AVT Stingray

Technical Manual

V4.4.2

15 April 2011

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

Legal notice

For customers in the U.S.A.
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However there is no guarantee that interferences will not occur in a particular installation. If the equipment does cause harmful interference to radio or television reception, the user is encouraged to try to correct the interference by one or more of the following measures:

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

You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment. The shielded interface cable recommended in this manual must be used with this equipment in order to comply with the limits for a computing device pursuant to Subpart B of Part 15 of FCC Rules.

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

Pour utilisateurs au Canada
Cet appareil est conforme aux normes classe B pour bruits radioélectriques, spécifiées dans le Règlement sur le brouillage radioélectrique.

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

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Allied Vision Technologies GmbH 04/2011

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Contents

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Introduction

This **STINGRAY Technical Manual** describes in depth the technical specifications, dimensions, all camera features (IIDC standard and AVT 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 **Hardware Installation Guide**.

Note

Please read through this manual carefully.

We assume that you have read already the Hardware Installation Guide 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	31.03.08	New Manual - RELEASE status
V2.1.0	23.05.08	New CAD drawings due to new flange in Chapter *Camera dimensions* on page 75ff. Added Appendix: Chapter *Sensor position accuracy of AVT GigE cameras* on page 346 Added direct fiber technology in Chapter *STINGRAY cameras* on page 29 Added fiber cameras (1 x copper, 1 x GOF) and fiber power consumption in all tables in Chapter *Specifications* on page 50ff. Added Chapter *Pulse-width modulation (Stingray housing and Stingray board level models)* on page 110ff. Added Chapter *Horizontal mirror function* on page 133ff. Added Chapter *Shading correction* on page 134
to be continued on next page		

Table 1: Document history

Version	Date	Remarks
	continued from last page	
V2.1.0 [continued]	23.05.08 [continued]	Added 4 x and 8 x binning in Chapter *Binning (only Stingray b/w and F-201C/504C)* on page 150ff. Added 2 out of 8 sub-sampling in Chapter *Sub-sampling (Stingray b/w and color)* on page 156ff. Changed *Figure 90: Mapping of possible Format_7 modes to F7M1...F7M7* on page 164 Added fiber models in *Table 55: FIFO memory size* on page 173 Added Chapter *Temperature register* on page 296 Added Shading control registers (0xF1000250, 0xF1000254, 0xF1000258) in *Table 128: Advanced registers summary* on page 297ff. Added Mirror image register (0xF1000410) in *Table 128: Advanced registers summary* on page 297ff. Added board level variants in *Table 130: Camera type ID list* on page 302 Added Shading and Mirror image in *Table 131: Advanced register: Advanced feature inquiry* on page 303 Added Chapter *Shading correction* on page 312ff. Added Chapter *Mirror image* on page 324 Added Appendix Chapter *Sensor position accuracy of AVT GigE cameras* on page 346 Added 0x09 PWM in *Table 30: Output routing* on page 108 Added Chapter *Board level camera: IEEE 1394b port pin assignment* on page 95 Added Chapter *Board level camera: I/O pin assignment* on page 97 Added PWM feature in Chapter *IO_OUTP_CTRL 1-4* on page 107ff. Added *Pulse-width modulation (Stingray housing and Stingray board level models)* on page 110 Added PWM feature in *Table 30: Output routing* on page 108.
	to be continued on next page	

Table 1: Document history

Version	Date	Remarks
	continued from last page	
V2.1.0 [continued]	23.05.08 [continued]	[continued] Added board level in *Video formats, modes and bandwidth* on page 219ff. Added board level (BL) in *Table 130: Camera type ID list* on page 302 Added PWM in *Table 131: Advanced register: Advanced feature inquiry* on page 303f. Changed resolutions of Format_7 modes in Chapter *Video formats, modes and bandwidth* on page 219ff. Corrected RGB8 frame rates in Format_7 Mode_0 in Chapter *Video formats, modes and bandwidth* on page 219ff. Added frame rates for binning and sub-sampling modes in Chapter *Video formats, modes and bandwidth* on page 219ff. Added Chapter *Sensor position accuracy of AVT GigE cameras* on page 346 Changed provisions directive to 2004/108/EG in Chapter *Conformity* on page 30.
V2.2.0	15.08.08	Corrected HIROSE connector in CAD drawings in Chapter *Camera dimensions* on page 75ff. Added cross-reference from **upload LUT** to **GPDATA_BUFFER** in Chapter *Loading a shading image into the camera* on page 140 Added cross-reference from **upload/download shading image** to **GPDATA_BUFFER** in: – Chapter *Loading a shading image out of the camera* on page 139 – Chapter *Loading a shading image into the camera* on page 140 Added little endian vs. big endian byte order in Chapter *GPDATA_BUFFER* on page 345 Added detailed cross-reference in Chapter *Camera I/O connector pin assignment* on page 96 Added detailed level values of I/Os in Chapter *Camera I/O connector pin assignment* on page 96. Rounded shutter speeds in Chapter *Specifications* on page 50.
	to be continued on next page	

Table 1: Document history

Version	Date	Remarks
		continued from last page
V2.2.0 [continued]	15.08.08 [continued]	[continued] Rounded offsets in Chapter *Exposure time (shutter) and offset* on page 199f. and in *Figure 102: Data flow and timing after end of exposure* on page 204. Added new image of Stingray camera with two screws on either side of the cameras for fixing the front flange: – See title page New Stingray photo on title page (with new screws on either side of camera) New photo of LED positions in *Figure 47: Position of status LEDs* on page 98
V2.3.0	12.09.08	New Stingray board level CAD drawing with new Molex 1.25 mm Pitch PicoBlade Wire-to-Board Header (53047-1310) and new cable lengths in *Figure 44: Board level camera: two IEEE 1394b FireWire connectors* on page 95 and in *Figure 46: Board level camera: I/O pin assignment* on page 97
V2.4.0	30.09.08	New Stingray board level CAD drawing with new Molex 1.25 mm Pitch PicoBlade Wire-to-Board Header (53047-1310) in: – *Figure 40: Stingray board level dimensions* on page 90 – *Figure 41: Stingray board level: CS-Mount* on page 91 – *Figure 42: Stingray board level: C-Mount* on page 92
		to be continued on next page

Table 1: Document history

Version	Date	Remarks
		continued from last page
V3.0.0	08.10.08	New Stingray board level CAD drawing with name of screws M2x14 ISO7045-A2 (2x): – *Figure 41: Stingray board level: CS-Mount* on page 91 – *Figure 42: Stingray board level: C-Mount* on page 92 New Stingray F-125B/C: Read information in the following sections: • *Table 15: Specification STINGRAY F-125B/C (fiber)* on page 56f. • *Table 55: FIFO memory size* on page 173 • *Table 66: Camera-specific exposure time offset* on page 199 • *Table 67: Camera-specific minimum exposure time* on page 199 • *Figure 102: Data flow and timing after end of exposure* on page 204 • *Table 72: Jitter at exposure start (no binning, no sub-sampling)* on page 207 • *Table 83: Video fixed formats Stingray F-125B / F-125C* on page 226 • *Table 84: Video Format_7 default modes Stingray F-125B / F-125C* on page 227 • *Table 130: Camera type ID list* on page 302 For Stingray F-125B/C output switching times (tp and min. shutter) see **Hardware Installation Guide**, subsection *STINGRAY delay*
		to be continued on next page

Table 1: Document history

Version	Date	Remarks
		continued from last page
V4.0.0	21.10.08	New Stingray F-504B/C: Read information in the following sections: • *Table 19: Specification STINGRAY F-504B/C (fiber)* on page 64f. • *Table 55: FIFO memory size* on page 173 • *Table 66: Camera-specific exposure time offset* on page 199 • *Table 67: Camera-specific minimum exposure time* on page 199 • *Figure 102: Data flow and timing after end of exposure* on page 204 • *Table 72: Jitter at exposure start (no binning, no sub-sampling)* on page 207 • *Table 91: Video fixed formats Stingray F-504B / F-504C* on page 239 • *Table 92: Video Format_7 default modes Stingray F-504B / F-504C* on page 240 • *Table 130: Camera type ID list* on page 302f. For Stingray F-504B/C output switching times (tp and min. shutter) see **Hardware Installation Guide**, subsection *STINGRAY delay*
		to be continued on next page

Table 1: Document history

Version	Date	Remarks
		continued from last page
V4.1.0	28.01.09	All advanced registers in 8-digit format beginning with 0xF1... in Chapter *Advanced features (AVT-specific)* on page 297ff. and in Chapter *Parameter-List Update* on page 331 New CAD drawings (hexagon socket head cap screw ISO 4762): • *Figure 40: Stingray board level dimensions* on page 90 • *Figure 41: Stingray board level: CS-Mount* on page 91 • *Figure 42: Stingray board level: C-Mount* on page 92 • *Figure 44: Board level camera: two IEEE 1394b FireWire connectors* on page 95 • *Figure 46: Board level camera: I/O pin assignment* on page 97 SEQUENCE_RESET register moved to SEQUENCE_STEP register (0xF1000228) in *SEQUENCE_STEP* on page 210 and in *SEQUENCE_STEP* on page 297 Corrected CAD drawing in *Figure 31: Stingray W90 S90 (2 x 1394b copper)* on page 81 Revised Chapter *White balance* on page 121ff Memory size (Internal FIFO memory) of Stingray F-125 is 12 frames in *Table 15: Specification STINGRAY F-125B/C (fiber)* on page 56 and in *Table 55: FIFO memory size* on page 173 Revised *Table 100: Frame rates (fps) Stingray F-125 as function of AOI height (pixel) [width=1292]* on page 253 Corrected black level increments in Chapter *Brightness (black level or offset)* on page 131 New AOI frame rates of Stingray F-504 in Chapter *Frame rates of Stingray F-504 as function of AOI height [width=2452]* on page 257 New Stingray F-125C RGB8 modes in *Table 83: Video fixed formats Stingray F-125B / F-125C* on page 226 New Stingray F-504C RGB8 modes in *Table 91: Video fixed formats Stingray F-504B / F-504C* on page 239
		to be continued on next page

Table 1: Document history

Version	Date	Remarks
		continued from last page
V4.2.0	28.05.09	Calculated **effective chip size** for all sensors (with resolution of Format_7 Mode_0) in Chapter *Specifications* on page 50ff. SIS feature: standardized terminology, added examples in Chapter *Secure image signature (SIS): definition and scenarios* on page 217 Stingray cameras do not support storing shading image data into non-volatile memory, see *Table 139: Advanced register: Shading* on page 312 (0XF1000250 bit 8 to 10) Corrected drawing in *Figure 119: Delayed integration timing* on page 319. In SIS chapter: added cycle time examples: Chapter *Examples: cycle time* on page 336
		to be continued on next page

