Technical Manual

V7.4.0

09 March 2015

Allied Vision Technologies GmbH
Taschenweg 2a
D-07646 Stadtroda / Germany

Allied Vision

Allied Vision

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.

Life support applications

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

Trademarks

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Warranty

The information provided by Allied Vision Technologies is supplied without any guarantees or warranty whatsoever, be it specific or implicit. Also excluded are all implicit warranties concerning the negotiability, the suitability for specific applications or the non-breaking of laws and patents. Even if we assume that the information supplied to us is accurate, errors and inaccuracy may still occur.

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Introduction

This **Guppy Technical Manual** describes in depth the technical specifications, dimensions, all camera features (IIDC standard and Allied Vision smart features) and their registers, trigger features, all video and color formats, bandwidth and frame rate calculation.

For information on hardware installation, safety warnings, pin assignments on I/O connectors and 1394b connectors read the **1394 Installation Manual.**

Note

Please read through this manual carefully.

We assume that you have read already the **1394 Installation Manual** (see: http://www.alliedvision.com/en/support/technical-documentation) and that you have installed the hardware and software on your PC or laptop (FireWire card, cables).

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 Added Guppy F-036B/C Correction in Chapter Multi-shot on page 160 New CAD drawing in Figure 22: Camera dimensions (new CS-/C-Mounting) on page 51. New CAD drawing in Figure 24: Guppy C-Mount dimensions on page 53. New CAD drawing in Figure 25: Guppy CS-Mount dimensions on page 54.
to be continued on next page		

Table 1: Document history

Version	Date	Remarks
	continued from previous page	
PRE_V3.0.0 [continued]	30.10.2006 [continued]	New CS-Mount and C-Mount adapter in Chapter Guppy cameras on page 25. Added Guppy F-33B/C BL (board level version) Changed camera status register (Table 107: Advanced register: Camera status on page 235) 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
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 40: CSR: Shutter on page 105 Added detailed description of BRIGHTNESS (800h) in Table 100: Feature control register on page 222 Added detailed description of WHITE-BALANCE (80Ch) in Table 100: Feature control register on page 222 et seq.
V5.0.1	09.05.2007	RELEASE status
V6.0.0	01.06.2007	Added interlaced Guppys F-025 and Guppy F-029 Added description of sensor readout and color: Chapter Format_7 Mode_0: sensor readout and color on page 87 and Chapter Format_7 Mode_1: sensor readout and color on page 88
V6.0.1	08.06.2007	Corrected image device type and diag. of Guppy F-025B/C and Guppy F-029B/C
	to be continued on next page	

Table 1: Document history

Version	Date	Remarks
		continued from previous page
V6.0.2	31.03.2008	**Minimum shutter time** of Guppy F-036B/C is now **180 µs**: see Chapter Guppy F-036B/C on page 28 and Chapter Minimum shutter time of Guppy F-036 on page 156. Added note: Guppy F-036 supports only Trigger_Mode_0. See Chapter Trigger modes on page 144. Corrected drawing in Figure 52: Format_7 Mode_0: Sensor readout on page 87 (lines of the first field are merged above those of the second field) Moved Allied Vision Glossary from Appendix of Guppy Technical Manual to Allied Vision Website. New M3 x 3 (2x) in Figure 22: Camera dimensions (new CS-/C-Mounting) on page 51
V6.1.0	09.07.2008	New ordering numbers of I/O cables K1200196 (2 m) and K1200197 (5 m) in Chapter Camera I/O connector pin assignment on page 59 New board level CAD drawing and marked Pin 1 with blue color in Figure 32: Board level camera: IEEE 1394 FireWire connector 1 (view on pins) on page 66 Restructuring of Guppy Technical Manual: • Added Chapter Contacting Allied Vision on page 9 • Added Chapter Manual overview on page 21 • Restructured Chapter Guppy types and highlights to Chapter Guppy cameras on page 25. – Infos from Guppy camera types table moved to Chapter Specifications on page 27 – Safety instructions moved to Hardware Installation Guide, Chapter Safety instructions and Allied Vision camera cleaning instructions – Environmental conditions moved to Guppy Instruction Leaflet and Guppy Board Level Instruction Leaflet – Infos on CS-/C-Mounting moved to Hardware Installation Guide, Chapter Guppy: changing filters safety instructions – Infos on System components moved to Guppy Instruction Leaflet and Guppy Board Level Instruction Leaflet
		to be continued on next page

Table 1: Document history

Version	Date	Remarks
		continued from previous page
V6.1.0 [continued]	09.07.2008 [continued]	**Restructuring of Guppy Technical Manual [continued]:** – Infos on *System components* and *Environmental conditions* moved to *Guppy Instruction Leaflet* and *Guppy Board Level Instruction Leaflet* – Infos on *IR cut filter* and *Lenses* moved to Chapter Filter and lenses on page 55 – Removed infos on old CS-/C-Mounting in Chapter Specifications on page 27 – Moved binning explanation from Chapter Specifications on page 27 to Chapter Video formats, modes and bandwidth on page 164 – Binning / sub-sampling modes and color modes are only listed in Chapter Video formats, modes and bandwidth on page 164 – Moved detailed description of the camera interfaces (FireWire, I/O connector), ordering numbers and operating instructions to the *Hardware Installation Guide*. – Revised Chapter Description of the data path on page 75 – Revised Chapter Controlling image capture on page 141; added Table 53: Trigger modes on page 144 – Revised Chapter Video formats, modes and bandwidth on page 164 – Revised Chapter How does bandwidth affect the frame rate? on page 193 – Revised Chapter Configuration of the camera on page 198 – Revised Chapter Firmware update on page 259 – Added Chapter Sensor position accuracy of Guppy cameras on page 260 – Revised Chapter Index on page 261 Changed provisions directive to 2004/108/EG in Chapter Conformity on page 26 Added Chapter Packed 12-Bit Mode on page 128 Added tables Table 28: Packed 12-Bit Mode (mono and raw) Y12 format from Allied Vision on page 72 and Table 29: Data structure of Packed 12-Bit Mode (mono and raw) from Allied Vision on page 74.
		to be continued on next page

Table 1: Document history

Version	Date	Remarks
	continued from previous page	
V6.1.0 [continued]	09.07.2008 [continued]	Added 30 fps as fixed frame rate in Table 11: Guppy F-146B/C on page 37 Added Vendor Unique Color_Coding in Table 102: Format_7 control and status register on page 226f Minimum delay time is 1µs in Table 58: Advanced CSR: trigger delay on page 153 Added Raw12 and Raw16 frame rates in Chapter Guppy F-146: AOI frame rates on page 190 Added Format_7 Mode_3 in: • Table 67: Video formats Guppy F-038B / Guppy F-038C on page 167 • Table 68: Video formats Guppy F-038B NIR / Guppy F-038C NIR on page 167 • Table 69: Video formats Guppy F-044B / Guppy F-044C on page 168 • Table 70: Video formats Guppy F-044B NIR / Guppy F-044C NIR on page 168 Added Chapter Extended version number (FPGA/µC) on page 259 Added extended version registers (0xF1000014 and 0xF100001C) in Table 103: Advanced registers summary on page 228 Added **VERSION_INFOx_EX** registers and description in Chapter Extended version information register on page 231
	to be continued on next page	

Table 1: Document history

Version	Date	Remarks
		continued from previous page
V6.2.0	15.08.2008	Added cross-reference from **upload LUT** to **GPDATA_BUFFER** in Chapter Loading an LUT into the camera on page 107 Added Guppy F-146 with Mono8 (8-bit format) and Mono12/16 (12-bit format) in Chapter Pixel data on page 70. In 12-bit mode the data output is MSB aligned (12 significant bits). In 16-bit mode the data output is MSB aligned (also 12 significant bits). Added detailed level values of I/Os in Chapter Guppy (housing) on page 59 and Chapter Guppy (board level) on page 68. Added little endian vs. big endian byte order in Chapter GPDATA_BUFFER on page 257 Added RoHS in Chapter Conformity on page 26 Listed shutter speed with offset in Chapter Specifications on page 27 New measurement of IntEna signals, therefore new offsets in Chapter Exposure time (shutter) and offset on page 155 and in Figure 96: Data flow and timing after end of exposure (Guppy F-038/044 also NIR) on page 160. New photo of LED positions in Figure 29: Status LEDs on page 60
		to be continued on next page

Table 1: Document history

Version	Date	Remarks
		continued from previous page
V7.0.0	31.10.2008	Operating temperature changed from 50 °C to 45 °C for all Guppy types in Chapter Specifications on page 27 New Guppy camera photos with new camera naming font: • Title page New Guppy F-503B/C: Read information in the following sections: • Chapter Conformity on page 26 • Table 14: Focal width vs. field of view (Guppy F-503) on page 56 • Chapter Specification Guppy F-503B/C on page 38 • Chapter Horizontal and vertical mirror function (only Guppy F-036/F-503) on page 90 • Chapter White balance on page 90 • Chapter Manual gain on page 98 • Chapter Brightness (black level or offset) on page 102 • Chapter Look-up table (LUT) and gamma function on page 106 • Chapter Binning (only Guppy F-036B and Guppy F-503B/C) on page 113 • Chapter Packed 12-Bit Mode on page 128. This mode is not yet available for Guppy F-503B/C. • Chapter Exposure time (shutter) and offset on page 155 • Table 59: Camera-specific exposure time offset on page 156 • Figure 96: Data flow and timing after end of exposure (Guppy F-038/044 also NIR) on page 160 • Table 64: Jitter at exposure start on page 162 • Table 74: Video formats Guppy F-503B / Guppy F-503C on page 172 • Guppy F-503: AOI frame rates on page 191 • Table 105: Camera type ID list on page 232 For Guppy F-503B/C output switching times (tp and min. shutter) see **Hardware Installation Guide**, subsection *Guppy delay*.
		to be continued on next page

Table 1: Document history

Version	Date	Remarks
		continued from previous page
V7.1.0	07.05.2009	All advanced registers in 8-digit format beginning with 0xF1... in Chapter Advanced features (Allied Vision-specific) on page 228 Firing a new trigger while IntEna is still active can result in **missing image** (not image corruption): see Caution on page 70. Revised Chapter White balance on page 90 **New Features: Guppy F-503:** • Defect pixel correction in Chapter Defect pixel correction (only Guppy F-503B/C) on page 108 and Table 115: Advanced register: Defect pixel correction on page 243 • More gain steps in Table 36: Manual gain range of the various Guppy types (CCD and CMOS) on page 99 • Global reset release shutter in Chapter Electronic rolling shutter (ERS) and global reset release shutter (GRR) (only Guppy F-503) on page 143 • Format_7 mode mapping in Chapter Binning and sub-sampling access (only Guppy F-503) on page 125 and Chapter Format_7 mode mapping (only Guppy F-503) on page 255 • Description of Trigger_Mode_0 with electronic rolling shutter and global reset release shutter in Chapter Trigger modes on page 144 • Changing between electronic rolling shutter (ERS) and global reset release shutter (GRR) in Table 128: Advanced register: Global reset release shutter on page 257 • Max. exposure time in Chapter Extended shutter on page 238 Changed sensor name from Micron to **Micron/Aptina** in Table 4: Specification Guppy F-036B/C on page 28 Changed sensor name from Micron to **Micron/Aptina** in Table 12: Specification Guppy F-503B/C on page 38 Changed sensor name from Micron to **Micron/Aptina** in Chapter HDR (high dynamic range) (Guppy F-036 only) on page 129 Changed sensor name from Micron to **Micron/Aptina** in Chapter Controlling image capture on page 141
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Table 1: Document history

Version	Date	Remarks
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V7.1.0 [continued]	07.05.2009 [continued]	[continued] Offset of low noise binning mode changed from 0xF1000580 to 0xF10005B0 in Table 127: Advanced register: Low noise binning mode on page 256. Changed *Camera In 1 signal* U_{in}(high) from 2 V to **2.4 V** in Figure 28: Guppy (housing): Camera I/O connector pin assignment on page 59 Corrected HUE and SATURATION in *Feature control register* to **Always 0 (for b/w and color cameras)** on page 225 (TestTrack Defect 605) Calculated **effective chip size** for all sensors (with resolution of Format_7 Mode_0) in Chapter Specifications on page 27 Due to discontinuation: removed Guppy F-025/029 cameras in • Chapter Guppy cameras on page 25 • Chapter Conformity on page 26 • Chapter Specifications on page 27 • Chapter Video formats, modes and bandwidth on page 164 • Chapter Description of the data path on page 75 • Chapter Controlling image capture on page 141 Corrected drawing in Figure 113: Delayed integration timing on page 245
V7.1.1	23.02.2010	**Minor corrections:** • Corrected registers for IO_OUTP_PWM2/3/4 in Table 30: PWM configuration registers on page 81 and in Table 103: Advanced registers summary on page 228 • Revised Chapter Conformity on page 26. • Corrected Guppy F-503 Format_7 Mode_4 to Mode_6: These are sub-sampling modes: Table 74: Video formats Guppy F-503B / Guppy F-503C on page 172 • Corrected Camera Input 1: U_{in}(high) = 3.8 V...5 V U_{in}(low) = 0 V...1 V in Figure 28: Guppy (housing): Camera I/O connector pin assignment on page 59 • Corrected: Board level cameras have also Input_2 ... Input_4/Output_4 in Register 0xF1000044 on page 234 • Corrected: Defect pixel correction: Mono8 for b/w and Raw8 for color cameras: see Chapter Building defect pixel data on page 110
	to be continued on next page	

Table 1: Document history

Version	Date	Remarks
	continued from previous page	
V7.1.1 [continued]	23.02.2010 [continued]	[continued] **Improved descriptions:** • Defect pixel correction: – Added information on limited block writes (GPData buffer) in Chapter DPC data: storing mechanism on page 112 – DPDataSize divided by 4 gives the number of defect pixels: Table 115: Advanced register: Defect pixel correction on page 243 – Organization of DPC data in two 16-bit registers (y and x coordinates) in Chapter Calculate defect pixel coordinates on page 110 – Added improved description in Note on page 112 **Corrections:** • Guppy F-038B and Guppy F-038B NIR don't have F7M3 in Table 67: Video formats Guppy F-038B / Guppy F-038C on page 167 and in Table 68: Video formats Guppy F-038B NIR / Guppy F-038C NIR on page 167. **New storage temperature:** • 70 °C, see Chapter Specifications on page 27 **New links to new Allied Vision website** • Chapter Contacting Allied Vision on page 9 and many others **New measured sensor curves** • Chapter Spectral sensitivity on page 39
V7.2.0	05.07.2010	• Standard IR cut filter for all Guppy color models: IRC Edmund Optics, spectral diagram is similar to Jenofilt 217, see Figure 26: Spectral transmission of IR cut filter (e.g. Jenofilt 217) on page 55
	to be continued on next page	

Table 1: Document history

Version	Date	Remarks
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V7.3.0	21.09.2010	**Updated data:** • Corrected trigger diagram (Busy signal), see Figure 32: Output impulse diagram on page 69 • Converted FrameMaker files from FM7 to FM9 • Corrected: mirror function is also available for Guppy F-503, see Chapter Mirror image (only Guppy F-036/F-503) on page 250 • Added Chapter Frame information on page 242 • Added advanced registers FRAMEINFO and FRAMECOUNTER in Table 103: Advanced registers summary on page 228
V7.4.0	09.03.2015	**Updated data:** • Corrected hyperlinks to targets on the Allied Vision website • Added information that all color modes in Chapter Specifications on page 27 comply with the IIDC specifications • Corrected information in Chapter Sensor position accuracy of Guppy cameras on page 260 • Adapted addresses in Chapter Contacting Allied Vision on page 9 • Corrected information for binning in **Chapter Definition** on page 113 • Corrected list of cameras supporting Chapter Packed 12-Bit Mode on page 128 • Updated spectral sensor curves in Chapter Spectral sensitivity on page 39 • Deleted information on Guppy board level cameras **Layout changes due to a changed Corporate identity:** • Replaced the previous Allied Vision logo by the current one • Reworded all appropriate contents from AVT and Allied Vision Technologies to Allied Vision

Table 1: Document history

Manual overview

This **manual overview** describes each chapter of this manual shortly.

- Chapter Contacting Allied Vision on page 9 lists Allied Vision contact data for both:
  - technical information / ordering
  - commercial information
- Chapter Introduction on page 10 (this chapter) gives you the document history, a manual overview and conventions used in this manual (styles and symbols). Furthermore you learn how to get more information on **how to install hardware (1394 Installation Manual)**.
- Chapter Guppy cameras on page 25 gives you a short introduction to the Guppy cameras with their FireWire technology. Links are provided to data sheets and brochures on Allied Vision website.
- Chapter Conformity on page 26 gives you information about conformity of Allied Vision cameras.
- Chapter Filter and lenses on page 55 describes the IR cut filter and suitable camera lenses.
- Chapter Specifications on page 27 lists camera details and spectral sensitivity diagrams for each camera type.
- Chapter Camera dimensions on page 50 provides CAD drawings of standard housing (copper) models, tripod adapter, cross sections of CS-Mount and C-Mount.
- Chapter Camera interfaces on page 58 describes in detail the inputs/outputs of the cameras (incl. trigger features). For a general description of the interfaces (FireWire and I/O connector) see **1394 Installation Manual.**
- Chapter Description of the data path on page 75 describes in detail IIDC conformable as well as Allied Vision-specific camera features.
- Chapter Controlling image capture on page 141 describes shutter and trigger modi, exposure time, one-shot/multi-shot/ISO_Enable features and jitter.
- Chapter Video formats, modes and bandwidth on page 164 lists all available fixed and Format_7 modes (incl. color modes, frame rates, binning/sub-sampling, AOI=area of interest).
- Chapter How does bandwidth affect the frame rate? on page 193 gives some considerations on bandwidth details.
- Chapter Configuration of the camera on page 198 lists standard and advanced register descriptions of all camera features.
- Chapter Firmware update on page 259 explains where to get information on firmware updates.
- Chapter Appendix on page 260 lists the sensor position accuracy of Allied Vision cameras.
- Chapter Index on page 261 gives you quick access to all relevant data in this manual.

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 avoid malfunctions.

www

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

Example:

http://www.alliedvision.com

More information

For more information on hardware and software read the following:

- The **1394 Installation Manual** describes the hardware installation procedures for all 1394 cameras (Marlin, Guppy, Pike, Stingray). Additionally, you get safety instructions and information about camera interfaces (IEEE1394a/b copper and GOF, I/O connectors, input and output).

www

You find the **1394 Installation Manual** here:

http://www.alliedvision.com/en/support/technical-documentation

www

All **software packages** (including **documentation** and **release notes**) provided by Allied Vision can be downloaded at:

http://www.alliedvision.com/en/support/software-downloads

Before operation

We place the highest demands for quality on our cameras.

Target group This **Technical Manual** is the guide to detailed technical information of the camera and **is written for experts.**

Getting started For a quick guide how to get started read **1394 Installation Manual** first.

Note

Please read through this manual carefully before operating the camera.

For information on Allied Vision **accessories** and **software** read **1394 Installation Manual**.

Caution

Before operating any Allied Vision camera read **safety instructions** and **ESD warnings** in **1394 Installation Manual**.

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.

Note

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

All naming in this document relates to FirePackage, not to GenICam.

www

For downloads see:

Software (Vimba and all other software):
http://www.alliedvision.com/en/support/software-downloads

Firmware: http://www.alliedvision.com/en/support/firmware

Technical documentation (overview page):
http://www.alliedvision.com/en/support/technical-documentation

Technical papers (appnotes, white papers) and knowledge base:
http://www.alliedvision.com/en/support/technical-papers-knowledge-base

Guppy cameras

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

IEEE 1394a With the Guppy, Allied Vision presents a whole series of attractive digital camera entry-level models of the FireWire™ type.

Note

All naming in this document relates to FirePackage, not to GenICam.

www

For further information on the highlights of Guppy types and the Guppy family read the data sheets and brochures on our website:

http://www.alliedvision.com/en/support/technical-documentation/guppy-documentation

Conformity

Allied Vision Technologies declares under its sole responsibility that all standard cameras of the **Guppy** family to which this declaration relates are in conformity with the following standard(s) or other normative document(s):

- CE, following the provisions of 2004/108/EG directive
- FCC Part 15 Class B
- RoHS (2011/65/EU)
- CE
- WEEE

CE

We declare, under our sole responsibility, that the previously described **Guppy** cameras conform to the directives of the CE.

FCC – Class B Device

Note: 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 in a residential environment. This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment.

Specifications

Note

- For information on bit/pixel and byte/pixel for each color mode see Table 84: ByteDepth on page 193.
- **Maximum protrusion** means the **distance from lens flange to the glass filter in the camera**.

Guppy F-033B/C

Feature	Specification
Image device	Type 1/3 (diag. 6 mm) progressive scan SONY IT CCD ICX424AL/AQ w HAD microlens
Effective chip size	**4.9 mm x 3.7 mm**
Cell size	7.4 µm x 7.4 µm
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 24: Guppy C-Mount dimensions on page 53) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 25: Guppy CS-Mount dimensions on page 54)
Picture size (max.)	656 x 494 pixels (Format_7 Mode_0)
ADC	10 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	**129** µs … 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) **only color:** AWB (auto white balance) • 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 3: Specification Guppy F-033B/C

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 ... + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 70 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2011/65/EU)f
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter
Optional accessories	• **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	http://www.alliedvision.com/en/support/software-downloads (free of charge)

Table 3: Specification Guppy F-033B/C

Guppy F-036B/C

Feature	Specification
Image device	Type 1/3 (diag. 5.35 mm) progressive scan Micron/Aptina CMOS MT9V022 with microlens
Effective chip size	**4.5 mm x 2.9 mm**
Cell size	6.0 µm x 6.0 µm
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 24: Guppy C-Mount dimensions on page 53) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 25: Guppy CS-Mount dimensions on page 54)
Picture size (max.)	752 x 480 pixels (Format_7 Mode_0)
ADC	10 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 98
Shutter speed	**179** µs … ~979 ms
External trigger shutter	Trigger_Mode_0, trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)

Table 4: Specification Guppy F-036B/C

Feature	Specification
Smart functions	• AGC (auto gain control), LUT (look-up table), mirror, **only b/w:** binning (average) **only color:** AWB (auto white balance) • 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 ... + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 70 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2011/65/EU)
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter
Optional accessories	• **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	http://www.alliedvision.com/en/support/software-downloads (free of charge)

Table 4: Specification Guppy F-036B/C

Guppy F-038B/C

Feature	Specification
Image device	Type 1/2 (diag. 8 mm) interlaced SONY EIA/NTSC CCD ICX418ALL/AKL with HAD microlens
Effective chip size	**6.5 mm x 4.8 mm**
Cell size	8.4 µm x 9.8 µm
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 24: Guppy C-Mount dimensions on page 53) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 25: Guppy CS-Mount dimensions on page 54)
Picture size (max.)	768 x 492 pixels (Format_7 Mode_0)
ADC	12 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	**62** µs … 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) **only color:** AWB (auto white balance) • 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 … + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 70 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2011/65/EU)
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter
Optional accessories	• **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	http://www.alliedvision.com/en/support/software-downloads (free of charge)

Table 5: Specification Guppy F-038B/C

Guppy F-038B/C NIR

Feature	Specification
Image device	Type 1/2 (diag. 8 mm) interlaced SONY EIA/NTSC ICX428ALL/AKL with EXview HAD microlens for enhanced near infrared light sensitivity
Effective chip size	**6.5 mm x 4.8 mm**
Cell size	8.4 µm x 9.8 µm
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 24: Guppy C-Mount dimensions on page 53) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 25: Guppy CS-Mount dimensions on page 54)
Picture size (max.)	768 x 492 pixels (Format_7 Mode_0)
ADC	12 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	**62** µs … 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) **only color:** AWB (auto white balance) • 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 … + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 70 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2011/65/EU)
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter
Optional accessories	• **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	http://www.alliedvision.com/en/support/software-downloads (free of charge)

Table 6: Specification Guppy F-038B/C NIR

Guppy F-044B/C

Feature	Specification
Image device	Type 1/2 (diag. 8 mm) interlaced SONY CCIR/PAL CCD ICX419ALL/AKL with HAD microlens
Effective chip size	**6.5 mm x 4.8 mm**
Cell size	8.6 µm x 8.3 µm
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 24: Guppy C-Mount dimensions on page 53) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 25: Guppy CS-Mount dimensions on page 54)
Picture size (max.)	752 x 580 (Format_7 Mode_0)
ADC	12 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	**62** µs … 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) **only color:** AWB (auto white balance) • 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 … + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 70 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2011/65/EU)
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter
Optional accessories	• **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	http://www.alliedvision.com/en/support/software-downloads (free of charge)

Table 7: Specification Guppy F-044B/C

Guppy F-044B/C NIR

Feature	Specification
Image device	Type 1/2 (diag. 8 mm) interlaced SONY CCIR/PAL CCD ICX429ALL/AKL with EXview HAD microlens for enhanced near infrared light sensitivity
Effective chip size	**6.5 mm x 4.8 mm**
Cell size	8.6 µm x 8.3 µm
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 24: Guppy C-Mount dimensions on page 53) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 25: Guppy CS-Mount dimensions on page 54)
Picture size (max.)	752 x 580 (Format_7 Mode_0)
ADC	12 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	**62** µs … 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) **only color:** AWB (auto white balance) • 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 … + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 70 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2011/65/EU)
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter
Optional accessories	• **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	http://www.alliedvision.com/en/support/software-downloads (free of charge)

Table 8: Specification Guppy F-044B/C NIR

Guppy F-046B/C

Feature	Specification
Image device	Type 1/2 (diag. 8 mm) progressive scan SONY IT CCD ICX415AL/AQ with HAD micro-lens
Effective chip size	**6.5 mm x 4.8 mm**
Cell size	8.3 µm x 8.3 µm
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 24: Guppy C-Mount dimensions on page 53) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 25: Guppy CS-Mount dimensions on page 54)
Picture size (max.)	780 x 582 pixels (Format_7 Mode_0)
ADC	12 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	**42** µs … 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) **only color:** AWB (auto white balance) • 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 … + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 70 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2011/65/EU)
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter

Table 9: Specification Guppy F-046B/C

Feature	Specification
Optional accessories	• **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	http://www.alliedvision.com/en/support/software-downloads (free of charge)

Table 9: Specification Guppy F-046B/C

Guppy F-080B/C

Feature	Specification
Image device	Type 1/3 (diag. 6 mm) progressive scan SONY IT CCD ICX204AL/AK with HAD micro-lens
Effective chip size	**4.8 mm x 3.6 mm**
Cell size	4.65 µm x 4.65 µm
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 24: Guppy C-Mount dimensions on page 53) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 25: Guppy CS-Mount dimensions on page 54)
Picture size (max.)	1032 x 778 (Format_7 Mode_0)
ADC	12 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	**54** µs ...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) **only color:** AWB (auto white balance) • 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

Table 10: Guppy F-080B/C

Feature	Specification
Mass	50 g (without lens)
Operating temperature	+ 5 °C ... + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 70 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2011/65/EU)
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter
Optional accessories	• **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	http://www.alliedvision.com/en/support/software-downloads (free of charge)

Table 10: Guppy F-080B/C

Guppy F-146B/C

Feature	Specification
Image device	Type 1/2 (diag. 8 mm) progressive scan SONY IT CCD ICX267AL/AK with HAD micro-lens
Effective chip size	**6.5 mm x 4.8 mm**
Cell size	4.65 µm x 4.65 µm
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 24: Guppy C-Mount dimensions on page 53) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 25: Guppy CS-Mount dimensions on page 54)
Picture size (max.)	1392 x 1040 (Format_7 Mode_0)
ADC	12 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	**40** µs …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) **only color:** AWB (auto white balance) • 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 … + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 70 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2011/65/EU)
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter

Table 11: Guppy F-146B/C

Feature	Specification
Optional accessories	• **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	http://www.alliedvision.com/en/support/software-downloads (free of charge)

Table 11: Guppy F-146B/C

Guppy F-503B/C

Feature	Specification
Image device	Type 1/2.5 (diag. 7.13 mm) Micron/Aptina CMOS MT9P031 with microlens • Electronic rolling shutter (ERS) • Global reset release shutter (GRR)
Effective chip size	**5.7 mm x 4.3 mm**
Cell size	2.2 µm x 2.2 µm
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 24: Guppy C-Mount dimensions on page 53) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 25: Guppy CS-Mount dimensions on page 54)
Picture size (max.)	2592 x 1944 pixels (Format_7 Mode_0)
ADC	12 bit
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps variable frame rates in Format_7 up to 6.5 fps
Gain control	Manual: 0-26 dB (average ~0.928 dB/step) for details see Chapter Manual gain on page 98
Shutter speed	**41.8** µs … ~2.3 s
External trigger shutter	Trigger_Mode_0, trigger delay, IntEna 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 (horizontal and vertical), defect pixel correction, 2x - 4x binning (horizontal: additive or average; vertical: average) or sub-sampling, multi-shot, separate reference AOI for auto features **only color:** AWB (auto white balance) • 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-503B/C

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 ... + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 70 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2011/65/EU)
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter
Optional accessories	• **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter • **color:** C/CS-Mount: protection glass available as CS-Mount adapter
Software packages	http://www.alliedvision.com/en/support/software-downloads (free of charge)

Table 12: Specification Guppy F-503B/C

Spectral sensitivity

Note

All measurements were done without protection glass / without filter.

The uncertainty in measurement of the QE values is ±10%.

This is mainly due to:

- Manufacturing tolerance of the sensor
- Uncertainties in the measuring apparatus itself

