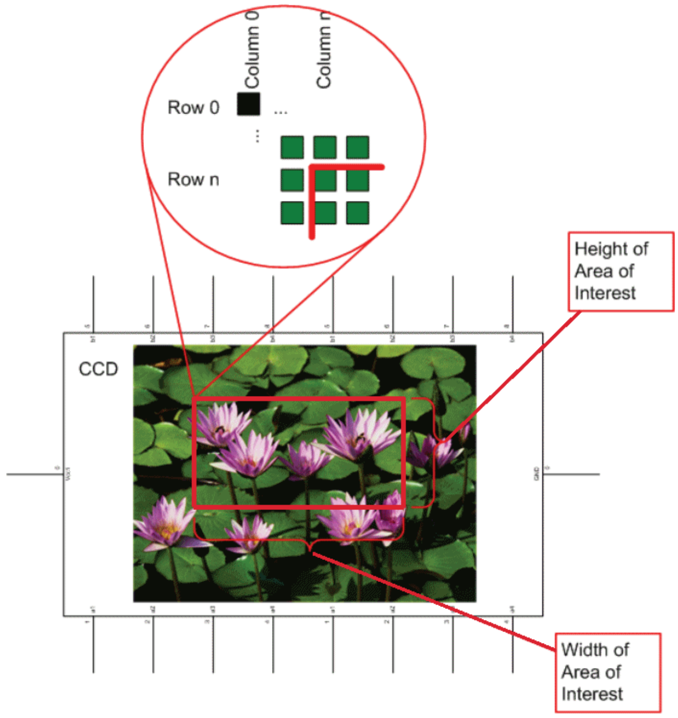


Figure 88: Area of interest (AOI)

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. The minimum AOI of the Guppy F036 is limited to 92 x 60 pixels.

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

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

Autofunction AOI (not interlaced GUPPYs)

Note

Interlaced GUPPY cameras do not have autofunction AOI feature.

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

- Auto shutter
- Auto gain
- Auto white balance

Note

Auto gain of **CMOS models** is directly controlled by the CMOS sensor (the target grey level is fixed to 125). Autofunction AOI does not work with auto gain. Auto exposure works in conjunction with auto shutter only and therefore works also with autofunction AOI.

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

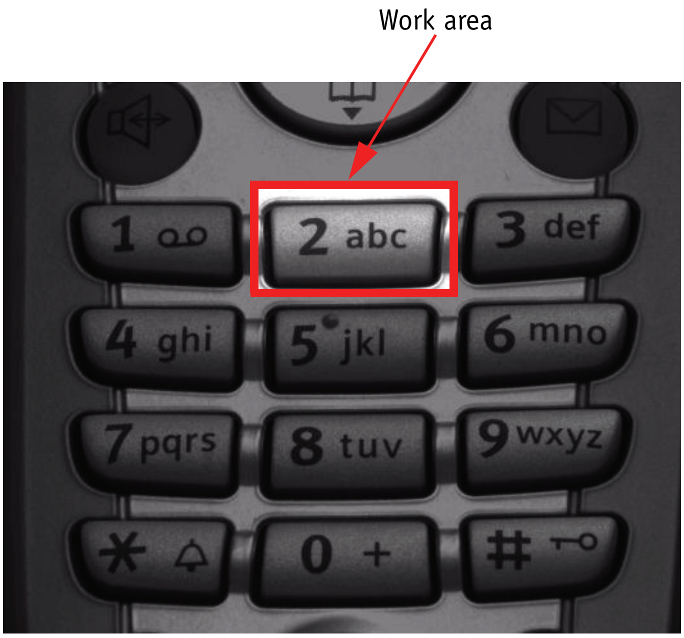


Figure 89: Example of autofunction AOI (Show work area is on)

Note

For more information see Chapter Autofunction AOI on page 257.

Frame rates

An IEEE 1394 camera requires bandwidth to transport images.

The IEEE 1394a bus has very large bandwidth of at least 32 MB/s for transferring (isochronously) image data. Per cycle up to 4096 bytes (or around 1000 quadlets = 4 bytes@ 400 Mbit/s) can thus be transmitted.

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 requires transmission.

The following tables indicate the volume of data in various formats and modes to be sent within one cycle (125 µs) at 400 Mbit/s of bandwidth.

The tables are divided into three formats; F_0 up to VGA, F_1 up to XGA, and F_2 up to UXGA.

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.

Note

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

The frame rates in video modes 0 to 2 are specified, and settings are fixed by IIDC V1.3.

In video Format_7 frame rates are no longer fixed.

Note

Different values apply for the different sensors.

Frame rates may be further limited by longer shutter times and/or bandwidth limitation from the IEEE 1394 bus.

GUPPY F-025

tbd

GUPPY F-029

tbd

GUPPY F-033 and board level versions

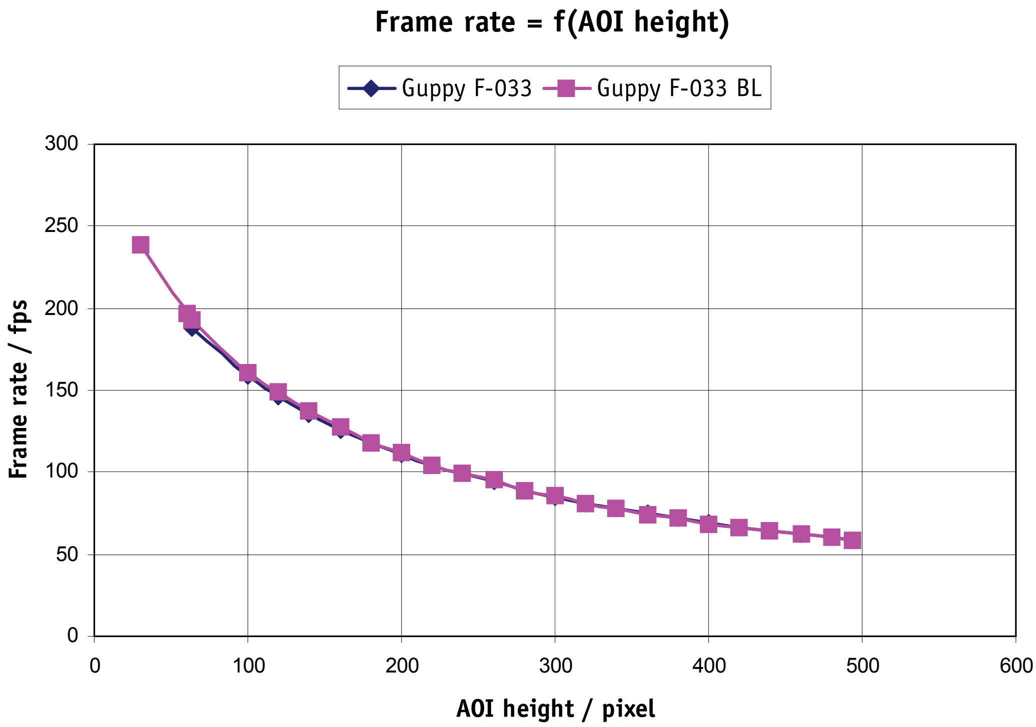


Figure 90: Frame rates GUPPY F-033 and board level versions

AOI height / pixel	Frame rate / fps Guppy F-033	Frame rate / fps Guppy F-033 BL
494	58	58
480	60	60
460	62	62
440	64	64
420	66	66
400	69	68
380	72	72
360	75	74
340	78	78
320	81	81
300	85	86