Table 1: Document history

Version	Date	Remarks
		continued from last page
V4.2.0 [continued]	28.05.09 [continued]	**Stingray update round (SUR):** • Only **GOF models: new LED signals** (asynchronous traffic and signal detect) in *Table 21: LEDs showing normal conditions* on page 99 • Stingray F-504 cameras are also available with **64 MByte internal FIFO memory** (instead of 32 MByte): – *Table 19: Specification STINGRAY F-504B/C (fiber)* on page 64 and – *Table 55: FIFO memory size* on page 173 • All Stingray models: added **defect pixel correction**: – Chapter *Defect pixel correction* on page 144 – *Table 143: Advanced register: Defect pixel correction* on page 317 • All Stingray models: added **low noise binning mode**: – *Table 159: Advanced register: Low noise binning mode* on page 333 • All Stingray models: added **software trigger**: – In inquiry register *530h* on page 286 added: Value_Read_Inq [7], Trigger_Source0_Inq [8] and Software_Trigger_Inq [15] – In inquiry register *62Ch* on page 288 added: Software_Trigger • All Stingray models: added **disable LEDs** function: – Chapter *Software feature control (disable LEDs)* on page 340 • All Stingray **GOF models**: added **two new LED signals** – *Only GOF: asynchronous traffic* on page 99 – *Only GOF: GOF signal detect* on page 99 • All Stingray models: added **debounce feature**: – Advanced register summary *0xF1000840* on page 300 – Advanced register summary *0xF1000850* on page 300 – Advanced register summary *0xF1000860* on page 300 – Advanced register summary *0xF1000870* on page 300 – Chapter *Debounce* on page 197f. – *Table 65: Advanced register: Debounce time for input ports* on page 198
V4.2.0 [continued]	28.05.09 [continued]	**Stingray update round (SUR):** [continued] • **WaitingForTrigger** signal for outputs – *Table 28: Output signals* on page 105 – Output mode: trigger ID *0x0A* on page 108 – *Figure 50: Output impulse diagram* on page 109
		to be continued on next page

Table 1: Document history

<table>
<tr><th>Version</th><th>Date</th><th>Remarks</th></tr>
<tr><td colspan="3">continued from last page</td></tr>
<tr><td>V4.3.0</td><td>15.09.09</td><td>Minor corrections:
• Notice about connection between temperature at sensor and temperature at camera housing on page 296.
• Corrected registers for IO_OUTP_PWM2/3/4 in Table 31: PWM configuration registers on page 110 and in Table 128: Advanced registers summary on page 297ff.
• Revised Chapter Conformity on page 30.
• New drawings to show maximum protrusion: Figure 38: Stingray CS-Mount dimension on page 88 and Figure 39: Stingray C-Mount dimensions on page 89
• New values for maximum protrusion: tables in Chapter Camera dimensions on page 75ff.
• Corrected addresses of debounce registers:
– Advanced register summary 0xF1000840 on page 300
– Advanced register summary 0xF1000850 on page 300
– Advanced register summary 0xF1000860 on page 300
– Advanced register summary 0xF1000870 on page 300
– Table 65: Advanced register: Debounce time for input ports on page 198
• Stingray cameras with serial numbers S/N greater 09/17-285831532 have a heat sink and thus the mass of the camera increases from 92 g up to 108 g: see Chapter Specifications on page 50ff.

New front flange:
• Title page: new Stingray photo
• New CAD drawings:
– All CAD drawings in Chapter Camera dimensions on page 75ff.
– Cross section drawings in Figure 38: Stingray CS-Mount dimension on page 88 and Figure 39: Stingray C-Mount dimensions on page 89. Note: Adjustments by means of the adjustment spacer(s) have to to be done in the AVT factory. Contact Customer Care.
– Figure 44: Board level camera: two IEEE 1394b FireWire connectors on page 95
– Figure 46: Board level camera: I/O pin assignment on page 97

2x/4x/8x binning:
Stingray F-504C has now also the usual 2x/4x/8x binning (no color binning): see Chapter Binning (only Stingray b/w and F-201C/504C) on page 150ff. and Chapter Binning and sub-sampling access on page 163ff. and Table 19: Specification STINGRAY F-504B/C (fiber) on page 64</td></tr>
<tr><td colspan="3">to be continued on next page</td></tr>
</table>

Table 1: Document history

Version	Date	Remarks
		continued from last page
V4.4.0	12.07.10	**Improvements:** • HSNR description, see Chapter *High SNR mode (High Signal Noise Ratio)* on page 326 **New Stingray front flange:** • Serial numbers for Stingray camera models starting new front flange: Chapter *Serial numbers for starting new front flange* on page 75 **Corrections:** • Corrected Note on BitsPerValue, see *Note* on page 311. **New Stingray Compact:** • Chapter *Stingray Compact* on page 87 **New storage temperature:** • 70 °C, see Chapter *Specifications* on page 50ff. **New links to new AVT website:** • Chapter *Contacting Allied Vision Technologies* on page 11 and many others **New measured sensitivity curves:** • Chapter *Spectral sensitivity* on page 66ff. **Added RGB8 in fixed formats:** • *Table 77: Video fixed formats Stingray F-033B / F-033C* on page 220 • *Table 79: Video fixed formats Stingray F-046B / F-046C* on page 222 • *Table 85: Video fixed formats Stingray F-145B / F-145C* on page 229 **Added Full support Windows 7 for 1394a/1394b:** • *Table 7: FireWire and operating systems* on page 46 **Corrected trigger diagram:** • *Figure 50: Output impulse diagram* on page 109
		to be continued on next page

Table 1: Document history

Version	Date	Remarks
		continued from last page
V4.4.1	07.01.11	• Minor corrections • Converted FrameMaker files from FM7 to FM9 • Added required minimum number of GrabCount value (2) for HIGH_SNR ON in *Table 152: Advanced register: High Signal Noise Ratio (HSNR)* on page 326 • Added info that for 8-bit video modes, the internal HSNR calculations are done with 14 bit: Chapter *High SNR mode (High Signal Noise Ratio)* on page 172 • Changed tripod drawing: added dimensions of three big holes (M6 and UNC 1/4-20) in *Figure 28: Tripod dimensions* on page 78. • Added Windows 7 support and revised Windows XP/ Windows Vista in in Chapter *FireWire and operating systems* on page 46
V4.4.2	15.04.11	• Added sensitivity curves for Stingray F-125B/F-125C: see *Figure 16: Spectral sensitivity of Stingray F-125B* on page 70 and see *Figure 17: Spectral sensitivity of Stingray F-125C (without IR cut filter)* on page 70 **C-/CS-Mount no more adjustable, for modifications contact Customer Care and send camera to AVT:** • See Chapter *Specifications* on page 50ff. • See Chapter *Adjustment of C-Mount and CS-Mount* on page 89. **Stingray firmware update round:** • Defect pixel correction: you don’t need to set value for brightness to max. any more: see *Figure 69: Defect pixel correction: build and store* on page 146 and Chapter *Grab an image with defect pixel data* on page 147 • Besides in Mono8 mode defect pixel correction is also possible in Raw8 mode: see note in Chapter *Building defect pixel data* on page 147 • Revised Chapter *Defect pixel correction* on page 144 • Image is shot internally during calculating a mean value: see note in Chapter *Calculate defect pixel coordinates* on page 147 • Activate HSNR mode to improve defect pixel correction: see note in Chapter *Building defect pixel data* on page 147 • Added descriptions for defect pixel correction in F7 modes: see Chapter *Building defect pixel correction image in Format_7 modes* on page 145
		to be continued on next page

Table 1: Document history

Version	Date	Remarks
		continued from last page
V4.4.2 [continued]	15.04.11 [continued]	• Shading correction in Format_7 mode 0 (Mono8) is only available upt to S400: see note in Chapter *Building shading image in Format_7 modes* on page 134 **Some smaller corrections:** • At register 0xF1000200 changed width and height: see *Table 133: Advanced register: Maximum resolution inquiry* on page 306 • YUV8: deleted description of data type *straight binary*: *Figure 53: Data structure of YUV8; Source: IIDC V1.31* on page 117 • Y (Mono8/Raw8) are AVT own formats: see *Table 33: Y (Mono8) format: Source: IIDC V1.31 / Y (Raw8) format: AVT* on page 76

Table 1: Document history

Manual overview

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

- Chapter *Contacting Allied Vision Technologies* on page 11 lists AVT contact data for both:
  - technical information / ordering
  - commercial information
- Chapter *Introduction* on page 12 (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 (Hardware Installation Guide)**, available **AVT software** (incl. documentation) and where to get it.
- Chapter *STINGRAY cameras* on page 29 gives you a short introduction to the STINGRAY cameras with their FireWire technology. Links are provided to data sheets and brochures on AVT website.
- Chapter *Conformity* on page 30 gives you information about conformity of AVT cameras.
- Chapter *FireWire* on page 31 describes the FireWire standard in detail, explains the compatibility between 1394a and 1394b and explains bandwidth details (incl. Stingray examples).
  - **Read and follow the FireWire hot-plug and screw-lock precautions in Chapter *FireWire hot-plug and screw-lock precautions* on page 45.**
  - **Read Chapter *Operating system support* on page 46.**
- Chapter *Filter and lenses* on page 47 describes the IR cut filter and suitable camera lenses.

- Chapter *Specifications* on page 50 lists camera details and spectral sensitivity diagrams for each camera type.
- Chapter *Camera dimensions* on page 75 provides CAD drawings of standard housing (copper and GOF) models, tripod adapter, available angled head models, cross sections of CS-Mount and C-Mount.
- Chapter *Camera interfaces* on page 93 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 **Hardware Installation Guide**.
- Chapter *Description of the data path* on page 119 describes in detail IIDC conform as well as AVT-specific camera features.
- Chapter *Controlling image capture* on page 190 describes trigger modi, exposure time, one-shot/multi-shot/ISO_Enable features. Additionally special AVT features are described: sequence mode and secure image signature (SIS).

- Chapter *Video formats, modes and bandwidth* on page 219 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 258 gives some considerations on bandwidth details.
- Chapter *Configuration of the camera* on page 262 lists standard and advanced register descriptions of all camera features.
- Chapter *Firmware update* on page 347 explains where to get information on firmware updates and explains the extended version number scheme of FPGA/µC.
- Chapter *Appendix* on page 346 lists the sensor position accuracy of AVT cameras.
- Chapter *Index* on page 348 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.alliedvisiontec.com

More information

For more information on hardware and software read the following:

- **Hardware Installation Guide** describes the hardware installation procedures for all 1394 AVT cameras (Dolphin, Oscar, 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).

Note

You find the Hardware Installation Guide here:

http://www.alliedvisiontec.com/emea/support/downloads/product-literature.html

There is no product CD.

www

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

http://www.alliedvisiontec.com/emea/support/downloads/software.html

There is no product CD.

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 **Hardware Installation Guide** first.

Note

Please read through this manual carefully before operating the camera.

For information on AVT accessories and AVT software read Hardware Installation Guide.

Caution

Before operating any AVT camera read safety instructions and ESD warnings in Hardware Installation Guide.

Note

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

www

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

www.alliedvisiontec.com

Note

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

STINGRAY cameras

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

IEEE 1394b With the new Stingray, Allied Vision Technologies presents a wide range of cameras with **IEEE 1394b interfaces**. Moreover, with daisy chain as well as direct fiber technology they gain the highest level of acceptance for demanding areas of use in manufacturing industry.

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

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

Note

For further information on FireWire read Chapter *FireWire* on page 31.

www

For further information on the highlights of Stingray types, the Stingray family and the whole range of AVT FireWire cameras read the data sheets and brochures on the website of Allied Vision Technologies:

www.alliedvisiontec.com

Conformity

Allied Vision Technologies declares under its sole responsibility that all standard cameras of the **AVT Stingray** 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
  (**Stingray** board level cameras do not have CE)
- FCC Part 15 Class B
  (**Stingray** board level cameras do not have FCC)
- RoHS (2002/95/EC)

CE

We declare, under our sole responsibility, that the previously described **AVT Stingray** 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 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.

FireWire

Overview

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

Definition

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

Figure 1: FireWire Logo

IEEE 1394 standards

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

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

FireWire is used to connect digital cameras, especially in industrial systems for machine vision.

Advantages Advantages over USB are:

- Faster effective speed
- Higher power distribution capabilities
- Multi-camera applications are easier to set up than in USB.