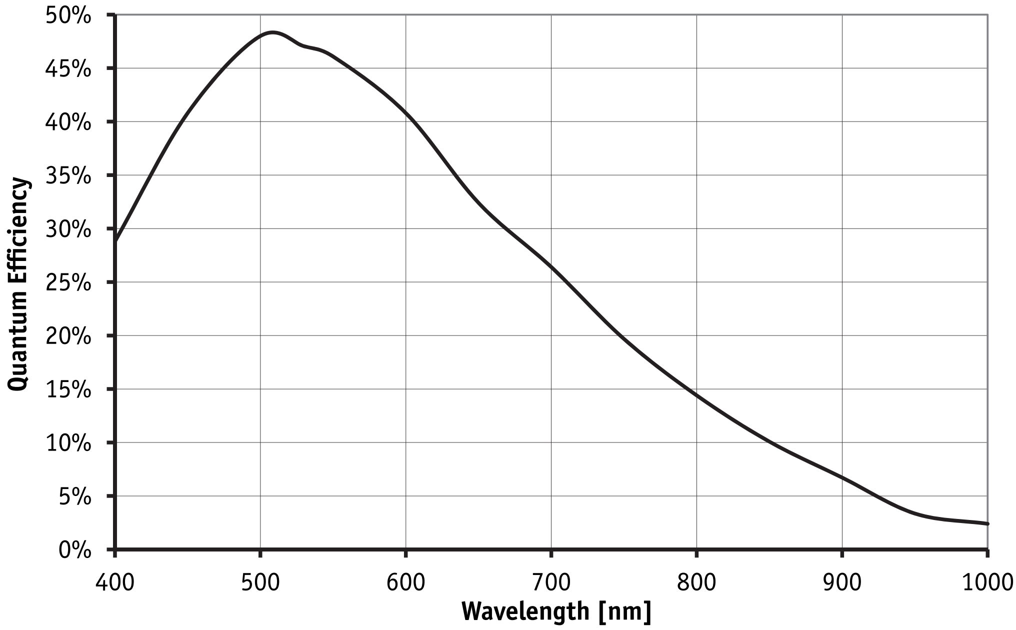


Figure 1: Spectral sensitivity of Guppy F-033B without cut filter and optics

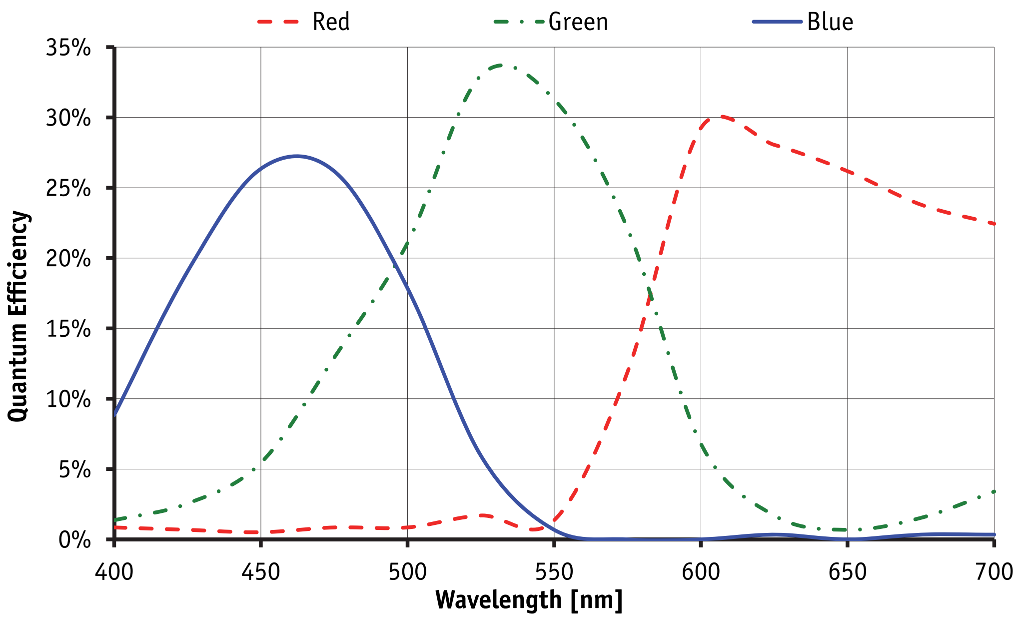


Figure 2: Spectral sensitivity of Guppy F-033C without cut filter and optics

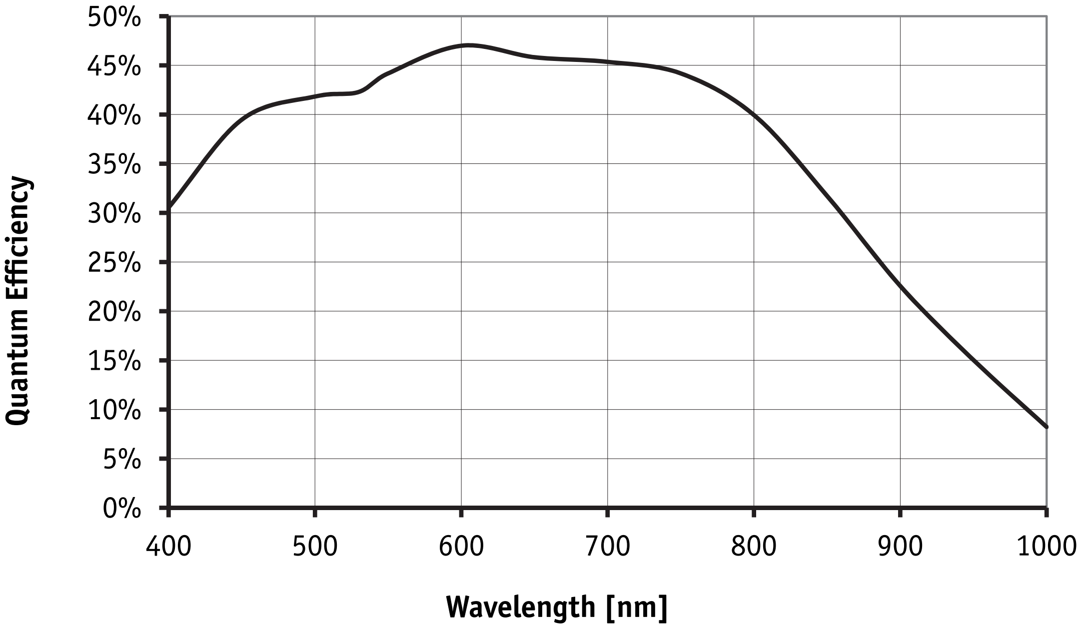


Figure 3: Spectral sensitivity of Guppy F-036B without cut filter and optic

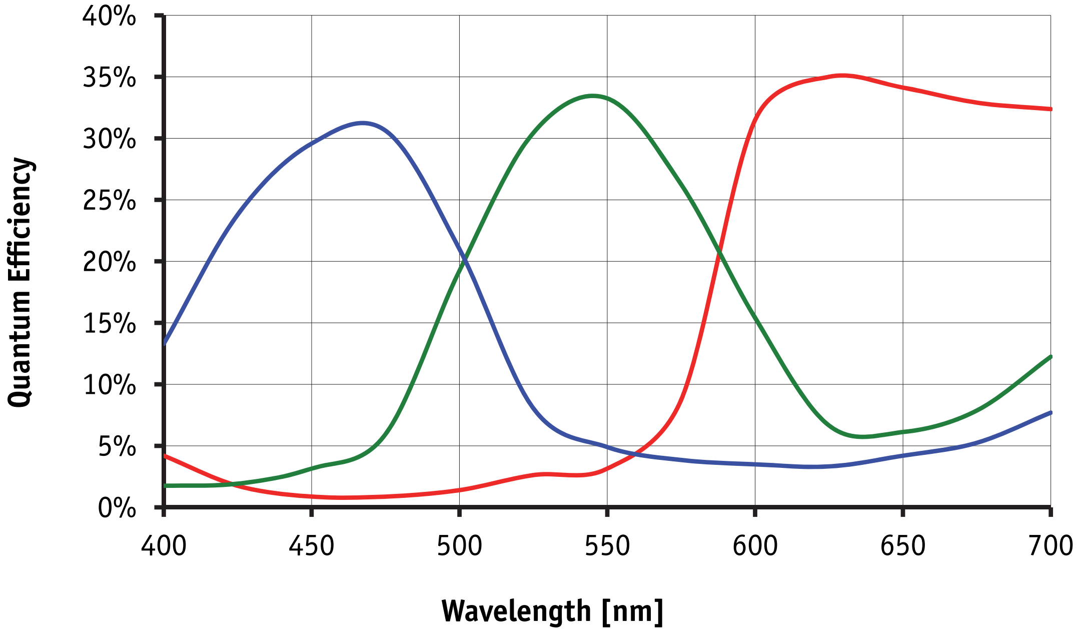


Figure 4: Spectral sensitivity of Guppy F-036C without cut filter and optics

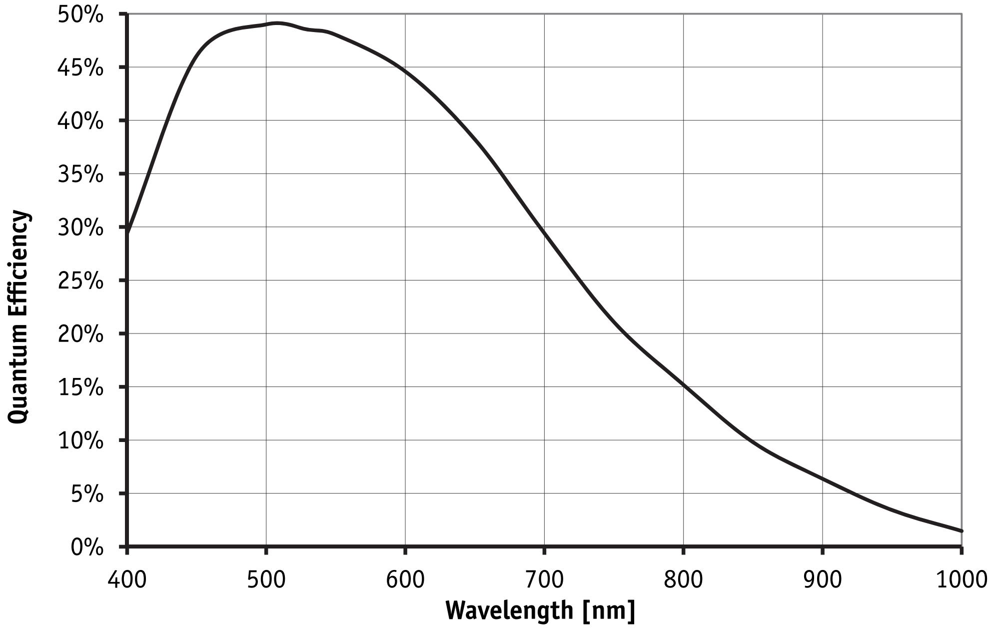


Figure 5: Spectral sensitivity of Guppy F-038B without cut filter and optics

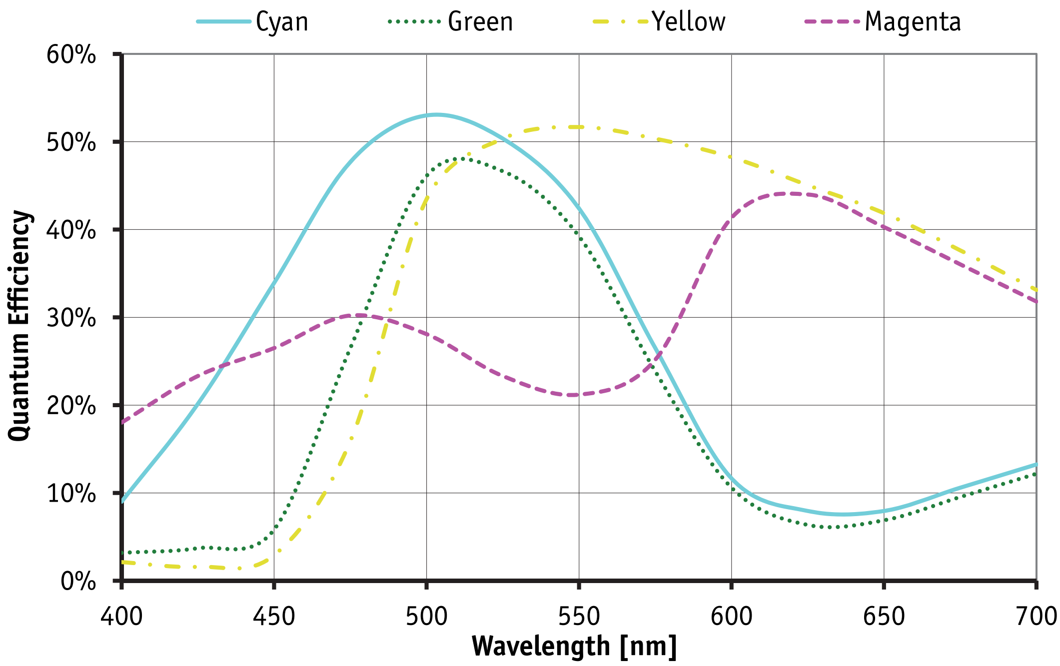


Figure 6: Spectral sensitivity of Guppy F-038C without cut filter and optics

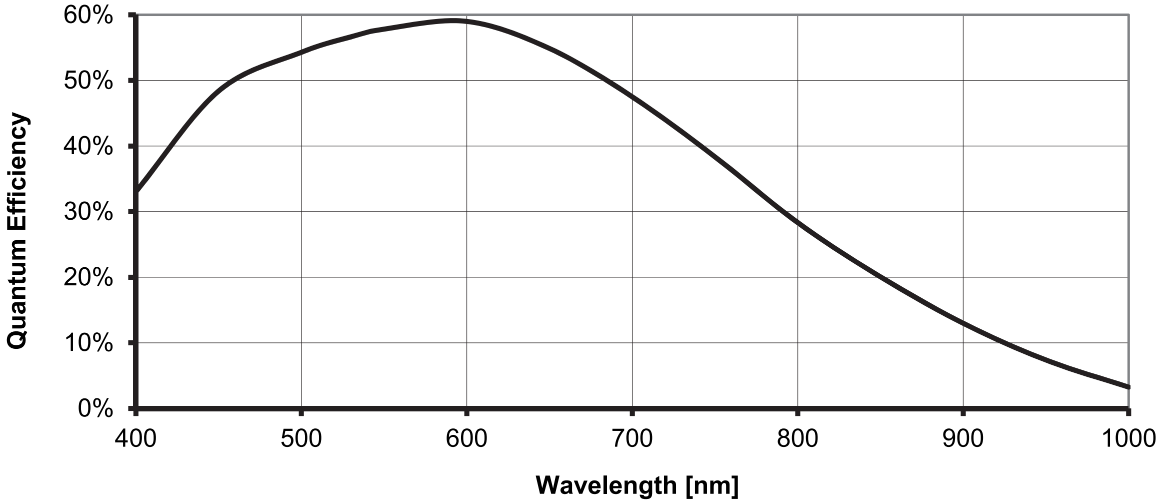


Figure 7: Spectral sensitivity of Guppy F-038B NIR without cut filter and optics

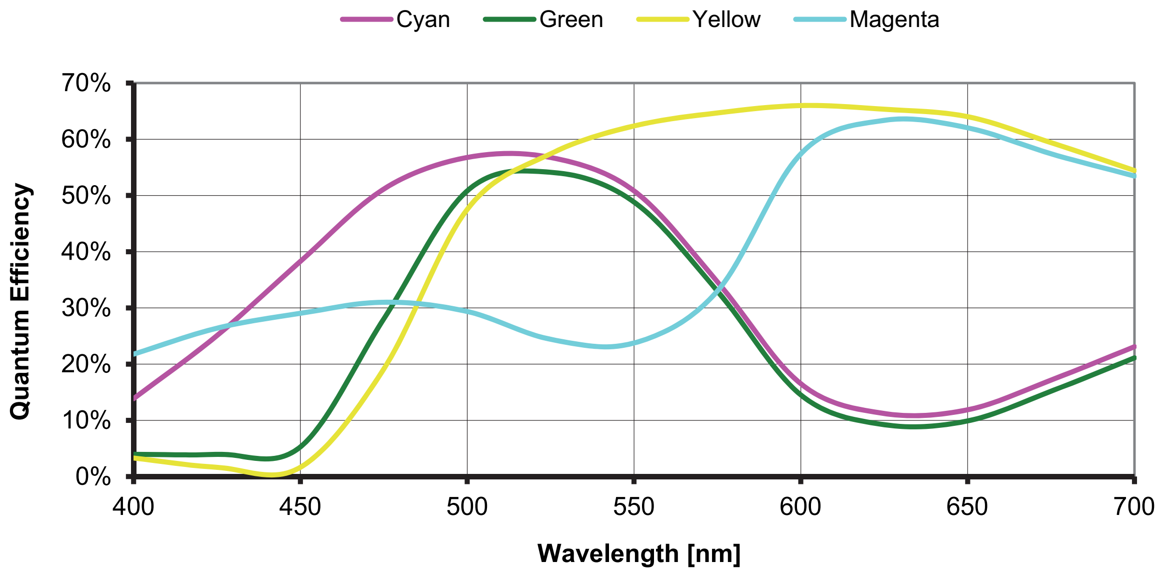


Figure 8: Spectral sensitivity of Guppy F-038C NIR without cut filter and optics

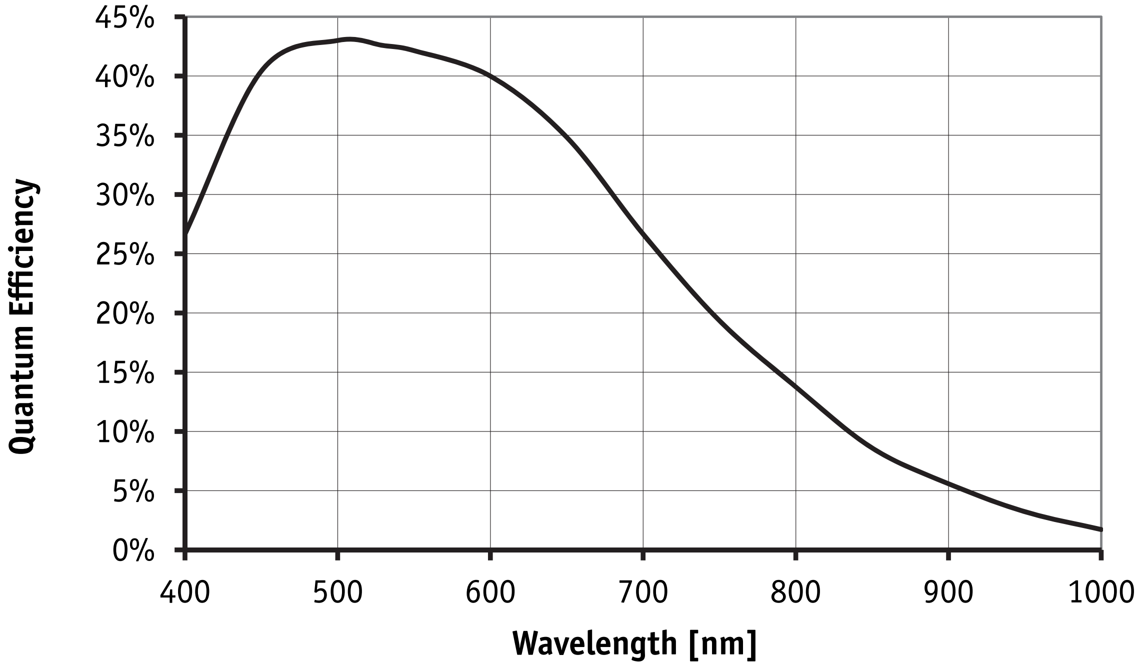


Figure 9: Spectral sensitivity of Guppy F-044B without cut filter and optics

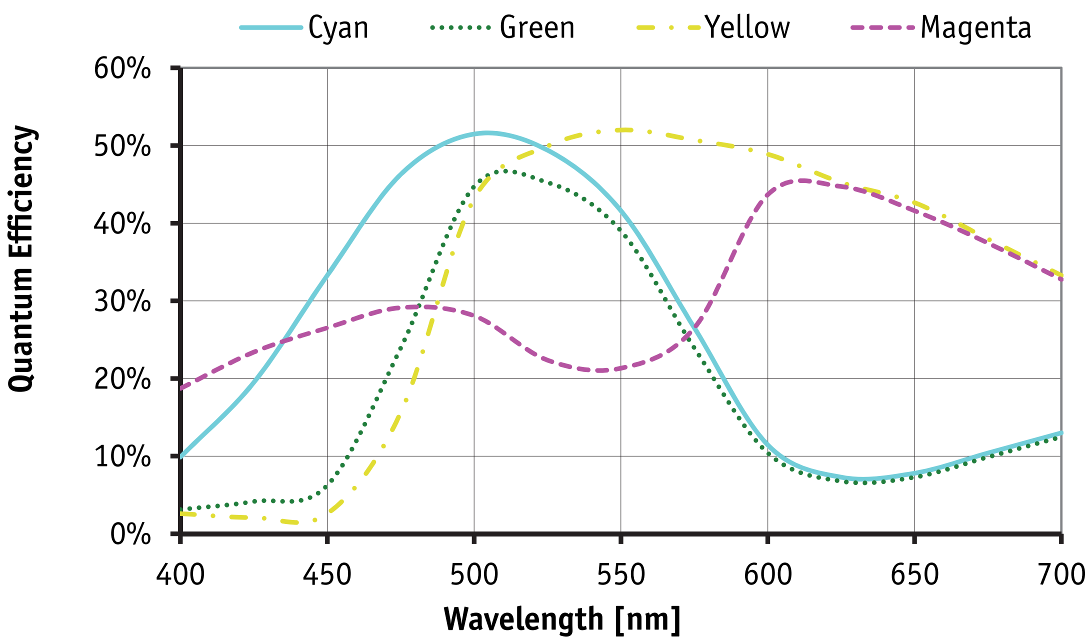


Figure 10: Spectral sensitivity of Guppy F-044C without cut filter and optics

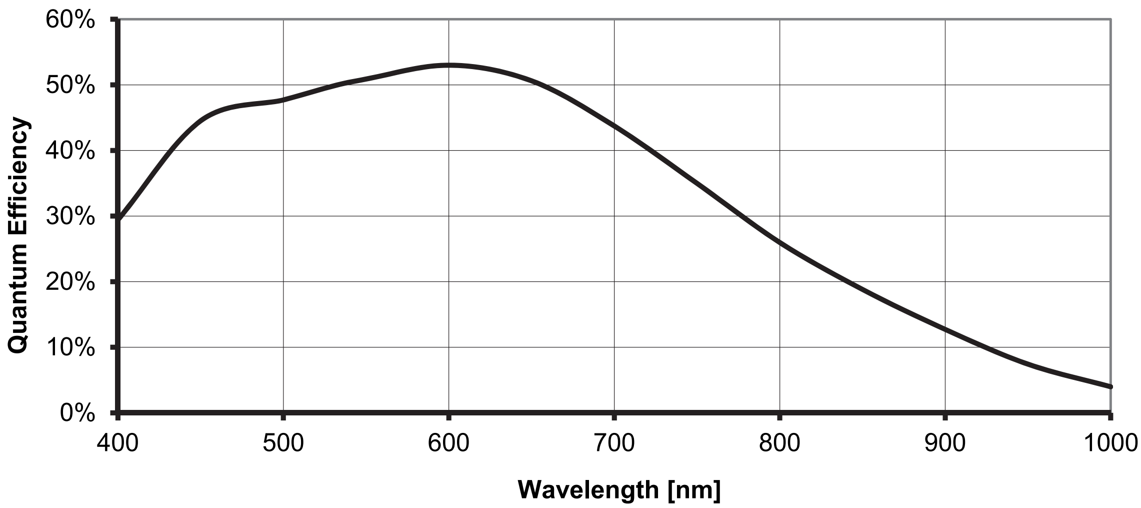


Figure 11: Spectral sensitivity of Guppy F-044B NIR without cut filter and optics

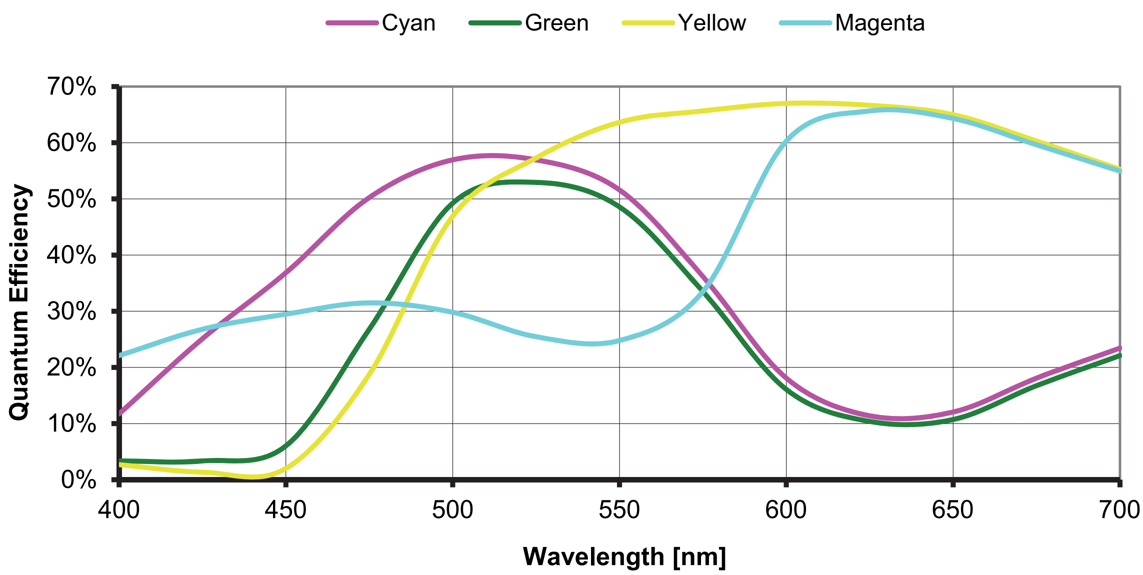


Figure 12: Spectral sensitivity of Guppy F-044C NIR without cut filter and optics