Table 88: Frame rates Guppy F-033 and board level versions

AOI height / pixel	Frame rate / fps Guppy F-033	Frame rate / fps Guppy F-033 BL
280	89	89
260	94	95
240	99	99
220	104	104
200	111	112
180	118	118
160	126	128
140	135	137
120	146	149
100	159	161
64	188	193
60	not available	197
30	not available	239

Table 88: Frame rates Guppy F-033 and board level versions

GUPPY F-036

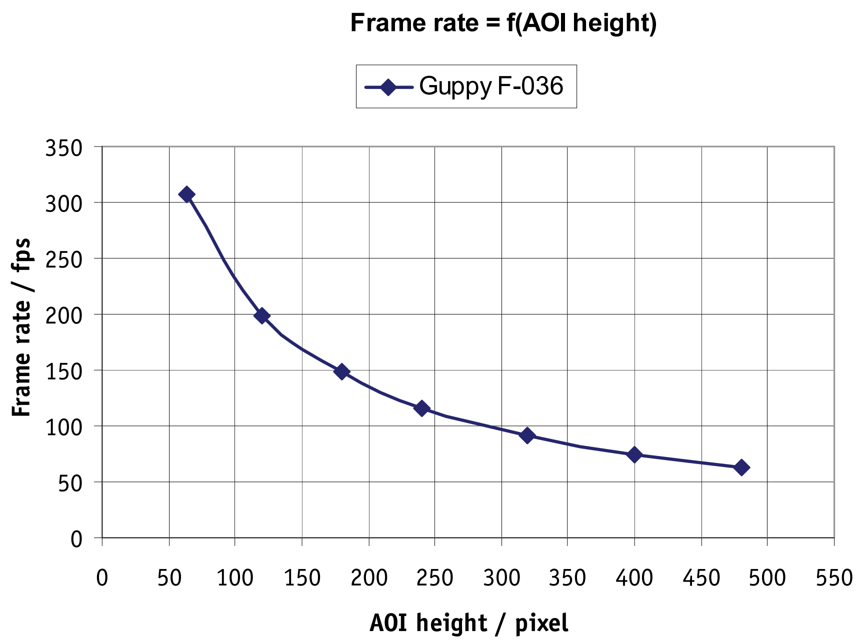


Figure 91: Frame rates GUPPY F-036 as function of AOI height

The frame rates in the following table are measured directly at the output of the camera. Compare with Chapter How does bandwidth affect the frame rate? on page 205.

AOI height / pixel	Frame rate / fps
480	63.5
400	75
320	91
240	116
180	148
120	199
64	307

Table 89: Frame rates Guppy F-036 as function of AOI height

Note

The minimum AOI is 92 x 60 (AOI width x AOI height).

The readout time for one row is constant. That means: the behavior of a CCD sensor is approximated.

GUPPY F-038 / GUPPY F-038 NIR

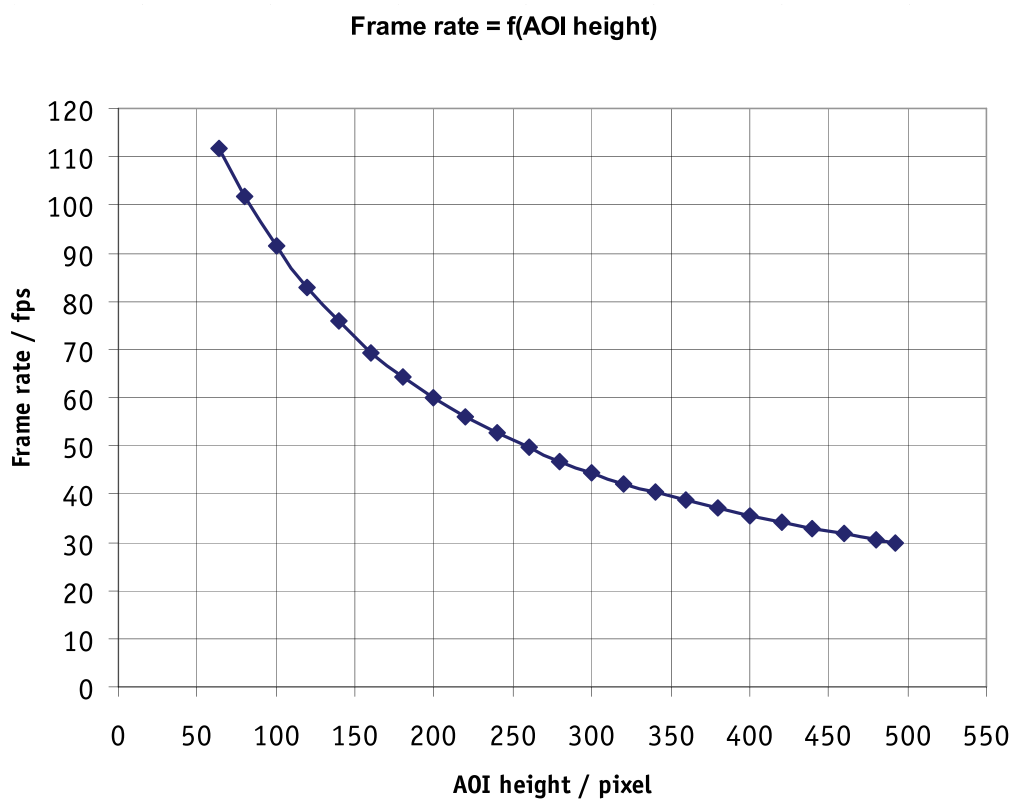


Figure 92: Frame rates GUPPY F-038 / GUPPY F-038 NIR as function of AOI height

The frame rates in the following table are measured directly at the output of the camera. Compare with Chapter How does bandwidth affect the frame rate? on page 205.