Why use FireWire?

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

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

FireWire in detail

Serial bus

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

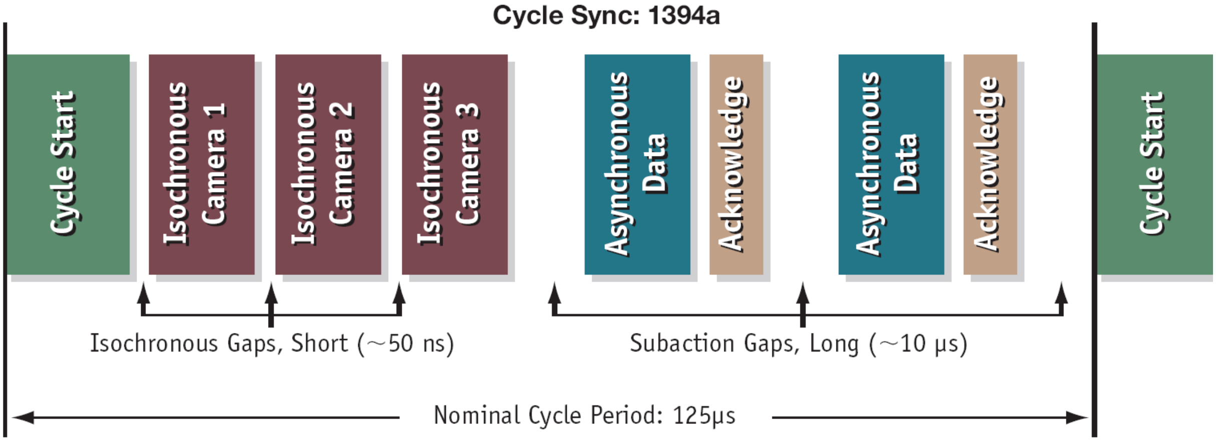

Figure 2: 1394a data transmission

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

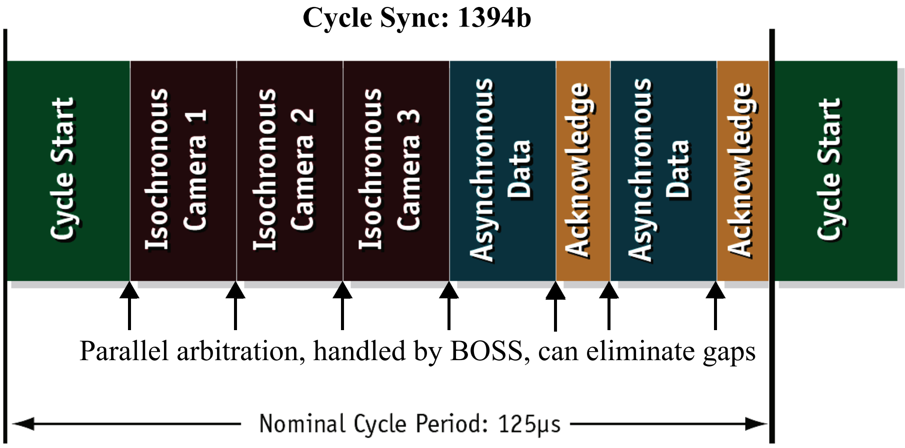

Figure 3: 1394b data transmission

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

Note

How to extend the size of an isochronous packet up to 11.000 byte at S800:

- see register 0xF1000048, ADV_INQ_3, Max IsoSize [1] in *Table 131: Advanced register: Advanced feature inquiry* on page 303
- see Chapter *Maximum ISO packet size* on page 327

FireWire connection capabilities

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

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

FireWire also supports multiple hosts per bus. **FireWire** requires only a cable with the correct number of pins on either end (normally 6 or 9). It is designed to support plug-and-play and hot swapping. It can supply up to 45 W of power per port at 30 V, allowing high consumption devices to operate without a separate power cord.

Caution

While supplying such an amount of bus power is clearly a beneficial feature, it is very important not to exceed the inrush current of 18 mJoule in 3 ms.

Higher inrush current may damage the Phy chip of the camera and/or the Phy chip in your PC.

Capabilities of 1394a (FireWire 400)

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

The 1394a capabilities in detail:

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

IIDC V1.3 camera control standards

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

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

- higher resolutions
- higher frame rates
- diverse color modes

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

Capabilities of 1394b (FireWire 800)

FireWire 800 (S800) was introduced commercially by Apple in 2003 and has a 9-pin FireWire 800 connector (see details in **Hardware Installation Guide** and in Chapter *IEEE 1394b port pin assignment* on page 93). This newer 1394b specification allows a transfer rate of 800 MBit/s with backward compatibilities to the slower rates and 6-pin connectors of FireWire 400.

The 1394b capabilities in detail:

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

IIDC V1.31 camera control standards

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

Compatibility between 1394a and 1394b

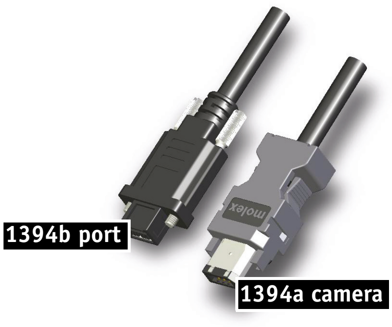	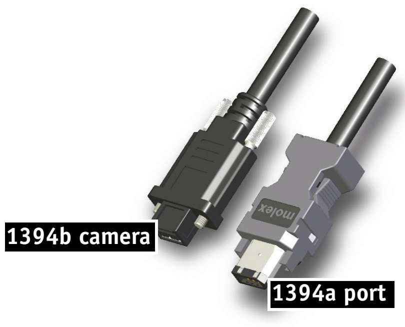
1394a camera connected to 1394b bus	**1394b camera connected to 1394a bus**
The cable explains dual compatibility: This cable serves to connect an IEEE 1394a camera with its six-pin connector to a bilingual port (a port which can talk in a- or b-language) of a 1394b bus. **In this case the b-bus communicates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

Figure 4: 1394a and 1394b cameras and compatibility

FireWire cable	Description	Ordering number
FireWire cable -2x Interlock	IEEE 1394a; (2x Interlock) 4.5 m with Ferrites, for Marlin / Oscar / Guppy	K1200064
FireWire cable -2x Interlock	IEEE 1394a; (2x Interlock) 10 m with Ferrites, for Marlin / Oscar / Guppy	K1200163
FireWire cable -2x Interlock	IEEE 1394a; (2x Interlock) 12.5 m with Ferrites, for Marlin / Oscar / Guppy	K1200165
FireWire cable -2x Interlock	IEEE 1394a; (2x Interlock) 17.5 m with Ferrites, for Marlin / Oscar / Guppy	K1200162
FireWire cable -1x Interlock	IEEE 1394a; (1x Interlock) 3.0 m, for Marlin / Oscar / Guppy	K1200167
FireWire cable -1x Interlock	IEEE 1394a; (1x Interlock) 4.5 m, for Marlin / Oscar / Guppy	K1200091
FireWire cable -1x Interlock	IEEE 1394a; (1x Interlock) 6.0 m, for Marlin / Oscar / Guppy	K1200160

Table 3: 1394 locking cables

FireWire cable	Description	Ordering number
FireWire cable -1x Interlock	IEEE 1394a; (1x Interlock) 10 m, for Marlin / Oscar / Guppy	K1200159
Cable 0.5 m 9 pin - 6 pin, industrial	IEEE 1394b/a; 9 pin (screw lock)/6 pin (latch), 0.5 m	K1200198
Cable 4.5 m 9 pin - 6 pin, industrial	IEEE 1394b/a; 9 pin (screw lock)/6 pin (latch), 4.5 m	K1200171
Cable 0.5 m 9-pin - 9-pin, industrial	IEEE 1394b; 2x screw lock, 0.5 m, black, 2x ferrite	K1200201
Cable 5.0 m 9-pin - 9-pin, industrial	IEEE 1394b; 2x screw lock, 5.0 m, black, 2x ferrite	K1200133
Cable 7.5 m 9-pin - 9 pin, industrial	IEEE 1394b; 2x screw lock, 7.5 m, black, 2x ferrite	K1200134

Table 3: 1394 locking cables

Compatibility example

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

You can e.g. run a STINGRAY F-033B and a MARLIN F-033B on the same bus:

- STINGRAY F-033B @ S800 and 60 fps (2560 bytes per cycle, 32% of the cycle slot)
- MARLIN F-033B @ S400 and 30 fps (1280 bytes, 32% of the cycle slot)

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

Image transfer via 1394a and 1394b

Technical detail	1394a	1394b
Transmission mode	Half duplex (both pairs needed) 400 Mbit/s data rate aka: a-mode, data/strobe (D/S) mode, legacy mode	Full duplex (one pair needed) 1 Gbit/s signaling rate, 800 Mbit/s data rate 10b/8b coding (Ethernet), aka: b-mode (beta mode)
Devices	**Up to 63 devices per network**	
Number of cameras	**Up to 16 cameras per network**	
Number of DMAs	**4 to 8 DMAs (parallel) cameras / bus**	
Real time capability	**Image has real time priority**	
Available bandwidth acc. IIDC (per cycle 125 µs)	**4096 bytes per cycle** **~ 1000q @ 400 Mbit/s**	**8192 bytes per cycle** **~ 2000q @ 800 Mbit/s (@1 GHz clock rate)**
	For further detail read Chapter *Frame rates* on page 245.	
Max. image bandwidth	**31.25 MByte/s**	**62.5 MByte/s**
Max. total bandwidth	**~45 MByte/s**	**~85 MByte/s**
Number of busses	**Multiple busses per PC** **limit: PCI bus**	**Multiple busses per PC** **limit: PCI (Express) bus**
CPU load	**Almost none for DMA image transfer**	
Gaps	**Gaps negatively affect asynchronous performance of widespread network (round trip delay), reducing efficiency**	**No gaps needed, BOSS mode for parallel arbitration**

Table 4: Technical detail comparison: 1394a and 1394b

Note

The bandwidth values refer to the fact:

1 MByte = 1024 kByte

1394b bandwidths

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

Note

Certain cameras may offer, depending on their settings in combination with the use of AVT FirePackage higher packet sizes.

Consult your local dealer's support team, if you require additional information on this feature.

For further details read Chapter *How does bandwidth affect the frame rate?* on page 258.

Requirements for PC and 1394b

One Stingray camera connected to a PC's 1394b bus can saturate the standard PCI bus.