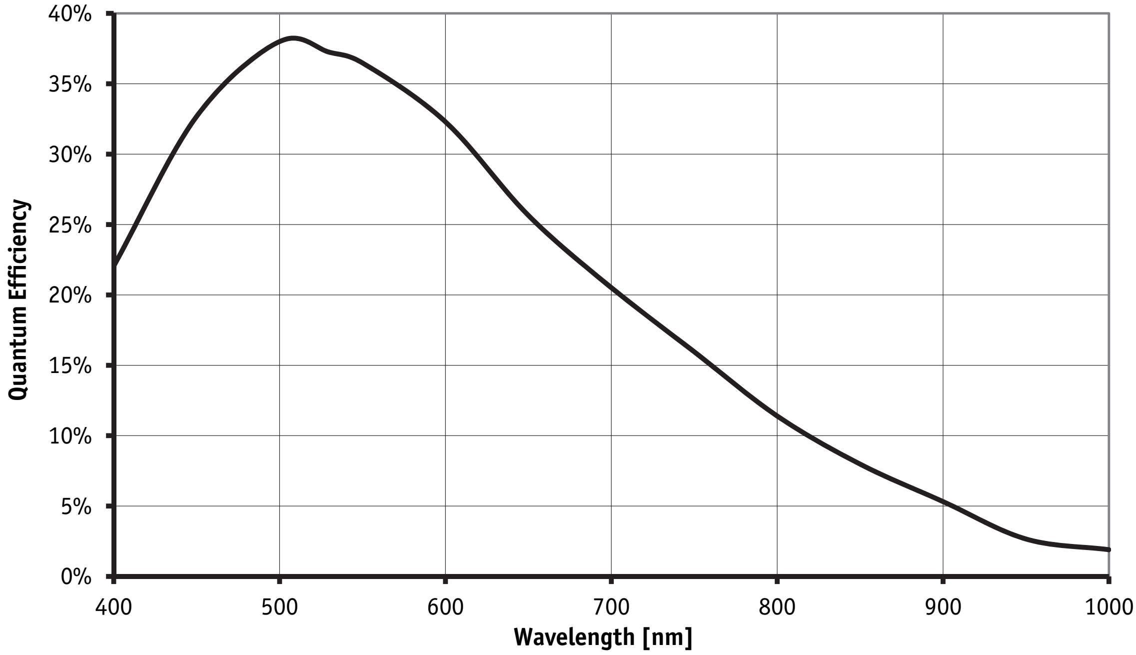


Figure 13: Spectral sensitivity of Guppy F-046B without cut filter and optics

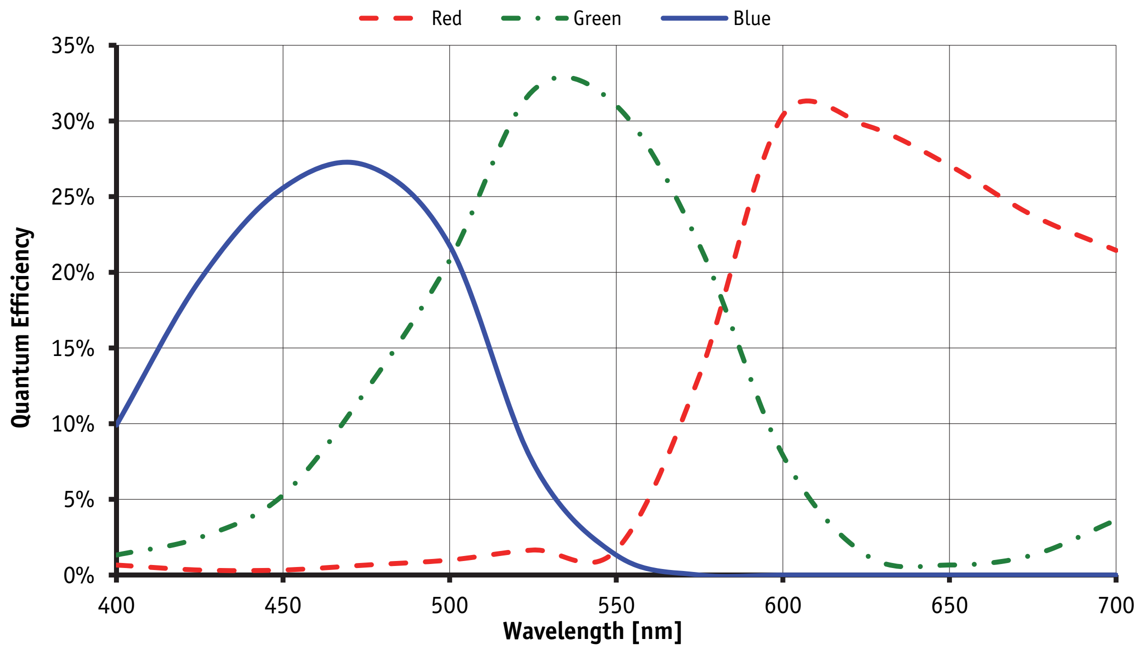


Figure 14: Spectral sensitivity of Guppy F-046C without cut filter and optics

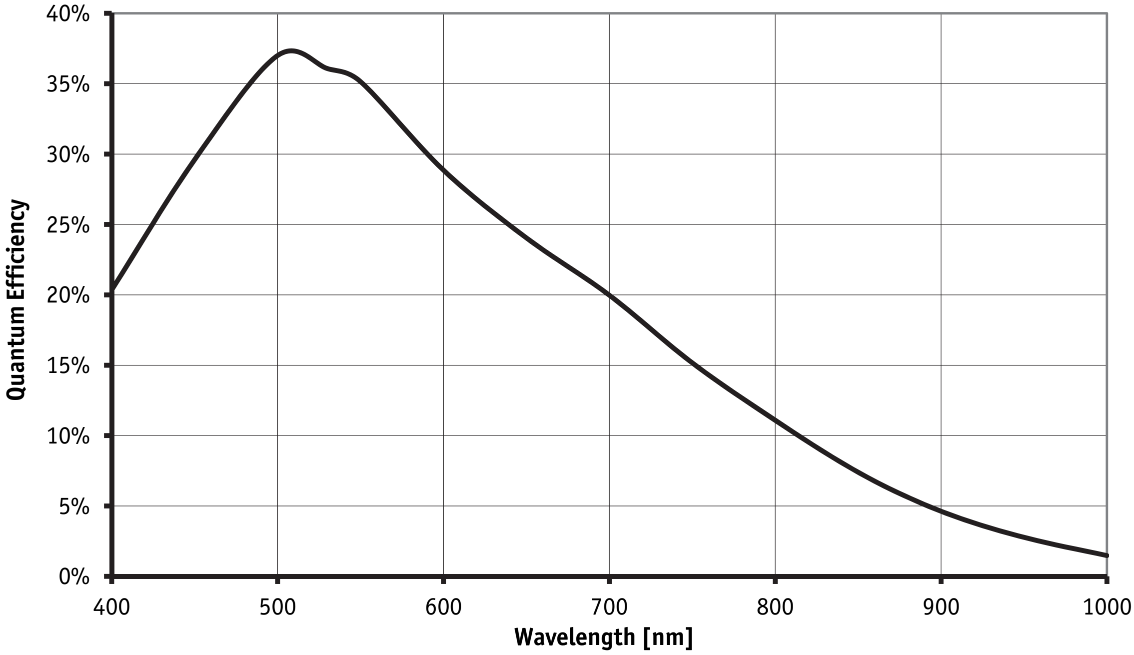


Figure 15: Spectral sensitivity of Guppy F-080B without cut filter and optics

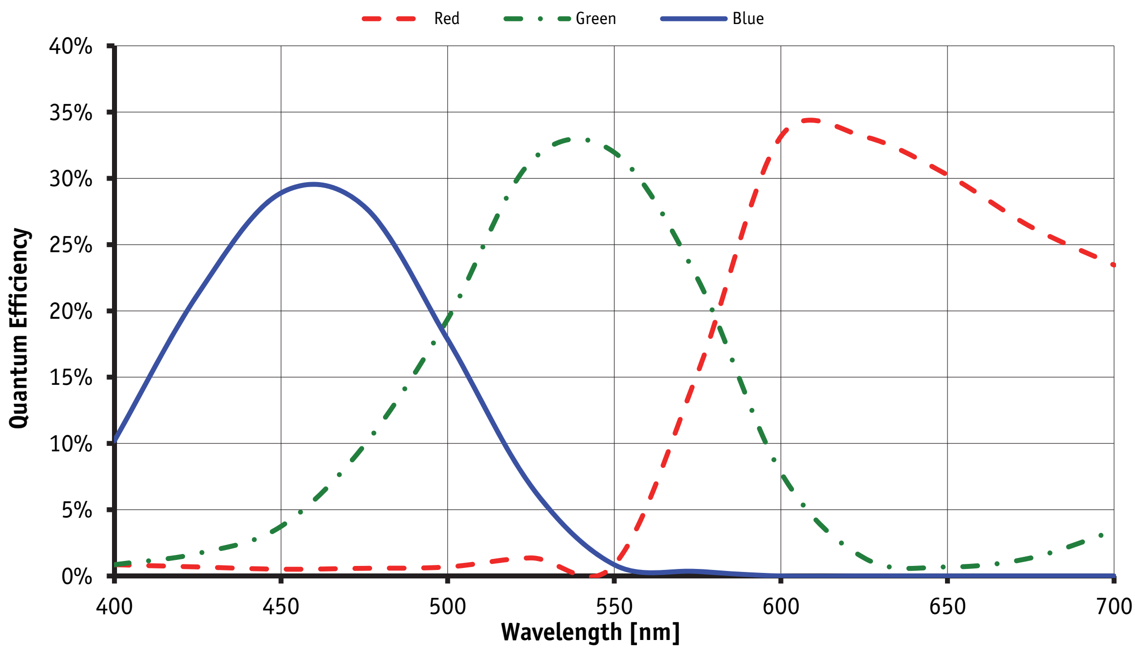


Figure 16: Spectral sensitivity of Guppy F-080C without cut filter and optics

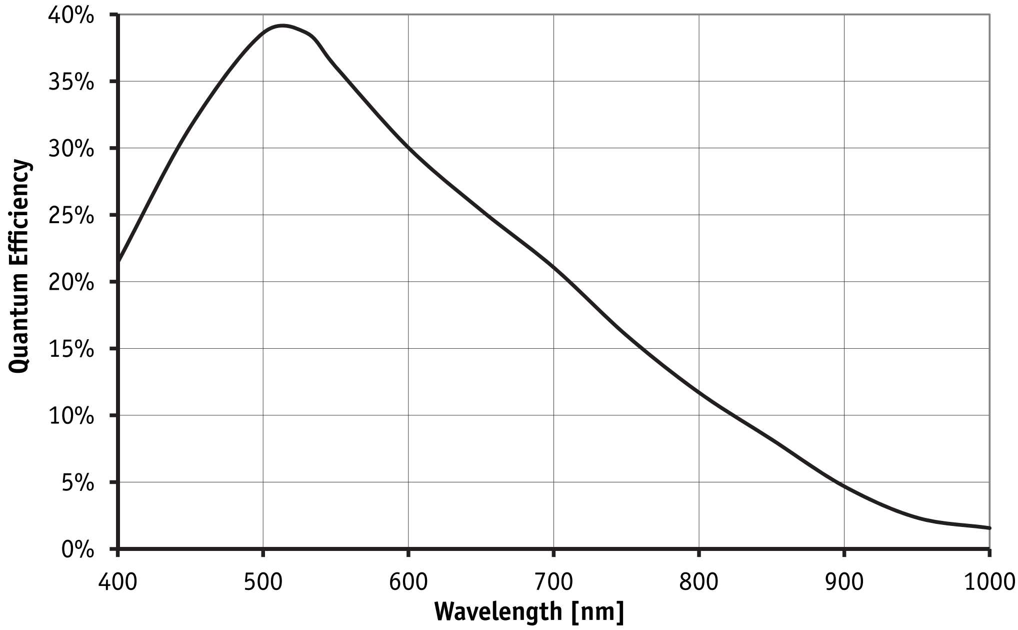


Figure 17: Spectral sensitivity of Guppy F-146B without cut filter and optics

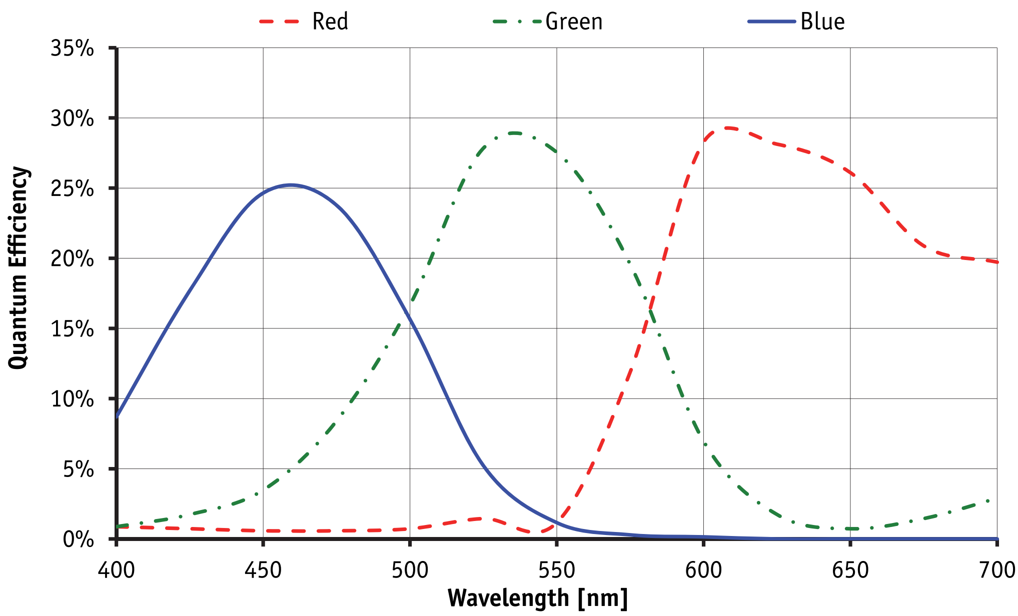


Figure 18: Spectral sensitivity of Guppy F-146C without cut filter and optics

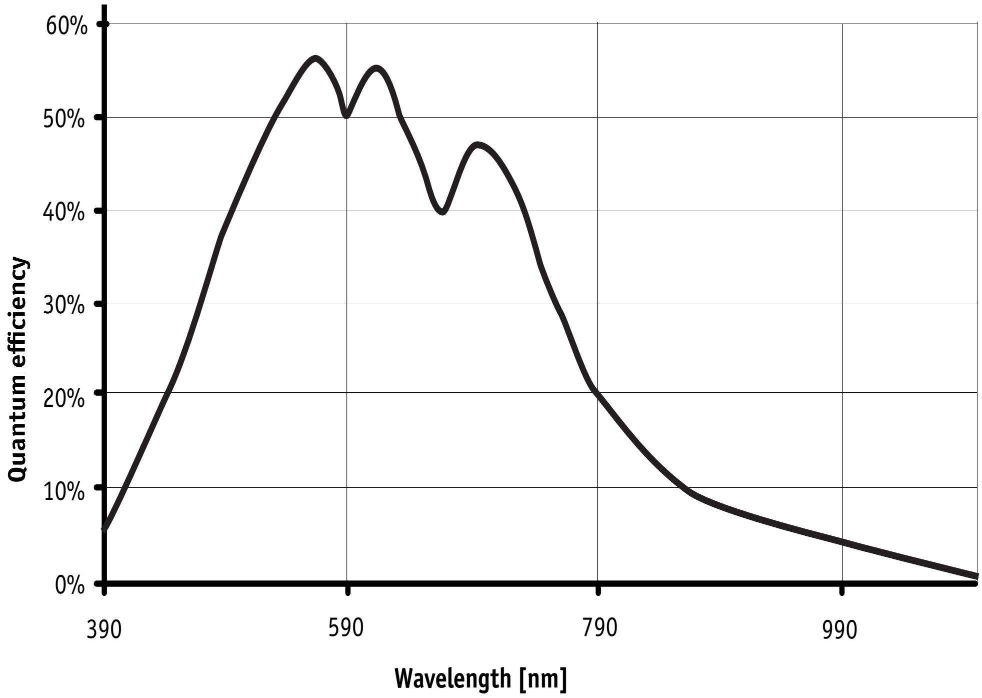


Figure 19: Spectral sensitivity of Guppy F-503B without cut filter and optics

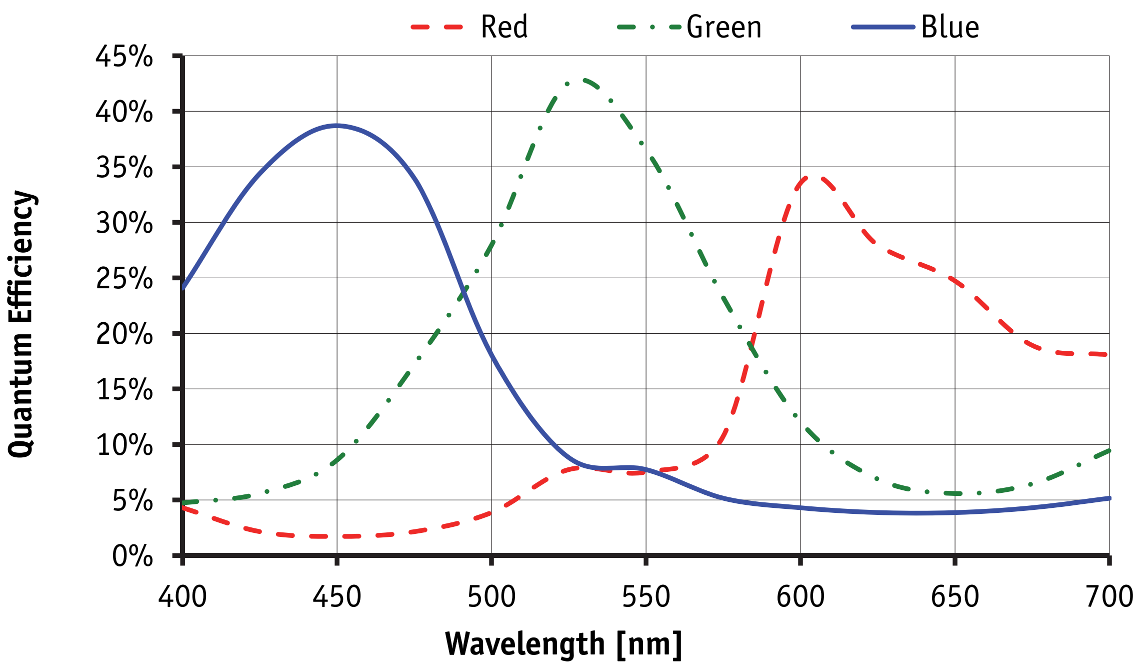


Figure 20: Spectral sensitivity of Guppy F-503C without cut filter and optics

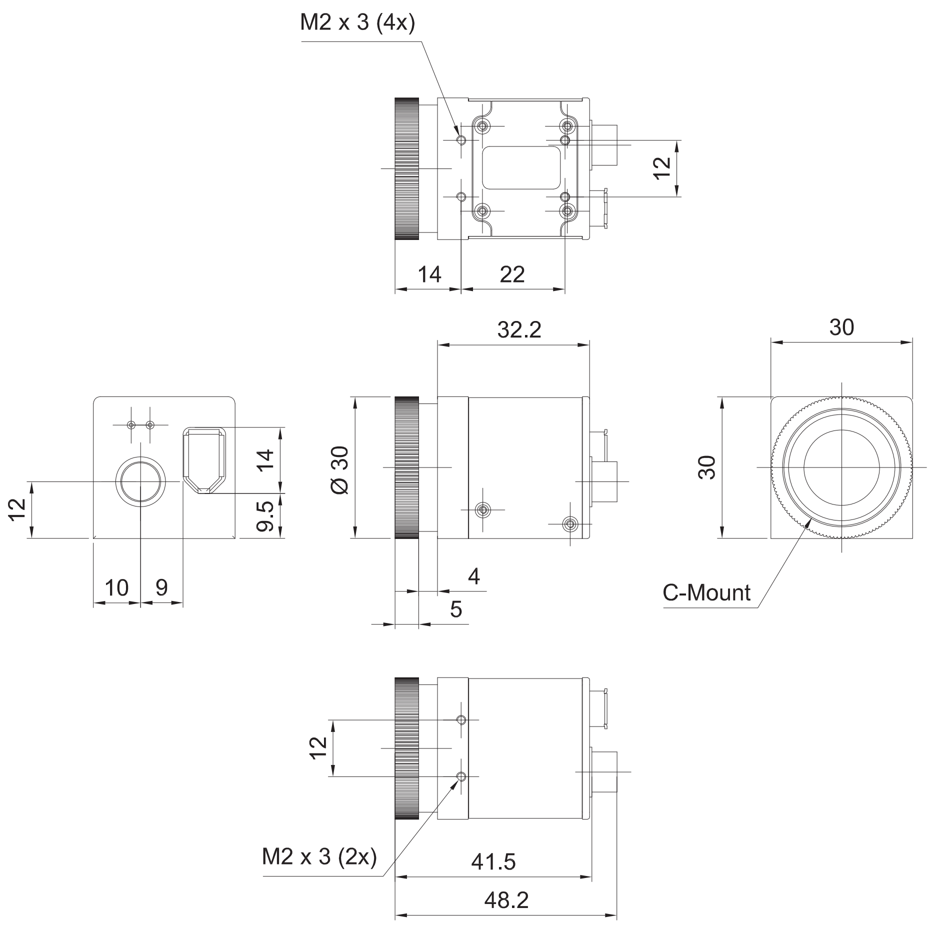
Camera dimensions

Note

For information on **sensor position accuracy:**

(sensor shift x/y, optical back focal length z and sensor rotation α) see Chapter Sensor position accuracy of Guppy cameras on page 260.

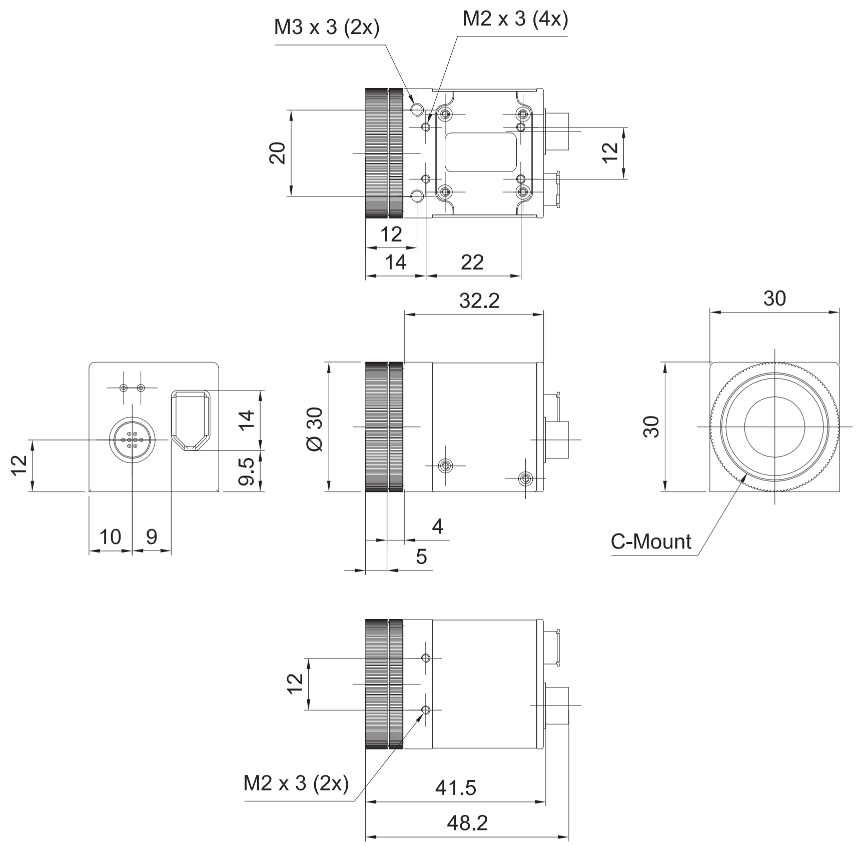
Guppy standard housing (old CS-/C-Mounting)



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

Figure 21: 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 22: Camera dimensions (new CS-/C-Mounting)

Tripod adapter

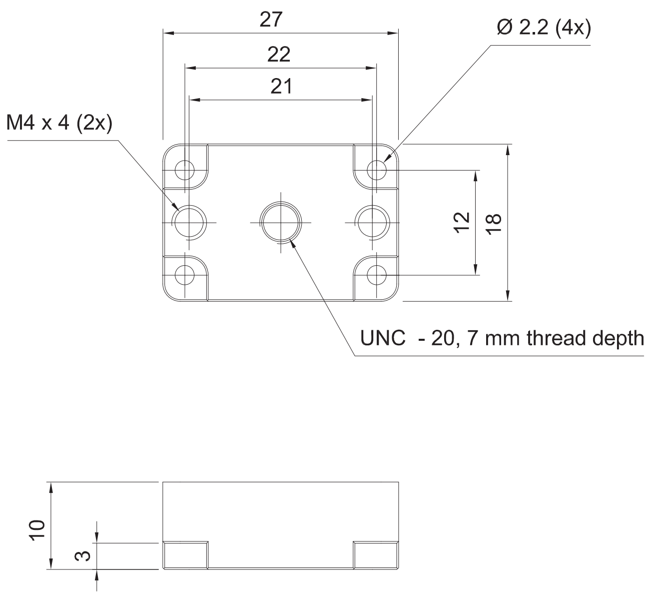
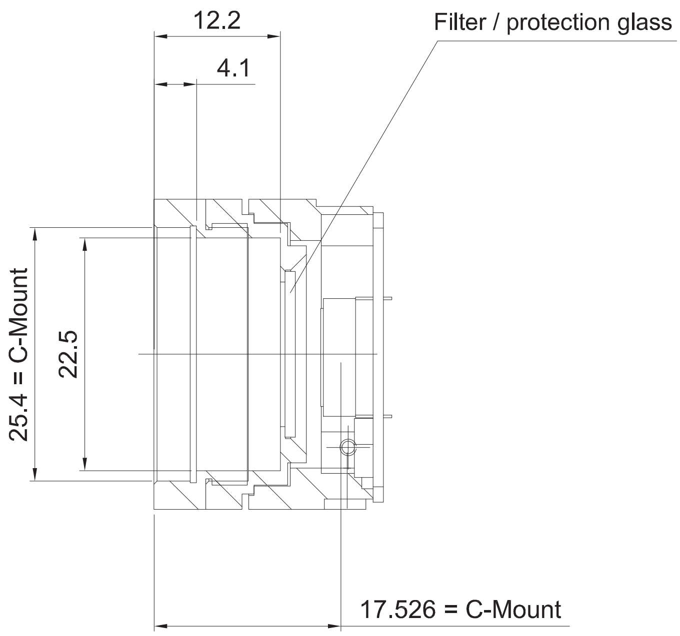


Figure 23: Tripod dimensions

Cross section: C-Mount



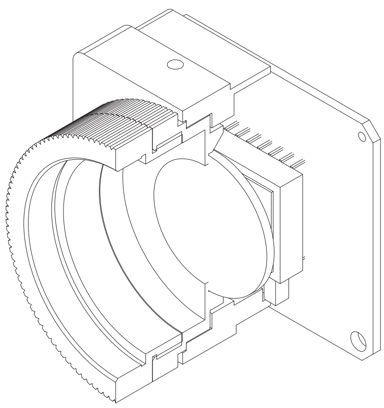
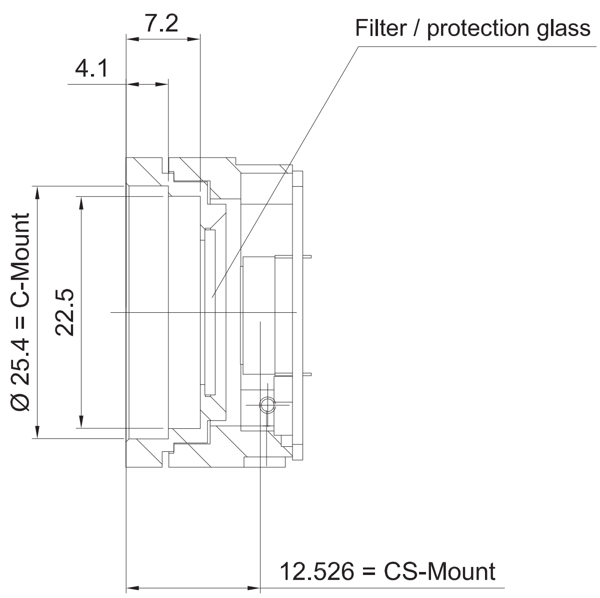


Figure 24: Guppy C-Mount dimensions

Cross section: CS-Mount



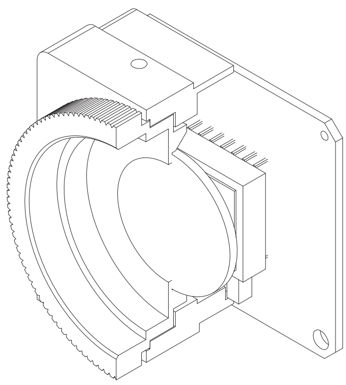


Figure 25: Guppy CS-Mount dimensions

Filter and lenses

IR cut filter

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

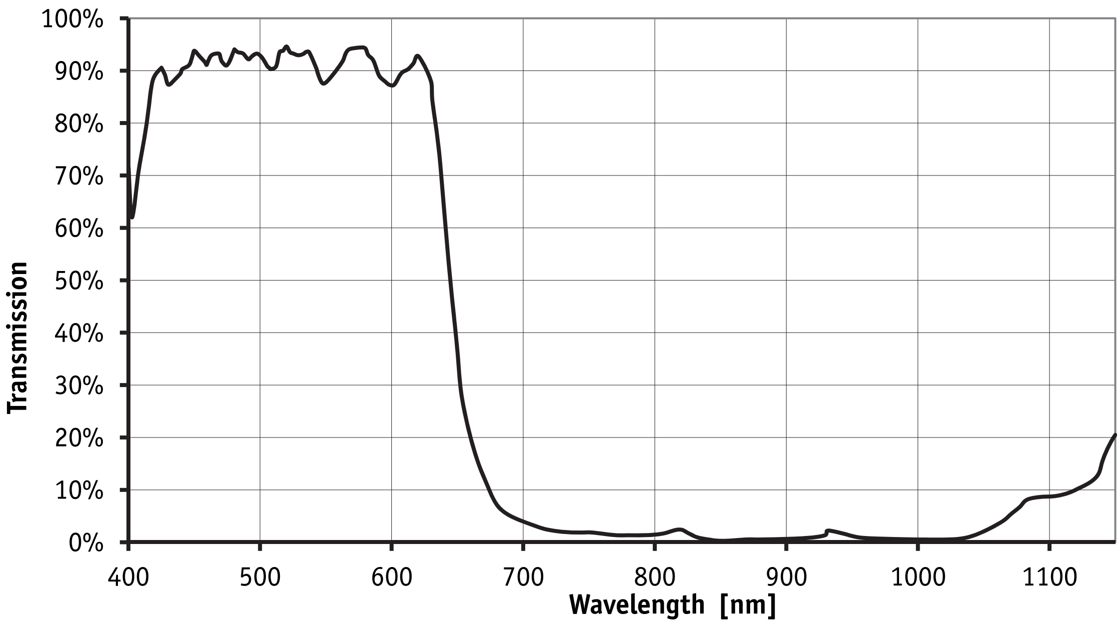


Figure 26: Spectral transmission of IR cut filter (e.g. Jenofilt 217)

Camera lenses

Allied Vision 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 13: Focal width vs. field of view (Guppy F-046)

Focal Width for type 1/2.5 sensors Guppy F-503	Distance = 0.5 m	Distance = 1 m
4.8 mm	0.44 m x 0.59 m	0.89 m x 1.18 m
8 mm	0.26 m x 0.35 m	0.53 m x 0.70 m
12 mm	0.17 m x 0.23 m	0.35 m x 0.47 m
16 mm	0.13 m x 0.17 m	0.26 m x 0.35 m
25 mm	0.08 m x 0.11 m	0.17 m x 0.22 m
35 mm	0.06 m x 0.08 m	0.12 m x 0.16 m
50 mm	0.04 m x 0.05 m	0.08 m x 0.11 m

Table 14: Focal width vs. field of view (Guppy F-503)

Focal Width for type 1/3 sensors Guppy F-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 15: Focal width vs. field of view (Guppy F-033/036/080)

Camera interfaces

This chapter gives you detailed information on status LEDs, inputs and outputs, trigger features and transmission of data packets.

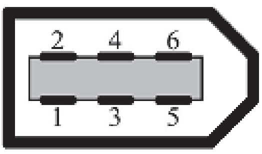
Note

For a detailed description of the **camera interfaces (FireWire, I/O connector), ordering numbers and operating instructions** see the **1394 Installation Manual**.

Read all **Notes** and **Cautions** in the **1394 Installation Manual**, before using any interfaces.

IEEE 1394a port pin assignment

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



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

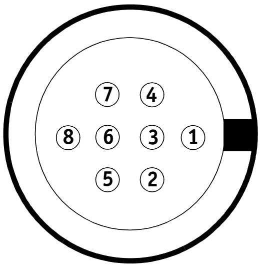
Figure 27: IEEE 1394 connector

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.

Camera I/O connector pin assignment

Guppy (housing)



Pin	Signal	Direction	Level	Description
1	Camera Out 1	Out	U_{out}(high) = 2.4 V...5 V U_{out}(low) = 0 V...0.4 V	Camera Output 1 (GPOut1) default: IntEna
2	Camera Out 2	Out	U_{out}(high) = 2.4 V...5 V U_{out}(low) = 0 V...0.4 V	Camera Output 2 (GPOut2) default: -
3	Camera Out 3	Out	U_{out}(high) = 2.4 V...5 V U_{out}(low) = 0 V...0.4 V	Camera Output 3 (GPOut3) default: Busy
4	Camera In 1	In	U_{in}(high) = 3.8 V...5 V U_{in}(low) = 0 V...1 V	Camera Input 1 (GPIn1) default: Trigger
5	RxD RS232	In	RS232	Terminal Receive Data
6	TxD RS232	Out	RS232	Terminal Transmit Data
7	External Power		+8 ... +36 V DC	Power supply
8	External GND		GND for RS232, GPIOs and ext. power	External Ground for RS232, GPIOs and external power

Figure 28: Guppy (housing): Camera I/O connector pin assignment

Note

GP = General Purpose

For a detailed description of the **I/O connector and its operating instructions** see the **1394 Installation Manual, Chapter *Guppy input description***.

Read all **Notes** and **Cautions** in the **1394 Installation Manual**, before using the I/O connector.

www

For **more information on cables** and on **ordering cables online** (by clicking the article and sending an inquiry) go to:

http://www.alliedvision.com/en/contact

Status LEDs

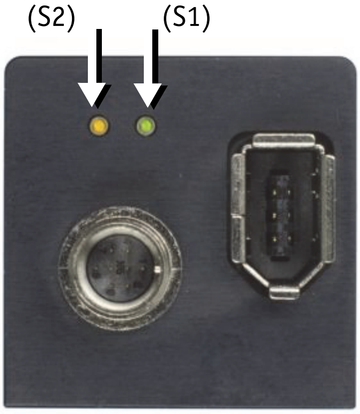


Figure 29: Status LEDs

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 16: 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 17: Error codes

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

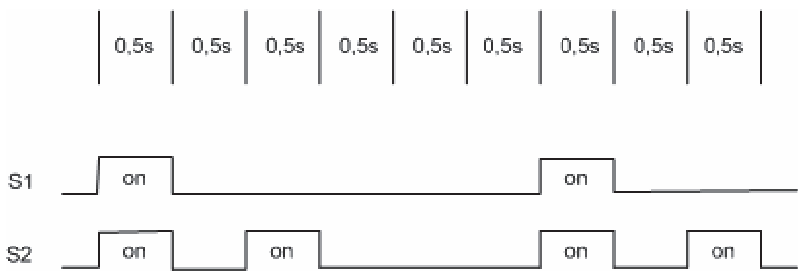


Figure 30: Warning and error states

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.

Control and video data signals

The inputs and outputs of the camera can be configured by software. The different modes are described below.

Inputs

Note

For a general description of the **inputs** and **warnings** see the **1394 Installation Manual**.

Triggers

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

Input/output pin control

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

Register	Name	Field	Bit	Description
0xF1000300	IO_INP_CTRL1	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[2..6]	Reserved
		Polarity	[7]	0: Signal not inverted 1: Signal inverted
		---	[8..10]	Reserved
		InputMode	[11..15]	Mode see Table 19: Input routing on page 63
		---	[16..30]	Reserved
		PinState	[31]	RD: Current state of pin

Table 18: 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 18: Input configuration register on page 62.

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 19: 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 (1 µs)
		Max_Value	[20..31]	Max. value for this feature

Table 20: 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 21: Trigger Delay CSR

The cameras also 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 22: 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

Note

For a general description of the **outputs** and **warnings** see the **1394 Installation Manual**.

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. The camera is busy.

Table 23: Output signals

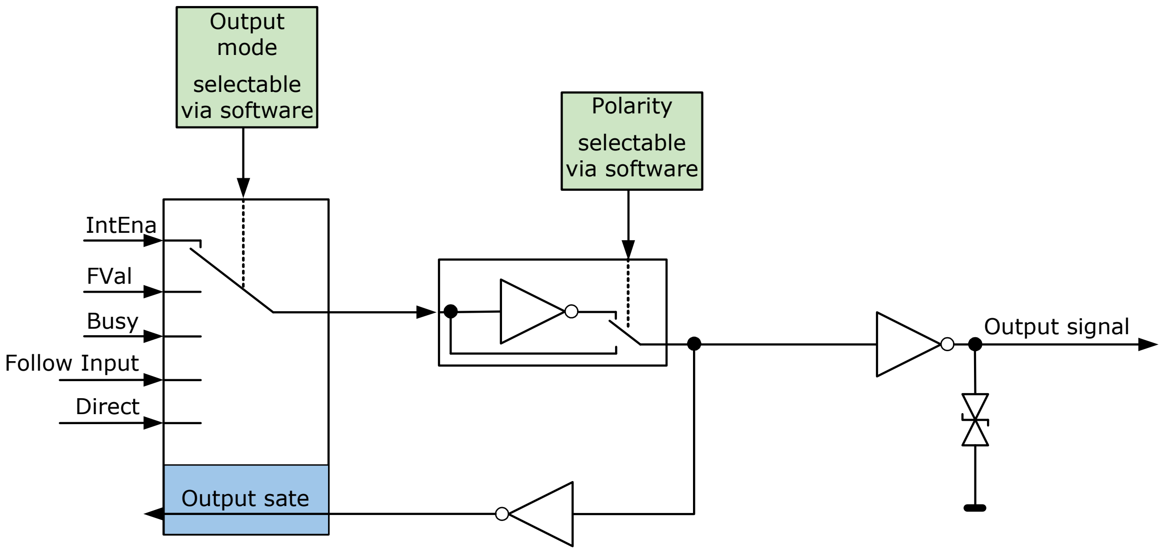


Figure 31: Output block diagram

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 (see Table 24: Advanced register: Output control on page 68).

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)
		---	[2..6]	Reserved
		Polarity	[7]	0: Signal not inverted 1: Signal inverted
		---	[8..10]	Reserved
		Output mode	[11..15]	Mode See Table 25: Output routing on page 68.
		---	[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		

Table 24: Advanced register: **Output control**

Output modes

ID	Mode	Default
0x00	Off	
0x01	Output state follows **PinState** bit	
0x02	Integration enable	Output 1
0x03	Reserved	
0x04	Reserved	
0x05	Reserved	

Table 25: Output routing

ID	Mode	Default
0x06	FrameValid	
0x07	Busy	Output 2
0x08	Follow corresponding input (Inp1 → Out1)	
0x0A..0x1F	Reserved	

Table 25: 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.

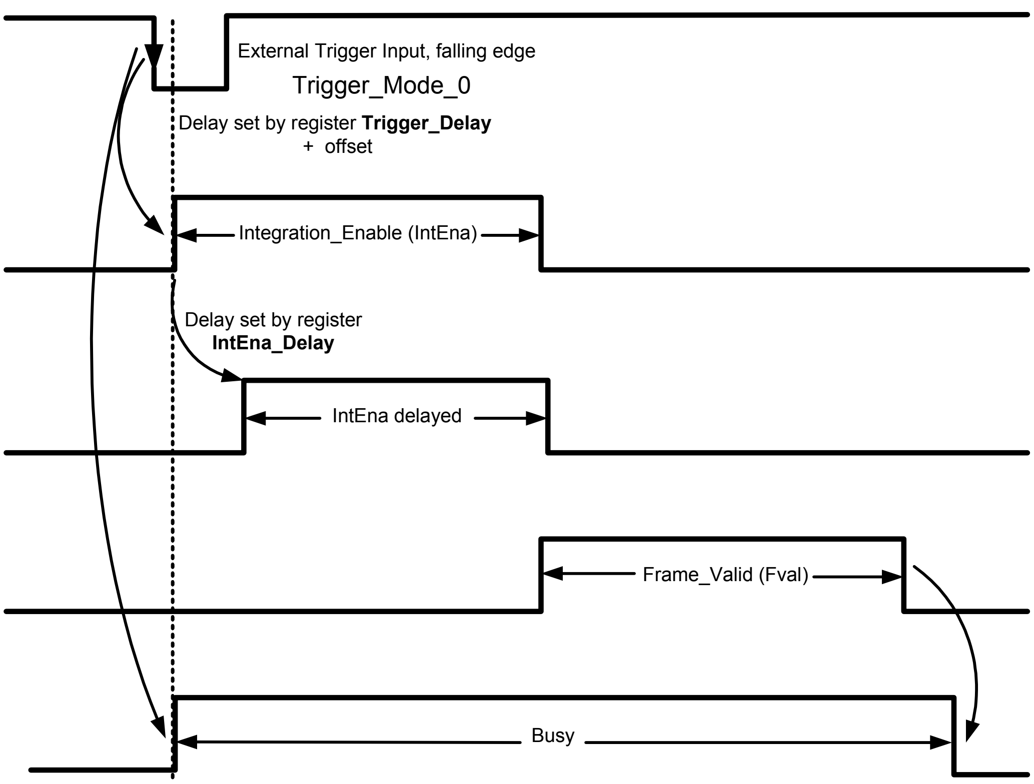


Figure 32: Output impulse diagram

See also Chapter Jitter at start of exposure on page 162.

Offsets are camera specific. For more information read Chapter Exposure time offset on page 156.

Note

The signals can be inverted.

Caution

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

Note

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

Pixel data

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

sync bit

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

Table 26: Isochronous data block packet format. Source: IIDC V1.3

Field	Description
data_length	Number of bytes in the data field
tg	**Tag field** shall be set to zero
channel	**Isochronous channel number**, as programmed in the iso_channel field of the cam_sta_ctrl register
tCode	**Transaction code** shall be set to the isochronous data block packet tCode
sy	**Synchronization value (sync bit)** This is one single bit. It indicates the start of a new frame. It shall be set to 0001h on the first isochronous data block of a frame, and shall be set to zero on all other isochronous blocks
Video data payload	Shall contain the digital video information

Table 27: Description of data block packet format

- The video data for each pixel are output in 8-bit format (**Packed 12-Bit Mode**: 12-bit format). Exception: Guppy F-146 (Mono8: 8-bit format, Mono12/16: 12-bit format)
- Each pixel has a range of 256 (**Packed 12-Bit Mode**: 4096) shades of gray.
- The digital value 0 is black and 255 (**Packed 12-Bit Mode**: 4095) is white.
- In 12-bit mode the data output is MSB aligned (12 significant bits).
- In 16-bit mode the data output is MSB aligned (also 12 significant bits).

Video data formats (IIDC V1.3 and Allied Vision)

The following tables provide a description of the video data format for the different modes:

Y (Mono) and Y (Mono16) format
⇨ Source: IIDC V1.3 specification

Y (Mono12) format
⇨ Allied Vision own format (**Packed 12-Bit Mode**)

<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)

Figure 33: **Y8 format** [Source: IIDC V1.3]

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)

Figure 33: **Y8 format** [Source: IIDC V1.3]

<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 34: **Y16 format** [Source: IIDC V1.3]

<Y (Mono12) format> (Allied Vision)

Y-(K+0) [11..4]	Y-(K+1) [3..0] Y-(K+0) [3..0]	Y-(K+1) [11..4]	Y-(K+2) [11..4]
Y-(K+3) [3..0] Y-(K+2)[3..0]	Y-(K+3) [11..4]	Y-(K+4) [11..4]	Y-(K+5) [3..0] Y-(K+4)[3..0]
Y-(K+5) [11..4]	Y-(K+6) [11..4]	Y-(K+7) [3..0] Y-(K+6) [3..0]	Y-(K+7) [11..4]

Table 28: **Packed 12-Bit Mode** (mono and raw) Y12 format from Allied Vision

Data structure (IIDC V1.3 and Allied Vision)

The following tables provide a description of the data structure for the different modes
⇨ Source: IIDC V1.3 specification

<Y, R, G, B>

Each component has 8-bit data. The data type is *Unsigned Char*.

	Signal level (decimal)	Data (hexadecimal)
Highest	255	0xFF
	254	0xFE
	.	.
	.	.
	1	0x01
Lowest	0	0x00

Figure 35: Data structure of Y, R, G, B [Source: IIDC V1.3]

<U, V>

Each component has 8-bit data. The data type is *Straight Binary*.

	Signal level (decimal)	Data (hexadecimal)
Highest (+)	127	0xFF
	126	0xFE
	.	.
	.	.
	1	0x81
Lowest	0	0x80
	-1	0x7F
	.	.
	.	.
	-127	0x01
Highest (-)	-128	0x00

Figure 36: Data structure of U, V [Source: IIDC V1.3]

<Y (Mono16>

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

Y	Signal level (decimal)	Data (hexadecimal)
Highest	65535	0xFFFF
	65534	0xFFFE
	.	.
	.	.
	1	0x0001
Lowest	0	0x0000

Figure 37: Data structure of Y (Mono16) [Source: IIDC V1.3]

<Y (Mono12)> (Allied Vision)

Y component has 12-bit data. The data type is *Unsigned*.

Y	Signal level (decimal)	Data (hexadecimal)
Highest	4095	0x0FFF
	4094	0x0FFE
	.	.
	.	.
	1	0x0001
Lowest	0	0x0000

Table 29: Data structure of **Packed 12-Bit Mode** (mono and raw) from Allied Vision

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 (CCD or CMOS) in the camera. The individual blocks are described in more detail in the following paragraphs. For sensor data see Chapter Specifications on page 27.

Note

The following drawings are examples of Guppy cameras with 10-bit ADCs.