AOI height / pixel	Frame rate / fps
492	30.0
480	30.5
460	31.7
440	32.8
420	34.0
400	35.5
380	37.1
360	38.7

Table 90: Frame rates GUPPY F-038 / F-038 NIR as function of AOI height

AOI height / pixel	Frame rate / fps
340	40.5
320	42.2
300	44.4
280	46.9
260	49.8
240	52.7
220	56.0
200	59.9
180	64.2
160	69.2
140	75.8
120	82.9
100	91.4
80	101.9
64	111.7

Table 90: Frame rates GUPPY F-038 / F-038 NIR as function of AOI height

GUPPY F-044 / GUPPY F-044 NIR

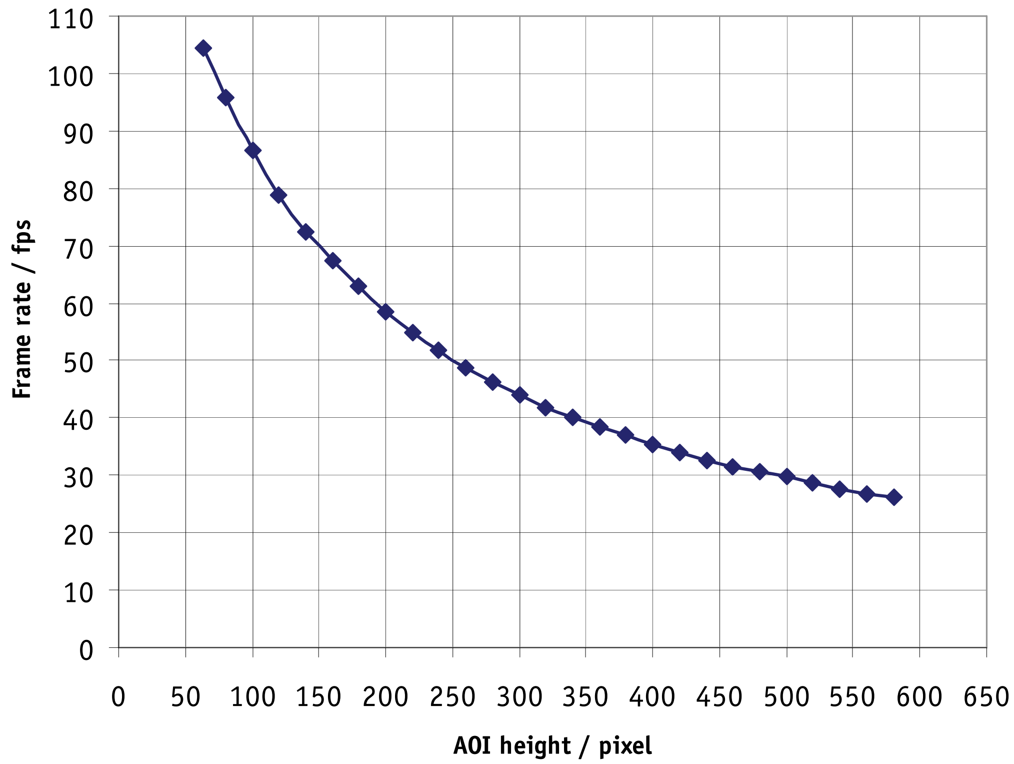


Figure 93: Frame rates GUPPY F-044 / GUPPY F-044 NIR as function of AOI height

The frame rates in the following table are measured directly at the output of the camera. Compare with Chapter How does bandwidth affect the frame rate? on page 205.

AOI height / pixel	Frame rate / fps
580	26.1
560	26.8
540	27.7
520	28.6
500	29.7
480	30.5
460	31.5
440	32.7

Table 91: Frame rates GUPPY F-044 / F-044 NIR as function of AOI height

AOI height / pixel	Frame rate / fps
420	33.9
400	35.3
380	37.1
360	38.5
340	40.1
320	41.9
300	44.0
280	46.3
260	48.8
240	51.8
220	55.0
200	58.6
180	62.8
160	67.5
140	72.4
120	78.8
100	86.5
80	95.7
64	104.4

Table 91: Frame rates GUPPY F-044 / F-044 NIR as function of AOI height

GUPPY F-046

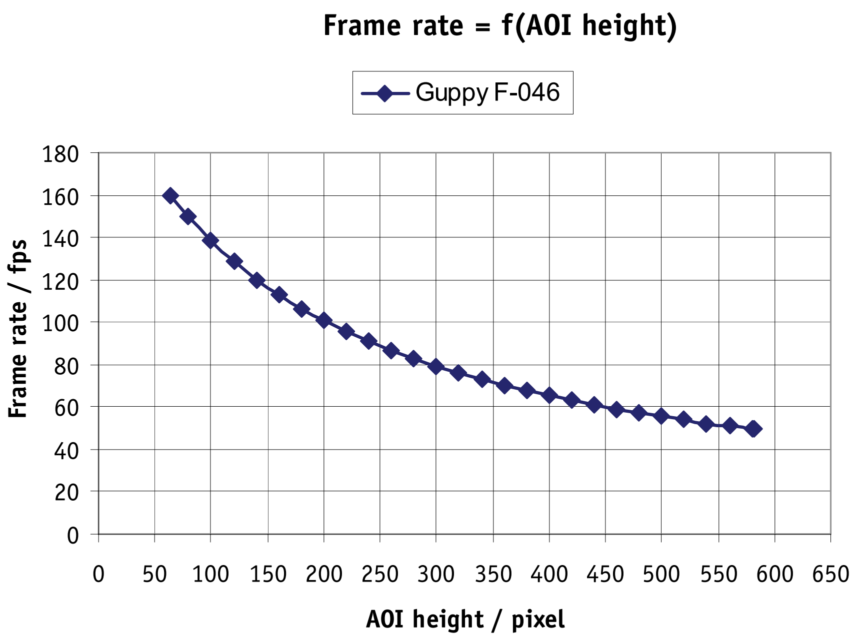


Figure 94: Frame rates Guppy F-046 as function of AOI height

AOI height / pixel	Frame rate / fps
582	49.4
580	49.5
560	50.9
540	52.3
520	54.0
500	55.5
480	57.1
460	59.0
440	60.9
420	63.1
400	65.2
380	67.5
360	70.2
340	72.9
320	76.0

Table 92: Frame rates Guppy F-046

AOI height / pixel	Frame rate / fps
300	79.1
280	82.8
260	86.6
240	91.0
220	95.5
200	100.9
180	106.4
160	113.1
140	120.0
120	128.5
100	138.5
80	149.5
64	159.8