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

- For Intel-based desktops, chipset 945 (or higher)
- For non-Intel based desktops (e.g. AMD), PCI Express compatible chipset

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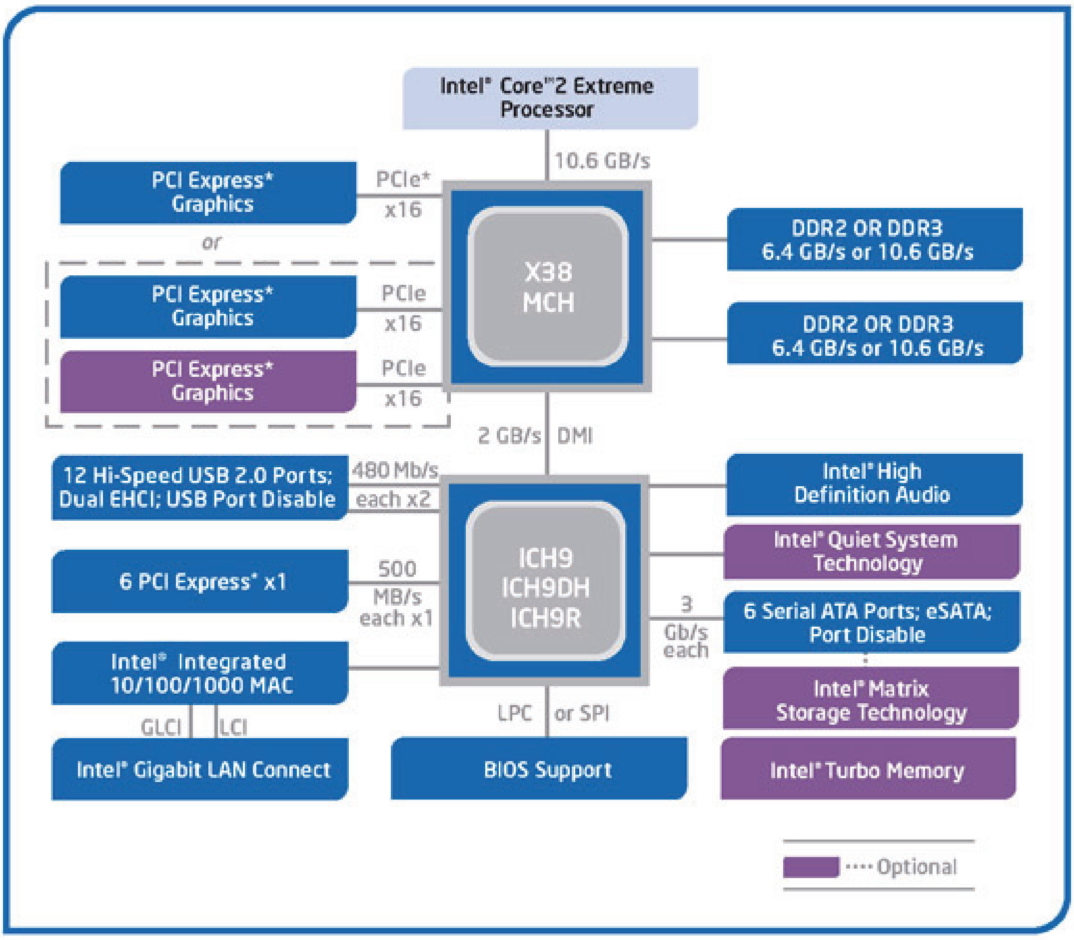
For more information:

http://support.intel.com/support/chipsets/#desktop

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

- PCI ExpressCard with potential 250 MByte/s per lane (up to 6 supported by chipset) or
- 64-bit PCI-X card (160 MByte/s)



Intel® X38 Express Chipset Block Diagram

Figure 5: Block diagram of modern PC (X38 chipset by INTEL)

Caution

As mentioned earlier, it is very important not to exceed an inrush current of 18 mJoule in 3 ms. (This means that a device, when powered via 12 V bus power must never draw more than 1.5 A, even not in the first 3 ms.)

Higher inrush current may damage the physical interface chip of the camera and/or the phy chip in your PC.

Whereas inrush current is not a problem for one Stingray camera, daisy chaining multiple cameras or supplying bus power via (optional) HIROSE power out to circuitry with unknown inrush currents needs careful design considerations to be on the safe side.

Requirements for laptop and 1394b

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

- For Intel-based laptops, chipset 915 (or higher)
- For non-Intel based laptops (e.g. AMD), PCI Express compatible chipset

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

Note

Recent developments at Apple (TM) allow the INTEL based Apple computers (both laptops as well as desktops) to run a Win-OS. This makes it possible to use AVT 1394 camera technology with the same AVT-SDKs.

The following cardbus adapter for laptops allows the connection of two industrial screw locking cables (obtainable at AVT).

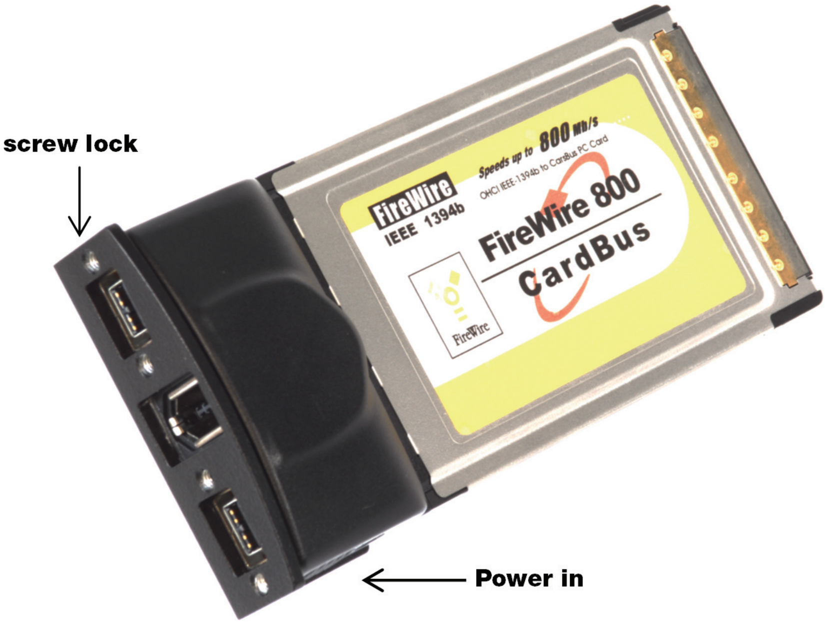


Figure 6: Cardbus adapter with two screw locks (AVT order number E3000104)

Figure 7: ExpressCard Logo, ExpressCard/54 (SIIG)

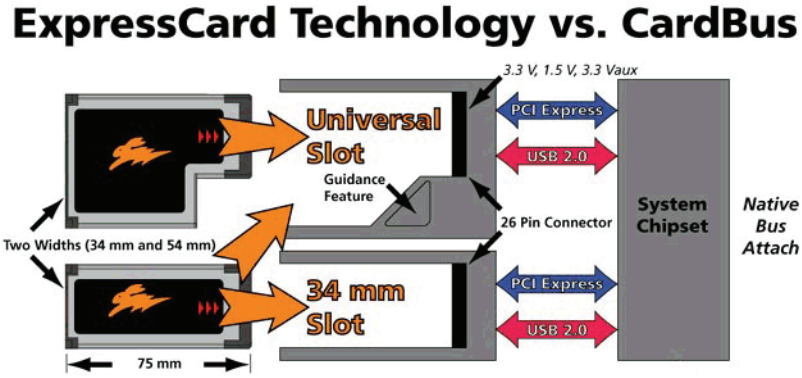


Figure 8: ExpressCard technology

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ExpressCard is a new standard set by PCMCIA.
For more information visit:
http://www.expresscard.org/web/site/

Example 1: 1394b bandwidth of Stingray cameras

STINGRAY model	Resolution	Frame rate	Bandwidth
Stingray F-033 B/C	0.3 megapixel	84 fps	27.11 MByte/s
Stingray F-046 B/C	0.45 megapixel	61 fps	27.60 MByte/s
Stingray F-080 B/C	0.8 megapixel	31 fps	24.83 MByte/s
Stingray F-125 B/C	1.25 megapixel	30 fps	36.49 MByte/s
Stingray F-145 B/C	1.44 megapixel	16 fps	23.05 MByte/s
Stingray F-146 B/C	1.44 megapixel	15 fps	21.61 MByte/s
Stingray F-201 B/C	2 megapixel	14 fps	17.20 MByte/s
Stingray F-504 B/C	5 megapixel	9 fps	45.35 MByte/s

Table 5: Bandwidth of Stingray cameras

Note

All data are calculated using Raw8 / Mono8 color mode. Higher bit depths or color modes will double or triple bandwidth requirements.

Example 2: More than one Stingray camera at full speed

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

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

Table 6: Required hardware for multiple camera applications

FireWire Plug & play capabilities

FireWire devices implement the ISO/IEC 13213 **configuration ROM** model for device configuration and identification, to provide plug & play capability. All FireWire devices are identified by an IEEE EUI-64 unique identifier (an extension of the 48-bit Ethernet MAC address format) in addition to well-known codes indicating the type of device and protocols it supports. For further details read Chapter *Configuration of the camera* on page 262.

FireWire hot-plug and screw-lock precautions

Caution

Hot-plug precautions

- Although FireWire devices can **theoretically** be hot-plugged without powering down equipment, **we strongly recommend turning the computer power off, before connecting a digital camera** to it via a FireWire cable.
- **Static electricity or slight plug misalignment during insertion may short-circuit and damage components.**
- The physical ports **may be damaged** by **excessive ESD** (electrostatic discharge), when connected under powered conditions. It is good practice to ensure proper grounding of computer case and camera case to the same ground potential, before plugging the camera cable into the port of the computer. This ensures that no excessive difference of electrical potential exists between computer and camera.
- As mentioned earlier, it is **very** important **not** to exceed the **inrush energy of 18 mJoule in 3 ms**. (This means that a device, when powered via 12 V bus power must NEVER draw more than 1.5 A, but only 0.5 A in the first 3 ms, assuming constant flow of current.)
- Higher inrush current over longer periods **may damage the physical interface chip of the camera and/or the phy chip in your PC**. Whereas inrush current is not a problem for one Stingray camera, daisy chaining multiple cameras or supplying bus power via (optional) HIROSE power out to circuitry with unknown inrush currents needs careful design considerations to be on the safe side.

Screw-lock precautions

- Also, all AVT 1394b camera and cables have **industrial screw-lock fasteners**, to insure a tight electrical connection that is resistant to vibration and gravity.
- **We strongly recommend using only 1394b adapter cards with screw-locks.**

Operating system support

Operating system	1394a	1394b
Linux	Full support	Full support
Apple Mac OS X	Full support	Full support
Windows XP	With SP2 / SP3 the default speed for 1394b is S100 (100 Mbit/s). A download and registry modification is available from Microsoft to restore performance to either S400 or S800. http://support.microsoft.com/kb/885222 Alternatively use the drivers of SP1 instead: Microsoft Windows XP SP2 and XP SP3 do not correctly support IEEE 1394b FireWire adapters. Downgrading the Windows XP FireWire bus driver to the SP1 version is required for IEEE 1394a or 1394b FireWire cameras to work correctly on an IEEE 1394b adapter, or if you want to use a 1394b FireWire camera with an IEEE 1394a adapter. Or: use either the driver of the **AVT Universal Package/ AVT FirePackage** or install the driver provided with the **AVT 1394 Bus Driver Package**. Both drivers replace the Microsoft OHCI IEEE 1394 driver, but the second is 100% compliant to the driver of Microsoft. This means, applications using the MS1394 driver will continue to work.	
Windows Vista	Full support	Windows Vista incl. SP1/SP2 supports 1394b only with S400. Use either the driver of the **AVT Universal Package/ AVT FirePackage** or install the driver provided with the **AVT 1394 Bus Driver Package**. Both drivers replace the Microsoft OHCI IEEE 1394 driver, but the second is 100% compliant to the driver of Microsoft. This means, applications using the MS1394 driver will continue to work.
Windows 7	Full support	Full support