For cameras with different ADCs see the comments with asterisks below (* and **):

* Cameras with 10-bit ADC: 10 bit
Cameras with 12-bit ADC: 12 bit

** e.g. Guppy F-146 (CCD), Guppy F-503 (CMOS)
with activated LUT: 8 bit
without LUT: 12 bit

Black and white cameras (CCD and CMOS)

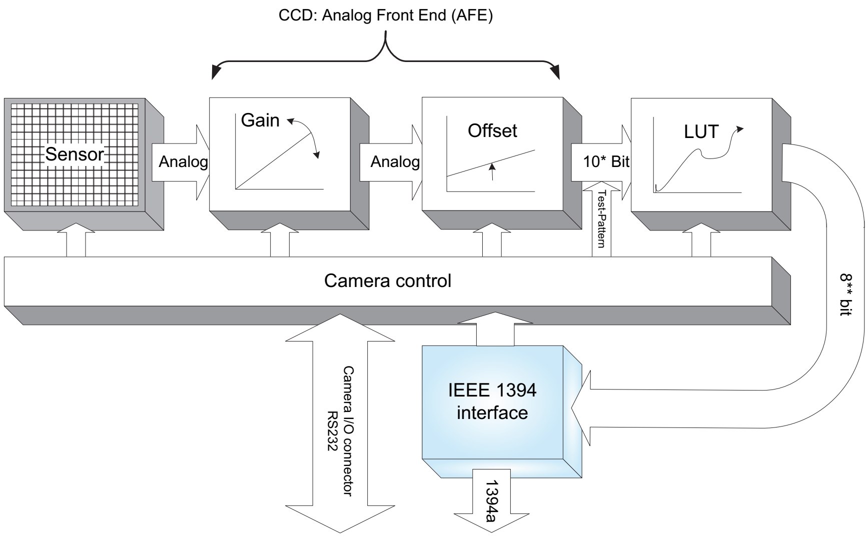


Figure 38: Block diagram b/w camera (CCD)

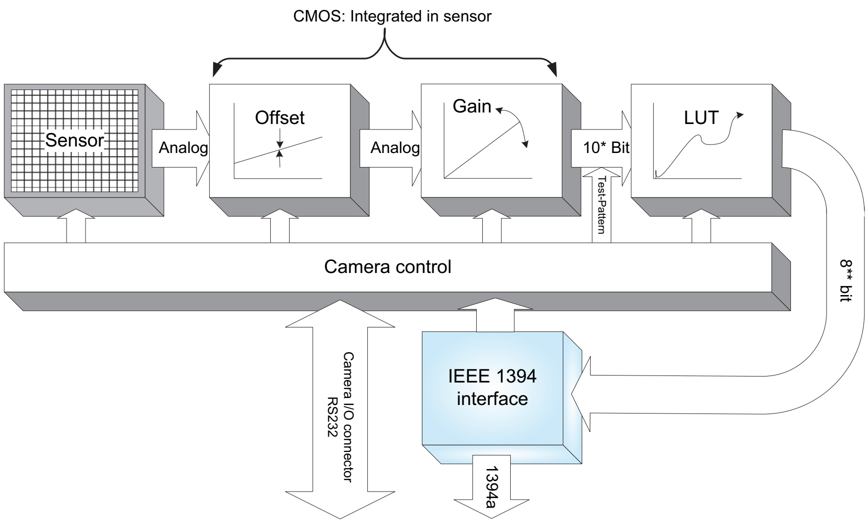


Figure 39: Block diagram b/w camera (CMOS)

Color cameras (CCD and CMOS)

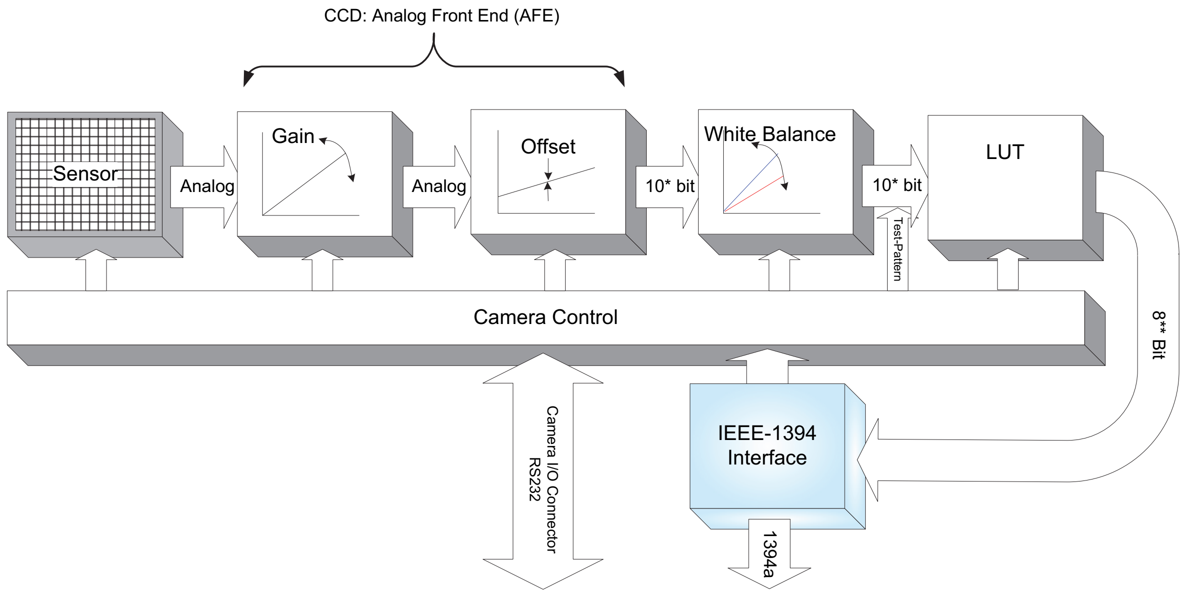


Figure 40: Block diagram color camera (CCD)

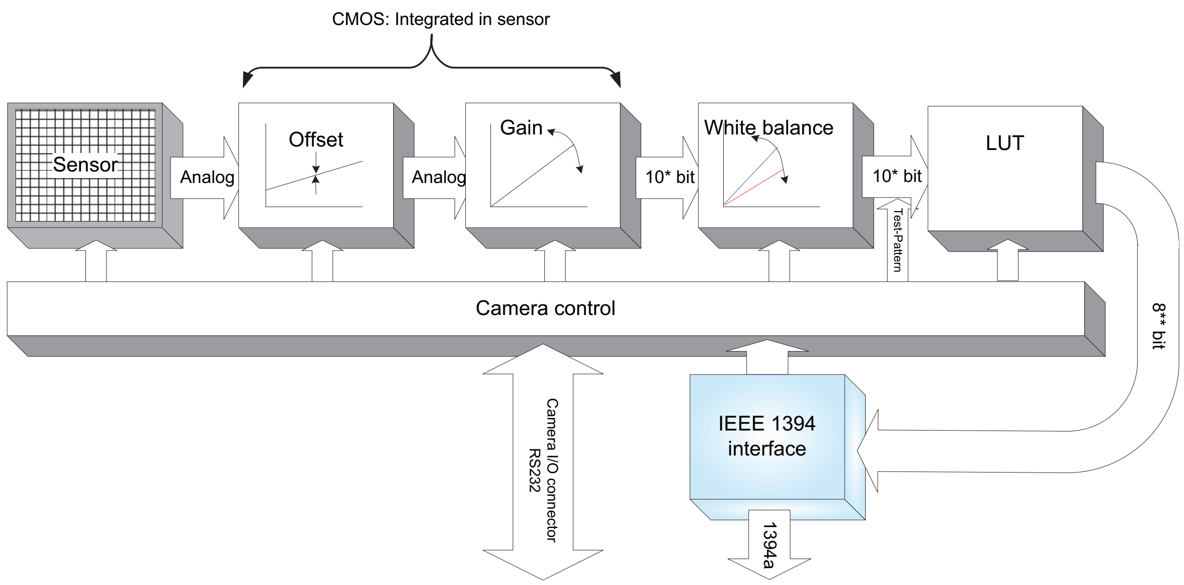


Figure 41: Block diagram color camera (CMOS)

Readout schemes: Guppy interlaced models (F-038, F-038 NIR, F-044, F-044 NIR, F-025, F-029)

The Guppy F-038/038 NIR/044/044 NIR/025/029 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_1: interlaced, frame integration
- Format_7 Mode_2: non-interlaced, field integration (horizontal + vertical binning), so-called progressive readout mode

Note

For demosaicing process outside of the camera, see Chapter BAYER pattern (raw data output) on page 134.

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 79 and
  - Figure 49: Format_7 Mode_2: 4-phase vertical shift register precharging (non-interlaced, field) on page 83
- Frame integration: the two gates are activated every other field
  - see Figure 46: Format_7 Mode_1: 4-phase vertical shift register pre-charging (interlaced, frame) on page 81
- 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, ...

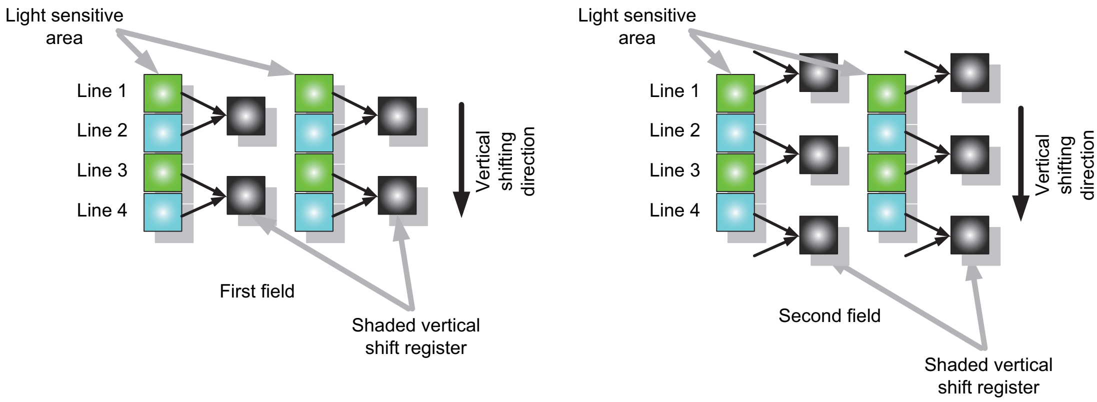


Figure 42: Format_7 Mode_0: field integration readout mode (interlaced)

- 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.

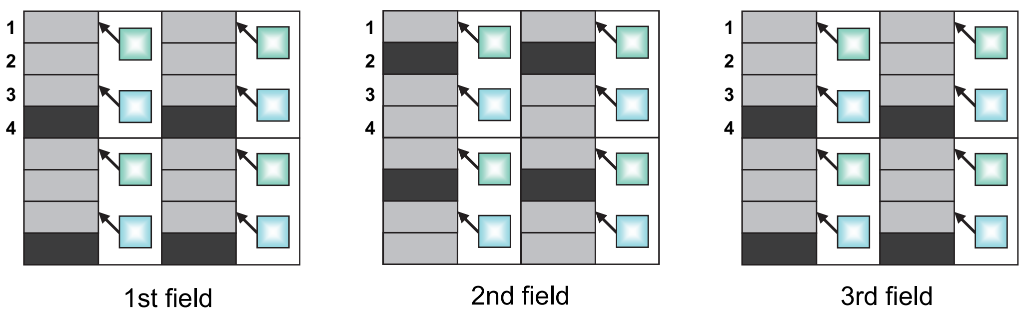


Figure 43: Format_7 Mode_0: 4-phase vertical shift register precharging (interlaced, field)

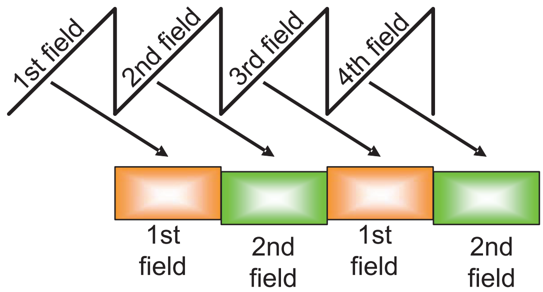


Figure 44: Format_7 Mode_0: output (interlaced, field)

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 30: Format_7 Mode_0: output parameters (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, ...

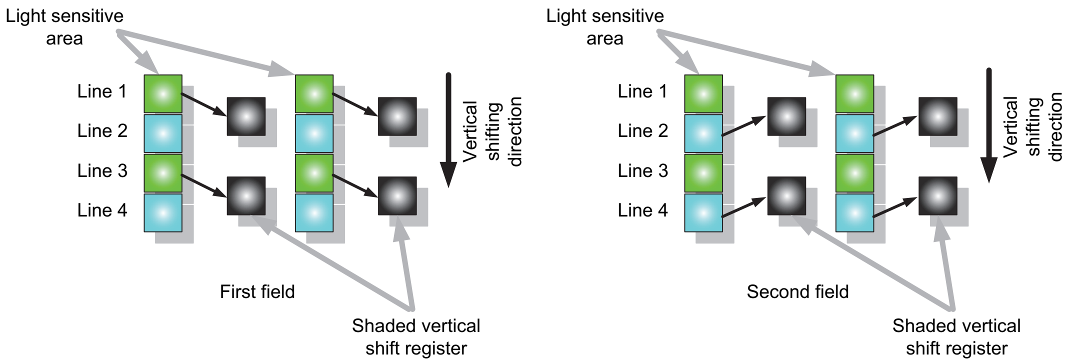


Figure 45: Format_7 Mode_1: frame integration readout mode (interlaced)

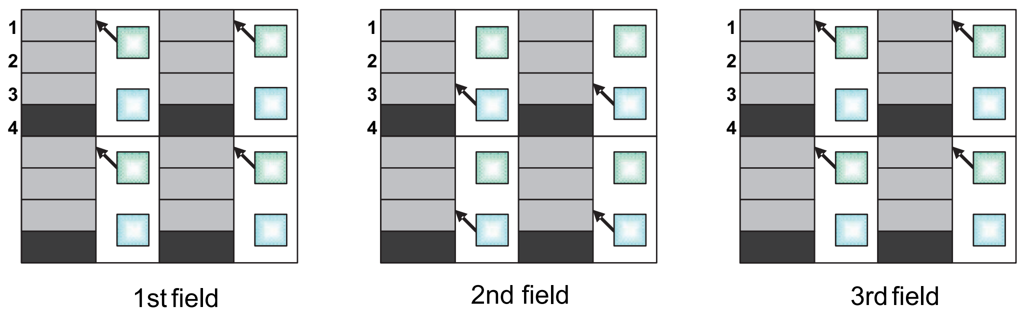


Figure 46: Format_7 Mode_1: 4-phase vertical shift register precharging (interlaced, frame)

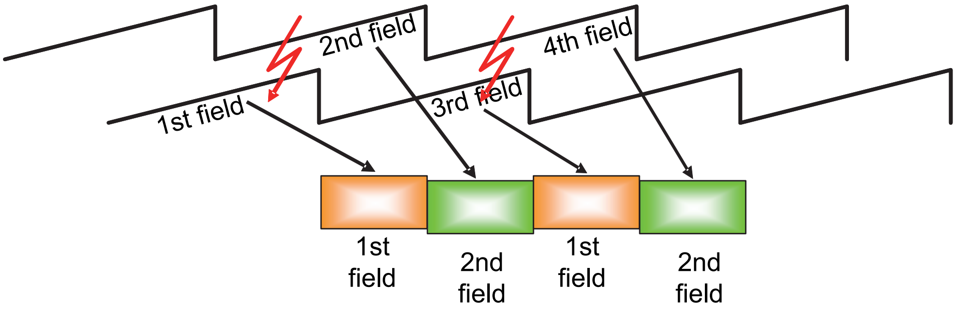


Figure 47: Format_7 Mode_1: output (interlaced, frame)

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 31: Format_7 Mode_1: output parameters (interlaced, frame)

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, ...

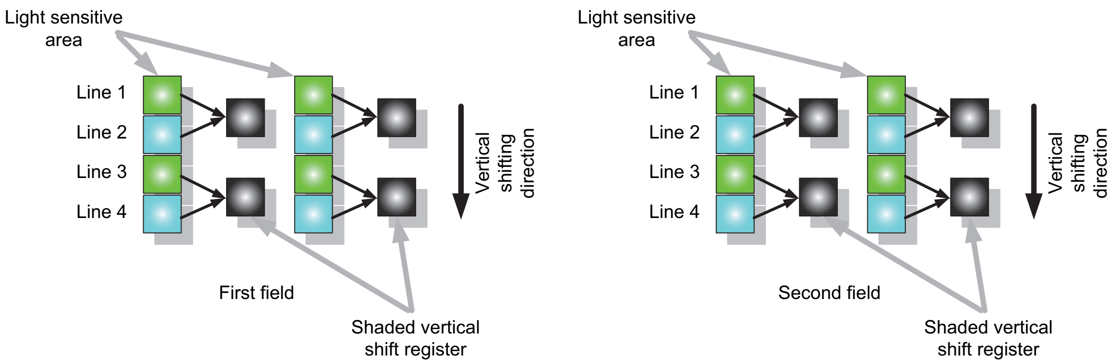


Figure 48: Format_7 Mode_2: field integration readout mode (non-interlaced)

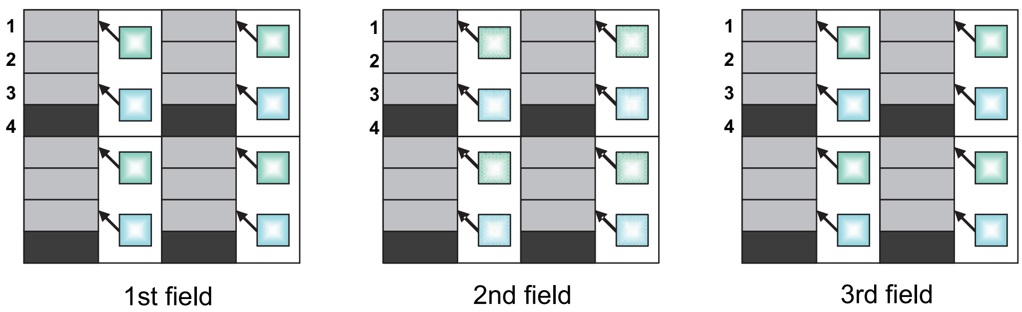


Figure 49: Format_7 Mode_2: 4-phase vertical shift register precharging (non-interlaced, field)

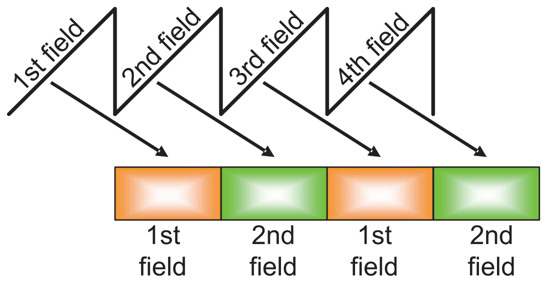


Figure 50: Format_7 Mode_2: output (non-interlaced, field integration, emulating progressive scan)

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)

Complementary colors and demosaicing

Note

Color correction: see Chapter Color correction (only interlaced Guppys) on page 89.

BAYER pattern: see Figure 88: BAYER pattern of SONY complementary sensors: 1st line: G - Mg, 2nd line: Cy - Ye on page 136

Debayering: see Chapter Format_7 Mode_0: sensor readout and color on page 87 and Chapter Format_7 Mode_1: sensor readout and color on page 88

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 39)

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 33: 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 either in the analog domain (by field readout of the CCD in Format_7 Mode_0) or by a digital representation of this calculation process in Format_7 Mode_1 because of frame integration.

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, starting from the bottom gives:

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

and the second two lines from the bottom give:

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

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

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

Formula 2: First chroma signal V

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

For the second 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 second line pair

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

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

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

Formula 4: Second 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, which is generated by a vertical shift by one line. Complementary filtering is thus a way to achieve higher sensitivity at a slight expense of color resolution.

Format_7 Mode_0: sensor readout and color

In Format_7 Mode_0 controlling gain of the binned signals is done via SmartView or via the advanced registers. That means there are four separate gains, one for each binned component Cy+G, Mg+Ye, Mg+Cy and G+Ye.

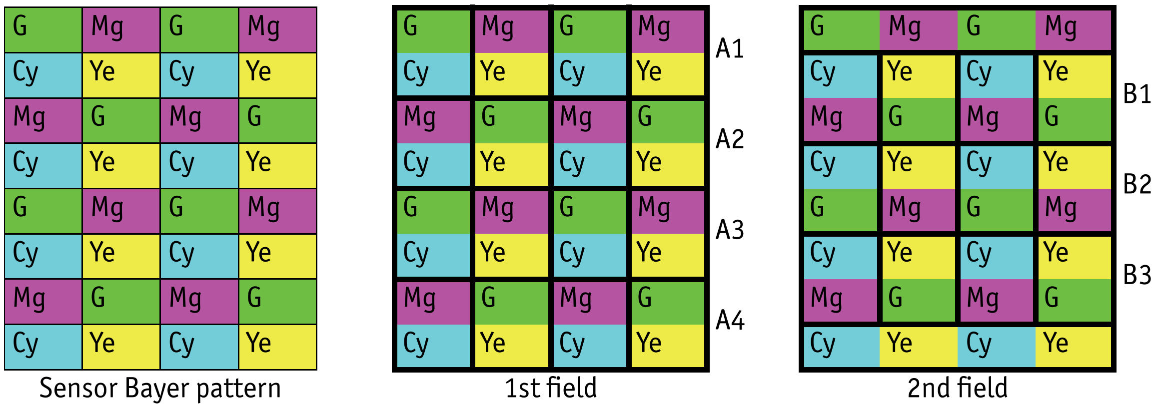


Figure 51: Format_7 Mode_0: Binning for 1st field and 2nd field

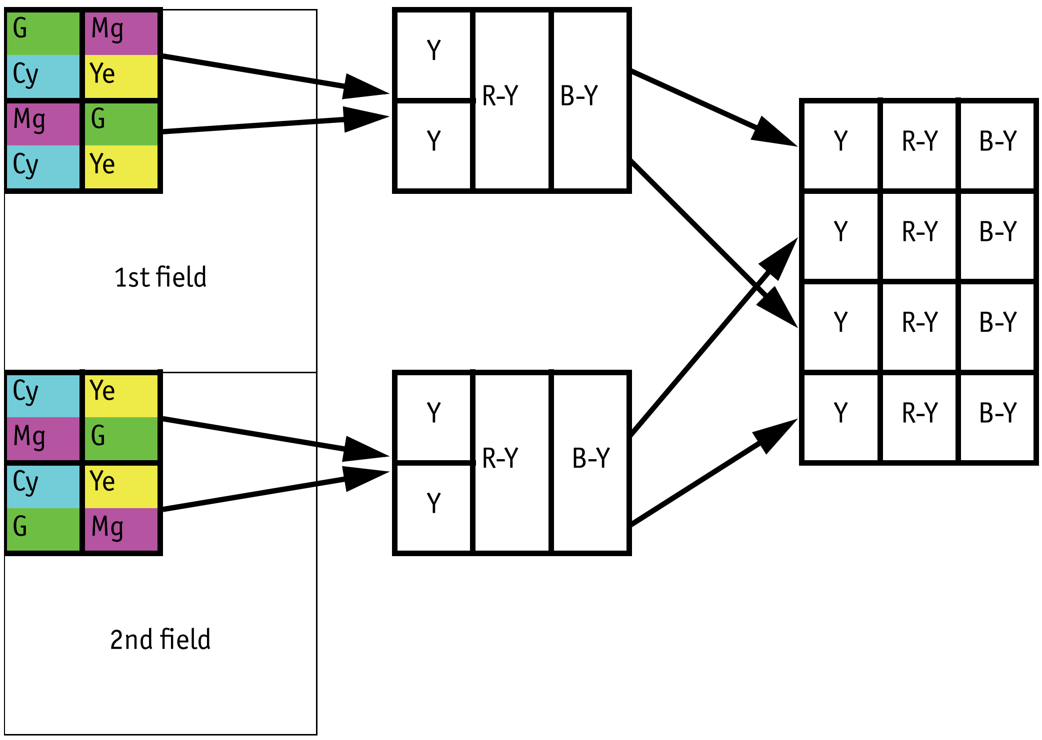


Figure 52: Format_7 Mode_0: Sensor readout

As mentioned before two adjacent pixels in a line are used to calculate a luma (Y) value and one component (R-Y or B-Y) of the chroma values. This means: a half sized color image per field is reconstructed. After deinterlacing the image has the properties of a 4:2:2 image.

Format_7 Mode_1: sensor readout and color

In Format_7 Mode_1 controlling gain is done digitally for each of the four channels Cyan, Yellow, Magenta and Green.

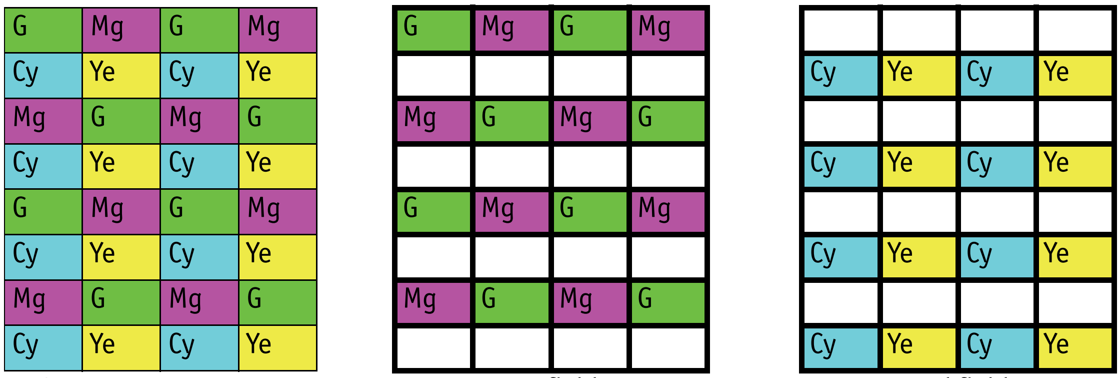


Figure 53: Format_7 Mode_1: 1st field and 2nd field

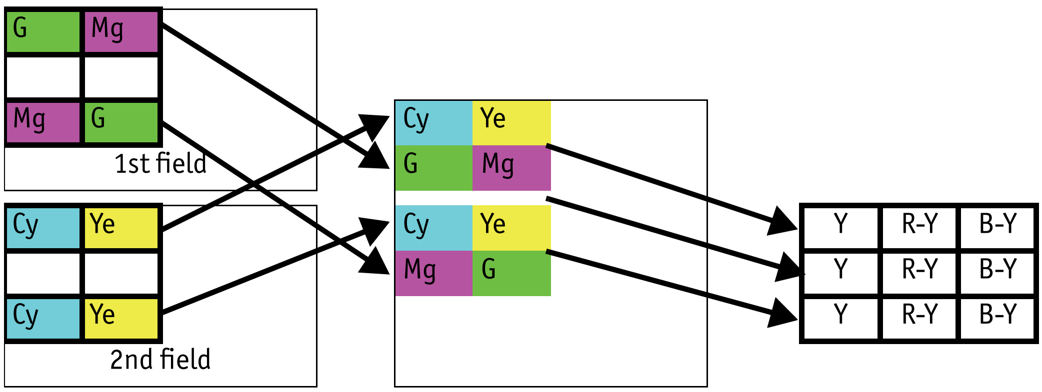


Figure 54: Format_7 Mode_1: Sensor readout

Because it is not possible to obtain full color or chroma information per field, the data has to be deinterlaced first. After that demosaicing is done (see Chapter How demosaicing works on page 85): luma (Y) and the two chroma values (R-Y and B-Y) are calculated from each 2x2 pixel array.

Color correction (only interlaced Guppys)

In order to further improve the color response of complementary color filter sensors, a color correction is built 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 85).

The color correction RGB_{cor} 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/F-503)

The Guppy F-036/F-503 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.

Note

Configuration

To configure this feature in an advanced register: See Table 121: Advanced register: Mirror on page 250.

Note

- **Guppy F-036**: When using the mirror function, the starting color is maintained.
- **Guppy F-503**: When using the mirror function, the Bayer pattern changes from GRBG to RGGB.

White balance

There are two types of white balance:

- **one-push white balance**: white balance is done only once (not continuously)
- **auto white balance** (AWB): continuously optimizes the color characteristics of the image

Guppy color cameras have both **one-push white balance** and **auto 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.

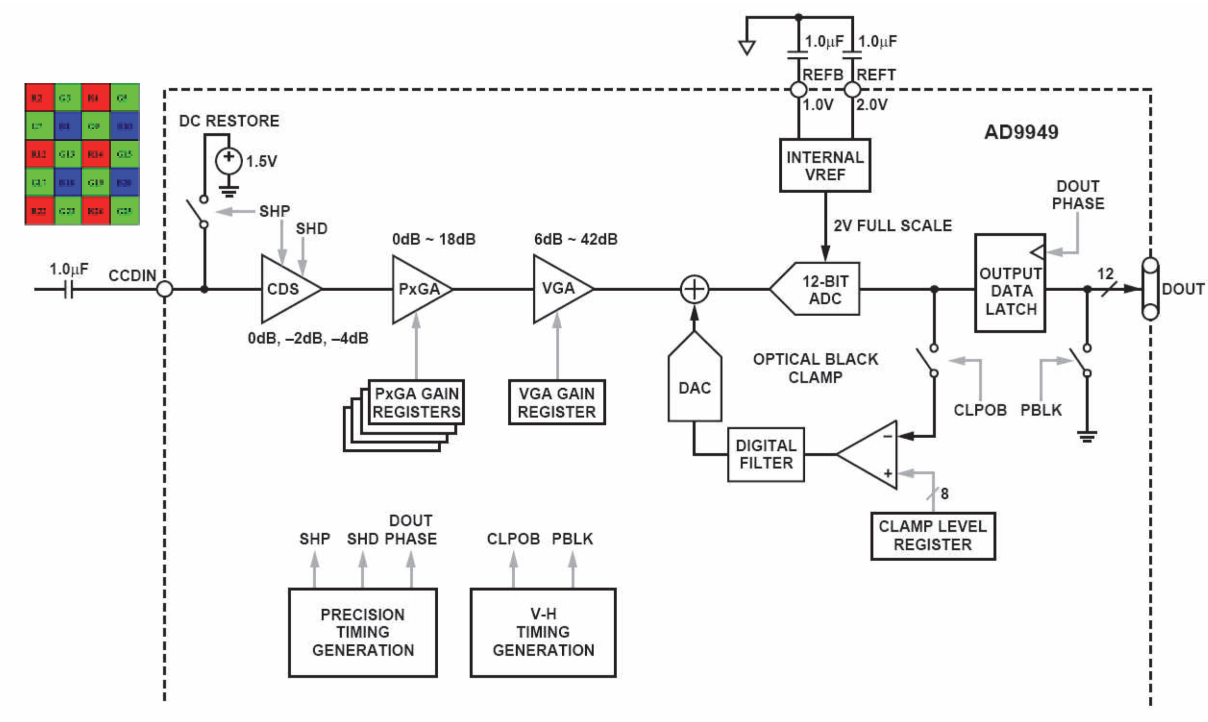


Figure 55: Block diagram of AFE (Source: Analog Devices)

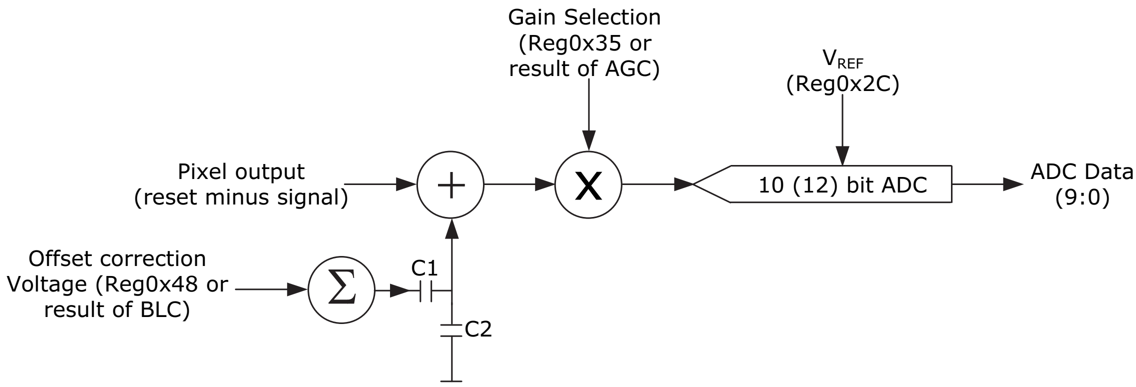


Figure 56: Signal path of MT9V022 (Guppy F-036 with CMOS sensor)

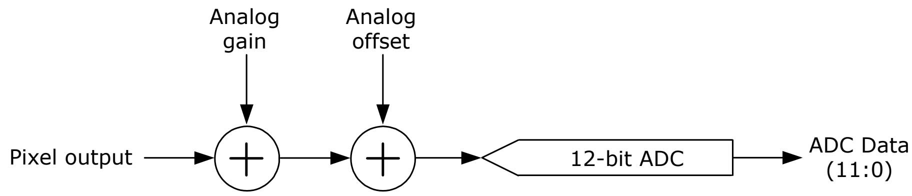


Figure 57: Signal path of MT9P031 (Guppy F-503 with CMOS sensor)

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 Read: read a status 0: OFF 1: ON
		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 34: 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.

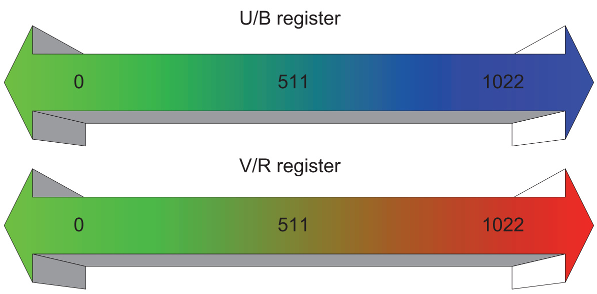


Figure 58: U/V slider range

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 (0xF10080C4 and 0xF10080C8). 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
0xF10080C0	WHITE_BAL_INQ	Presence_Inq	[0]	Always 0
		-	[1..31]	Reserved
0xF10080C4	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
0xF10080C8	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 35: White balance register for interlaced Guppys

One-push white balance

Note

Interlaced Guppys (Guppy F-038/038 NIR/044/044 NIR) do **not** have **one-push white balance**.

Note

Configuration

To configure this feature in control and status register (CSR): See Table 100: Feature control register on page 222.

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 the **one-push 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 equally weighted RGB pixels in the image.

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.

The following flow diagram illustrates the **one-push white balance** sequence.

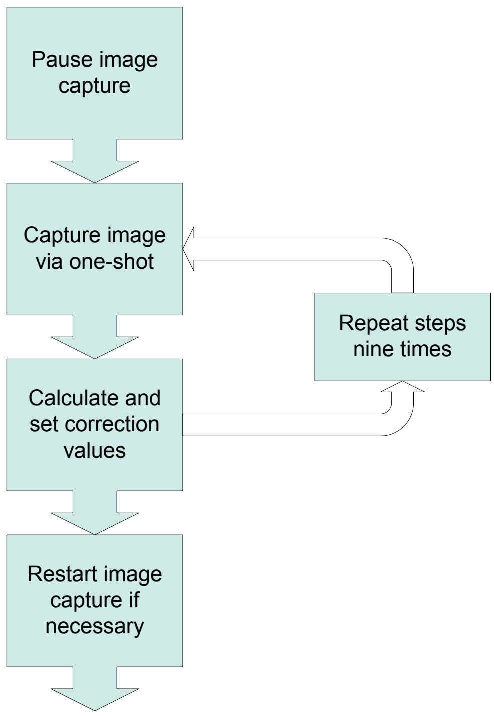


Figure 59: **One-push white balance** sequence

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

Auto white balance (AWB)

The **auto white balance** feature 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.

Auto white balance (AWB) 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.

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 equally weighted RGB pixels in the image.
- **Auto white balance** can be started both during active image capture and when the camera is in idle state.

Note

Configuration

To set position and size of the control area (Auto_Function_AOI) in an advanced register: see Table 119: Advanced register: Autofunction AOI on page 248.

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.

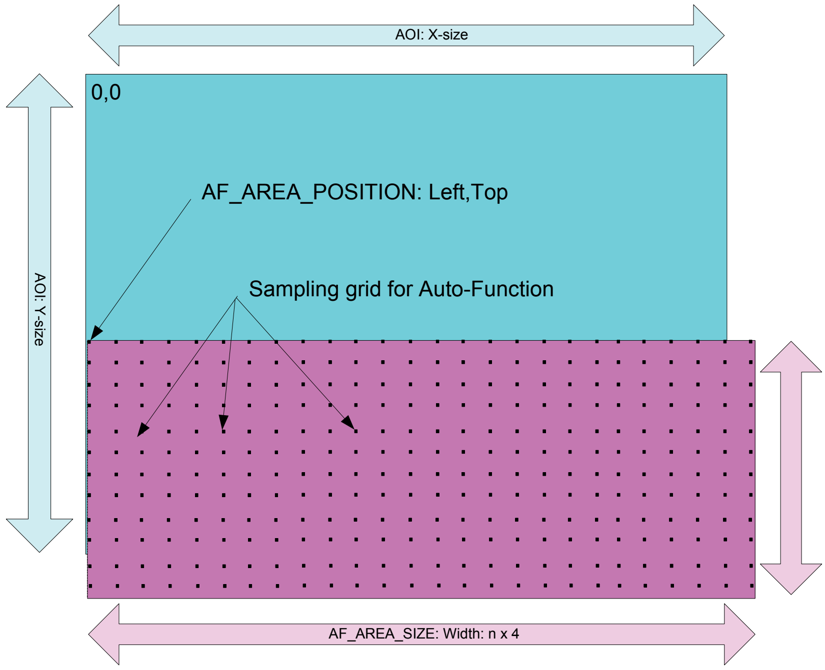


Figure 60: AUTOFNC_AOI positioning

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 **auto white balance ON**.