Table 92: Frame rates Guppy F-046

GUPPY F-080 and board level versions

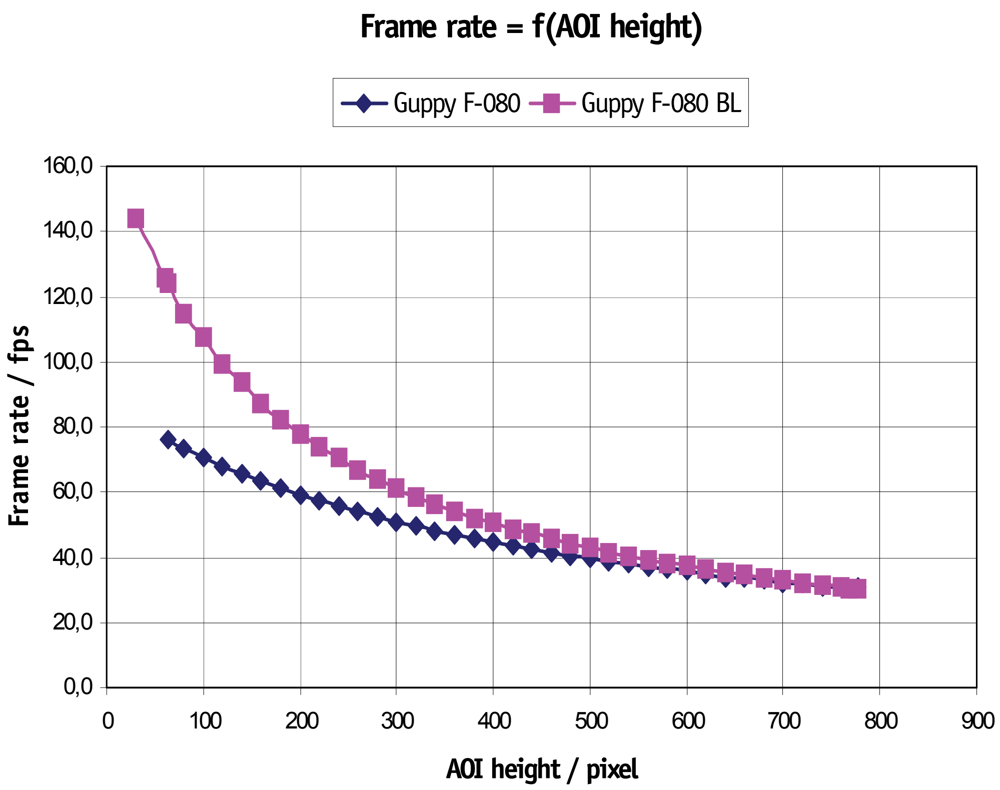


Figure 95: Frame rates GUPPY F-080 and board level versions

AOI height / pixel	Frame rate / fps Guppy F-080	Frame rate / fps Guppy F-080 BL
778	30.9	30.3
768	30.6	30.5
760	30.8	30.8
740	31.0	31.4
720	31.9	32.2
700	32.2	33.0
680	33.1	33.7
660	33.5	34.5
640	33.4	35.5

Table 93: Frame rates GUPPY F-080 and board level versions

AOI height / pixel	Frame rate / fps Guppy F-080	Frame rate / fps Guppy F-080 BL
620	34.7	36.3
600	35.6	37.3
580	36.4	38.2
560	37.2	39.3
540	38.0	40.3
520	38.8	41.6
500	39.7	43.0
480	40.5	44.1
460	41.4	45.6
440	42.5	47.2
420	43.5	48.6
400	44.5	50.5
380	45.7	52.1
360	46.8	54.2
340	48.1	56.1
320	49.4	58.6
300	50.8	61.3
280	52.3	63.8
260	53.9	67.0
240	55.5	70.5
220	57.3	73.7
200	59.1	78.0
180	61.2	82.0
160	63.2	87.4
140	65.5	93.6
120	68.0	99.4
100	70.8	107.4
80	73.6	115.0
64	76.2	124.0
60	not available	126.0
30	not available	144.0

Table 93: Frame rates GUPPY F-080 and board level versions

GUPPY F-146

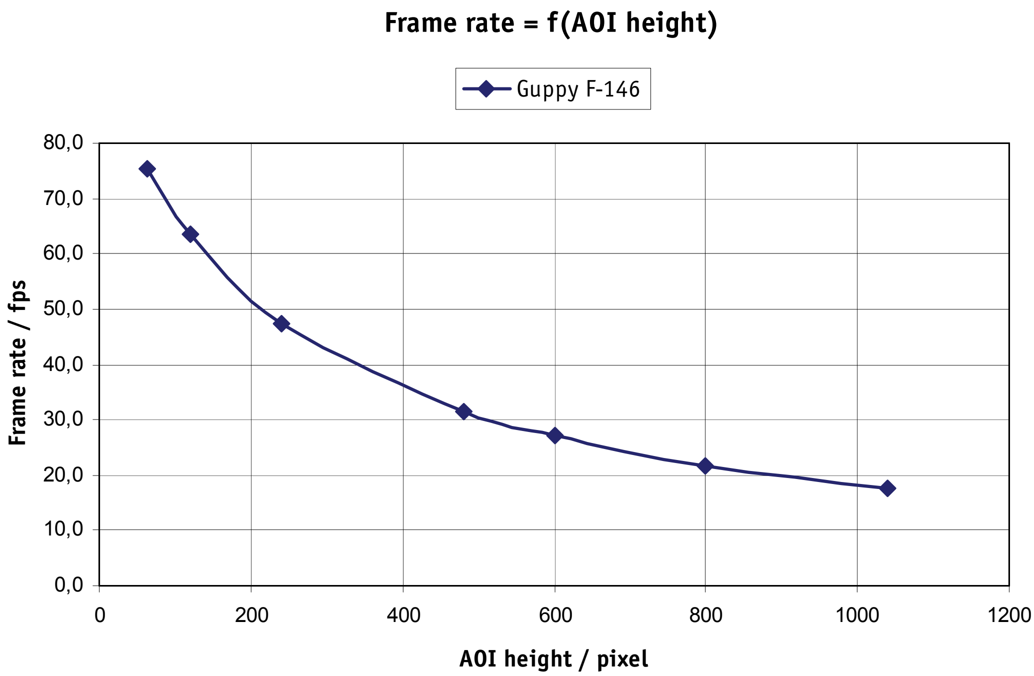


Figure 96: Frame rates GUPPY F-146

AOI height / pixel	Frame rate / fps Guppy F-146
1040	17.7
800	21.8
600	27.1
480	31.6
240	47.5
120	63.6
64	75.5

Table 94: Frame rates GUPPY F-146

How does bandwidth affect the frame rate?