Table 7: FireWire and operating systems

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For more information see **AVT Software Selector Guide:**

http://www.alliedvisiontec.com/emea/support/downloads/software.html

Filter and lenses

IR cut filter: spectral transmission

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

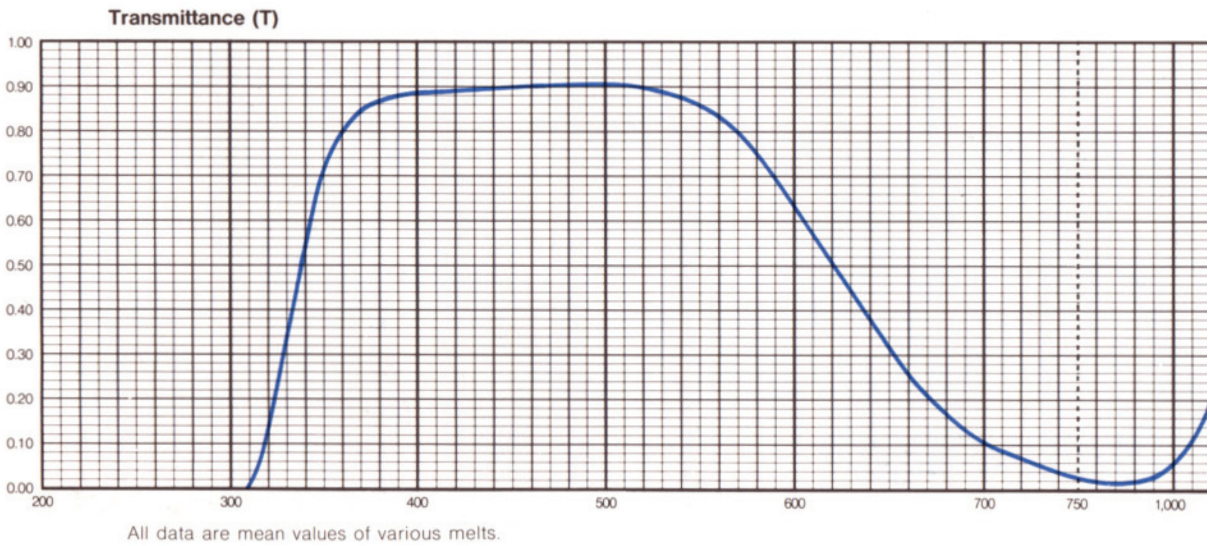


Figure 9: Spectral transmission of Hoya C5000

Note

Stingray uses a different IR cut filter than the other AVT cameras.

Camera lenses

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

Focal length for type 1/3 sensors Stingray F-080/125	Distance = 500 mm	Distance = 1000 mm
4.8 mm	495 mm x 371 mm	995 mm x 746 mm
8 mm	295 mm x 221 mm	595 mm x 446 mm
12 mm	195 mm x 146 mm	395 mm x 296 mm
16 mm	145 mm x 109 mm	295 mm x 221 mm
25 mm	91 mm x 68 mm	187 mm x 140 mm
35 mm	64 mm x 48 mm	132 mm x 99 mm
50 mm	43 mm x 32 mm	91 mm x 68 mm

Table 8: Focal length vs. field of view (Stingray F-080)

Focal length for type 1/2 sensors Stingray F-033/046/146	Distance = 500 mm	Distance = 1000 mm
4.8 mm	660 mm x 495 mm	1327 mm x 995 mm
8 mm	394 mm x 295 mm	794 mm x 595 mm
12 mm	260 mm x 195 mm	527 mm x 395 mm
16 mm	194 mm x 145 mm	394 mm x 295 mm
25 mm	122 mm x 91 mm	250 mm x 187 mm
35 mm	85 mm x 64 mm	176 mm x 132 mm
50 mm	58 mm x 43 mm	122 mm x 91 mm

Table 9: Focal length vs. field of view (Stingray F-033/046/146)

Focal length for type 1/1.8 sensors Stingray F-201	Distance = 500 mm	Distance = 1000 mm
4.8 mm	740 mm x 549 mm	1488 mm x 1103 mm
8 mm	441 mm x 327 mm	890 mm x 660 mm
12 mm	292 mm x 216 mm	591 mm x 438 mm
16 mm	217 mm x 161 mm	441 mm x 327 mm
25 mm	136 mm x 101 mm	280 mm x 207 mm
35 mm	95 mm x 71 mm	198 mm x 147 mm
50 mm	65 mm x 48 mm	136 mm x 101 mm

Table 10: Focal length vs. field of view (Stingray F-201)

Focal length for type 2/3 sensors Stingray F-145/504	Distance = 500 mm	Distance = 1000 mm
4.8 mm	908 mm x 681 mm	1825 mm x 1368 mm
8 mm	541 mm x 406 mm	1091 mm x 818 mm
12 mm	358 mm x 268 mm	725 mm x 543 mm
16 mm	266 mm x 200 mm	541 mm x 406 mm
25 mm	167 mm x 125 mm	343 mm x 257 mm
35 mm	117 mm x 88 mm	243 mm x 182 mm
50 mm	79 mm x 59 mm	167 mm x 125 mm

Table 11: Focal length vs. field of view (Stingray F-145)

Note

Lenses with focal lengths < 8 mm may show shading in the edges of the image and due to micro lenses on the sensor's pixel.

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

Specifications

Note

- For information on bit/pixel and byte/pixel for each color mode see *Table 105: ByteDepth* on page 259.
- **Maximum protrusion** means the **distance from lens flange to the glass filter in the camera**.

STINGRAY F-033B/C (fiber)

Feature	Specification
Image device	Type 1/2 (diag. 8 mm) progressive scan SONY IT CCD ICX414AL/AQ with HAD microlens
Effective chip size	**6.5 mm x 4.9 mm**
Cell size	9.9 µm x 9.9 µm
Picture size (max.)	656 x 492 pixels (Format_7 Mode_0)
Lens mount	C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) maximum protrusion: 10.1 mm (see *Figure 39: Stingray C-Mount dimensions* on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi) maximum protrusion: 5.1 mm (see *Figure 38: Stingray CS-Mount dimension* on page 88) Note: **Maximum protrusion** means the distance from lens flange to the glass filter in the camera.
ADC	14 bit
Color modes	**Only color:** Raw8, Raw12, Raw16, Mono8, YUV422, YUV411, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps Up to 84 fps in Format_7
Gain control	Manual: 0-24.4 dB (0.0359 dB/step); auto gain (select. AOI)
Shutter speed	**31** µs … 67,108,864 µs (~ 67 s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	32 MByte, up to 50 frames
Look-up tables	User programmable (12 bit → 10 bit); default gamma (0.45)

Table 12: Specification STINGRAY F-033B/C (fiber)

Feature	Specification
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 32 MByte image memory, mirror, binning (only b/w), sub-sampling, High SNR, deferred image transport, SIS (secure image signature), sequence mode, 4 storable user sets **only color:** AWB (auto white balance), color correction, hue, saturation, sharpness Two configurable inputs, four configurable outputs RS232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical <3.5 watt (@ 12 V DC); **fiber:** typical <4 watt (@ 12 V DC) (full resolution and maximal frame rates)
Dimensions	72.9 mm x 44 mm x 29 mm (L x W x H); incl. connectors, without tripod and lens
Mass	92 g (without lens) 108 g (without lens) for cameras with S/N greater 09/17-285831532
Operating temperature	+ 5 °C ... + 45 °C ambient temperature (without condensation)
Storage temperature	- 10 °C ... + 70 °C ambient temperature (without condensation)
Regulations	CE, FCC Class B, RoHS (2002/95/EC)
Standard accessories	**b/w:** protection glass **color:** IR cut filter
Optional accessories	**b/w:** IR cut filter, IR pass filter **color:** protection glass
On request	Host adapter card, angled head, power out: 6 W (HIROSE)
Software packages	API (FirePackage, Active FirePackage, Fire4Linux)

Table 12: Specification STINGRAY F-033B/C (fiber)

Note

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

STINGRAY F-046B/C (fiber)

Feature	Specification
Image device	Type 1/2 (diag. 8 mm) progressive scan SONY IT CCD ICX415AL/AQ with HAD microlens
Effective chip size	**6.5 mm x 4.8 mm**
Cell size	8.3 µm x 8.3 µm
Picture size (max.)	780 x 580 pixels (Format_7 Mode_0)
Lens mount	C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) maximum protrusion: 10.1 mm (see *Figure 39: Stingray C-Mount dimensions* on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi) maximum protrusion: 5.1 mm (see *Figure 38: Stingray CS-Mount dimension* on page 88) Note: **Maximum protrusion** means the distance from lens flange to the glass filter in the camera.
ADC	14 bit
Color modes	**Only color:** Raw8, Raw12, Raw16, Mono8, YUV422, YUV411, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps Up to 61 fps in Format_7
Gain control	Manual: 0-24.4 dB (0.0359 dB/step); auto gain (select. AOI)
Shutter speed	**31** µs … 67,108,864 µs (~ 67 s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	32 MByte, up to 35 frames
Look-up tables	User programmable (12 bit → 10 bit); default gamma (0.45)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 32 MByte image memory, mirror, binning (only b/w), sub-sampling, High SNR, deferred image transport, SIS (secure image signature), sequence mode, 4 storable user sets **Only color:** AWB (auto white balance), color correction, hue, saturation Two configurable inputs, four configurable outputs RS232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 13: Specification STINGRAY F-046B/C (fiber)

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical <3.5 watt (@ 12 V DC); **fiber:** typical <4 watt (@ 12 V DC) (full resolution and maximal frame rates)
Dimensions	72.9 mm x 44 mm x 29 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	92 g (without lens) 108 g (without lens) for cameras with S/N greater 09/17-285831532
Operating temperature	+ 5 °C ... + 45 °C ambient temperature (without condensation)
Storage temperature	- 10 °C ... + 70 °C ambient temperature (without condensation)
Regulations	CE, FCC Class B, RoHS (2002/95/EC)
Standard accessories	**b/w:** protection glass **color:** IR cut filter
Optional accessories	**b/w:** IR cut filter, IR pass filter **color:** protection glass
On request	Host adapter card, angled head, power out: 6 W (HIROSE)
Software packages	API (FirePackage, Active FirePackage, Fire4Linux)

Table 13: Specification STINGRAY F-046B/C (fiber)

Note

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

STINGRAY F-080B/C (fiber)

Feature	Specification
Image device	Type 1/3 (diag. 6 mm) progressive scan SONY IT CCD ICX204AL/AK with HAD microlens
Effective chip size	**4.8 mm x 3.6 mm**
Cell size	4.65 µm x 4.65 µm
Picture size (max.)	1032 x 776 pixels (Format_7 Mode_0)
Lens mount	C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) maximum protrusion: 10.1 mm (see *Figure 39: Stingray C-Mount dimensions* on page 89) S-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi) maximum protrusion: 5.1 mm (see *Figure 38: Stingray CS-Mount dimension* on page 88) Note: **Maximum protrusion** means the distance from lens flange to the glass filter in the camera.
ADC	14 bit
Color modes	**Only color:** Raw8, Raw12, Raw16, Mono8, YUV422, YUV411, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps Up to 31 fps in Format_7
Gain control	Manual: 0-24.4 dB (0.0359 dB/step); auto gain (select. AOI)
Shutter speed	**49** µs … 67,108,864 µs (~ 67 s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	32 MByte, up to 19 frames
Look-up tables	User programmable (12 bit → 10 bit); default gamma (0.45)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 32 MByte image memory, mirror, binning (only b/w), sub-sampling, High SNR, deferred image transport, SIS (secure image signature), sequence mode, 4 storable user sets **only color:** AWB (auto white balance), color correction, hue, saturation, sharpness Two configurable inputs, four configurable outputs RS232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 14: Specification STINGRAY F-080B/C fiber