Manual gain

As shown in:

- Figure 55: Block diagram of AFE (Source: Analog Devices) on page 91
- Figure 56: Signal path of MT9V022 (Guppy F-036 with CMOS sensor) on page 92
- Figure 57: Signal path of MT9P031 (Guppy F-503 with CMOS sensor) on page 92

... 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	Increment length
CCD cameras	0 … 680	0 … 24 dB	~0.035 dB/step
Guppy F-036 (CMOS camera)	16 … 64	0 … 12 dB	0..15: ~0.2 dB/step (1 step = 1 LSB) 16..64: ~0.25 dB/step (1 step = 2 LSB)
Guppy F-503 (CMOS camera)	8 … 32 33 … 48 49 … 60	0 … 12 dB 12.56 … 18.06 dB 19.08 … 26 dB	~0.5 dB/step ~0.56 dB/step ~1 dB/step

Table 36: Manual gain range of the various Guppy types (CCD and CMOS)

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 Guppy 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 the gain and auto exposure CSR.

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

Table 37: CSR: **Gain**

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

Table 38: Auto_Exposure CSR

Note

Configuration

To configure this feature in an advanced register: See Table 118: Advanced register: Auto gain control on page 247.

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 Guppy F-036 (CMOS model)** 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.
- **Auto gain of Guppy F-503 (CMOS model)** behaves like Guppy CCD cameras.

Brightness (black level or offset)

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

CCD models and Guppy F-503 (CMOS model): 0...+16 gray values (@ 8 bit)

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

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

Guppy F-036 (CMOS model): -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 Read: read a status 0: OFF 1: ON
		A_M_MODE	[7]	Write: set mode Read: read current mode 0: MANUAL 1: AUTO
		---	[8..19]	Reserved
		Value	[20..31]	Read/Write Value; this field is ignored when writing the value in Auto or OFF mode; if readout capability is not available reading this field has no meaning

Table 39: CSR: **Brightness**

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 Guppy 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.

Note

Target grey level parameter in SmartView corresponds to **Auto_exposure** register 0xF0F00804 (IIDC).

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

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

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

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

Note

Minimum shutter time for **interlaced models in Format_7 Mode_1** is limited to the duration time of one field (33/25 ms) see description of **Shutter (integration)** parameter in Table 31: Format_7 Mode_1: output parameters (interlaced, frame) on page 82.

Note

Configuration

To configure this feature in an advanced register: See Table 117: Advanced register: Auto shutter control on page 246.

Look-up table (LUT) and gamma function

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

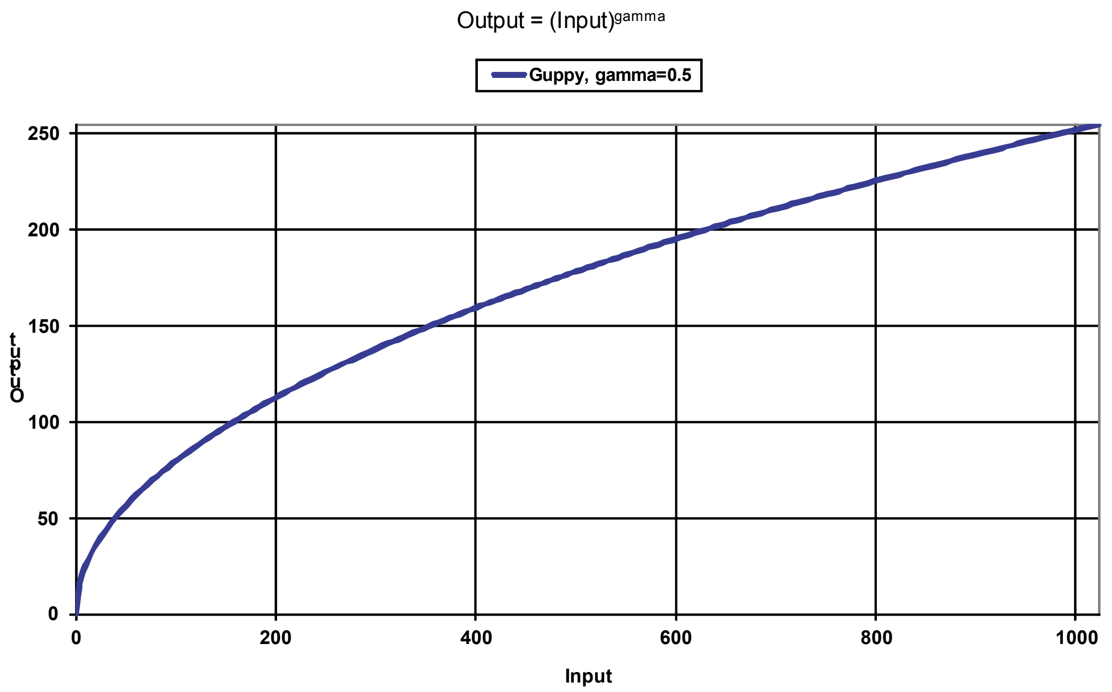


Figure 61: LUT with gamma=0.5

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.
- **Guppy F-036 (CMOS model)** has the gamma function built in the sensor, so that it will not be overridden.
- **Guppy F-503 (CMOS model)** behaves like Guppy CCD cameras.
- LUT content is volatile.

Loading an LUT into the camera

Loading the LUT is carried out through the data exchange buffer called GPDATA_BUFFER. As this buffer can hold a maximum of 2 kB, and a complete LUT at 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.

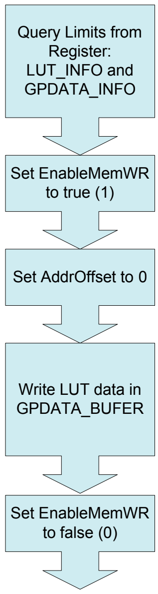


Figure 62: Loading an LUT

Note

Configuration

- To configure this feature in an advanced register: See Table 113: Advanced register: LUT on page 240.
- Information on GPDATA_BUFFER: See Chapter GPDATA_BUFFER on page 257.

Defect pixel correction (only Guppy F-503B/C)

The mechanisms of defect pixel correction are explained in the following drawings. All examples are done in Format_7 Mode_0 (full resolution).

The first two examples are explained for b/w cameras, the third example is explained for color cameras.

The **X** marks a defect pixel.

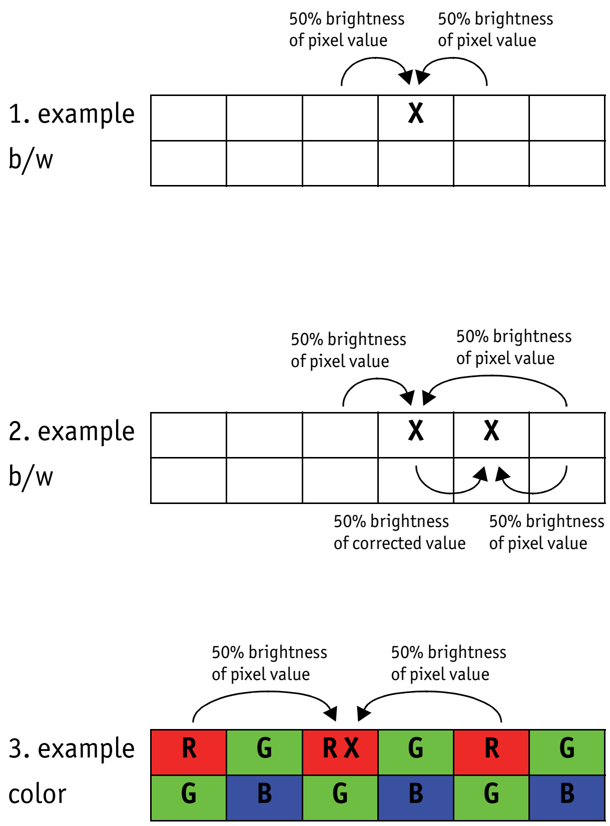


Figure 63: Mechanisms of defect pixel correction

The following flow diagram illustrates the defect pixel correction:

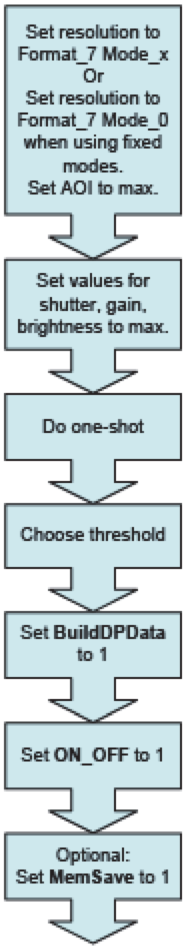


Figure 64: Defect pixel correction: build and store

Note

While building defect pixel correction data or uploading them from host, the defect pixel correction data are stored **volatile** in FPGA.

Optional you can store the data in EEPROM **non-volatile** (Set MemSave to 1).

Note

Configuration

To configure this feature in an advanced register: See Table 115: Advanced register: Defect pixel correction on page 243.

Building defect pixel data

Note

- Defect pixel correction is **only possible** in **Mono8 modes for monochrome cameras** and **Raw8 modes for color cameras.**
- In all other modes you get an error message in advanced register 0xF1000298 bit [1] see Table 115: Advanced register: Defect pixel correction on page 243.
- Using Format_7 Mode_x: Defect pixel correction is done in **Format_7 Mode_x.**
- Using a fixed format (Format_0, Format_1 or Format_2): Defect pixel correction is done in **Format_7 Mode_0.**
- When using defect pixel correction with **binning** and **sub-sampling**: first switch to binning/sub-sampling mode and then apply defect pixel correction.

To build defect pixel data perform the following steps:

Grab an image with defect pixel data

1. Take the camera, remove lens and put on lens cap.
2. Set image resolution to Format_7 Mode_x or Format_7 Mode_0 (when using fixed modes) and set AOI to maximum.
3. Set values for shutter, gain and brightness (offset) to maximum.
4. Grab a single image (one-shot).

Calculate defect pixel coordinates

5. Accept default threshold from system or choose own threshold.

Note

A mean value is calculated over the entire image that was grabbed previously.

Definition: A defect pixel is every pixel value of this previously grabbed image that is:

- greater than (mean value + threshold)

or

- less than (mean value - threshold)

6. Set the **BuildDPData** flag to 1.

   In microcontroller the defect pixel calculation is started. The detected defect pixel coordinates are stored in the dual port RAM of the FPGA.

   Defect pixel coordinates are:

   – 16-bit y-coordinate and

   – 16-bit x-coordinate

DPC data are organized like this:

31 16	15 0
y-coordinate	x-coordinate

The calculated mean value is written in advanced register **Mean** field (0xF1000298 bit [18..24]).

The number of defect pixels is written in advanced register **DPDataSize** (0xF100029C bit [4..17]). Due to 16-bit format: to get the number of defect pixels read out this value and divide through 4. For more information see Table 115: Advanced register: Defect pixel correction on page 243.

Reset values (resolution, shutter, gain, brightness)

7. Take the camera, remove lens cap and thread the lens onto the camera.
8. Reset values for image resolution, shutter, gain and brightness (offset) to their previous values.
9. Grab a single image (one-shot).

Activate/deactivate defect pixel correction

Activate:

1. Set **ON_OFF** flag to **1**.

   The defect pixel correction is activated in FPGA.

Deactivate:

1. Set **ON_OFF** flag to **0**.

   The defect pixel correction is deactivated in FPGA.

Store defect pixel data non-volatile

1. Set the **MemSave** flag to **1**.

   All previous calculated defect pixel coordinates are transferred from the dual port RAM to the EEPROM on the sensor board.

   ⇨ Defect pixel data is stored twice in the camera:
   - Stored volatile: in dual port RAM
   - Stored non-volatile: in EEPROM

Load non-volatile stored defect pixel data

1. Set the **MemLoad** flag to 1.

   All non-volatile stored defect pixel coordinates within the EEPROM are loaded into the dual port RAM.

Note

- Switch off camera and switch on again:
⇨ defect pixel data in dual port RAM will get lost, but are loaded automatically from EEPROM to dual port RAM during initialization (only if stored in EEPROM before switch off)
- Initialize camera (start-up or soft reset):
⇨ non-volatile stored defect pixel data are loaded automatically from EEPROM to dual port RAM.

Send defect pixel data to the host

1. Set **EnaMemRD** flag to **1**.

   Defect pixel data is transferred from dual port RAM to host.
2. Read **DPDataSize**.

   This is the current defect pixel count from the camera.

Receive defect pixel data from the host

1. Set **EnaMemWR** flag to **1**.

   Defect pixel data is transferred from host to dual port RAM.

DPC data: storing mechanism

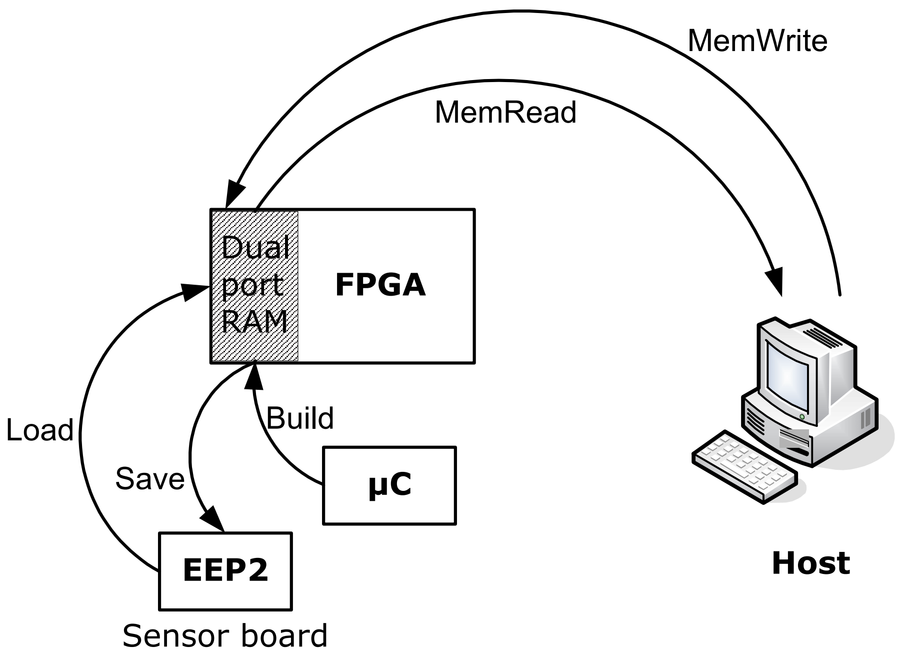


Figure 65: DPC data: storing mechanism

Note

All DPC data transfers between PC and camera run through GPData buffer. Block writes are thus limited by the GPData buffer size.

See Chapter GPDATA_BUFFER on page 257.

Binning (only Guppy F-036B and Guppy F-503B/C)

2 x and 4 x binning

Definition

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

Note

Only **Guppy F-036B and Guppy F-503B/C cameras** have this feature.

Guppy F-036: only b/w cameras

Guppy F-503: b/w and color cameras

Binning is used primarily for 3 reasons:

- A reduction in the number of pixels; thus, the amount of data while retaining the original image area angle
- An increase in the frame rate (vertical binning only)
- A brighter image, resulting in an improvement in the signal-to-noise ratio of the image (depending on the acquisition conditions)

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.

Only Format_7

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

Types

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:

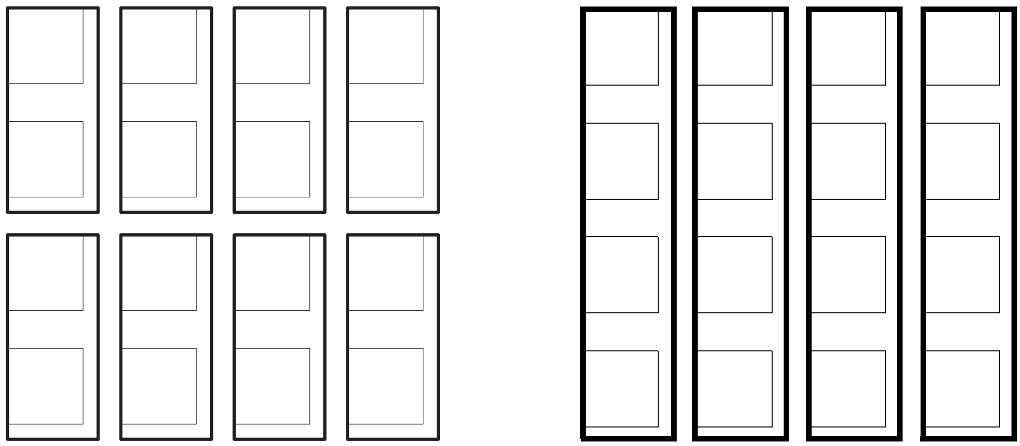
- 2 x full binning (a combination of 2 x H-binning and 2 x V-binning)

- 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

Binning mode	Guppy F-036B	Guppy F-503B/C
2 x vertical binning	2 pixel signals from 2 vertical **neighboring pixels** are combined and their signals are **averaged**.	2 pixel signals from 2 vertical **adjacent same-color 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**.	4 pixel signals from 4 vertical **adjacent same-color pixels** are combined and their signals are **averaged**.
Averaged? or Additive?	Only averaged	Only averaged
Because the signals are averaged, the image will not be brighter than without binning.		

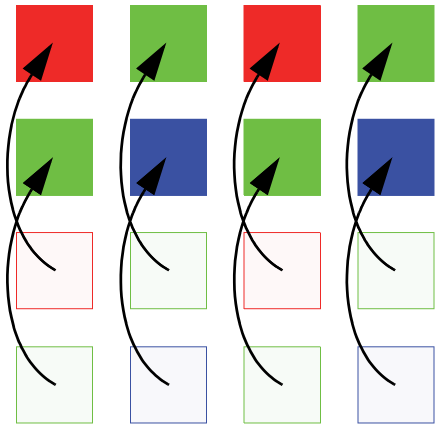
Table 41: Definition of 2 x and 4 x vertical binning



2 x vertical binning

4 x vertical binning

Figure 66: 2 x vertical binning and 4 x vertical binning (**Guppy F-036**)



2 x vertical binning (b/w and color)

Figure 67: 2 x vertical binning (**Guppy F-503**)

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**. (Guppy F-036B)

Note

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

Note

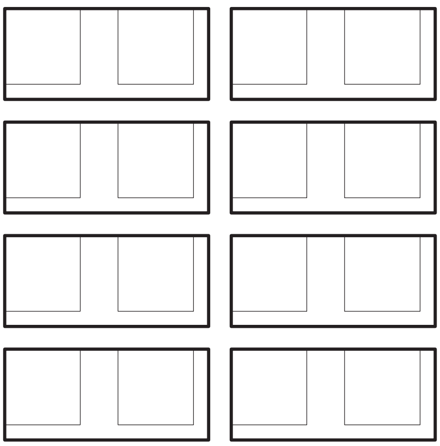
The frame rates in the vertical binning modes are lower than the frame rates in the corresponding AOI resolution.

Example: In the 2 x vertical binning mode, the camera outputs images with 240 lines, but the frame rates are lower than the AOI frame rates with an AOI height of 240.

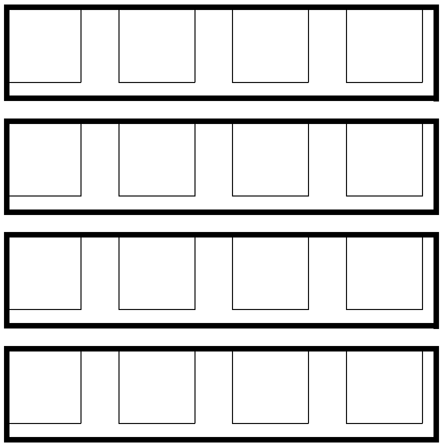
2 x horizontal binning and 4 x horizontal binning

Binning mode	Guppy F-036B	Guppy F-503B/C
2 x horizontal binning	2 pixel signals from 2 vertical **neighboring pixels** are combined and their signals are **averaged**.	2 pixel signals from 2 vertical **adjacent same-color pixels** are combined and their signals are **added** or **averaged**.
4 x horizontal binning	4 pixel signals from 4 vertical **neighboring** pixels are combined and their signals are **averaged**.	4 pixel signals from 4 vertical **adjacent same-color pixels** are combined and their signals are **added** or **averaged**.
Averaged? or Additive?	Only averaged	Default: additive There is also an average binning mode implemented. To activate this mode see Chapter Low noise binning mode (2 x and 4 x binning) (only Guppy F-503) on page 256
When the signals are **averaged**, the image will **not be brighter** than without binning. When the signals are **added**, the image will be **brighter** than without binning.		

Table 42: Definition of 2 x and 4 x horizontal binning

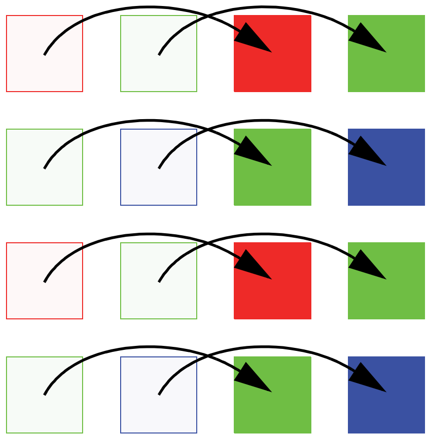


2 x horizontal binning



4 x horizontal binning

Figure 68: 2 x horizontal binning and 4 x horizontal binning (**Guppy F-036**)



2 x horizontal binning (b/w and color)

Figure 69: 2 x horizontal binning (**Guppy F-503**)

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), (**Guppy F-503**: if low noise binning mode is activated).

Guppy F-036B and Guppy F-503B/C:

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

Guppy F-036B:

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.

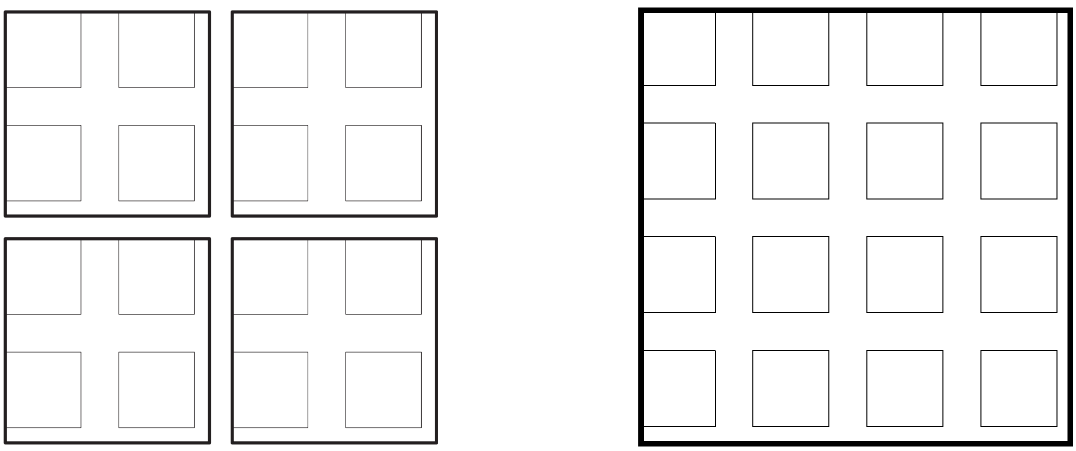
2 x full binning and 4 x full binning

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.

Binning mode	Guppy F-036B	Guppy F-503B/C
2 x full binning	4 pixel signals from 2 **adjacent rows and columns** are combined and their signals are **averaged**.	4 pixel signals from 2 vertical **adjacent rows and columns (same-color pixels)** are combined and their signals are horizontally **added/ averaged** and vertically **averaged**.
4 x full binning	16 pixel signals from 4 vertical **adjacent rows and columns** are combined and their signals are **averaged**.	16 pixel signals from 4 vertical **adjacent rows and columns (same-color pixels)** are combined and their signals are horizontally **added/ averaged** and vertically **averaged**.
Averaged? or Additive?	Only averaged	Horizontal: additive Vertical: averaged
When the signal is **averaged**, the image will **not be brighter** than without binning. When the signal is **additive**, the image will **be brighter** than without binning.		

Table 43: Definition of 2 x and 4 x full binning



2 x full binning 4 x full binning

Figure 70: Full binning (**Guppy F-036**)

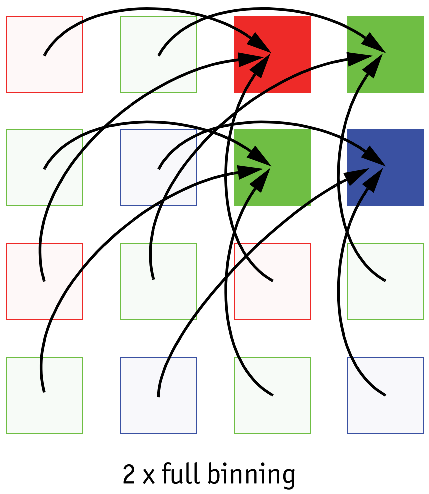


Figure 71: Full binning (**Guppy F-503**)

Note

Signal-to noise ratio (SNR) is increased by about:

Guppy F-036: 6 or 12 dB (2 x full or 4 x full binning)

Guppy F-503: 3 or 6 dB (2 x full or 4 x full binning)

Guppy F-036B and Guppy F-503B/C:

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

Guppy F-036B:

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

Sub-sampling (only Guppy F-503B/C)

What is sub-sampling?

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

Which Guppy models have sub-sampling?

All **Guppy F-503** models, both color and b/w, have this feature.

Description of sub-sampling

Sub-sampling is used primarily for the following reason:

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

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

Format_7 Mode_4 By default and without further remapping use **Format_7 Mode_4** for

- b/w cameras: 2 out of 4 horizontal sub-sampling
- color cameras: 2 out of 4 horizontal sub-sampling

The different sub-sampling patterns are shown below.

2 out of 4

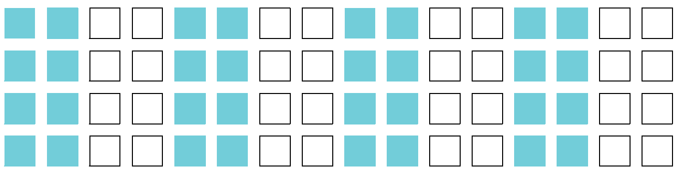


Figure 72: Horizontal sub-sampling 2 out of 4 (**b/w**)

2 out of 8

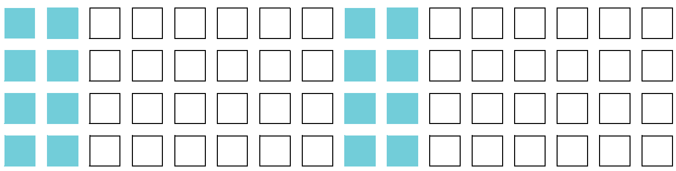


Figure 73: Horizontal sub-sampling 2 out of 8 (**b/w**)

2 out of 4

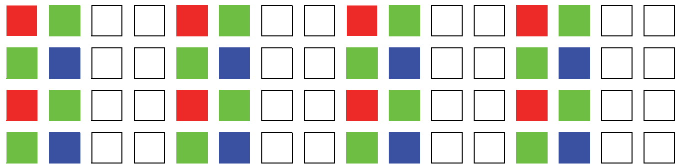


Figure 74: Horizontal sub-sampling 2 out of 4 (**color**)

2 out of 8

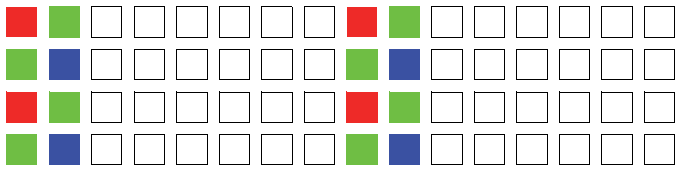


Figure 75: Horizontal sub-sampling 2 out of 8 (**color**)

Note

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

Format_7 Mode_5 By default and without further remapping use **Format_7 Mode_5** for

- **b/w** cameras: 2 out of 4 vertical sub-sampling
- **color** cameras: 2 out of 4 vertical sub-sampling

The different sub-sampling patterns are shown below.

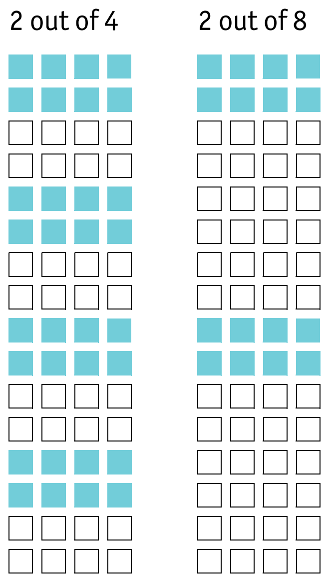


Figure 76: Vertical sub-sampling (**b/w**)

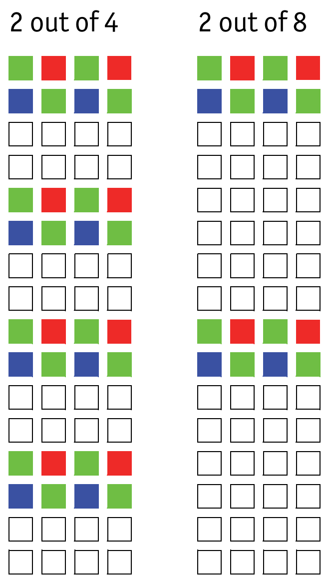


Figure 77: Vertical sub-sampling (**color**)

Note

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

Format_7 Mode_6

By default and without further remapping use **Format_7 Mode_6** for 2 out of 4 H+V sub-sampling

The different sub-sampling patterns are shown below.

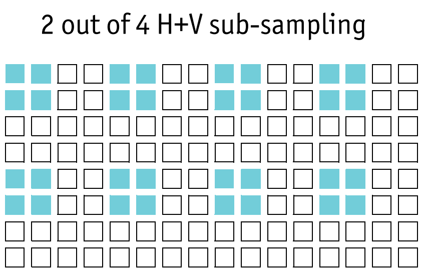


Figure 78: 2 out of 4 H+V sub-sampling (**b/w**)

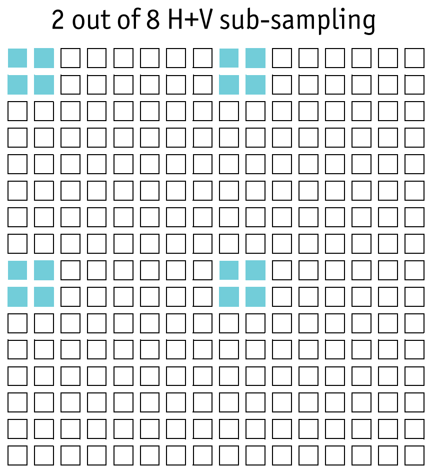


Figure 79: 2 out of 8 H+V sub-sampling (**b/w**)

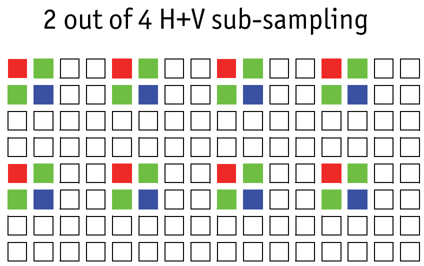


Figure 80: 2 out of 4 H+V sub-sampling (**color**)

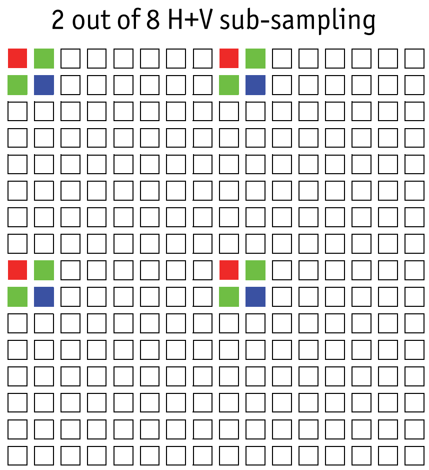


Figure 81: 2 out of 8 H+V sub-sampling (**color**)

Note

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

Binning and sub-sampling access (only Guppy F-503)

The binning and sub-sampling modes described in the last two chapters are only available as pure binning or pure sub-sampling modes. A combination of both is not possible.

As you can see there is a vast amount of possible combinations. But the number of available Format_7 modes is limited and lower than the possible combinations.

Thus access to the binning and sub-sampling modes is implemented in the following way:

- **Format_7 Mode_0** is fixed and cannot be changed
- A maximum of 7 individual Allied Vision modes can be mapped to **Format_7 Mode_1** to **Mode_7**
  (see *Figure 82: Mapping of possible Format_7 modes to F7M1...F7M7* on page 127)
- Mappings can be stored via register (see Chapter Format_7 mode mapping (only Guppy F-503) on page 255) and are uploaded automatically into the camera on camera reset.
- The **default settings** (per factory) in the Format_7 modes are listed in the following table:

Format_7	Guppy F-503B cameras Format_7	Guppy F-503C cameras Format_7
Mode_0	full resolution, no binning, no sub-sampling	full resolution, no binning, no sub-sampling
Mode_1	2 x **horizontal** binning	2 x **horizontal** binning
Mode_2	2 x **vertical** binning	2 x **vertical** binning
Mode_3	2 x **full** binning	2 x **full** binning
Mode_4	2 out of 4 **horizontal** sub-sampling	2 out of 4 **horizontal** sub-sampling
Mode_5	2 out of 4 **vertical** sub-sampling	2 out of 4 **vertical** sub-sampling
Mode_6	2 out of 4 **full** sub-sampling	2 out of 4 **full** sub-sampling

Table 44: Default Format_7 binning and sub-sampling modes (per factory)

Note

- A **combination** of binning and sub-sampling modes is **not possible**.
  Use either pure binning or pure sub-sampling modes.
- The Format_ID numbers 0...26 in the binning / sub-sampling list on page 127 do **not** correspond to any of the Format_7 modes.