In some modes the IEEE 1394a bus limits the attainable frame rate. According to the 1394a specification on isochronous transfer, the largest data payload size of 4096 bytes per 125 µs cycle is possible with bandwidth of 400 Mbit/s. In addition, there is a limitation, only a maximum number of 65535 (2^{16} -1) packets per frame are allowed (GUPPY F-036: max. number of 800 packets due to the sensor limitation).

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.

$$\text{BYTE\_PER\_PACKET} = \text{frame rate} \times \text{AOIWidth} \times \text{AOIHEIGHT} \times \text{ByteDepth} \times 125\mu s$$

Formula 9: Byte_per_Packet calculation (only Format_7)

If the value for **BYTE_PER_PACKET** is greater than 4096 (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):

$$\text{framerate}_{max} \approx \frac{\text{BYTE\_PER\_PACKET}}{\text{AOIWidth} \times \text{AOIHeight} \times \text{ByteDepth} \times 125\mu s}$$

Formula 10: Maximum frame rate calculation

ByteDepth based on the following values:

Mode	Bits/pixel	Byte per pixel
Mono8	8	1
RAW8	8	1

Table 95: ByteDepth

Example formula for the b/w camera

Mono8, 1024 x 768, 15 fps desired

$$\text{BYTE\_PER\_PACKET} = 15 \times (1024 \times 768) \times 125\mu s = 1474 < 4096$$

$$\Rightarrow \quad \text{frame rate}_{\text{reachable}} \approx \frac{4096}{1024 \times 768 \times 125\mu s} = 41.6 \text{ Hz}$$

Formula 11: Example max. fps calculation

A Frame rate of 15 fps can be achieved. Frame $\text{rate}_{\text{reachable}}$ is not possible due to the sensor limit.

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 96: Loading test images in different viewers

Test images b/w cameras (progressive and interlaced)

The b/w cameras have two test images that look the same. Both images show a gray bar running diagonally. One test image is static, the other moves upwards by 1 pixel/frame.

Figure 97: Gray bar test image (progressive and interlaced)

$$\text{Gray value} = (x + y)\text{MOD256} \qquad (8\text{-bit mode})$$

Formula 12: Calculating the gray value

Test images for color cameras

The color cameras have 2 test images.

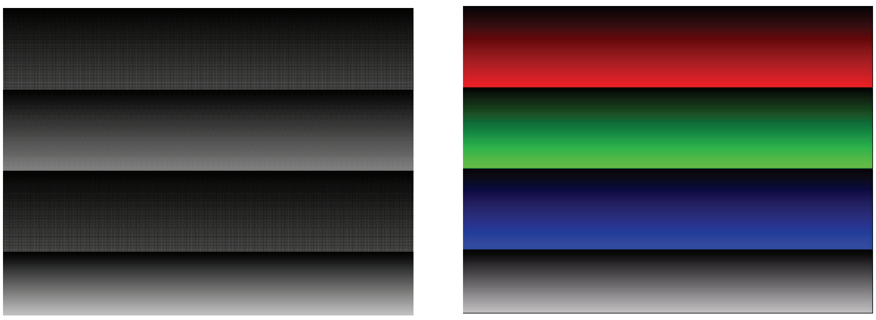
Test image	Description
Test image 1	Mono8 (raw data) static see screenshot below
Test image 2	Available with FPGA 1.05 and higher Mono8 (raw data) moving see screenshot below

Table 97: Test images color cameras

Note

The color camera outputs Bayer-coded raw data in Mono8 instead of a real Y signal (as described in IIDC V1.3).

Test image 1 (Mono8 mode) progressive



without Debayering

with Debayering

Figure 98: Test image 1 progressive

Test image 2 (Mono8 mode) progressive

without Debayering with Debayering

Figure 99: Test image 2 progressive

Test image 1 and 2 (Mono8 mode) interlaced

without Debayering with Debayering

Figure 100: Test image 1 (static) interlaced (Format_7 Mode_1)

Note

- Test image 2 interlaced is the same as test image 2 but moving.
- Test images show correct colors only in Format_7 Mode_1.

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 are is always FFFFh, leaving the description for the Camera_Status_Register in the last 32 bits.

If a CSR F0F00600h is mentioned below 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):

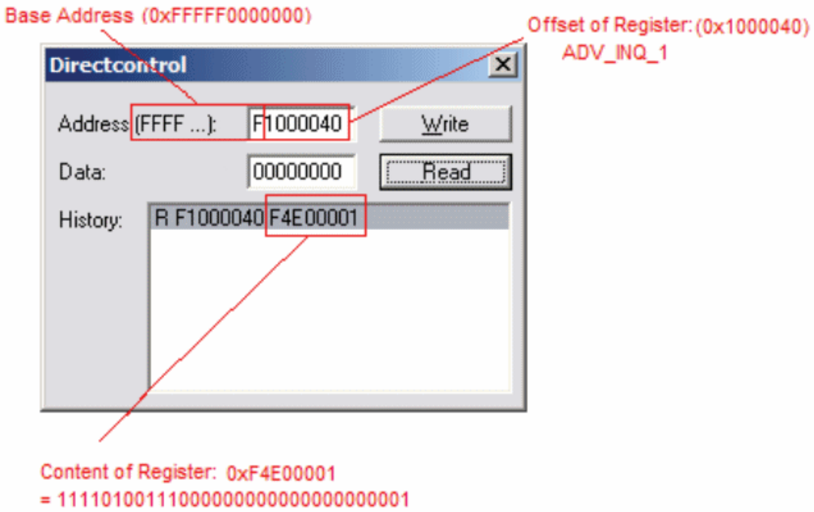
Far left

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

Table 98: 32-bit register

Example

This requires, for example, that to enable **ISO_Enabled mode** (see Chapter ISO_Enable / Free-Run on page 178), (bit 0 in register 614h), the value 80000000 h must be written in the corresponding register.



Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	1	1	1	1	0	1	0	0	1	1	1	0	0	0	0	0

Bit	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Figure 101: Configuration of the camera

Sample program

The following sample code in C shows how the register is set for frame rate, video mode/format and trigger mode using the **FireCtrl DLL** from the **FirePackage API**. How the camera is switched into **ISO_Enabled** mode is also shown below:

```
…
WriteQuad(m_cmdRegBase + CCR_FRAME-RATE, Frame-Rate << 29);
WriteQuad(m_cmdRegBase + CCR_VMODE, mode << 29);
WriteQuad(m_cmdRegBase + CCR_VFORMAT, format << 29);
WriteQuad(m_cmdRegBase + CCR_TRGMODE, extTrigger ? 0x82000000 : 0);
Sleep(100);
WriteQuad(m_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 **Direct access** program to read or write to a register, enter the following value in the Address field:

F0F00000h + Offset

The ConfigRom is divided into the

- 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

Note

The following assignments are only an example.

Because the key code can describe the roll of a register, the order of some registers is not mandatory.

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	C3	17	
	404h	31	33	39	34	.... ASCII for 1394
	408h	20	00	A2	02	.... Bus capabilities
	40Ch	00	0A	47	01	.... Node_Vendor_Id, Chip_id_hi
	410h	Serial number				.... Chip_id_lo
Root directory	414h	00	04	CRC		According to IEEE 1212, the root directory length may vary. 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 99: Config ROM

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

420h + 000002 * 4 = 428h

	Offset	0-7	8-15	16-23	24-31
Node unique ID leaf	428h	00	02	CRC	
	42Ch	00	0A	47	01
	430h	Serial number			

Table 100: 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	CRC	
Unit directory	438h	12	00	A0	2D
	43Ch	13	00	01	02
	440h	D4	00	00	01

Table 101: 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
	444h	00	0B	CRC	
Unit dependent info	448h	40	3C	00	00
	44Ch	81	00	00	0A
	450h	82	00	00	0E
	454h	38	00	00	00
	458h	39	00	00	00
	45Ch	3A	00	00	00
	460h	3B	00	00	00
	464h	3C	00	00	00
	468h	3D	00	00	00
	46Ch	3E	00	00	00
	470h	3F	00	00	00

Table 102: 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.

Note

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

F0F00000h + Offset

Implemented registers

The following tables show how standard registers from IIDC V1.3 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 103: 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 104: Format inquiry register

Inquiry register for video mode

Offset	Name	Field	Bit	Description	Supported
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	x
		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	x
		Mode _3	[3]	1024 x 768 YUV 4:2:2	
		Mode _4	[4]	1024 x 768 RGB	
		Mode _5	[5]	1024 x 768 MONO8	x
		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	x
		Mode _3	[3]	1600 x 1200 YUV 4:2:2	
		Mode _4	[4]	1600 x 1200 RGB	
		Mode _5	[5]	1600 x 1200 MONO8	x
		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 105: Video mode inquiry register

Offset	Name	Field	Bit	Description	Supported
19Ch	V_MODE_INQ (Format_7)	Mode_0	[0]	Format_7 Mode_0	Mono8 RAW8
		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 105: Video mode inquiry register

Note

GUPPY cameras do not deliver color formats. Therefore Mono8 corresponds to RAW8.

Both formats are supported to allow compatibility with IIDC V1.31 and with other camera models.

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)

Table 106: Frame rate inquiry register

Offset	Name	Field	Bit	Description
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)
208h	V_RATE_INQ (Format_0, 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]	240 fps (v1.31)
		-	[8..31]	Reserved (zero)
20Ch	V_RATE_INQ (Format_0, 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 106: Frame rate inquiry register

Offset	Name	Field	Bit	Description
210h	V_RATE_INQ (Format_0, 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)
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

Table 106: Frame rate inquiry register

Offset	Name	Field	Bit	Description
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)
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)

Table 106: Frame rate inquiry register

Offset	Name	Field	Bit	Description
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)
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)

Table 106: Frame rate inquiry register

Offset	Name	Field	Bit	Description
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)
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)

Table 106: Frame rate inquiry register

Offset	Name	Field	Bit	Description
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)
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)

Table 106: Frame rate inquiry register

Offset	Name	Field	Bit	Description
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)
254h	V_RATE_INQ (Format_2, 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]	Reserved
		FrameRate _7	[7]	Reserved
		-	[8..31]	Reserved (zero)
258h	V_RATE_INQ (Format_2, 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]	Reserved
		FrameRate _7	[7]	Reserved
		-	[8..31]	Reserved (zero)

Table 106: Frame rate inquiry register

Offset	Name	Field	Bit	Description
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
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 106: 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 107: 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 108: 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 108: 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. For interlaced GUPPYs: always 0. Use advanced registers 80C4 and 80C8 instead.		
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 109: 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 rigger 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..30]	Reserved
		Trigger_Mode15_Inq	[31]	Presence of Trigger_Mode 15
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		

Table 109: Feature elements inquiry register

Register	Name	Field	Bit	Description
584h	PAN_INQ	Always 0		
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 continuous shot; 0 for stop		
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 109: 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 110: 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.

Offset	Name	Field	Bit	Description
800h	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, value in the Value field is ignored.
			[2-4]	Reserved
		One_Push	[5]	Write '1': begin to work (Self cleared after operation) Read: Value='1' in operation Value='0' not in operation If A_M_Mode =1, this bit is ignored.
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF, 1: ON If this bit =0, other fields will be read only.
		A_M_Mode	[7]	Write: set the mode Read: read a current mode 0: Manual 1: Auto
			[8-19]	Reserved
		Value	[20-31]	Value. Write the value in Auto mode, this field is ignored. If "ReadOut" capability is not available, read value has no meaning.

Table 111: Feature control register

Offset	Name	Field	Bit	Description
804h	AUTO-EXPOSURE			See above
808h	SHARPNESS			See above

Table 111: Feature control register

Offset	Name	Field	Bit	Description
80Ch	WHITE-BALANCE	Presence_Inq	[0]	Presence of this feature 0: N/A 1: Available Always 0 for Mono
		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, value in the Value field is ignored.
			[2-4]	Reserved