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical <3.6 watt (@ 12 V DC); **fiber:** typical <4 watt (@ 12 V DC) (full resolution and maximal frame rates)
Dimensions	72.9 mm x 44 mm x 29 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	92 g (without lens) 108 g (without lens) for cameras with S/N greater 09/17-285831532
Operating temperature	+ 5 °C ... + 45 °C ambient temperature (without condensation)
Storage temperature	- 10 °C ... + 70 °C ambient temperature (without condensation)
Regulations	CE, FCC Class B, RoHS (2002/95/EC)
Standard accessories	**b/w:** protection glass **color:** IR cut filter
Optional accessories	**b/w:** IR cut filter, IR pass filter **color:** protection glass
On request	Host adapter card, angled head, power out: 6 W (HIROSE)
Software packages	API (FirePackage, Active FirePackage, Fire4Linux)

Table 14: Specification STINGRAY F-080B/C fiber

Note

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

STINGRAY F-125B/C (fiber)

Feature	Specification
Image device	Type 1/3 (diag. 6 mm) progressive scan SONY IT CCD ICX445ALA/AQA with EXview HAD microlens
Effective chip size	**4.8 mm x 3.6 mm**
Cell size	3.75 µm x 3.75 µm
Picture size (max.)	1292 x 964 pixels (Format_7 Mode_0)
Lens mount	C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) maximum protrusion: 10.1 mm (see *Figure 39: Stingray C-Mount dimensions* on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi) maximum protrusion: 5.1 mm (see *Figure 38: Stingray CS-Mount dimension* on page 88) Note: **Maximum protrusion** means the distance from lens flange to the glass filter in the camera.
ADC	14 bit
Color Modes	**Only color:** Raw8, Raw12, Raw16, Mono8, YUV422, YUV411, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps Up to 30 fps in Format_7
Gain control	Manual: 0-24.4 dB (0.0359 dB/step); auto gain (select. AOI)
Shutter speed	**25** µs … 67,108,864 µs (~ 67 s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	32 MByte, up to **12** frames
Look-up tables	User programmable (12 bit → 10 bit); default gamma (0.45)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 32 MByte image memory, mirror, binning, sub-sampling, High SNR, deferred image transport, SIS (secure image signature), sequence mode, 4 storable user sets **only color:** AWB (auto white balance), color correction, hue, saturation, sharpness Two configurable inputs, four configurable outputs RS232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 15: Specification STINGRAY F-125B/C (fiber)

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical <3.6 watt (@ 12 V DC); **fiber:** typical <4 watt (@ 12 V DC) (full resolution and maximal frame rates)
Dimensions	72.9 mm x 44 mm x 29 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	92 g (without lens) 108 g (without lens) for cameras with S/N greater 09/17-285831532
Operating temperature	+ 5 °C ... + 45 °C ambient temperature (without condensation)
Storage temperature	- 10 °C ... + 70 °C ambient temperature (without condensation)
Regulations	CE, FCC Class B, RoHS (2002/95/EC)
Standard accessories	**b/w:** protection glass **color:** IR cut filter
Optional accessories	**b/w:** IR cut filter, IR pass filter **color:** protection glass
On request	Host adapter card, angled head, power out: 6 W (HIROSE)
Software packages	API (FirePackage, Active FirePackage, Fire4Linux)

Table 15: Specification STINGRAY F-125B/C (fiber)

Note

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

STINGRAY F-145B/C (fiber)

Feature	Specification
Image device	Type 2/3 (diag. 11 mm) progressive scan SONY IT CCD ICX285AL/AQ with EXview HAD microlens
Effective chip size	**9.0 mm x 6.7 mm**
Cell size	6.45 µm x 6.45 µm
Picture size (max.)	1388 x 1038 pixels (Format_7 Mode_0)
Lens mount	C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) maximum protrusion: 10.1 mm (see *Figure 39: Stingray C-Mount dimensions* on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi) maximum protrusion: 5.1 mm (see *Figure 38: Stingray CS-Mount dimension* on page 88) Note: **Maximum protrusion** means the distance from lens flange to the glass filter in the camera.
ADC	14 bit
Color modes	**Only color:** Raw8, Raw12, Raw16, Mono8, YUV422, YUV411, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps Up to 16 fps in Format_7
Gain control	Manual: 0-24.4 dB (0.0359 dB/step); auto gain (select. AOI)
Shutter speed	**74** µs … 67,108,864 µs (~ 67 s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	32 MByte, up to 10 frames
Look-up tables	User programmable (12 bit → 10 bit); default gamma (0.45)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 32 MByte image memory, mirror, binning (only b/w), sub-sampling, High SNR, deferred image transport, SIS (secure image signature), sequence mode, 4 storable user sets **only color:** AWB (auto white balance), color correction, hue, saturation, sharpness Two configurable inputs, four configurable outputs RS232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 16: Specification STINGRAY F-145B/C (fiber)

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical <3.5 watt (@ 12 V DC); **fiber:** typical <4 watt (@ 12 V DC) (full resolution and maximal frame rates)
Dimensions	72.9 mm x 44 mm x 29 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	92 g (without lens) 108 g (without lens) for cameras with S/N greater 09/17-285831532
Operating temperature	+ 5 °C ... + 45 °C ambient temperature (without condensation)
Storage temperature	- 10 °C ... + 70 °C ambient temperature (without condensation)
Regulations	CE, FCC Class B, RoHS (2002/95/EC)
Standard accessories	**b/w:** protection glass **color:** IR cut filter
Optional accessories	**b/w:** IR cut filter, IR pass filter **color:** protection glass
On request	Host adapter card, angled head, power out: 6 W (HIROSE)
Software packages	API (FirePackage, Active FirePackage, Fire4Linux)

Table 16: Specification STINGRAY F-145B/C (fiber)

Note

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

STINGRAY F-146B/C (fiber)

Feature	Specification
Image device	Type 1/2 (diag. 8 mm) progressive scan SONY IT CCD ICX267AL/AK with HAD microlens
Effective chip size	**6.5 mm x 4.8 mm**
Cell size	4.65 µm x 4.65 µm
Picture size (max.)	1388 x 1038 pixels (Format_7 Mode_0)
Lens mount	C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) maximum protrusion: 10.1 mm (see *Figure 39: Stingray C-Mount dimensions* on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi) maximum protrusion: 5.1 mm (see *Figure 38: Stingray CS-Mount dimension* on page 88) Note: **Maximum protrusion** means the distance from lens flange to the glass filter in the camera.
ADC	14 bit
Color modes	**Only color:** Raw8, Raw12, Raw16, Mono8, YUV422, YUV411, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps Up to 15 fps in Format_7
Gain control	Manual: 0-24.4 dB (0.0359 dB/step); auto gain (select. AOI)
Shutter speed	**39** µs … 67,108,864 µs (~ 67 s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	32 MByte, up to 10 frames
Look-up tables	User programmable (12 bit → 10 bit); default gamma (0.45)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 32 MByte image memory, mirror, binning (only b/w), sub-sampling, High SNR, deferred image transport, SIS (secure image signature), sequence mode, 4 storable user sets **only color:** AWB (auto white balance), color correction, hue, saturation, sharpness Two configurable inputs, four configurable outputs RS232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 17: Specification STINGRAY F-146B/C (fiber)

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical <3.5 watt (@ 12 V DC); **fiber:** typical <4 watt (@ 12 V DC) (full resolution and maximal frame rates)
Dimensions	72.9 mm x 44 mm x 29 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	92 g (without lens) 108 g (without lens) for cameras with S/N greater 09/17-285831532
Operating temperature	+ 5 °C ... + 45 °C ambient temperature (without condensation)
Storage temperature	- 10 °C ... + 70 °C ambient temperature (without condensation)
Regulations	CE, FCC Class B, RoHS (2002/95/EC)
Standard accessories	**b/w:** protection glass **color:** IR cut filter
Accessories	**b/w:** IR cut filter, IR pass filter **color:** protection glass
On request	Host adapter card, angled head, power out: 6 W (HIROSE)
Software packages	API (FirePackage, Active FirePackage, Fire4Linux)

Table 17: Specification STINGRAY F-146B/C (fiber)

Note

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

STINGRAY F-201B/C (fiber)

Feature	Specification
Image device	Type 1/1.8 (diag. 8.9 mm) progressive scan SONY IT CCD ICX274AL/AQ with Super HAD microlens
Effective chip size	**7.1 mm x 5.4 mm**
Cell size	4.40 µm x 4.40 µm
Picture size (max.)	1624 x 1234 pixels (Format_7 Mode_0)
Lens mount	C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) maximum protrusion: 10.1 mm (see *Figure 39: Stingray C-Mount dimensions* on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi) maximum protrusion: 5.1 mm (see *Figure 38: Stingray CS-Mount dimension* on page 88) Note: **Maximum protrusion** means the distance from lens flange to the glass filter in the camera.
ADC	14 bit
Color Modes	**Only color:** Raw8, Raw12, Raw16, Mono8, YUV422, YUV411, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps Up to 14 fps in Format_7
Gain control	Manual: 0-24.4 dB (0.0359 dB/step); auto gain (select. AOI)
Shutter speed	**48** µs … 67,108,864 µs (~ 67 s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	32 MByte, up to 7 frames
Look-up tables	User programmable (12 bit → 10 bit); default gamma (0.45)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 32 MByte image memory, mirror, binning, sub-sampling, High SNR, deferred image transport, SIS (secure image signature), sequence mode, 4 storable user sets **only color:** AWB (auto white balance), color correction, hue, saturation, sharpness Two configurable inputs, four configurable outputs RS232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 18: Specification STINGRAY F-201B/C (fiber)

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical <3.5 watt (@ 12 V DC); **fiber:** typical <4 watt (@ 12 V DC) (full resolution and maximal frame rates)
Dimensions	72.9 mm x 44 mm x 29 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	92 g (without lens) 108 g (without lens) for cameras with S/N greater 09/17-285831532
Operating temperature	+ 5 °C ... + 45 °C ambient temperature (without condensation)
Storage temperature	- 10 °C ... + 70 °C ambient temperature (without condensation)
Regulations	CE, FCC Class B, RoHS (2002/95/EC)
Standard accessories	**b/w:** protection glass **color:** IR cut filter
Optional accessories	**b/w:** IR cut filter, IR pass filter **color:** protection glass
On request	Host adapter card, angled head, power out: 6 W (HIROSE)
Software packages	API (FirePackage, Active FirePackage, Fire4Linux)

Table 18: Specification STINGRAY F-201B/C (fiber)

Note

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

STINGRAY F-504B/C (fiber)

Feature	Specification
Image device	Type 2/3 (diag. 11 mm) progressive scan SONY IT CCD ICX655ALA/AQA with Super HAD microlens
Effective chip size	**8.5 mm x 7.1 mm**
Cell size	3.45 µm x 3.45 µm
Picture size (max.)	2452 x 2056 pixels (Format_7 Mode_0)
Lens mount	C-Mount: 17.526 mm (in air); Ø 25.4 mm (32 tpi) maximum protrusion: 10.1 mm (see *Figure 39: Stingray C-Mount dimensions* on page 89) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi) maximum protrusion: 5.1 mm (see *Figure 38: Stingray CS-Mount dimension* on page 88) Note: **Maximum protrusion** means the distance from lens flange to the glass filter in the camera.
ADC	14 bit
Color modes	**Only color:** Raw8, Raw12, Raw16, Mono8, YUV422, YUV411, RGB8
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps Up to 9 fps in Format_7
Gain control	Manual: 0-24.4 dB (0.0359 dB/step); auto gain (select. AOI)
Shutter speed	**42** µs … 67,108,864 µs (~ 67 s); auto shutter (select. AOI)
External trigger shutter	Programmable, trigger level control, single trigger, bulk trigger, programmable trigger delay
Internal FIFO memory	**64** MByte, up to **5** frames
Look-up tables	User programmable (12 bit → 10 bit); default gamma (0.45)
Smart functions	AGC (auto gain control), AEC (auto exposure control), real-time shading correction, LUT, 64 MByte image memory, mirror, binning (b/w and color models), sub-sampling, High SNR, deferred image transport, SIS (secure image signature), sequence mode, 4 storable user sets **only color:** AWB (auto white balance), color correction, hue, saturation, sharpness Two configurable inputs, four configurable outputs RS232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s, 800 Mbit/s