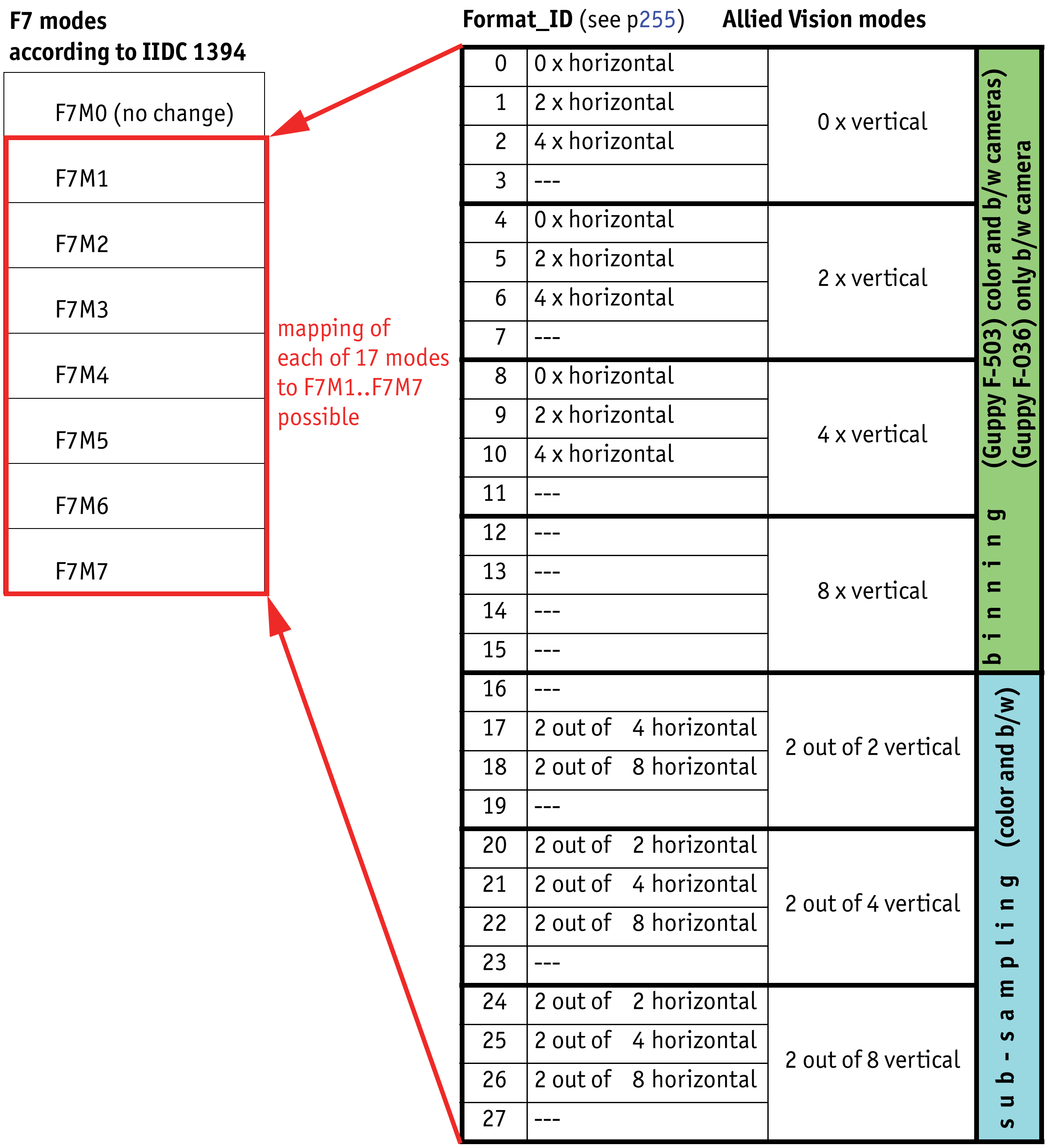


Figure 82: Mapping of possible Format_7 modes to F7M1...F7M7

Note

Configuration

To configure this feature in an advanced register: See Table 126: Advanced register: Format_7 mode mapping on page 255.

Packed 12-Bit Mode

Definition Guppy F-146B and F-503B have the so-called **Packed 12-Bit Mode**. This means: two 12-bit pixel values are packed into 3 bytes instead of 4 bytes.

B/w cameras	Color cameras
Packed 12-Bit MONO camera mode SmartView: MONO12	**Packed 12-Bit RAW** camera mode SmartView: RAW12
Mono and raw mode have the same implementation.	

Table 45: **Packed 12-Bit Mode**

Note

For data block packet format see Table 28: Packed 12-Bit Mode (mono and raw) Y12 format from Allied Vision on page 72.

For data structure see Table 29: Data structure of Packed 12-Bit Mode (mono and raw) from Allied Vision on page 74.

The color codings are implemented via Vendor Unique Color_Coding according to IIDC V1.31: COLOR_CODING_INQ @ 024h...033h, IDs=128-255)

See Table 102: Format_7 control and status register on page 226.

Mode	Color_Coding	ID
Packed 12-Bit MONO	ECCID_MONO12	ID=132
Packed 12-Bit RAW	ECCID_RAW12	ID=136

Table 46: **Packed 12-Bit Mode**: color coding

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

The HDR mode is available for the **Guppy F-036** cameras with the Micron/Aptina 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/Aptina'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 is controlled 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.

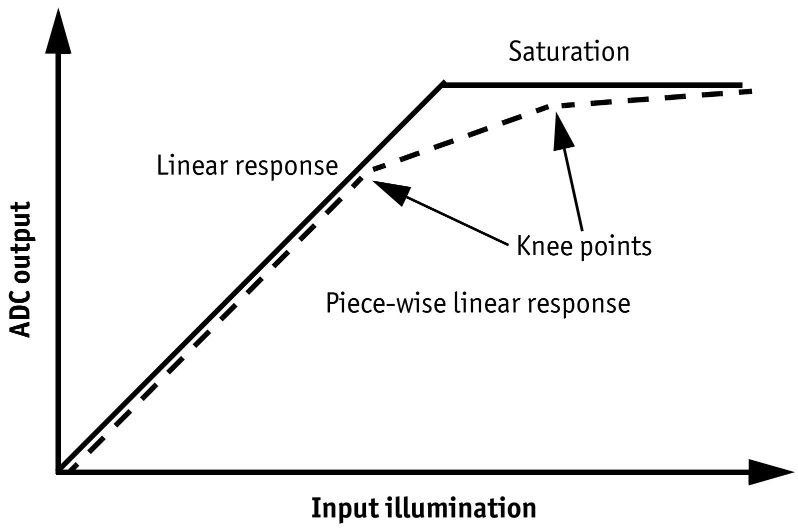


Figure 83: HDR response curves

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:

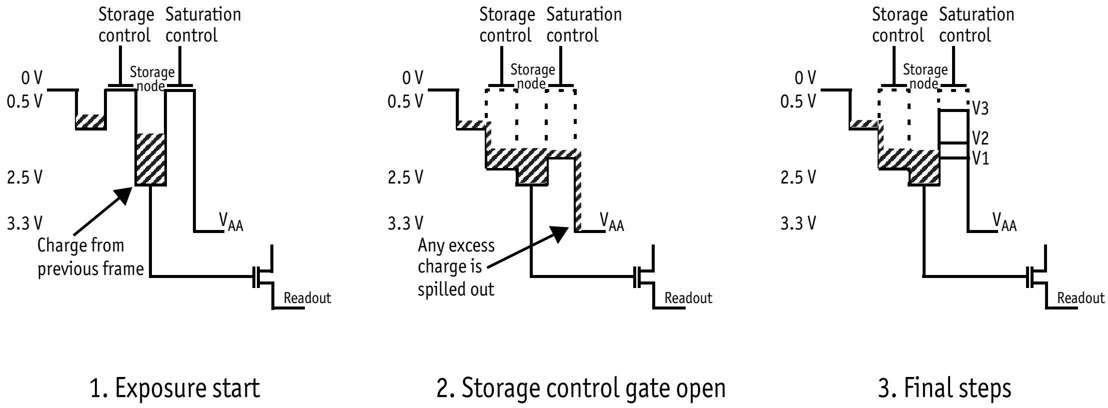


Figure 84: Details of pixel operations

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.

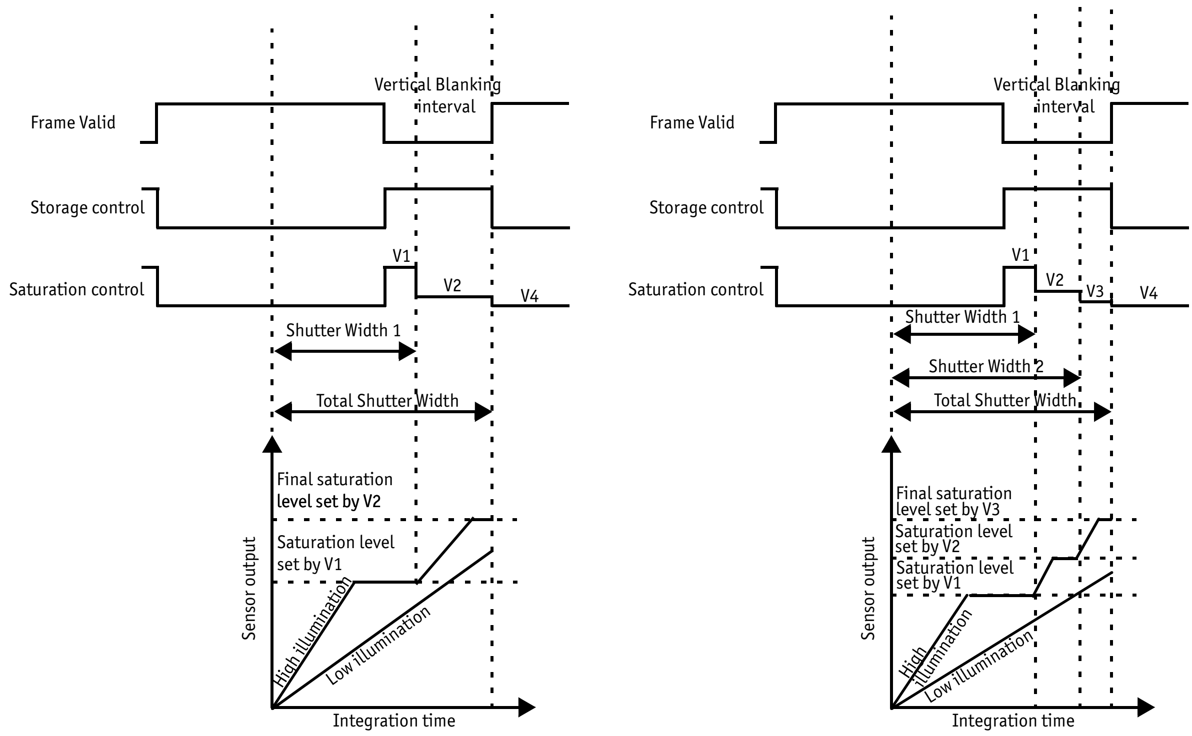


Figure 85: Single knee situation (left) and two knee point situation (right)

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.

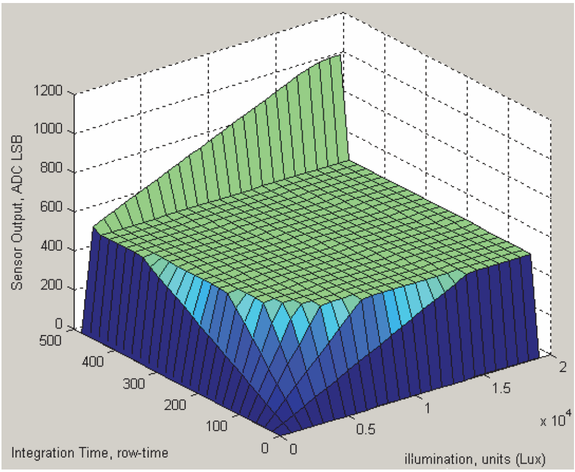
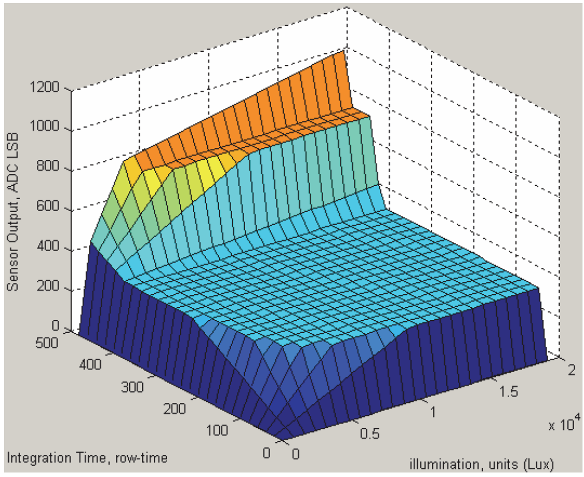
Setting one knee point	Setting two knee points
In **single knee automatic exposure mode,** the placement of a single knee point is set automatically.	In **two knee automatic exposure mode**, the placement of the two knee points is set automatically.
	
Pixel output response for one knee operation	Pixel output response for two knee operation

Table 47: Setting knee points and pixel output response

Effects of a HiDy sensor

The Micron/Aptina 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).

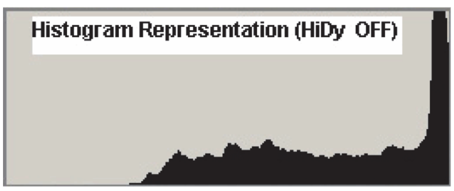
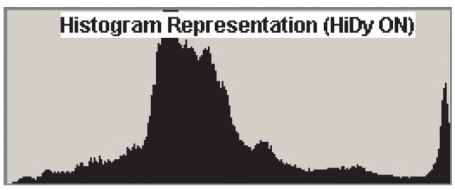
Histogram (HiDy off)	Histogram (HiDy on)
	
This is a histogram example from an outdoor scene taken with HiDy off (left) and HiDy on (right). The HiDy mode is able to show details in both the bright and dark areas to be resolved in a single image.	

Table 48: 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 49: 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)

Definition

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.

No color interpolation

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**.
- For Guppy F-503C the first pixel of the sensor is **GREEN**.
- For interlaced Guppy cameras 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 and **MAGENTA** change every second line.
  (Guppy F-038C, Guppy F-038C NIR, Guppy F-044C, Guppy F-044C NIR)

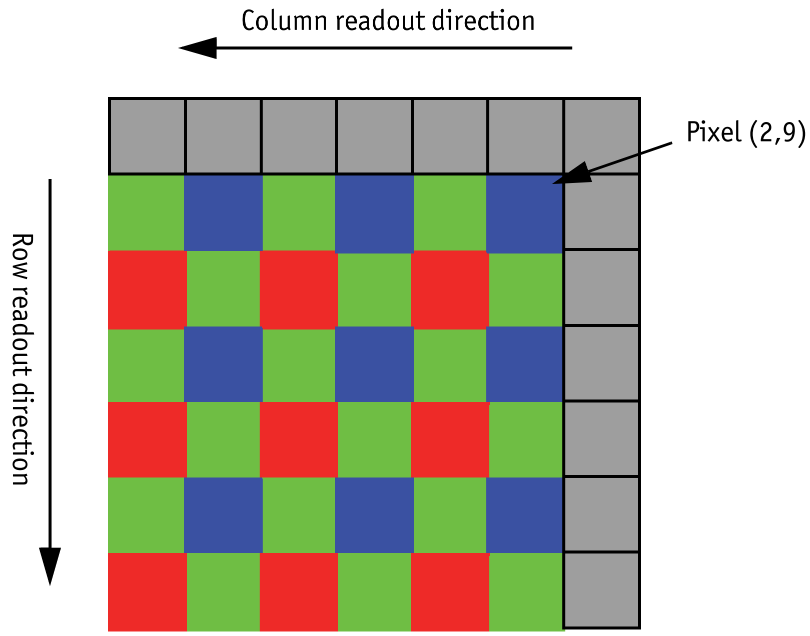


Figure 86: Bayer pattern of Guppy F-036C

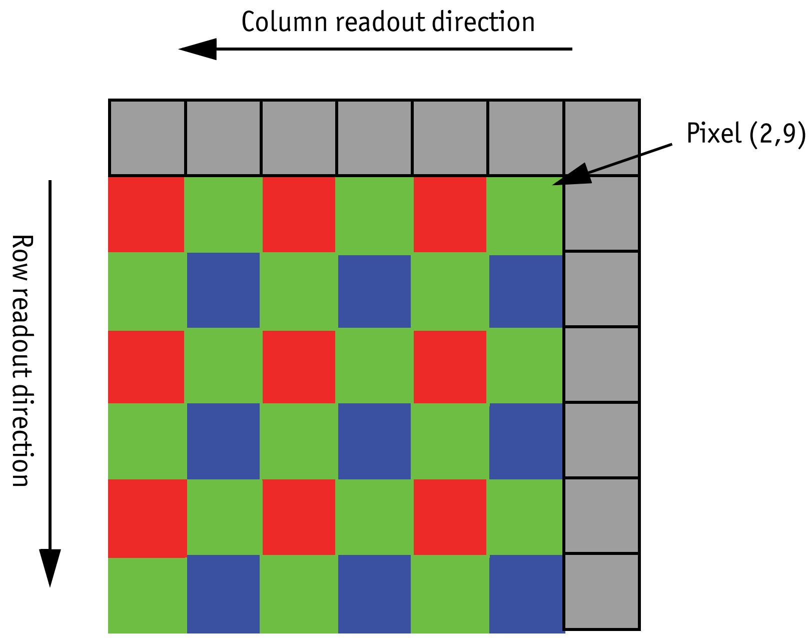


Figure 87: Bayer pattern of Guppy F-503C

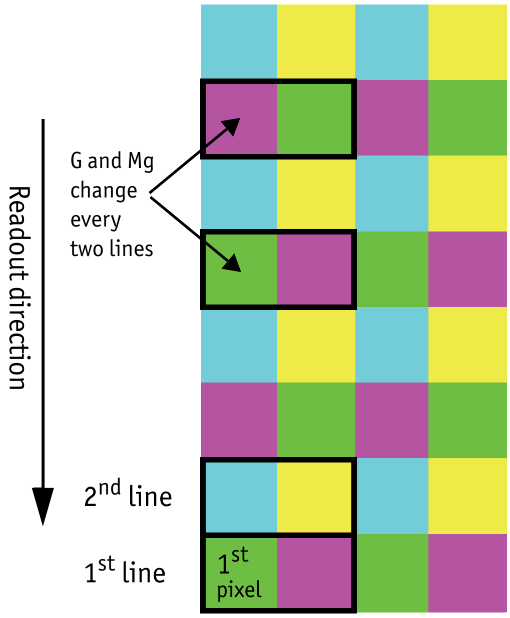


Figure 88: BAYER pattern of SONY complementary sensors: 1st line: G - Mg, 2nd line: Cy - Ye

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 data of the serial interface is put in a camera buffer and can be polled via simple read commands from this buffer. Controlling registers enable the settings of baud rates and the check of buffer sizes and serial interface errors.

Note

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

Base address for the function is: F0F02100h.

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

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

Table 50: Serial input/output control and status register (SIO CSR)

Offset	Name	Field	Bit	Description
0004h	SERIAL_CONTROL_REG	RE	[0]	Receive enable RD: Current status WR: 0: disable 1: Enable
		TE	[1]	Transmit enable RD: Current status WR: 0: disable 1: Enable
		-	[2..7]	Reserved
	SERIAL_STATUS_REG	TDRD	[8]	Transmit data buffer ready Read only 0: not ready 1: ready
		-	[9]	Reserved
		RDRD	[10]	Receive data buffer ready Read only 0: not ready 1: ready
		-	[11]	Reserved
		ORER	[12]	Receive data buffer overrun error Read: current status 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 50: Serial input/output control and status register (SIO CSR)

Offset	Name	Field	Bit	Description
008h	RECEIVE_BUFFER_STA-TUS_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	TRANS-MIT_BUFFER_STA-TUS_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 50: Serial input/output control and status register (SIO CSR)

To read data:

1. Query RDRD flag (buffer ready?) and write the number of bytes the host wants to read to RBUF_CNT.
2. Read the number of bytes pending in the receive buffer RBUF_ST (more data in the buffer than the host wanted to read?) and the number of bytes left for reading from the receive FIFO in RBUF_CNT (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.

To write data:

1. Query TDRD flag (buffer ready?) and write the number of bytes to send (copied from SIO register to transmit FIFO) to TBUF_CNT.
2. Read the available data space left in TBUF_ST (if the buffer can hold more bytes than are to be transmitted) and number of bytes written to transmit buffer in TBUF_CNT (if more data 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.
- Allied Vision recommends the use of Hyperterminal™ or other communication programs to test the functionality of this feature. Alternatively use SmartView to try out this feature.

Controlling image capture

Global shutter (CCD cameras only)

Shutter modes The cameras support the SHUTTER_MODES specified in IIDC V1.3. For all Guppy models (except Guppy F-036/503) 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.

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

External trigger 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.

Camera I/O The external trigger comes in as a TTL signal through **Pin 4** of the camera I/O connector.

Pipelined global shutter (only Guppy F-036)

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

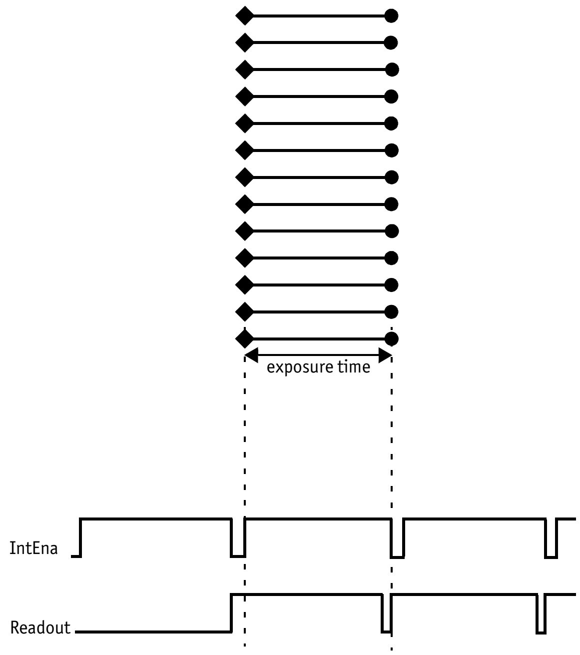
Shutter mode Guppy F-036	Description
Pipelined global shutter 	**Advantage:** designed for high frame rate and high sensitivity; behaves like CCD sensor **How it works:** • exposure time is the same for all rows • start of exposure is the same for each row ⇨ same behavior as Guppy CCD models

Table 51: Guppy F-036 shutter mode

Electronic rolling shutter (ERS) and global reset release shutter (GRR) (only Guppy F-503)

The CMOS Guppy F-503 (Micron/Aptina CMOS sensor MT9P031) has an **electronic rolling shutter (ERS)** and **a global reset release shutter (GRR)** but no global shutter.

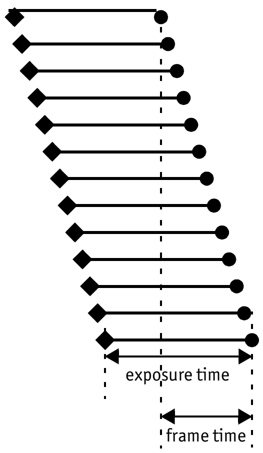
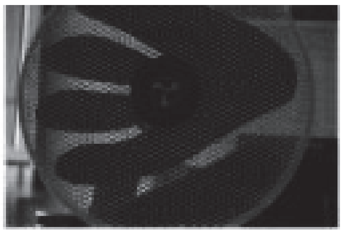
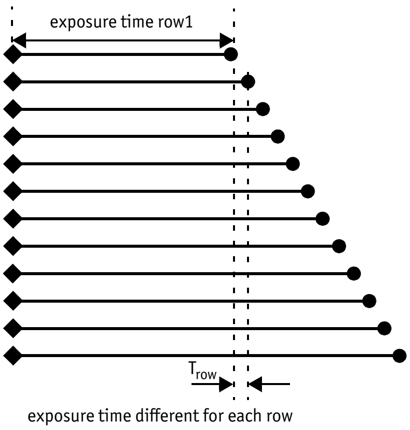
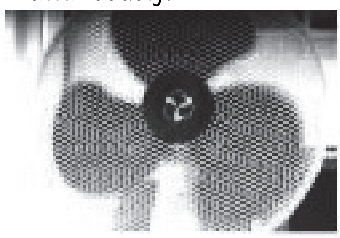
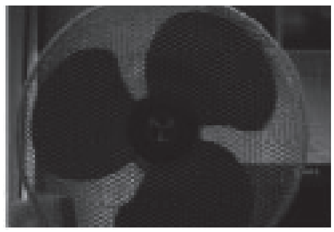
Shutter mode Guppy F-503	Description
Electronic rolling shutter (ERS)  	**Advantage:** designed for maximum frame rates **How it works:** • exposure time is the same for all rows • start of exposure is different for each row ⇨ This can cause a shear in moving objects, see photo below. **Customer action:** Use this mode only in situations with non-moving objects. 
Global reset release shutter (GRR)  	**Advantage:** designed for situations with moving objects; use this mode to avoid the problems with ERS described above **How it works:** Image acquisition is done by starting all rows exposures at the same time. ⇨ So there is no shear in moving objects. • exposure time is different for each row • start of exposure is the same for each row **Customer action:** Different exposure time for each row will result in images which get brighter with each row (see photo below left). In order to get an image with uniform illumination, use special lighting (flash) or mechanical/LCD extra shutter (see photo below right) which will stop the exposure of all rows simultaneously.  

Table 52: Guppy F-503 shutter modes

Trigger modes

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

Note

- **CMOS cameras Guppy F-036 / Guppy F-503** support only Trigger_Mode_0.
- **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_x ...	...also known as	Description
Trigger_Mode_0	Edge mode	Sets the shutter time according to the value set in the **shutter** (or extended shutter) **register**
Trigger_Mode_1	Level mode	Sets the shutter time according to the **active low time** of the pulse applied (or active high time in the case of an inverting input)
Trigger_Mode_15	Programmable mode	Is a **bulk trigger**, combining one external trigger event with continuous or one-shot or multi-shot internal trigger

Table 53: Trigger modes

Trigger_Mode_0 (edge mode) and Trigger_Mode_1 (level mode)

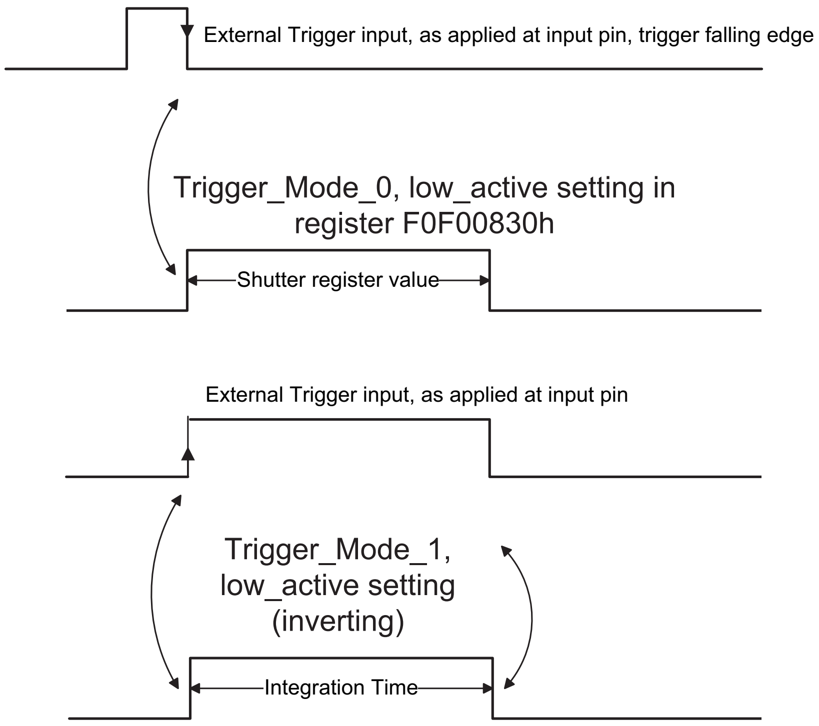


Figure 89: Trigger_Mode_0 and 1: global shutter (CCD only)

The Guppy F-503 has two shutter modes:
- electronic rolling shutter (ERS) and
- global reset release shutter (GRR)

Note

With this two shutter modes only Trigger_Mode_0 is possible. Details are explained in the following diagrams.

Guppy F-503, Trigger_Mode_0, electronic rolling shutter

- IntEna is high, when all pixels are integrated simultaneously.
- IntEna starts with start of exposure of last row.
- IntEna ends with end of exposure of first row.

⇨ No IntEna if exposure of first row ends before the last row starts.

Long exposure time:

To get an IntEna signal the following condition must be true:

$$T_{exp\ eff.} = T_{exp} - T_{frame} > 0$$

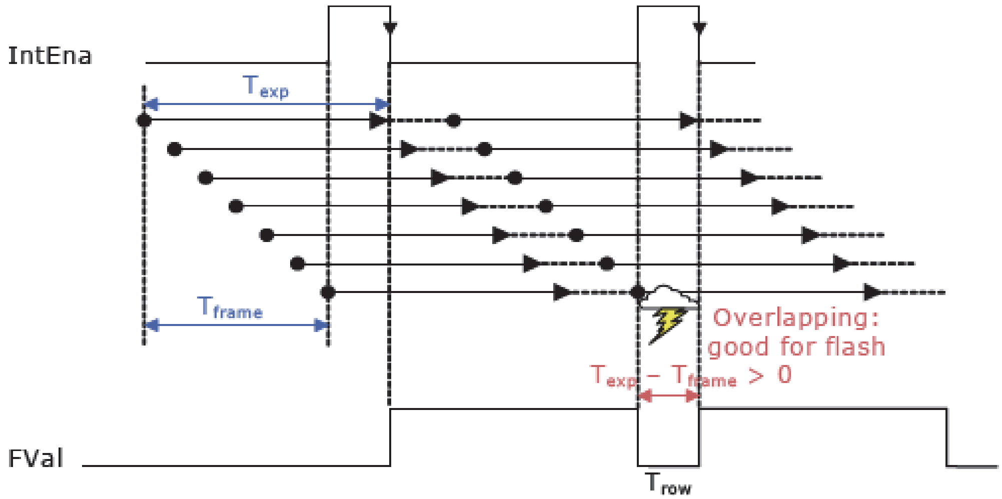


Figure 90: Trigger_Mode_0: Guppy F-503 electronic rolling shutter (**long** exposure time)

Short exposure time:

If the following condition is true:

$T_{exp\ eff.} = T_{exp} - T_{frame} < 0$

then you don’t get an IntEna signal and triggering is not possible.

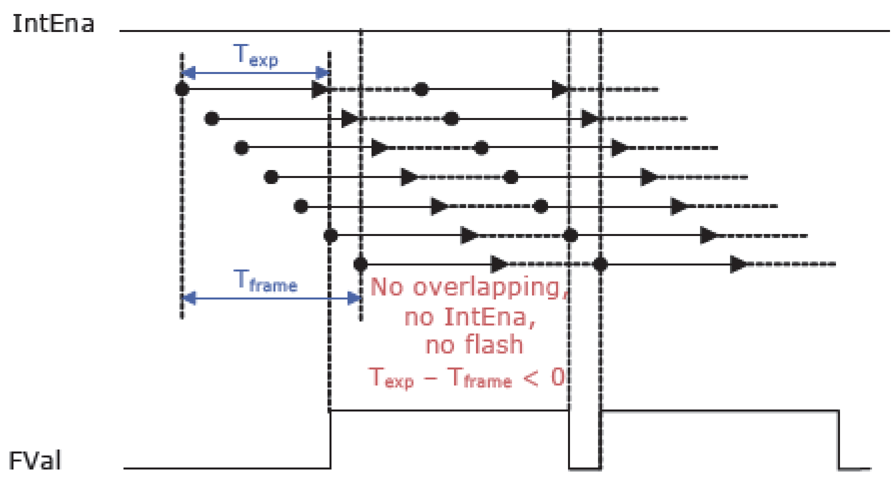


Figure 91: Trigger_Mode_0: Guppy F-503 electronic rolling shutter (**short** exposure time)

Guppy F-503, Trigger_Mode_0, global reset release shutter

Note

For activating **global reset release shutter** in an advanced register see Table 128: Advanced register: Global reset release shutter on page 257.

- IntEna is high, when all pixels are integrated simultaneously.
- Readout starts with end of exposure of first row.
- Readout ends with (end of exposure of last row) + (1x T_{row}).

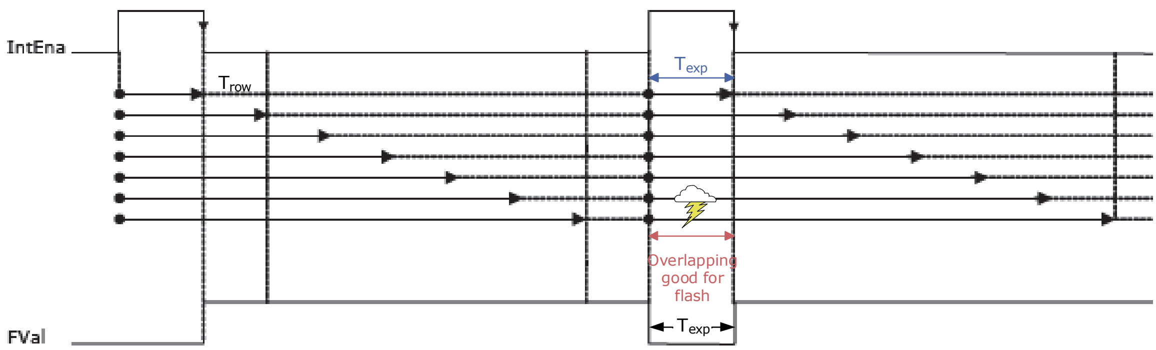


Figure 92: Trigger_Mode_0: Guppy F-503: global reset release shutter

Exposure time of first row is:	T_{exp}
Exposure time of second row is:	$T_{exp} + T_{row}$
Exposure time of n-th row is:	T_{exp} + (n-1) x T_{row}

Thus the image gets brighter with every row. To prevent this the customer should use:

- flash (when all rows are overlapping, see drawing above)
- or a mechanical/LCD shutter

Trigger_Mode_15 (bulk trigger)

Note

Trigger_Mode_15 is only available for Guppy CCD cameras.

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.

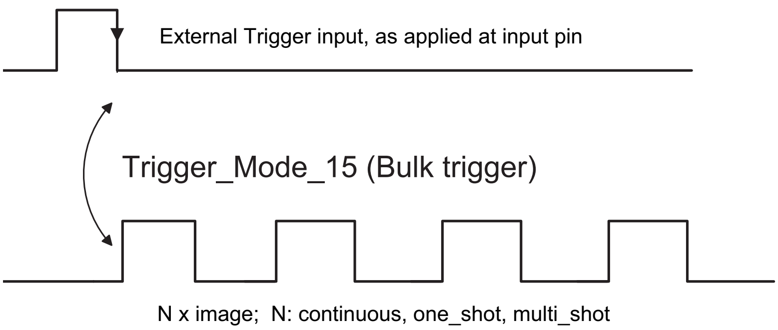


Figure 93: Trigger_Mode_15

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 Read: read a status 0: OFF 1: ON If this bit = 0, other fields will be read only.
		Trigger_Polarity	[7]	Select trigger polarity (Except for software trigger) If Polarity_Inq is 1: Write to change polarity of the trigger input. Read to get polarity of the trigger input. If Polarity_Inq is 0: Read only. 0: Low active (inverting) input 1: High active input
		Trigger_Source	[8..10]	Select trigger source Set trigger source ID from trigger source ID_Inq
		Trigger_Value	[11]	Trigger input raw signal value read only 0: Low 1: High
		Trigger_Mode	[12..15]	Trigger_Mode (Trigger_Mode_0..15)
		---	[16..19]	Reserved
		Parameter	[20..31]	Parameter for trigger function, if required (optional)

Table 54: 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 = continuous	Middle = one-shot	Right = multi-shot
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 55: Description: using Trigger_Mode_15: continuous, one-shot, multi-shot

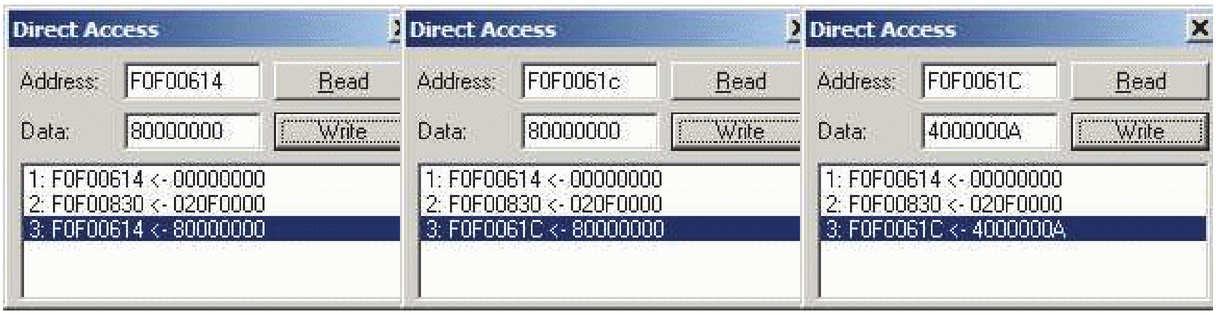


Figure 94: Using Trigger_Mode_15: continuous, one-shot, multi-shot

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

Table 56: Trigger delay inquiry register

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 If you write the value in OFF mode, this field will be ignored. If **ReadOut** capability is not available, then the read value will have no meaning.