		One_Push	[5]	Write '1': begin to work (Self cleared after operation) Read: Value='1' in operation Value='0' not in operation If A_M_Mode =1, this bit is ignored.
		ON_OFF	[6]	Write: ON or OFF this feature, Read: read a status 0: OFF 1: ON If this bit =0, other fields will be read only.
		A_M_Mode	[7]	Write: set the mode Read: read a current mode 0: Manual 1: Auto
		U_Value / B_Value	[8-19]	U Value / B_Value Write the value in AUTO mode, this field is ignored. If "ReadOut" capability is not available, read value has no meaning.
		V_Value / R_Value	[20-31]	V value / R value Write the value in AUTO mode, this field is ignored. If "ReadOut" capability is not available, read value has no meaning.

Table 111: Feature control register

Offset	Name	Field	Bit	Description
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 Timebase Chapter Shutter CSR on page 119
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
8C4h	CAPTURE-QUALITY			Always 0
8C8h .. 8FCh	Reserved for other FEATURE_LO			Always 0

Table 111: 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 112: 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 106: Frame rate inquiry register on page 218) gives 003C2000h.

4 x 3C2000h = F08000h so that the base address for the latter (Table 113: Format_7 control and status register on page 238) equals to 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 106: Frame rate inquiry register on page 218) gives 003C2400h.

4 x 003C2400h = F09000h so that the base address for the latter (Table 113: Format_7 control and status register on page 238) equals to F0000000h + F09000h = F0F09000h.

Format_7 control and status register (CSR)

Offset	Name	Notes
000h	MAX_IMAGE_SIZE_INQ	Acc. to IIDC V1.3
004h	UNIT_SIZE_INQ	Acc. to IIDC V1.3
008h	IMAGE_POSITION	Acc. to IIDC V1.3
00Ch	IMAGE_SIZE	Acc. to IIDC V1.3
010h	COLOR_CODING_ID	See note
014h	COLOR_CODING_INQ	Acc. to IIDC V1.3
034h	PIXEL_NUMBER_INQ	Acc. to IIDC V1.3
038h	TOTAL_BYTES_HI_INQ	Acc. to IIDC V1.3
03Ch	TOTAL_BYTES_LO_INQ	Acc. to IIDC V1.3
040h	PACKET_PARA_INQ	See note
044h	BYTE_PER_PACKET	Acc. to IIDC V1.3

Table 113: 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 V1.3, 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 V1.3, COLOR_CODING_ID is set to a default value after an INITIALIZE or **reset**.
- Contrary to IIDC V1.3, 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 V1.3. The following chapter summarizes all available advanced features in ascending register order.

The following table gives an overview of all available registers:

s

Register	Register name	Remarks
0XF1000010	VERSION_INFO	see Table 115: Version information register on page 243
0XF1000018	VERSION_INFO3	
0XF1000040	ADV_INQ_1	Table 117: Advanced feature inquiry register on page 245
0XF1000044	ADV_INQ_2	
0XF1000048	ADV_INQ_3	
0XF100004C	ADV_INQ_4	
0xF1000100	CAMERA_STATUS	see Table 118: Camera status register on page 247
0XF1000200	MAX_RESOLUTION	see Table 119: Max. resolution inquiry register on page 248
0XF1000208	TIMEBASE	see Table 120: Timebase configuration register on page 248
0XF100020C	EXTD_SHUTTER	see Table 122: Extended shutter configuration register on page 250
0XF1000210	TEST_IMAGE	see Table 123: Test image configuration register on page 251
0XF1000240	LUT_CTRL	see Table 124: LUT control register on page 252
0XF1000244	LUT_MEM_CTRL	
0XF1000248	LUT_INFO	
0XF1000270	FRAMEINFO	Not supported
0XF1000274	FRAMECOUNTER	Not supported
0XF1000280	HDR_CONTROL	High dynamic range mode (only Guppy F-036) see Chapter HDR (high dynamic range) (GUPPY F-036 only) on page 128
0XF1000284	KNEEPOINT_1	
0XF1000288	KNEEPOINT_2	
0XF100028C	KNEEPOINT_3	
0XF1000300	IO_INP_CTRL1	see Table 56: Input configuration register on page 149

Table 114: Advanced registers summary

Register	Register name	Remarks
0XF1000304	IO_INP_CTRL2	only Guppy board level cameras see Table 56: Input configuration register on page 149
0XF1000308	IO_INP_CTRL3	
0XF100030C	IO_INP_CTRL4	
0XF1000320	IO_OUTP_CTRL1	see Table 63: Output configuration register on page 155
0XF1000324	IO_OUTP_CTRL2	
0XF1000328	IO_OUTP_CTRL3	
0XF100032C	IO_OUTP_CTRL4	only Guppy board level cameras see Table 63: Output configuration register on page 155
0XF1000340	IO_INTENA_DELAY	see Table 125: Delayed integration enable configuration register on page 255
0XF1000360	AUTOSHUTTER_CTRL	see Table 126: Auto shutter control advanced register on page 255
0XF1000364	AUTOSHUTTER_LO	
0XF1000368	AUTOSHUTTER_HI	
0XF1000370	AUTOGAIN_CTRL	see Table 127: Advanced register for auto gain control on page 256
0XF1000390	AUTOFNC_AOI	see Table 128: Advanced register for autofunction AOI on page 258
0xF1000394	AF_AREA_POSITION	
0xF1000398	AF_AREA_SIZE	
0XF1000400	TRIGGER_DELAY	see Table 129: Trigger Delay Advanced CSR on page 259
0XF1000510	SOFT_RESET	see Table 131: Soft reset register on page 261
0XF1000550	USER PROFILES	see Table 132: Advanced register: user profiles on page 262
0XF1000800	IO_OUTP_PWM1	Guppy board level cameras only see Table 66: PWM configuration registers on page 159
0XF1000804	IO_OUTP_PWM2	
0XF1000808	IO_OUTP_PWM3	
0XF100080C	IO_OUTP_PWM4	
0XF1000FFC	GPDATA_INFO	see Table 135: GPData buffer register on page 265
0xF1001000 … 0xF10017FC	GPDATA_BUFFER	

Table 114: 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 116: Camera type ID list on page 243
		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 115: 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 (decimal)	Camera type
201	Guppy F-033B
202	Guppy F-033C
203	Guppy F-036B
204	Guppy F-036C
205	Guppy F-046B
206	Guppy F-046C
207	Guppy F-080B
208	Guppy F-080C

Table 116: Camera type ID list

ID (decimal)	Camera type
209	Guppy F-146B
210	Guppy F-146C
213	Guppy F-033B BL (board level)
214	Guppy F-033C BL (board level)
215	Guppy F-025B
216	Guppy F-025C
217	Guppy F-029B
218	Guppy F-029C
219	Guppy F-038B
220	Guppy F-038C
221	Guppy F-038B NIR
222	Guppy F-038C NIR
223	Guppy F-044B NIR
224	Guppy F-044C NIR
225	Guppy F-080B BL (board level)
226	Guppy F-080C BL (board level)
227	Guppy F-044B
228	Guppy F-044C

Table 116: 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]	
		---	[5]	Reserved
		VersionInfo	[6]	
		---	[7]	Reserved
		Look-up tables	[8]	
		---	[9]	Reserved
		---	[10]	Reserved
		HDR control	[11]	Guppy F-036 only
		---	[12]	Reserved
		---	[13]	Reserved
		TriggerDelay	[14]	
		Mirror image	[15]	Guppy F-036 only
		Soft Reset	[16]	
		---	[17]	Reserved
		---	[18]	Reserved
		---	[19..20]	Reserved
		User Sets	[21]	
		---	[22..30]	Reserved
		GP_Buffer	[31]	

Table 117: Advanced feature inquiry register

Register	Name	Field	Bit	Description
0xF1000044	ADV_INQ_2	Input_1	[0]	
		---	[1]	Reserved
		---	[2]	Reserved
		---	[3..7]	Reserved
		Output_1	[8]	
		Output_2	[9]	
		Output_3	[10]	
		---	[11..15]	Reserved
		IntEnaDelay	[16]	
		---	[17..23]	Reserved
		Output 1 PWM	[24]	only board level
		Output 2 PWM	[25]	only board level
		Output 3 PWM	[26]	only board level
		Output 4 PWM	[27]	only board level
		---	[28..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	---	[0..31]	Reserved

Table 117: 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 any images and the camera 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 118: 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 119: 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.

GUPPY 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 121: Time base ID on page 249.

Table 120: Timebase configuration register

IDs 0-9 are in bits 28 to 31. See Table 121: Time base ID on page 249. Refer to the following table for code.