Table 19: Specification STINGRAY F-504B/C (fiber)

Feature	Specification
Digital interface	IEEE 1394b (IIDC V1.31), 2 x copper connectors (bilingual) (daisy chain) **fiber**: IEEE 1394b, 2 connectors: 1 x copper (bilingual), 1 x GOF connector (2 x optical fiber on LCLC), (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 12-pin HIROSE
Power consumption	Typical <3.9 watt (@ 12 V DC); **fiber:** typical <4.2 watt (@ 12 V DC) (full resolution and maximal frame rates)
Dimensions	72.9 mm x 44 mm x 29 mm (L x W x H); incl. connectors, w/o tripod and lens
Mass	92 g (without lens) 108 g (without lens) for cameras with S/N greater 09/17-285831532
Operating temperature	+ 5 °C ... + 45 °C ambient temperature (without condensation)
Storage temperature	- 10 °C ... + 70 °C ambient temperature (without condensation)
Regulations	CE, FCC Class B, RoHS (2002/95/EC)
Standard accessories	**b/w:** protection glass **color:** IR cut filter
Optional accessories	**b/w:** IR cut filter, IR pass filter **color:** protection glass
On request	Host adapter card, angled head, power out: 6 W (HIROSE)
Software packages	API (FirePackage, Active FirePackage, Fire4Linux)

Table 19: Specification STINGRAY F-504B/C (fiber)

Note

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

Spectral sensitivity

Note

All measurements were done without protection glass / without filter.

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

This is due to:

- Manufacturing tolerance of the sensor
- Uncertainties in the measuring apparatus itself (Ulbricht-Kugel/Ulbricht sphere, optometer, etc.)

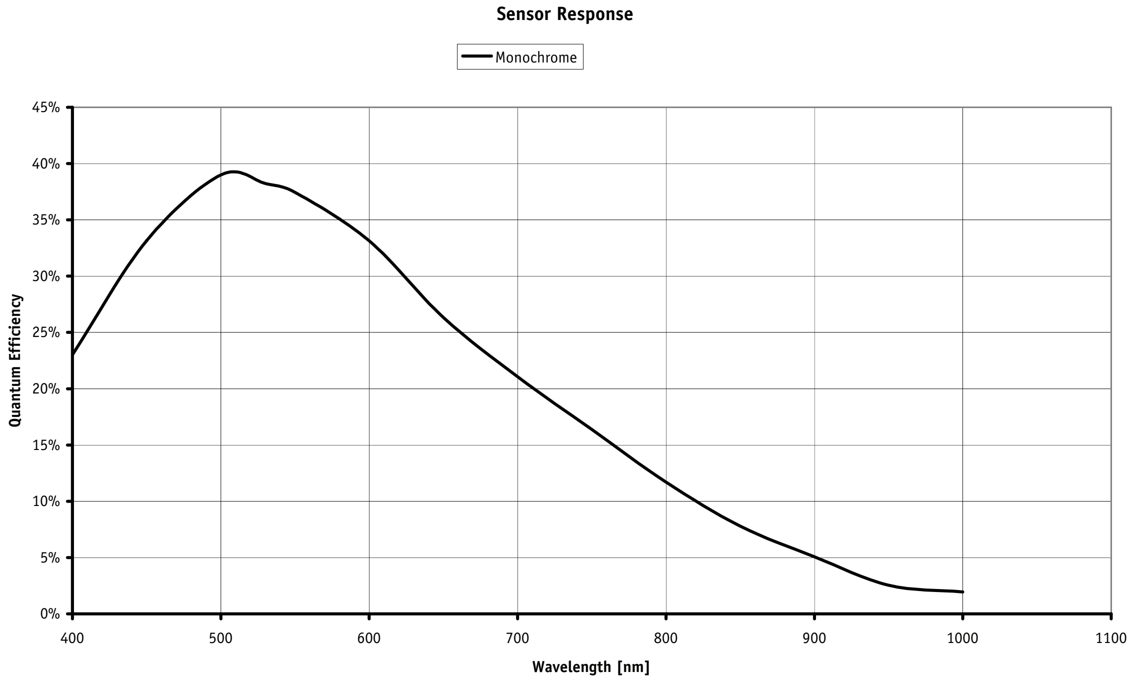


Figure 10: Spectral sensitivity of Stingray F-033B

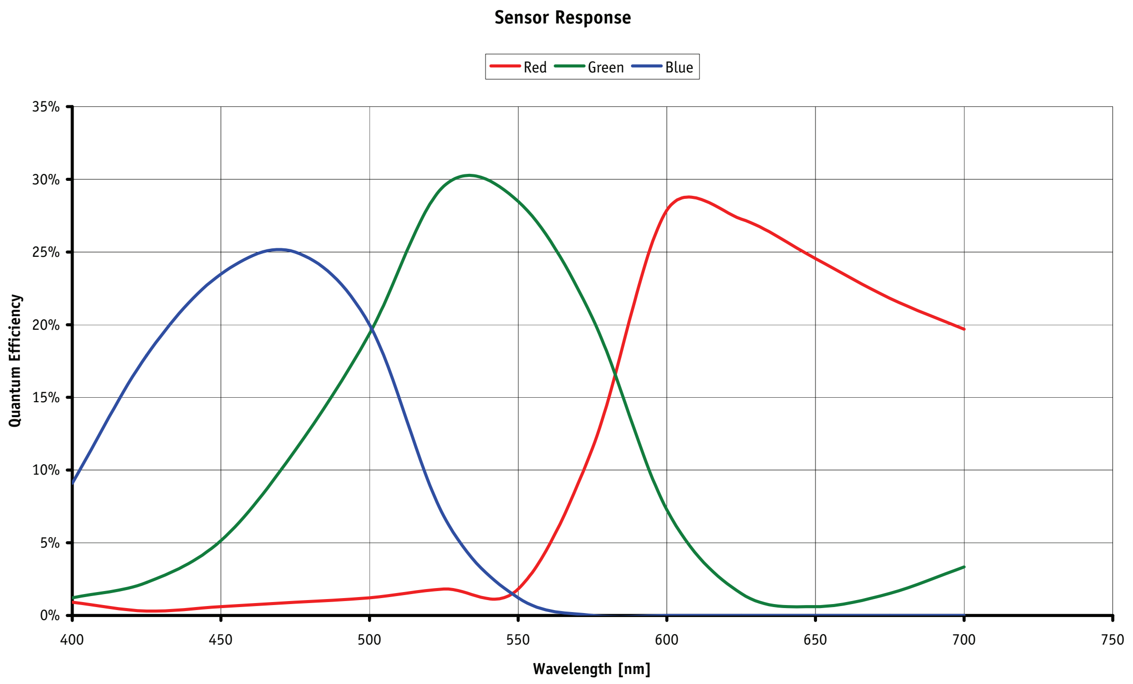


Figure 11: Spectral sensitivity of Stingray F-033C (without IR cut filter)

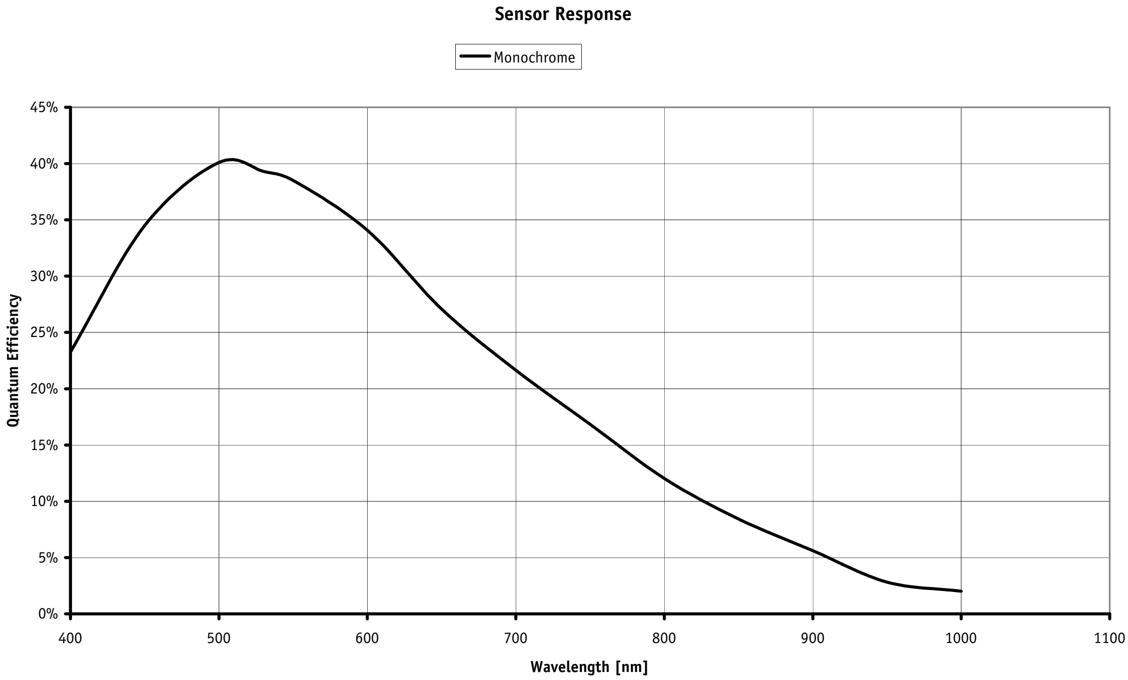


Figure 12: Spectral sensitivity of Stingray F-046B

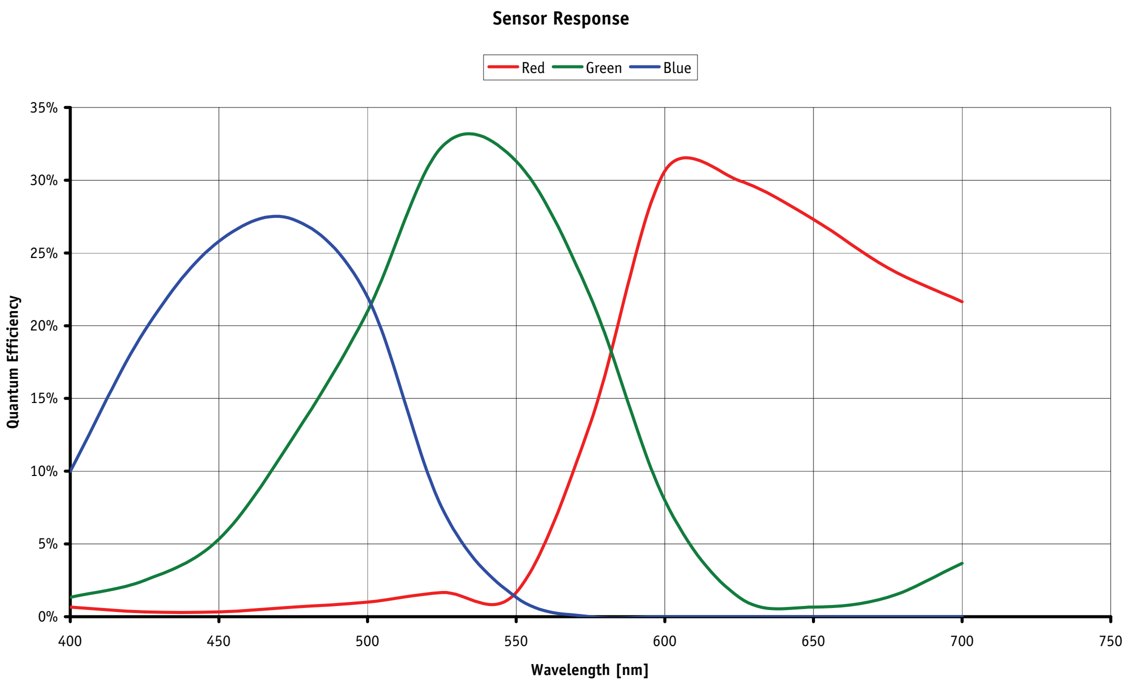


Figure 13: Spectral sensitivity of Stingray F-046C (without IR cut filter)