Table 57: CSR: **trigger delay**

Trigger delay advanced register

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

Register	Name	Field	Bit	Description
0xF1000400	TRIGGER_DELAY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Trigger delay on/off
		---	[7..10]	Reserved
		DelayTime	[11..31]	Delay time in µs (only with microcontroller firmware greater V2.10: minimum = 1 µs)

Table 58: Advanced CSR: **trigger delay**

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 110: Time base ID on page 237). The default value here is set to 20 µs.

Exposure time of Guppy F-036 (CMOS)

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.

Exposure time of Guppy F-503 (CMOS)

The row time of Guppy F-503 depends on the shutter mode.

Guppy F-503 row time for global reset release shutter (GRR)

In global reset release shutter the formula for the row time is:

$$t_{row} = 11.97\text{ns} \times \text{width} + 10.77\mu\text{s}$$

Formula 6: Row time for Guppy F-503 (CMOS): GRR

The minimum row time and the row time by maximum resolution are:

$$t_{row\ min} = 11.63\mu\text{s}$$
$$t_{row\ max\ res} = 41.80\mu\text{s}$$

Formula 7: Min. row time and row time by max. resolution for Guppy F-503 (CMOS): GRR

Guppy F-503 row time for electronic rolling shutter (ERS)

In electronic rolling shutter the exposure time is independent from row time and is set via **Extended shutter** advanced register with µs precision.

For more information see Chapter Extended shutter on page 238 and Table 111: Advanced register: Extended shutter on page 238.

Minimum shutter time of Guppy F-036

Note The **minimum shutter time (without offset)** is **179 µs**.

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)

Example Guppy F-503

Set Shutter register: 100

100 x 20 µs = 2000 µs

2000 µs/41.8 µs = 47.85

Effective shutter:

47 x 41.8 µs = 1964.6 µs (without offset)

Exposure time offset

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

Camera model	Exposure time offset
Guppy F-033	109 µs
Guppy F-036	-21 µs
Guppy F-038	42 µs
Guppy F-038 NIR	42 µs
Guppy F-044	42 µs
Guppy F-044 NIR	42 µs
Guppy F-046	22 µs
Guppy F-080	34 µs
Guppy F-146	20 µs
Guppy F-503	-42 µs

Table 59: Camera-specific exposure time offset

Example Guppy F-033

Camera	Register value	Timebase
Guppy F-033	100	20 µs

Table 60: Register value and Timebase for Guppy F-033

100 x 20 µs + 109 µs = 2109 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 + 109 µs = 129 µs.

Extended shutter

The exposure time for long-term integration of:

- up to 67 seconds for the CCD models
- up to 979 ms for the Guppy F-036 (CMOS model)
- up to 2.3 seconds for the Guppy F-503 (CMOS model)

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]	Reserved
		ExpTime	[6..31]	Exposure time in µs

Table 61: Extended shutter configuration

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

Note

Minimum shutter time for **interlaced models in Format_7 Mode_1** is limited to the duration time of one field (33/25 ms) see description of **Shutter (integration)** parameter in Table 31: Format_7 Mode_1: output parameters (interlaced, frame) on page 82.

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 161), 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.

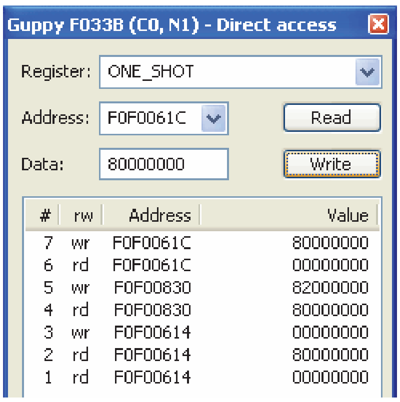


Figure 95: One-shot control (SmartView)

#	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 62: 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 63: 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).

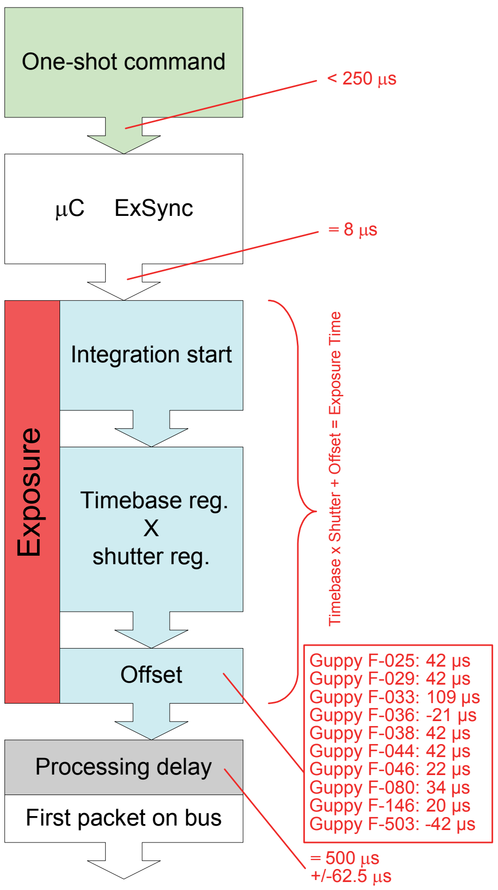


Figure 96: Data flow and timing after end of exposure (Guppy F-038/044 also NIR)

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 161), 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 162.

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

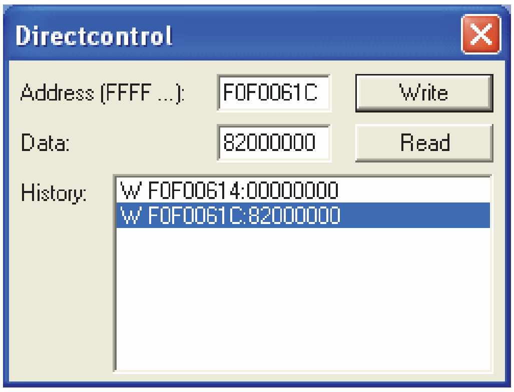


Figure 97: Broadcast one-shot

- 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/Aptina 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 more information see Chapter Pipelined global shutter (only Guppy F-036) on page 142.
- The **Micron/Aptina CMOS sensor** of the **Guppy F-503** uses an **electronic rolling shutter** and a **global reset release shutter.** For more information see Chapter Electronic rolling shutter (ERS) and global reset release shutter (GRR) (only Guppy F-503) on page 143.

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-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

Table 64: Jitter at exposure start

Model	Camera idle	Camera busy
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
Guppy F-503	11.97 ns	t_{row}

Table 64: 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 252.

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.
- **The following 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.
- For information on bit/pixel and byte/pixel for each color mode see Table 84: ByteDepth on page 193.

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 / Guppy F-033C

Format	Mode	Resolution	Color mode	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 494 656 x 494	MONO8 Raw8	@58 fps @58 fps					
	1								
	2								
	3								

Table 65: Video formats Guppy F-033B / Guppy F-033C

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

Guppy F-036B / Guppy F-036C

Format	Mode	Resolution	Color mode	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 480 752 x 480	MONO8 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 66: 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	Color mode	Max. frame rates in Format_7
7	0	768 x 492	MONO8	@30 fps, 2 x V-binning, interlaced, field integration mode
		768 x 492	Raw8	@30 fps, 2 x V-binning, interlaced, field integration mode (binned colors)
	1	768 x 492	MONO8	@30 fps, no binning, interlaced, frame integration mode
		768 x 492	Raw8	@30 fps, no binning, interlaced, frame integration mode
	2	384x244	MONO8	@59 fps, 2 x full binning for aspect ratio, non-interlaced, progressive readout mode

Table 67: 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	Color mode	Max. frame rates in Format_7
7	0	768 x 492	MONO8	@30 fps, 2 x V-binning, interlaced, field integration mode
		768 x 492	Raw8	@30 fps, 2 x V-binning, field integration mode (binned colors)
	1	768 x 492	MONO8	@30 fps, no binning, interlaced, frame integration mode
		768 x 492	Raw8	@30 fps, no binning, interlaced, frame integration mode
	2	384x244	MONO8	@59 fps, 2 x full binning for aspect ratio, non-interlaced, progressive readout mode

Table 68: 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	Color mode	Max. frame rate in Format_7
7	0	752 x 580	MONO8	@25 fps, 2 x V-binning, field readout mode
		752 x 580	Raw8	@25 fps, 2 x V-binning, field readout mode
	1	752 x 580	MONO8	@25 fps, no binning, frame integration mode
		752 x 580	Raw8	@ 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
	3	752 x 288	MONO8	@52 fps, 2 x V-binning, non-interlaced, progressive readout mode

Table 69: 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	Color mode	Max. frame rate in Format_7
7	0	752 x 580	MONO8	@25 fps, 2 x V-binning, interlaced, field readout mode
		752 x 580	Raw8	@25 fps, 2 x V-binning, interlaced, field readout mode
	1	752 x 580	MONO8	@25 fps, no binning, interlaced, frame integration mode
		752 x 580	Raw8	@ 25 fps, no binning, interlaced, 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
	3	752 x 288	MONO8	@52 fps, 2 x V-binning, non-interlaced, progressive readout mode

Table 70: 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	Color mode	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 582 780 x 582	MONO8 Raw8	@49.4 fps @49.4 fps					
	1								
	2								
	3								

Table 71: 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

Format	Mode	Resolution	Color mode	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 1032 x 778	MONO8 Raw8	@30 fps @30 fps					
	1								
	2								
	3								

Table 72: 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	Color mode	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		x	x	x	x	
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			x	x		
	7	1024 x 768	MONO16			x	x	x	x
2	0	1280 x 960	YUV422						
	1	1280 x 960	RGB8						
	2	1280 x 960	Mono8			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				x	x	x
	7	1600 x1200	Mono16						
7	0	1392 x 1040 1392 x 1040	Mono8 Mono12 Mono16 Raw8,Mono8 Raw12 Raw16	@17.7 fps @15.0 fps @11.3 fps @17.7 fps @15.0 fps @11.3 fps					
	1								
	2								
	3								

Table 73: Video formats Guppy F-146B / Guppy F-146C

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

Guppy F-503B / Guppy F-503C

Format	Mode	Resolution	Color mode	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*	x x*
	6	640 x 480	MONO16		x x*	x x*	x x*	x x*	x x*

Table 74: Video formats Guppy F-503B / Guppy F-503C

Format	Mode	Resolution	Color mode	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
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*	x x*
	6	800 x 600	MONO16		x x*	x x*	x x*	x x*	x x*
	7	1024 x 768	MONO16			x x*	x x*	x x*	x x*
2	0	1280 x 960	YUV422						
	1	1280 x 960	RGB8						
	2	1280 x 960	Mono8			x x*	x x*	x x*	x x*
	3	1600 x1200	YUV422						
	4	1600 x1200	RGB8						
	5	1600 x1200	Mono8			x x*	x x*	x x*	x x*
	6	1280 x 960	Mono16				x x*	x x*	x x*
	7	1600 x1200	Mono16				x x*	x x*	x x*
7	0	2592 x 1944 2592 x 1944	MONO8/12/16 Raw8/12/16	@6.5/4.3/3.2 fps @6.5/4.3/3.2 fps					
	1	1296 x 1944 1296 x 1944	MONO8/12/16 Raw8/12/16	@12.9/8.6/6.5 fps, 2 x H-binning additive @12.9/8.6/6.5 fps, 2 x H-binning additive					
	2	2592 x 972 2592 x 972	MONO8/12/16 Raw8/12/16	@12.9/8.6/6.5 fps, 2 x V-binning average @12.9/8.6/6.5 fps, 2 x V-binning average					
	3	1296 x 972 1296 x 972	MONO8/12/16 Raw8/12/16	@25.9/17.3/12.9 fps, 2 x full binning (H-additive, V-averaged) @25.9/17.3/12.9 fps, 2 x full binning (H-additive, V-averaged)					
	4	648 x 1944 648 x 1944	MONO8/12/16 Raw8/12/16	@25.9/8.6/6.5 fps, 2 out of 4 H-sub-sampling @25.9/8.6/6.5 fps, 2 out of 4 H-sub-sampling					
	5	2592 x 486 2592 x 486	MONO8/12/16 Raw8/12/16	@25.9/8.6/6.5 fps, 2 out of 4 V-sub-sampling @25.9/8.6/6.5 fps, 2 out of 4 V-sub-sampling					
	6	648 x 486 648 x 486	MONO8/12/16 Raw8/12/16	@45.5/17.3/12.9 fps, 2 out of 4 H+V sub-sampling @45.5/17.3/12.9 fps, 2 out of 4 H+V sub-sampling					

Table 74: Video formats Guppy F-503B / Guppy F-503C

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

Area of interest (AOI)

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

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

Note

The setting of AOIs is supported only in video Format_7.

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

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

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.

Note

For more information see Table 102: Format_7 control and status register on page 226.

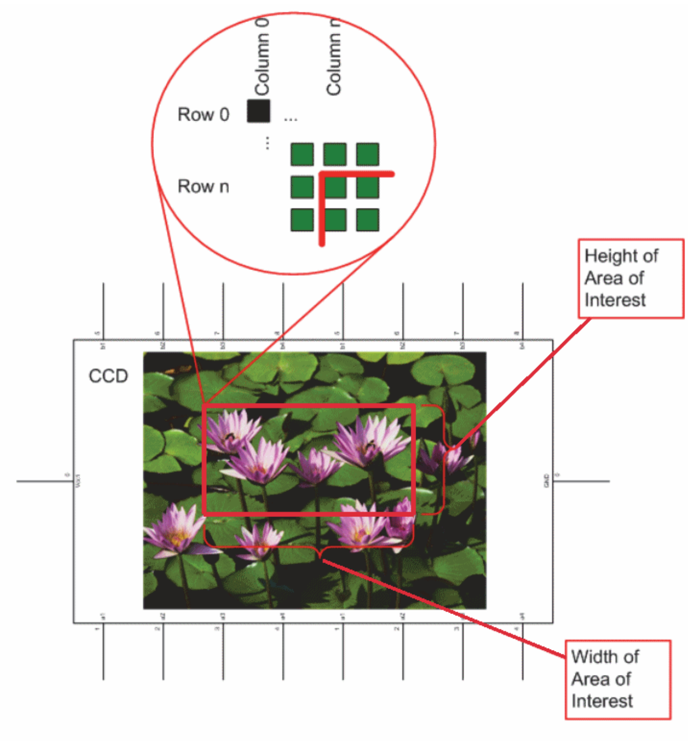


Figure 98: Area of interest (AOI)

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 (AOI), some other parameters have an effect on the maximum frame rate:

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

Autofunction AOI (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:

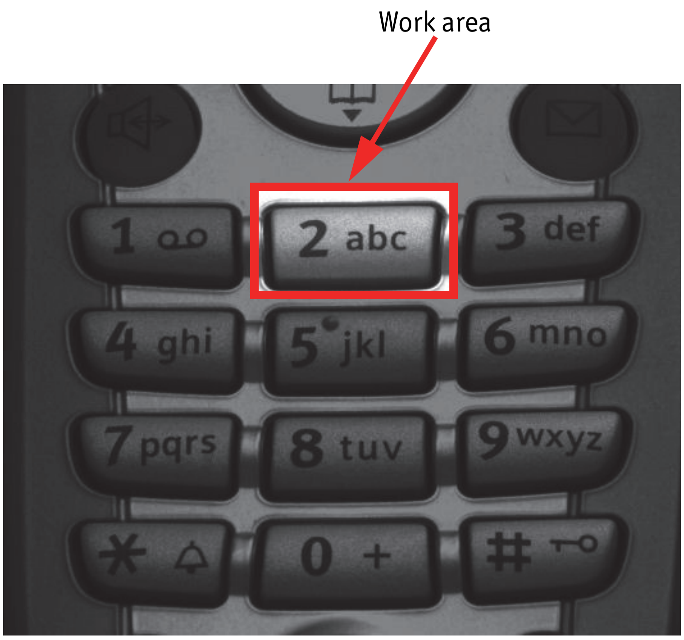


Figure 99: Example of autofunction AOI (Show work area is on)

Note

For more information see Chapter Autofunction AOI on page 248.

Note

Autofunction AOI is independent from Format_7 AOI settings.

If you switch off autofunction AOI, work area position and work area size follow the current active image size.

To switch off autofunctions, carry out following actions in the order shown:

1. Uncheck **Show AOI** check box (SmartView **Ctrl2** tab).
2. Uncheck **Enable** check box (SmartView **Ctrl2** tab).
Switch off Auto modi (e.g. **Shutter** and/or **Gain**) (SmartView **Ctrl2** tab).

As a reference it uses a grid of up to 65534 sample points (in 2^n steps) equally spread over the AOI.

Frame rates

An IEEE 1394 camera requires bandwidth to transport images.

The IEEE 1394a bus has very large bandwidth of at least 32 MByte/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.

Note

All bandwidth data is calculated with:

1 MByte = 1024 kByte

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

Format	Resolution	Max. video format
Format_0	up to VGA	640 x 480
Format_1	up to XGA	1024 x 768
Format_2	up to UXGA	1600 x 1200

Table 75: Overview fixed formats

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

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.

Frame rates Format_7

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.

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

Details are described in the next chapters:

- Max. frame rate of CCD (theoretical formula)
- Diagram of frame rates as function of AOI by constant width: the curves describe RAW8
- Table with max. frame rates as function of AOI by constant width

Guppy F-033 and board level versions: AOI frame rates

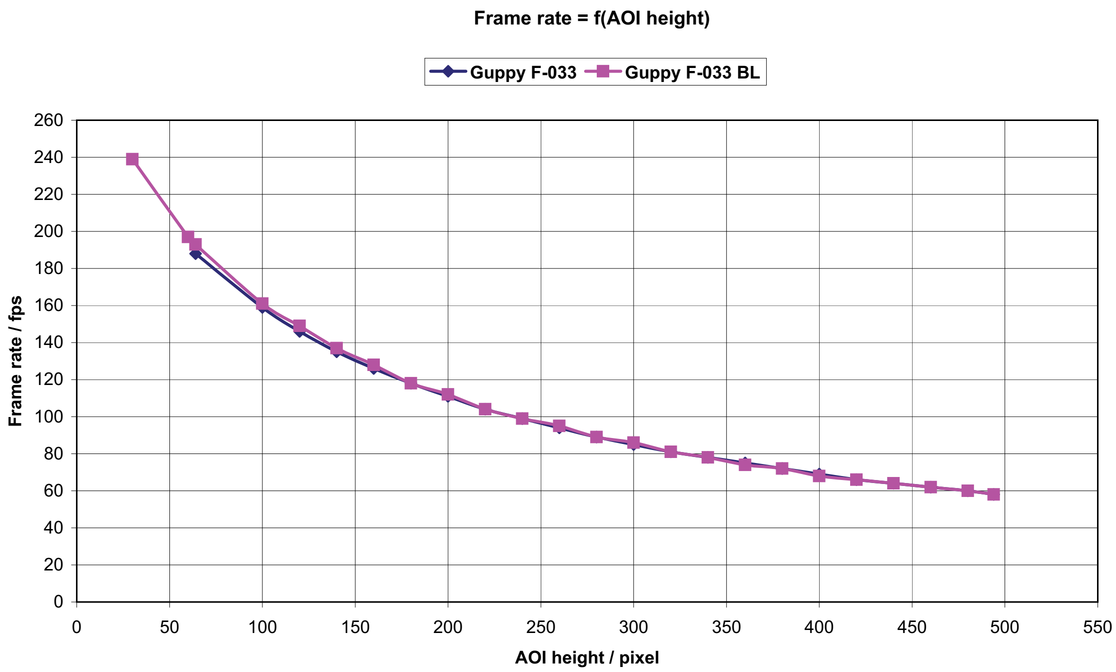


Figure 100: Frame rates Guppy F-033 and board level versions

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
280	89	89

Table 76: 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
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 76: Frame rates Guppy F-033 and board level versions

Guppy F-036: AOI frame rates

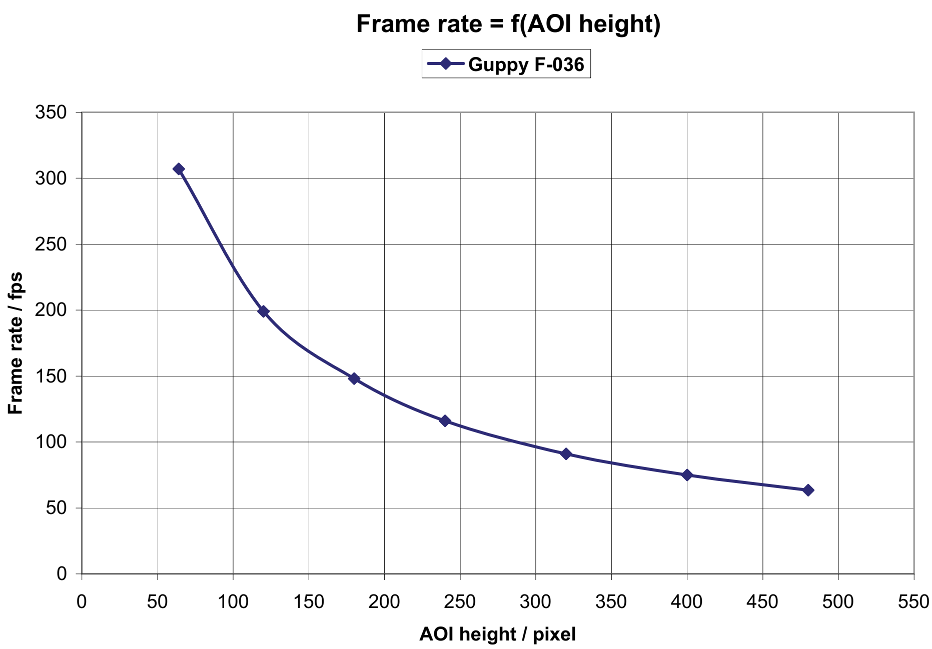


Figure 101: Frame rates Guppy F-036 as function of AOI height

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 193.

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

Table 77: 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 (only F7M0 and F7M1): AOI frame rates

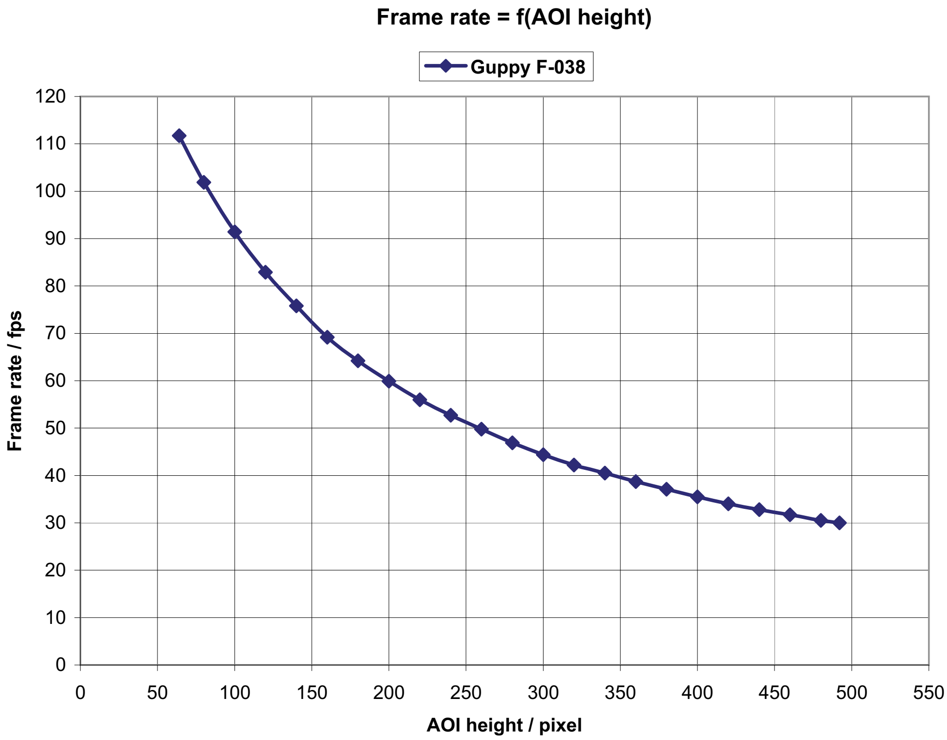


Figure 102: Frame rates Guppy F-038 / Guppy F-038 NIR as function of AOI height

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 193.

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

Table 78: Frame rates Guppy F-038 / F-038 NIR as function of AOI height

AOI height / pixel	Frame rate / fps
360	38.7
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 78: Frame rates Guppy F-038 / F-038 NIR as function of AOI height

Guppy F-044 / Guppy F-044 NIR (only F7M0 and F7M1): AOI frame rates

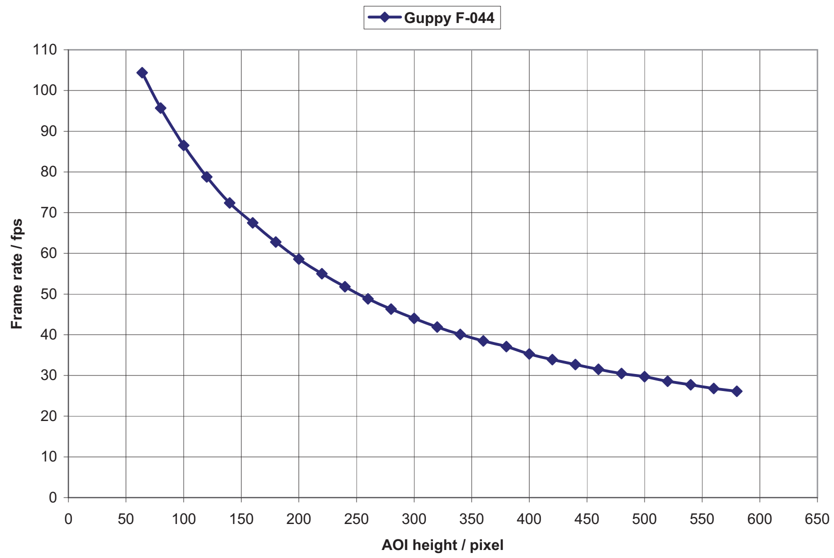


Figure 103: Frame rates Guppy F-044 / Guppy F-044 NIR as function of AOI height

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 193.

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
420	33.9
400	35.3
380	37.1
360	38.5
340	40.1
320	41.9

Table 79: Frame rates Guppy F-044 / F-044 NIR as function of AOI height

AOI height / pixel	Frame rate / fps
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 79: Frame rates Guppy F-044 / F-044 NIR as function of AOI height

Guppy F-046: AOI frame rates

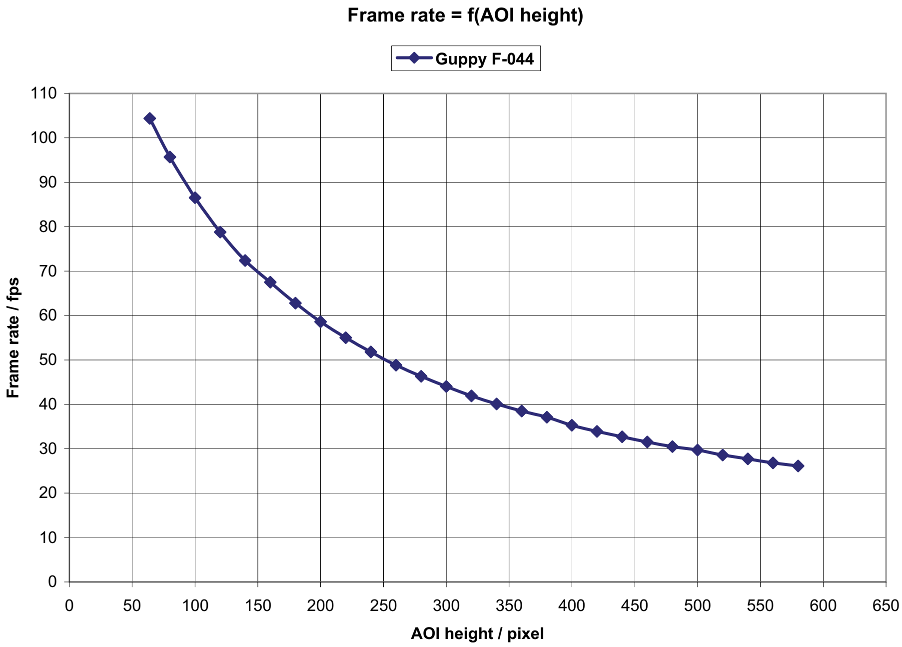


Figure 104: Frame rates Guppy F-046 as function of AOI height

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 80: 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 80: Frame rates Guppy F-046

Guppy F-080 and board level versions: AOI frame rates

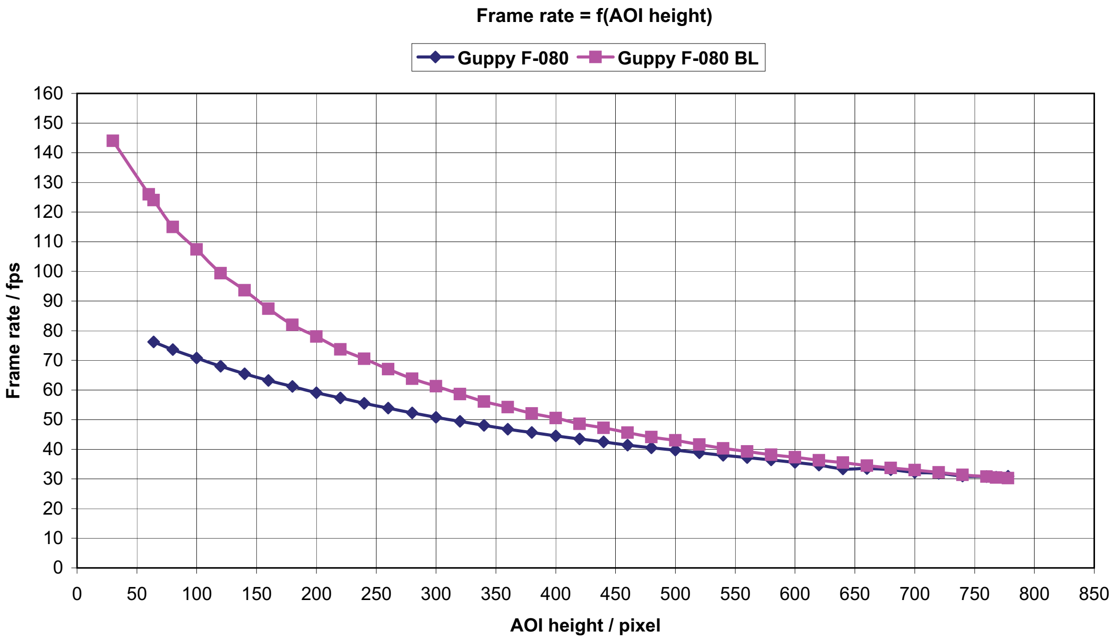


Figure 105: Frame rates Guppy F-080 and board level versions

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
620	34.7	36.3
600	35.6	37.3
580	36.4	38.2

Table 81: 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
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 81: Frame rates Guppy F-080 and board level versions

Guppy F-146: AOI frame rates

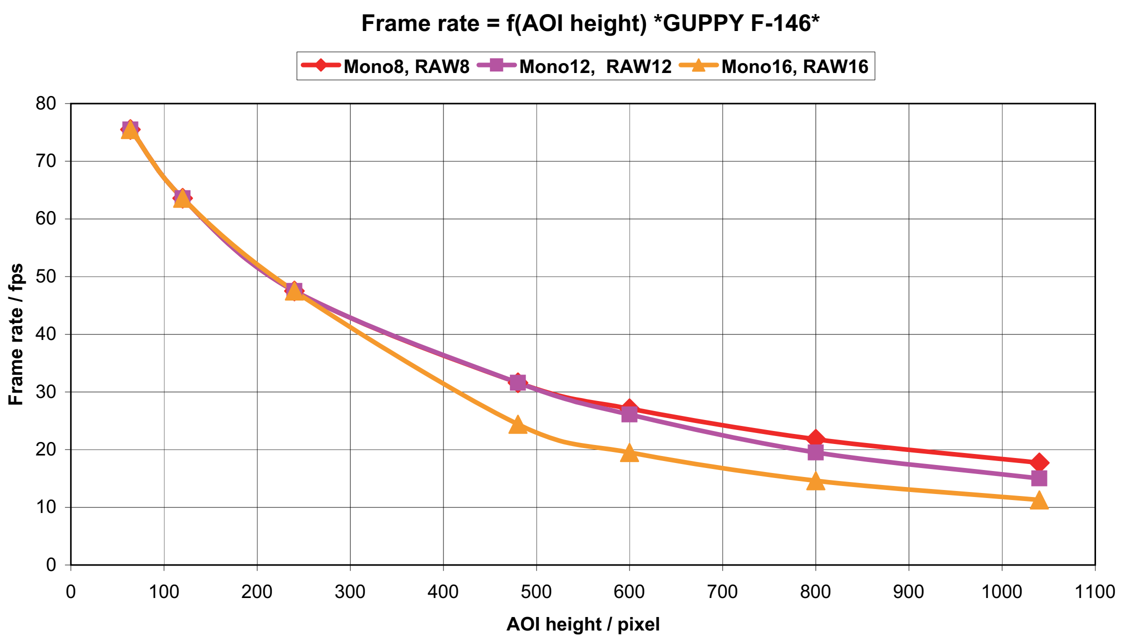


Figure 106: Frame rates Guppy F-146

AOI height / pixel	Mono8/Raw8	Mono12/Raw12	Mono16/Raw16
1040	17.7	15.0	11.3
800	21.8	19.5	14.6
600	27.1	26.1	19.5
480	31.6	31.6	24.4
240	47.5	47.5	47.5
120	63.6	63.6	63.6
64	75.5	75.5	75.5

Table 82: Frame rates (fps) of **Guppy F-146** as a function of AOI height

Guppy F-503: AOI frame rates

$$
\begin{aligned}
t_{row} &= 11.97\text{ns} \times \text{width} + 10.77\mu\text{s} \\
t_{frame} &= (\text{height} + 8) \times t_{row} \\
t_{frame} &= (\text{height} + 8) \times (11.97\text{ns} \times \text{width} + 10.77\mu\text{s}) \\
\text{max. frame rate of CMOS} &= \frac{1}{t_{frame}} \\
\text{max. frame rate of CMOS} &= \frac{1}{(\text{height} + 8) \times (11.97\text{ns} \times \text{width} + 10.77\mu\text{s})}
\end{aligned}
$$

Formula 8: **Guppy F-503**: theoretical max. frame rate of CMOS

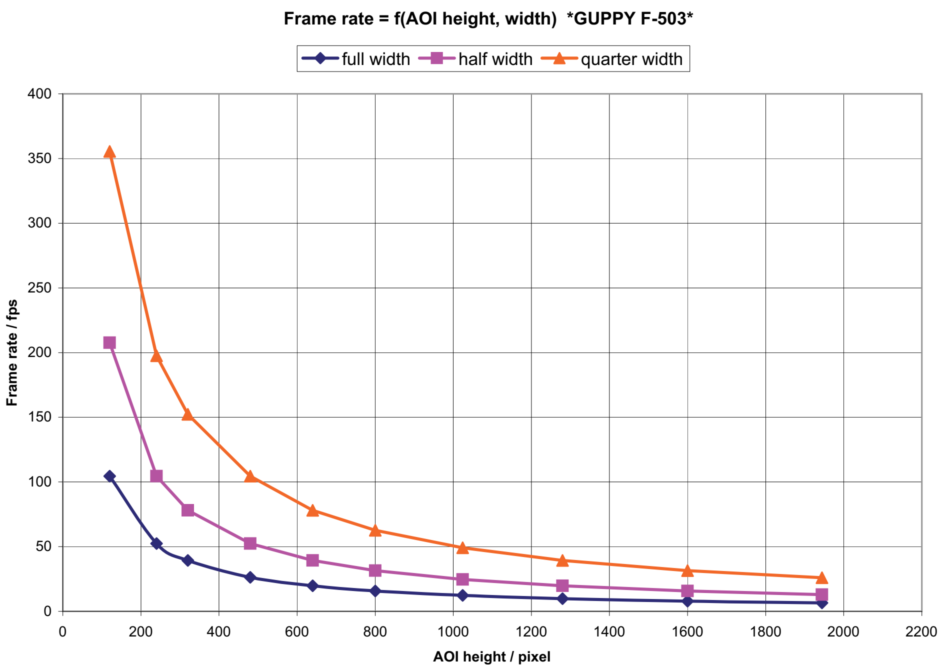


Figure 107: Frame rates Guppy F-503 as function of AOI height and AOI width (full/half/quarter)

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 193.