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 has to be added to the exposure time (set by any shutter register) to compute the real exposure time.

The **ExpOffset** field might be zero for some cameras: this has to be assumed as an unknown exposure time offset (according to former software versions).

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 121: Time base ID

Note

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

Extended shutter

- For **CCD** models: The exposure time for long-term integration of up to 67 seconds can be entered with µs precision via the EXTENDED_SHUTTER register.
- For **CMOS** models: The maximum exposure time is 32767 x 29.89 µs = 979.4 ms. Although you may enter values with µs precision, the camera will round down or up to integer multiples of the row time, leaving an uncertainty of only half of the row time.

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 122: 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 for CCD models is 3FFFFFFh, corresponding 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 123: 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 124: 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

Guppy 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

Input/output pin control

All input and output signals running over the HiRose plug are controlled by this register.

Note

See Chapter Input on page 148.

See Table 56: Input configuration register on page 149.

See Table 57: Input routing on page 150.

See Chapter Chapter IO_OUTP_CTRL 1-3 on page 155.

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.

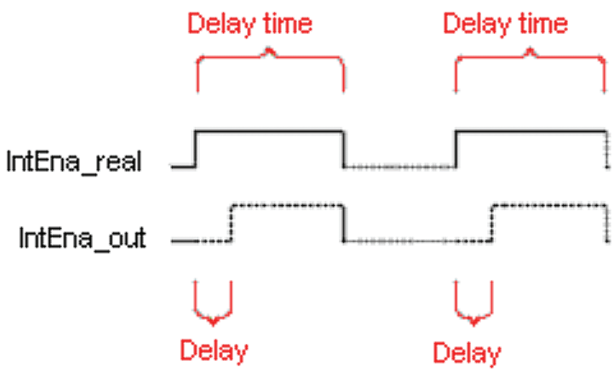


Figure 102: Delayed integration timing

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 125: 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
0xF1000368	AUTOSHUTTER_HI	---	[0..5]	Reserved
		MaxValue	[6..31]	Maximum auto shutter value

Table 126: 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 127: 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 follows 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).
3. 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 (in 2^n steps) 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)
0xF1000398	AF_AREA_SIZE	Width	[0..15]	Width of work area size
		Height	[16..31]	Height of work area size

Table 128: 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.

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 129: Trigger Delay Advanced CSR

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

Note

Trigger delay woks with external trigger modes only.

Mirror image (only Guppy F-036)

Guppy F-036 cameras are equipped with horizontal and vertical mirror function. The mirror is centered to the actual **FOV** center and can be combined with all image manipulation functions, like **binning**.

Register	Name	Field	Bit	Description
0xF1000410	MIRROR_IMAGE	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		HorzMirror_ON	[6]	Horizontal mirror on/off 1: on 0: off Default: off
		VertMirror_ON	[7]	Vertical mirror on/off 1: on 0: off Default: off
		---	[8..15]	Reserved
		HorzMirrorInq	[16]	Horizontal mirror presence
		VertMirrorInq	[17]	Vertical mirror presence
		---	[18..31]	Reserved

Table 130: Mirror control register

Pulse-width modulation (board level cameras only)

Note

See Table 66: PWM configuration registers on page 159.

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.

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.

Register	Name	Field	Bit	Description
0xF1000550	USER_PROFILE	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Error	[1]	An error ocurred
		---	[2..7]	Reserved
		SaveProfile	[8]	Save settings to profile
		RestoreProfile	[9]	Load settings from profile
		SetDefault	[10]	Set default user profile
		---	[11..19]	Reserved
		ErrorCode	[20..23]	Error code See Table 133: User profile: Error codes on page 263.
		---	[24..27]	Reserved
		ProfileID	[28..31]	User profile ID (memory channel)

Table 132: Advanced register: user profiles

In general this advanced register is a wrapper around the standard memory channel registers with some extensions. In order to query the number of available user profiles please check the **Memory_Channel** field of the **BASIC_FUNC_INQ** register at offset **0x400** (see IIDC V1.3x 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 is loaded on power-up or an INITIALIZE command.
- 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

To go back to the factory default profile:

1. Select ProfileID= 0 and toggle 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 133: User profile: 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) 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) TRIGGER_DELAY MIRROR_IMAGE LUT_CTRL (LutNo; ON_OFF is not saved)

Table 134: 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 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 is not reflected in the standard memory channel registers.

GPDATA_BUFFER

GPDATA_BUFFER is a register that regulates the exchange of data between camera and host for programming the LUT.

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 135: 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 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 luminance) 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 luminance 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 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

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.

Bayer, Dr. Bryce E.

Dr. Bryce E. Bayer (Eastman Kodak) is the inventor of the so-called BAYER patent (20 July 1976).

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.
Electrostatic discharge	Electrostatic discharge (=ESD) is the transfer of charge between two objects at different electrical potentials. While it takes an electrostatic discharge of about 3,000 volt for a human body to feel a shock, many of the more sophisticated electronic components can be damaged by charges as low as 10 volt.
ESD	ESD = **e**lectrostatic **d**ischarge
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:

$\text{Output} = \text{Input}^{\text{gamma}}$

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

Interlaced

Interlaced means: one complete image is scanned or reconstructed by a temporal succession of odd lines and interleaved even lines.

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)

Luma

In this glossary: the same as luminance

Luminance

The part of a composite video signal that expresses brightness.

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.

NIR	NIR means: **n**ear **i**nfra**r**ed (from latin infra=below and red). Infrared is light of wavelength longer than visible light but shorter than microwave radiation. NIR sensors have improved sensitivity (also in the near infrared light region: 700 nm to 1000 nm)
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

Portable **D**ocument **F**ormat

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.

Pulse-width modulation

Pulse-width modulation of a signal or power source involves the modulation of its duty cycle, to either convey information over a communications channel or control the amount of power sent to a load.

PWM

PWM = **p**ulse-**w**idth **m**odulation

PxGA

Pixel **G**ain **A**mplifier

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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