AOI height / pixel	Frame rate / fps full width	Frame rate / fps half width	Frame rate / fps quarter width
1944	6.5	12.9	25.9
1600	7.8	15.7	31.4
1280	9.8	19.7	39.3
1024	12.3	24.6	49.2
800	15.8	31.4	62.7
640	19.7	39.3	78.0
480	26.2	52.4	104.5
320	39.3	78.0	152.3
240	52.4	104.5	197.5
120	104.5	207.7	355.5

Table 83: Frame rates Guppy F-503 as function of AOI height and AOI width (full/half/quarter)

Note

The minimum AOI of Guppy F-503 is 64 x 64 (AOI width x AOI height).

The readout time for one row is not constant. It varies with AOI width.

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 84: ByteDepth

Example formula for the b/w camera

Mono8, 1024 x 768, 15 fps desired

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

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

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

Table 85: 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 108: Gray bar test image (progressive and interlaced)

$$\text{Gray value} = (x + y)\text{MOD}256 \qquad \text{(8-bit mode)}$$

Formula 12: Calculating the gray value

Test images for color cameras

The color cameras have 2 test images.

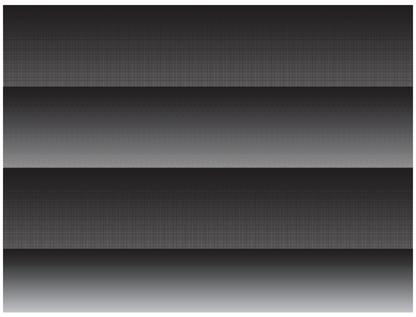
Test image	Description
Test image 1	Mono8 (raw data) static see screenshot below
Test image 2	Available with FPGA 1.05 and higher Mono8 (raw data) moving see screenshot below

Table 86: 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

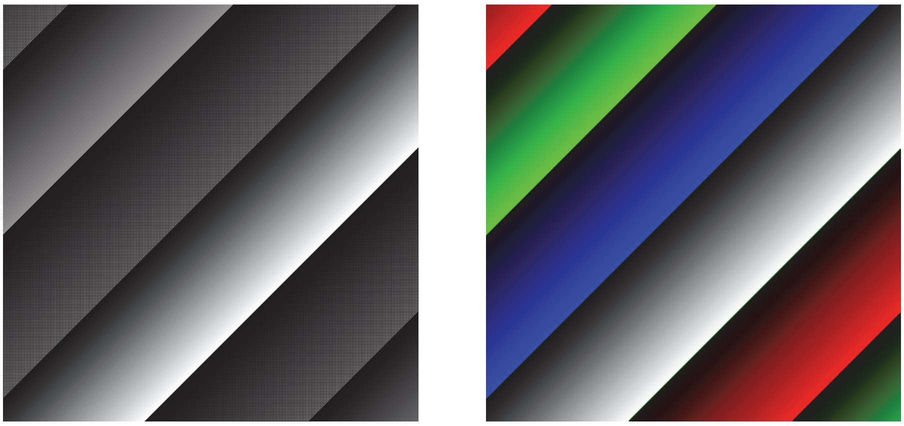


without Debayering

with Debayering

Figure 109: Test image 1 progressive

Test image 2 (Mono8 mode) progressive



without Debayering with Debayering

Figure 110: Test image 2 progressive

Test image 1 and 2 (Mono8 mode) interlaced

without Debayering with Debayering

Figure 111: 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 87: 32-bit register

Example

This requires, for example, that to enable **ISO_Enabled mode** (see Chapter ISO_Enable / free-run on page 161), (bit 0 in register 614h), the value 80000000 h must be written in the corresponding register.

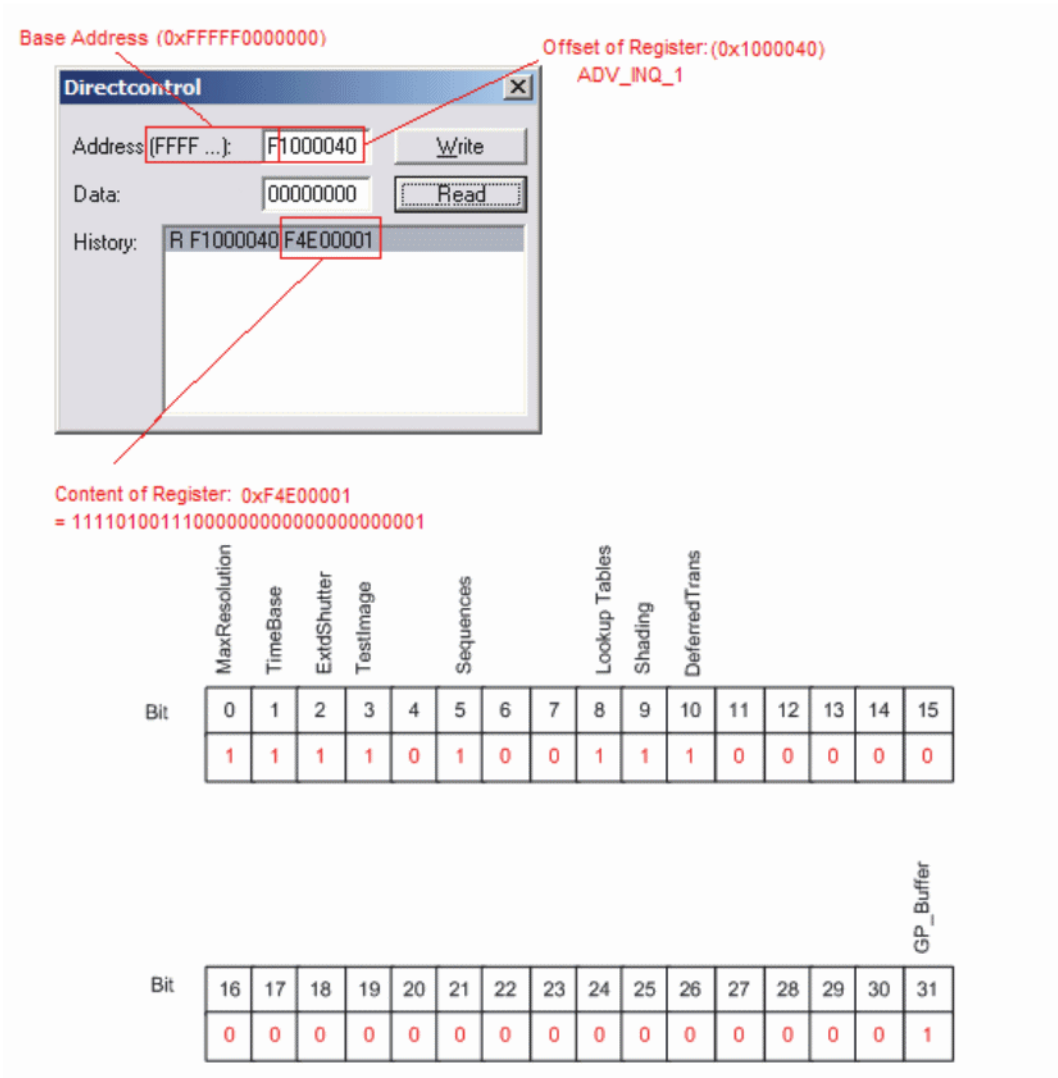


Figure 112: Configuration of the camera

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 88: 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 89: 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 90: 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 91: 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 (IIDC V1.3)

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 92: 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 93: **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 94: **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 94: **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 95: **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 95: **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 95: **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 95: **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 95: **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 95: **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 95: **Frame rate** inquiry register

Offset	Name	Field	Bit	Description
250h	V_RATE_INQ	FrameRate_0	[0]	1.875 fps
	(Format_2, Mode_4)	FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	Reserved
		FrameRate _6	[6]	Reserved
		FrameRate _7	[7]	Reserved
		-	[8..31]	Reserved (zero)
254h	V_RATE_INQ	FrameRate_0	[0]	1.875 fps
	(Format_2, Mode_5)	FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	Reserved
		FrameRate _7	[7]	Reserved
		-	[8..31]	Reserved (zero)
258h	V_RATE_INQ	FrameRate_0	[0]	1.875 fps
	(Format_2, Mode_6)	FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	Reserved
		FrameRate _7	[7]	Reserved
		-	[8..31]	Reserved (zero)

Table 95: **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 95: **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 96: **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
410h .. 47Fh	Reserved			Address error on access

Table 97: **Feature presence** inquiry register

Offset	Name	Field	Bit	Description
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 97: **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 98: **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			

Table 98: **Feature elements** inquiry register

Register	Name	Field	Bit	Description
580h	ZOOM_INQ	Always 0		
584h	PAN_INQ	Always 0		
588h	TILT_INQ	Always 0		
58Ch	OPTICAL_FILTER_INQ	Always 0		
590 .. 5BCh	Reserved for other FEA-TURE_LO_INQ	Always 0		
5C0h	CAPTURE_SIZE_INQ	Always 0		
5C4h	CAPTURE_QUALITY_INQ	Always 0		
5C8h .. 5FCh	Reserved for other FEA-TURE_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 98: **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 99: **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 100: **Feature** control register

Offset	Name	Field	Bit	Description
804h	AUTO-EXPOSURE			See above Note: **Target grey level** parameter in SmartView corresponds to Auto_exposure register 0xF0F00804 (IIDC).
808h	SHARPNESS			See above

Table 100: **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 100: **Feature** control register

Offset	Name	Field	Bit	Description
810h	HUE			Always 0
814h	SATURATION			Always 0
818h	GAMMA			See above
81Ch	SHUTTER			see Advanced Feature Timebase Chapter CSR: Shutter on page 105
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 100: **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 101: **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 95: Frame rate inquiry register on page 206) gives 003C2000h.

4 x 3C2000h = F08000h so that the base address for the latter (Table 102: Format_7 control and status register on page 226) 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 95: Frame rate inquiry register on page 206) gives 003C2400h.

4 x 003C2400h = F09000h so that the base address for the latter (Table 102: Format_7 control and status register on page 226) 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
024h . . 033h	COLOR_CODING_INQ	Vendor Unique Color_Coding 0-127 (ID=128-255) **ID=132 ECCID_MONO12** **ID=136 ECCID_RAW12** ID=133 Reserved ID=134 Reserved ID=135 Reserved See Chapter Packed 12-Bit Mode on page 128.
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

Table 102: **Format_7** control and status register

Offset	Name	Notes
040h	PACKET_PARA_INQ	See note
044h	BYTE_PER_PACKET	Acc. to IIDC V1.3

Table 102: **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 (Allied Vision-specific)

The camera has a variety of extended features going beyond the possibilities described in IIDC V1.3. The following chapter summarizes all available (Allied Vision-specific) advanced features in ascending register order.

Note

This chapter is a **reference guide for advanced registers** and does not explain the advanced features itself. For detailed description of the theoretical background see

- Chapter Description of the data path on page 75
- Links given in the table below

Advanced registers summary

The following table gives an overview of **all available registers**:

Register	Register name	Remarks
0xF1000010	VERSION_INFO	see Table 104: Advanced register: Extended version information on page 231
0xF1000014	VERSION_INFO1_EX	
0xF1000018	VERSION_INFO3	
0xF100001C	VERSION_INFO3_EX	
0xF1000040	ADV_INQ_1	Table 106: Advanced register: Advanced feature inquiry on page 233
0xF1000044	ADV_INQ_2	
0xF1000048	ADV_INQ_3	
0xF100004C	ADV_INQ_4	
0xF1000100	CAMERA_STATUS	see Table 107: Advanced register: Camera status on page 235
0xF1000200	MAX_RESOLUTION	see Table 108: Advanced register: Max. resolution inquiry on page 236
0xF1000208	TIMEBASE	see Table 109: Advanced register: Timebase on page 236
0xF100020C	EXTD_SHUTTER	see Table 111: Advanced register: Extended shutter on page 238
0xF1000210	TEST_IMAGE	see Table 112: Advanced register: Test image on page 239
0xF1000240	LUT_CTRL	see Table 113: Advanced register: LUT on page 240
0xF1000244	LUT_MEM_CTRL	
0xF1000248	LUT_INFO	
0xF1000270	FRAMEINFO	See Table 114: Advanced register: Frame information on page 242
0xF1000274	FRAMECOUNTER	

Table 103: **Advanced registers** summary

Register	Register name	Remarks
0xF1000280	HDR_CONTROL	High dynamic range mode (only Guppy F-036)
0xF1000284	KNEEPOINT_1	see Chapter HDR (high dynamic range) (Guppy F-036 only) on page 129
0xF1000288	KNEEPOINT_2	
0xF100028C	KNEEPOINT_3	
0xF1000298	DEFECT_PIXEL_CORRECTION	Defect pixel correction (only Guppy F-503)
0xF100029C		see Table 115: Advanced register: Defect pixel correction on page 243
0xF10002A0		
0xF1000300	IO_INP_CTRL1	see Table 18: Input configuration register on page 62
0xF1000320	IO_OUTP_CTRL1	see Table 24: Advanced register: Output control on page 68
0xF1000324	IO_OUTP_CTRL2	
0xF1000328	IO_OUTP_CTRL3	
0xF1000340	IO_INTENA_DELAY	see Table 116: Advanced register: Delayed Integration Enable (IntEna) on page 246
0xF1000360	AUTOSHUTTER_CTRL	see Table 117: Advanced register: Auto shutter control on page 246
0xF1000364	AUTOSHUTTER_LO	
0xF1000368	AUTOSHUTTER_HI	
0xF1000370	AUTOGAIN_CTRL	see Table 118: Advanced register: Auto gain control on page 247
0xF1000390	AUTOFNC_AOI	see Table 119: Advanced register: Autofunction AOI on page 248
0xF1000394	AF_AREA_POSITION	
0xF1000398	AF_AREA_SIZE	
0xF1000400	TRIGGER_DELAY	see Table 120: Advanced register: Trigger Delay Advanced CSR on page 249
0xF1000410	MIRROR_IMAGE	See Table 121: Advanced register: Mirror on page 250
0xF1000510	SOFT_RESET	see Table 122: Advanced register: Soft reset on page 250
0xF1000550	USER PROFILES	see Table 123: Advanced register: user profiles on page 252
0xF1000580	LOW_NOISE_BINNING	see Chapter Low noise binning mode (2 x and 4 x binning) (only Guppy F-503) on page 256
0xF1000FFC	GPDATA_INFO	see Table 129: Advanced register: GPData buffer register on page 257
0xF1001000 ... 0xF10017FC	GPDATA_BUFFER	

Table 103: **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**.
- Allied Vision reserves the right to require activation in future versions of the software.

Extended version information register

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	VERSION_INFO1_EX	µC version	[0..31]	Bcd-coded version number
0xF1000018	VERSION_INFO3	Camera type ID	[0..15]	See Table 105: Camera type ID list on page 232
		FPGA version	[16..31]	Bcd-coded version number
0xF100001C	VERSION_INFO3_EX	FPGA version	[0..31]	Bcd-coded version number
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 104: Advanced register: **Extended version** information

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 newly added **VERSION_INFOx_EX** registers contain extended bcd-coded version information formatted as *special.major.minor.patch*.

So reading the value **0x00223344** is decoded as:

- special: 0 (decimal)
- major: 22 (decimal)
- minor: 33 (decimal)
- patch: 44 (decimal)

This is decoded to the human readable version **22.33.44** (leading zeros are omitted).

Note

If a camera returns the register set to all zero, that particular camera does not support the extended version information.

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
209	Guppy F-146B
210	Guppy F-146C
215	
216	
217	
218	
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
227	Guppy F-044B
228	Guppy F-044C
233	Guppy F-503B
234	Guppy F-503C

Table 105: 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
		Color Correction	[18]	Reserved
		---	[19..20]	Reserved
		User Sets	[21]	
		---	[22..30]	Reserved
		GP_Buffer	[31]	

Table 106: Advanced register: **Advanced feature** inquiry

Register	Name	Field	Bit	Description
0xF1000044	ADV_INQ_2	Input_1	[0]	
		---	[4..7]	
		Output_1	[8]	
		Output_2	[9]	
		Output_3	[10]	
		---	[12..15]	Reserved
		IntEnaDelay	[16]	
		---	[17..23]	Reserved
		---	[28..31]	Reserved
0xF1000048	ADV_INQ_3	Camera Status	[0]	
		Max Isosize	[1]	
		---	[2]	Reserved
		Format_7 Mode Mapping	[3]	
		Auto Shutter	[4]	
		Auto Gain	[5]	
		Auto FNC AOI	[6]	
		---	[7..8]	Reserved
		Low Noise Binning	[9]	
		AFE References	[10]	
		Global Reset Release Shutter	[11]	
		Defect Pixel Correction	[12]	
		---	[13..31]	Reserved
0xF100004C	ADV_INQ_4	---	[0..3]	Reserved
		White Balance	[4..31]	Guppy interlaced only

Table 106: Advanced register: **Advanced feature** inquiry

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 107: Advanced register: **Camera status**

Maximum resolution

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

Note

This register normally outputs the MAX_IMAGE_SIZE_INQ Format_7 Mode_0 value.

This is the value given in the specifications tables under **Picture size (max.)** in Chapter Specifications on page 27.

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

Table 108: Advanced register: **Max. resolution** inquiry

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 110: Time base ID on page 237.

Table 109: Advanced register: **Timebase**

The time base IDs 0-9 are in bits 28 to 31. See Table 110: Time base ID on page 237. 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 (which should be equivalent to Table 59: Camera-specific exposure time offset on page 156) 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 110: Time base ID

Note

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

Extended shutter

- For **CCD** models and **Guppy F-503 with electronic rolling shutter**: The exposure time for long-term integration can be entered with µs precision via the EXTENDED_SHUTTER register.
  - **CCD models:** max. exposure time up to 67 seconds (3FFFFFFh)
  - **CMOS Guppy F-503 with electronic rolling shutter:** max. exposure time up to ~2.3 s
- For **CMOS** models: The maximum exposure time is **(Guppy F-036)** 32767 x 29.89 µs = 979.4 ms **(Guppy F-503 with global reset release shutter)** ~2.3 s
  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 111: Advanced register: **Extended shutter**

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.

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 112: Advanced register: **Test image**

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 113: Advanced register: **LUT**

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

Frame information

This register can be used to double-check the number of images received by the host computer against the number of images which were transmitted by the camera. The camera increments this counter with every FrameValid signal. This is a mirror of the frame counter information found at 0xF1000610.

Register	Name	Field	Bit	Description
0xF1000270	FRAMEINFO	Presence_Inq	[0]	Indicates presence of this feature (read only)
		ResetFrameCnt	[1]	Reset frame counter
		---	[2..31]	Reserved
0xF1000274	FRAMECOUNTER	FrameCounter	[0..31]	Number of captured frames since last reset

Table 114: Advanced register: **Frame information**

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

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

Defect pixel correction (only Guppy F-503)

Definition The defect pixel correction mode allows to correct an image with defect pixels. Via threshold you can define the defect pixels in an image. Defect pixel correction is done in the FPGA and defect pixel data can be stored inside the camera's EEPROM.

DPC = defect pixel correction

WR = write

RD = read

MEM, Mem = memory

Note

- Defect pixel correction is always done in **Format_7 Mode_0**.
- When using defect pixel correction with **binning** and **sub-sampling**: first switch to binning/sub-sampling modus and then apply defect pixel correction.

Register	Name	Field	Bit	Description
0xF1000298	DPC_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		BuildError	[1]	Build defect pixel data that reports an error, e.g. more than 2000 defect pixels, see DPDataSize.
		---	[2..4]	Reserved
		BuildDPData	[5]	Build defect pixel data now
		ON_OFF	[6]	Enable/disable this feature
		Busy	[7]	Build defect pixel data in progress
		MemSave	[8]	Save defect pixel data to storage
		MemLoad	[9]	Load defect pixel data from storage
		ZeroDPData	[10]	Zero defect pixel data
		---	[11..17]	Reserved
		Mean	[18..24]	Calculated mean value (7 bit)
		Threshold	[25..31]	Threshold for defect pixel correction

Table 115: Advanced register: **Defect pixel correction**

Register	Name	Field	Bit	Description
0xF100029C	DPC_MEM	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1]	Reserved
		EnaMemWR	[2]	Enable write access from host to RAM
		EnaMemRD	[3]	Enable read access from RAM to host
		DPDataSize	[4..17]	Size of defect pixel data to read from RAM to host. A maximum of 2000 defect pixels can be stored. To get the number of defect pixels read out this value and divide by 4. In case of more than 2000 defect pixels, DPDataSize is set to 2001 pixels (DPDatasize of 8004 divided by 4 equals 2001 pixels) and BuildError flag is set to 1. Defect pixel correction data is done with first 2000 defect pixels only.
		AddrOffset	[18..31]	Address offset to selected defect pixel data
0xF10002A0	DPC_INFO	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..3]	Reserved
		MinThreshold	[4..10]	Minimum value for threshold
		MaxThreshold	[11..17]	Maximum value for threshold
		MaxSize	[18..31]	Maximum size of defect pixel data

Table 115: Advanced register: **Defect pixel correction**

Input/output pin control

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

Note

- See Chapter Inputs on page 62.
- See Table 18: Input configuration register on page 62.
- See Table 19: Input routing on page 63.
- See Chapter IO_OUTP_CTRL 1-3 on page 68.

Delayed Integration Enable (IntEna)

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

- 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.

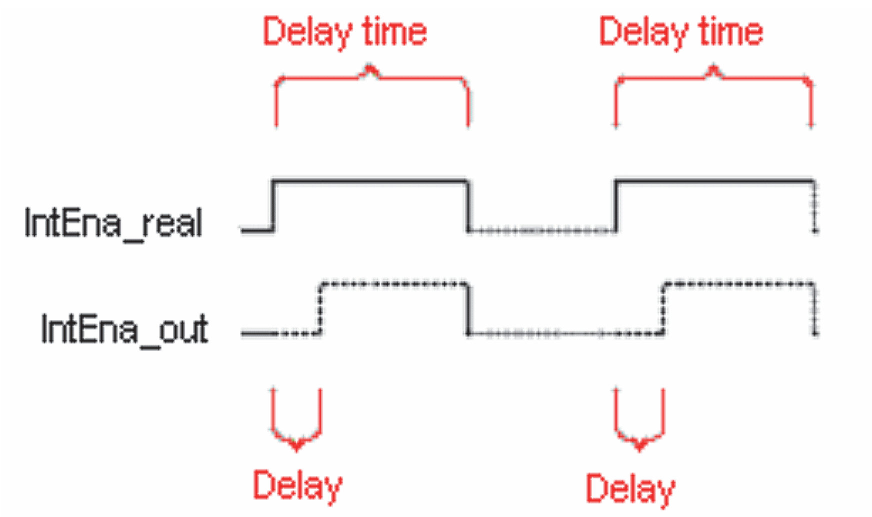


Figure 113: Delayed integration timing

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 116: Advanced register: **Delayed Integration Enable (IntEna)**

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 117: Advanced register: **Auto shutter control**

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 118: Advanced register: **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.

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**.

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 119: Advanced register: **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 120: Advanced register: 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/F-503)

Guppy F-036/F-503 CMOS 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 121: Advanced register: **Mirror**

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 122: Advanced register: **Soft reset**

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 occurred
		---	[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 124: User profile: Error codes on page 253.
		---	[24..27]	Reserved
		ProfileID	[28..31]	User profile ID (memory channel)

Table 123: 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.

Store 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

Restore 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

Set default 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 124: 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**, **Restore-Profile** 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	IMAGE_POSITION (AOI)	TIMEBASE
Cur_V_Mode	IMAGE_SIZE (AOI)	EXTD_SHUTTER
Cur_V_Format	COLOR_CODING_ID	IO_INP_CTRL
ISO_Channel	BYTES_PER_PACKET	IO_OUTP_CTRL
ISO_Speed		IO_INTENA_DELAY
BRIGHTNESS		AUTOSHUTTER_CTRL
AUTO_EXPOSURE (Target grey level)		AUTOSHUTTER_LO
SHARPNESS		AUTOSHUTTER_HI
WHITE_BALANCE (+ auto on/off)		AUTOGAIN_CTRL
GAMMA (+ gamma on)		AUTOFNC_AOI (+ on/off)
SHUTTER (+ auto on/off)		TRIGGER_DELAY
GAIN		MIRROR_IMAGE
TRIGGER_MODE		LUT_CTRL (LutNo; ON_OFF is not saved)
TRIGGER_POLARITY		
TRIGGER_DELAY		
ABS_GAIN		

Table 125: 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.

Format_7 mode mapping (only Guppy F-503)

With Format_7 mode mapping it is possible to map special binning and sub-sampling modes to F7M1..F7M7 (see Figure 82: Mapping of possible Format_7 modes to F7M1...F7M7 on page 127).

Register	Name	Field	Bit	Description	
0xF1000580	F7MODE_MAPPING	Presence_Inq	[0]	Indicates presence of this feature (read only)	
		---	[1..31]	Reserved	
0xF1000584	F7MODE_MAP_INQ	F7MODE_00_INQ	[0]	Format_7 Mode_0 presence	
		F7MODE_01_INQ	[1]	Format_7 Mode_1 presence	
		...	...	...	
		F7MODE_31_INQ	[31]	Format_7 Mode_31 presence	
0xF1000588	Reserved	---	---	---	
0xF100058C	Reserved	---	---	---	
0xF1000590	F7MODE_0	Format_ID	[0..31]	Format ID (read only)	
0xF1000594	F7MODE_1	Format_ID	[0..31]	Format ID for Format_7 Mode_1	Default: FFFFFFFF
0xF1000598	F7MODE_2	Format_ID	[0..31]	Format ID for Format_7 Mode_2	
0xF100059C	F7MODE_3	Format_ID	[0..31]	Format ID for Format_7 Mode_3	
0xF10005A0	F7MODE_4	Format_ID	[0..31]	Format ID for Format_7 Mode_4	
0xF10005A4	F7MODE_5	Format_ID	[0..31]	Format ID for Format_7 Mode_5	
0xF10005A8	F7MODE_6	Format_ID	[0..31]	Format ID for Format_7 Mode_6	
0xF10005AC	F7MODE_7	Format_ID	[0..31]	Format ID for Format_7 Mode_7	

Table 126: Advanced register: **Format_7 mode mapping**

Additional Format_7 modes

Guppy F-503 has additional Format_7 modes. There are some special Format_7 modes which aren't covered by the IIDC standard. These special modes implement **binning** and **sub-sampling**.

To stay as close as possible to the IIDC standard the Format_7 modes can be mapped into the register space of the standard Format_7 modes.

There are visible Format_7 modes and internal Format_7 modes:

- At any time only 8 Format_7 modes can be accessed by a host computer.
- **Visible Format_7 modes** are numbered from 0 to 2 and 4 to 6.
- **Internal Format_7 modes** are numbered from 0 to 2, 4 to 6, 8 to 10, 17 to 18, 20 to 22, 24 to 26.

Format_7 Mode_0 represents the **mode with the maximum resolution** of the camera: this visible mode cannot be mapped to any other internal mode.

The remaining visible Format_7 Mode_1 … Mode_7 can be mapped to any internal Format_7 mode.

Example

To map the internal Format_7 Mode_18 to the visible Format_7 Mode_1, write the decimal number 18 to the above listed F7MODE_1 register.

Note

For available Format_7 modes see Figure 82: Mapping of possible Format_7 modes to F7M1...F7M7 on page 127.

Setting the F7MODE_x register to:

- -1 (hex. FFFFFFFF) forces the camera to use the factory defined mode (Default)
- -2 (hex. FFFFFFFE) disables the respective Format_7 mode (no mapping is applied ⇨ this mode is no more available and is not shown in the viewer e.g. SmartView)

After setup of personal Format_7 mode mappings you have to reset the camera. The mapping is performed during the camera startup only.

Low noise binning mode (2 x and 4 x binning) (only Guppy F-503)

This register enables/disables **low noise binning mode**.

This means: an average (and not a sum) of the luminance values is calculated within the FPGA.

The image is therefore darker than with the usual binning mode, but the signal to noise ratio is better (approximately a factor of $\sqrt{2}$).

Offset	Name	Field	Bit	Description
0xF10005B0	LOW_NOISE_BINNING	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Low noise binning mode on/off
		---	[7..31]	Reserved

Table 127: Advanced register: **Low noise binning mode**

Global reset release shutter (only Guppy F-503)

Offset	Name	Field	Bit	Description
0xF10005C0	GLOBAL_RES_REL_SHUTTER	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Global reset release shutter on/off. If off, then electronic rolling shutter will be used.
		---	[7..31]	Reserved

Table 128: Advanced register: **Global reset release shutter**

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 129: Advanced register: GPData buffer register

Note

- Read the BufferSize before using.
- GPDATA_BUFFER can be used by only one function at a time.

Little endian vs. big endian byte order

- Read/WriteBlock accesses to GPDATA_BUFFER are recommended, to read or write more than 4 byte data. This increases the transfer speed compared to accessing every single quadlet.

- The big endian byte order of the 1394 bus is unlike the little endian byte order of common operating systems (Intel PC). Each quadlet of the local buffer, containing the LUT data or shading image for instance, has to be swapped bytewise from little endian byte order to big endian byte order before writing on the bus.

Bit depth	little endian ⇨ big endian	Description
8 bit	L0 L1 L2 L3 ⇨ L3 L2 L1 L0	L: low byte
16 bit	L0 H0 L1 H1 ⇨ H1 L1 H0 L0	H: high byte

Table 130: Swapped first quadlet at address offset 0

Firmware update

Firmware updates can be carried out via FireWire cable without opening the camera.

Note

For further information:

- Read the application note:
  How to update Guppy/Pike/Stingray firmware
  at Allied Vision website or
- Contact your local dealer.

Extended version number (FPGA/µC)

The new extended version number for microcontroller and FPGA firmware has the following format (4 parts separated by periods; each part consists of two digits):

Special.Major.Minor.Bugfix

or

xx.xx.xx.xx

Digit	Description
1st part: Special	Omitted if zero Indicates customer specific versions (OEM variants). Each customer has its own number.
2nd part: Major	Indicates big changes Old: represented the number before the dot
3rd part: Minor	Indicates small changes Old: represented the number after the dot
4th part: Bugfix	Indicates bugfixing only (no changes of a feature) or build number

Table 131: New version number (microcontroller and FPGA)

Appendix

Sensor position accuracy of Guppy cameras

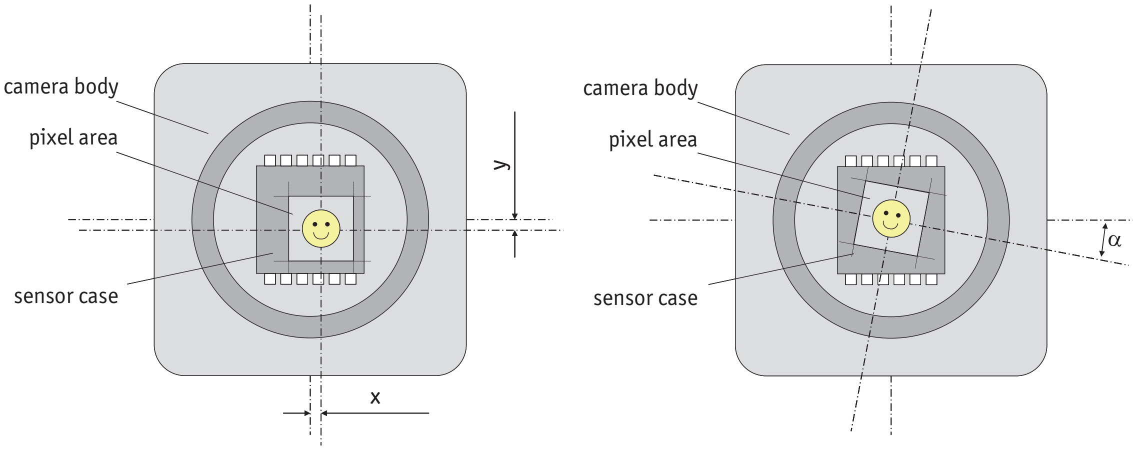


Figure 114: Sensor position accuracy

Criteria	Subject	Properties
Method of Positioning		Optical alignment of the photo sensitive sensor area into the camera front module (lens mount front flange)
Reference Points	Sensor	Center of the pixel area (photo sensitive cells)
	Camera	Center of the lens mount
Accuracy	x/y	+/- 0.25 mm (sensor shift)
	z	+50/-100 µm for SN > 84254727 (optical back focal length)
	z	+0/-100 µm for SN > 252138124 (optical back focal length)
	α	+/-0.5° (center rotation as the deviation from the parallel to the camera bottom)

Table 132: Criteria of Allied Vision sensor position accuracy

Note

x/y tolerances between C-Mount hole and pixel area may be higher.

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