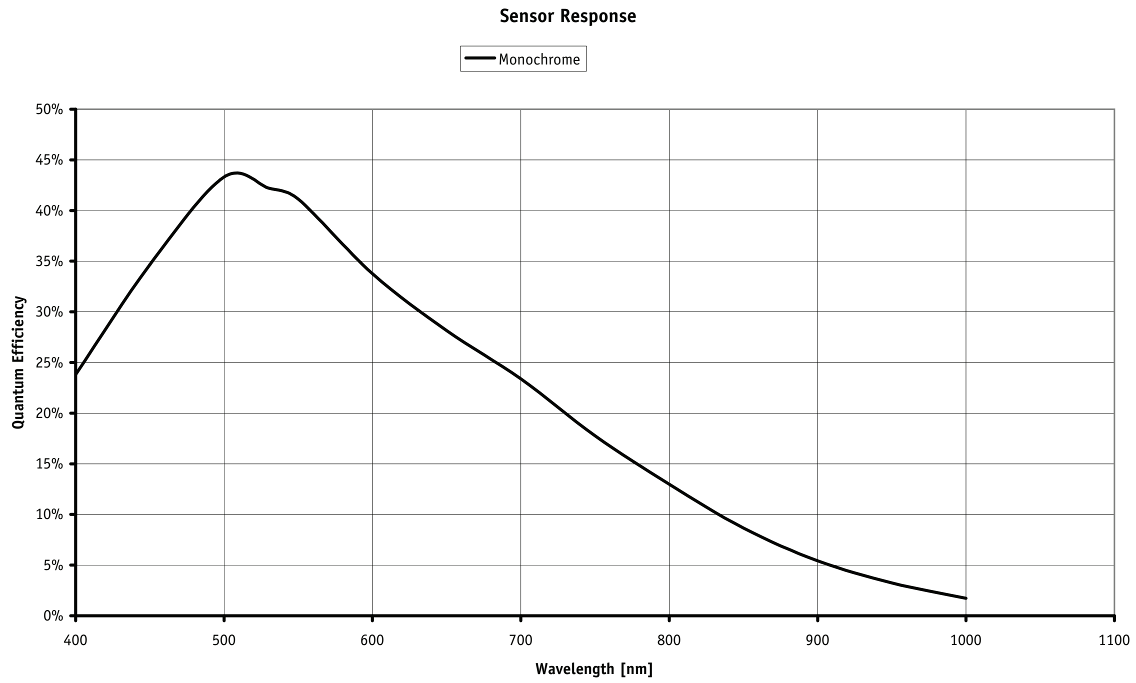


Figure 14: Spectral sensitivity of Stingray F-080B

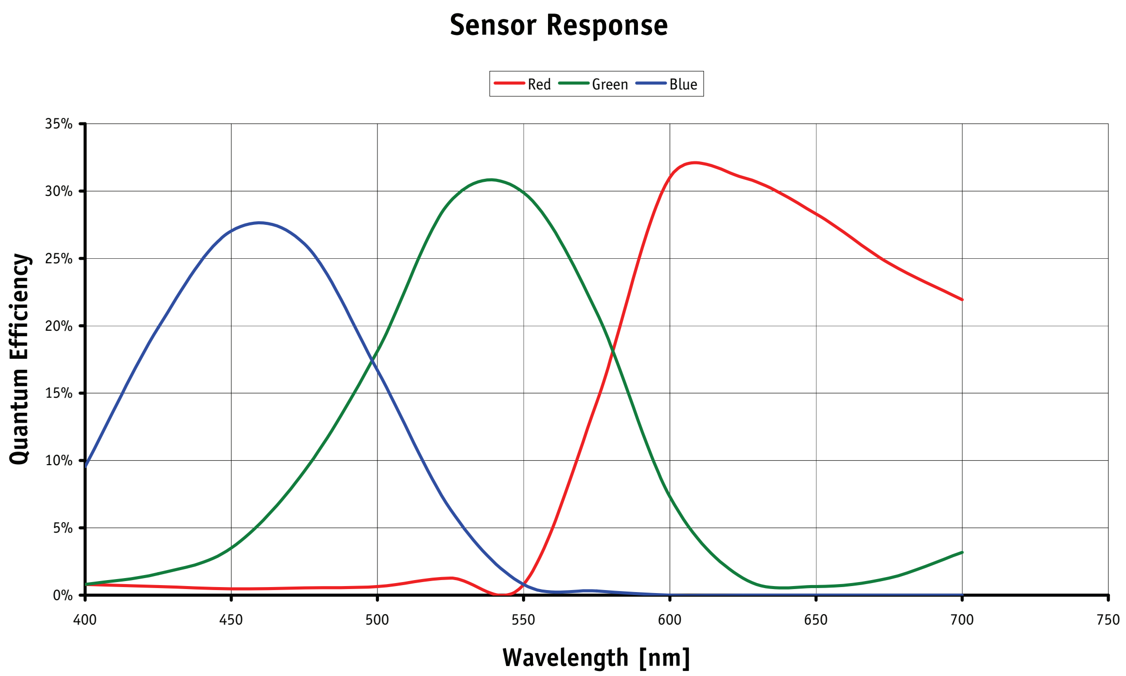


Figure 15: Spectral sensitivity of Stingray F-080C (without IR cut filter)

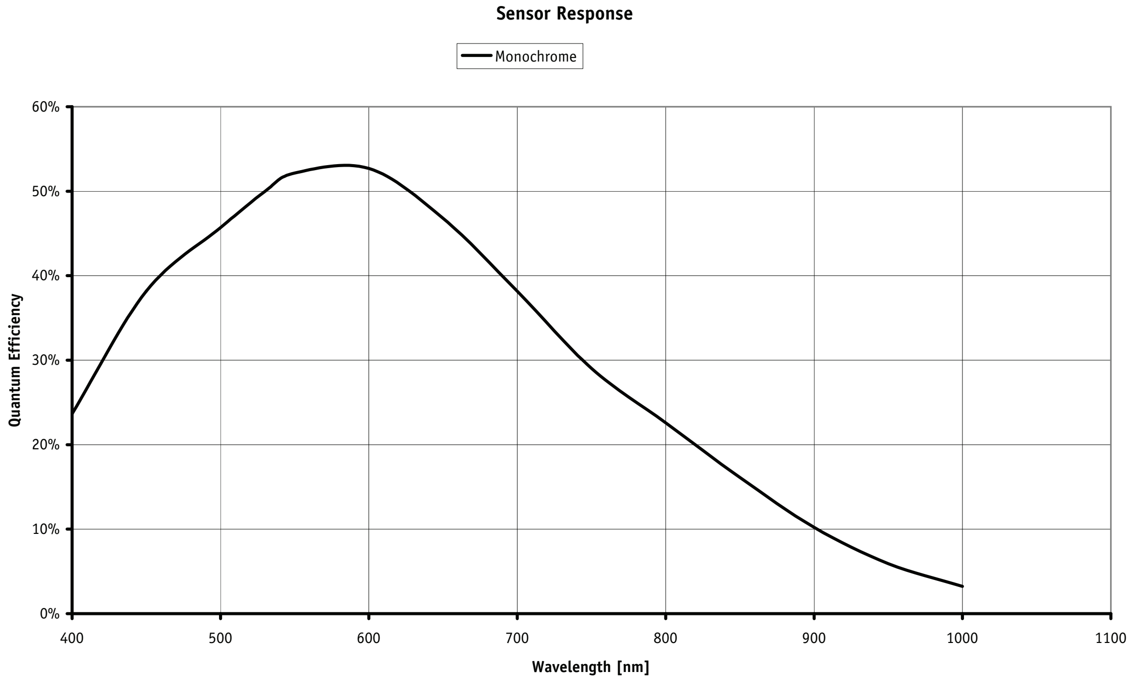


Figure 16: Spectral sensitivity of Stingray F-125B

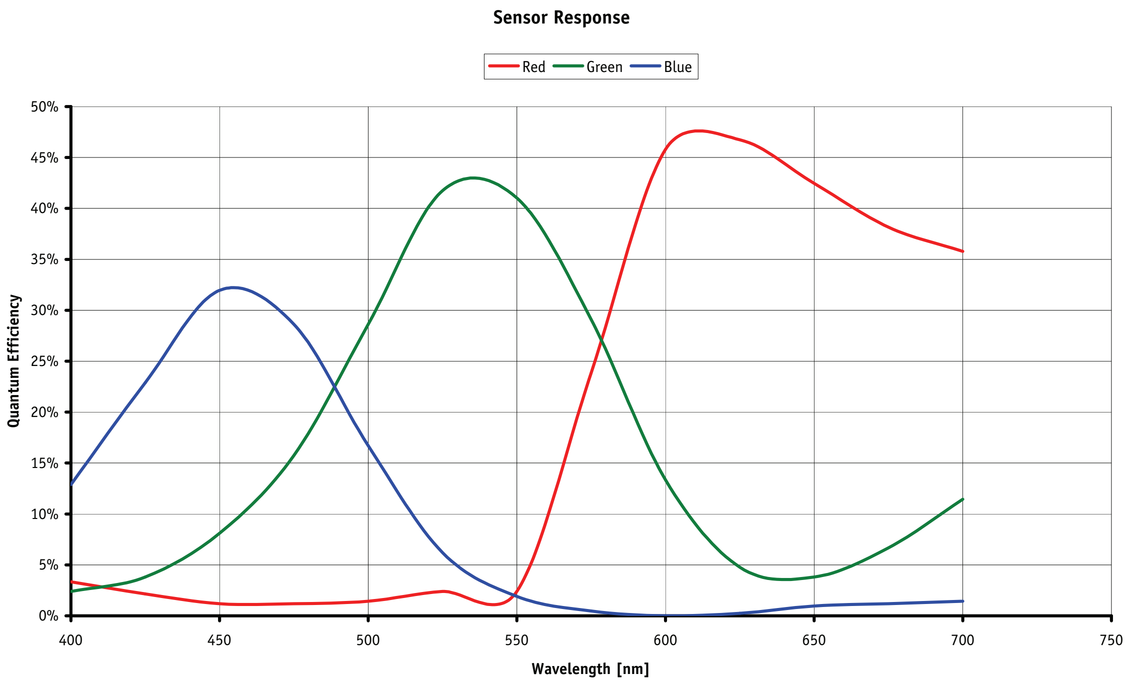


Figure 17: Spectral sensitivity of Stingray F-125C (without IR cut filter)

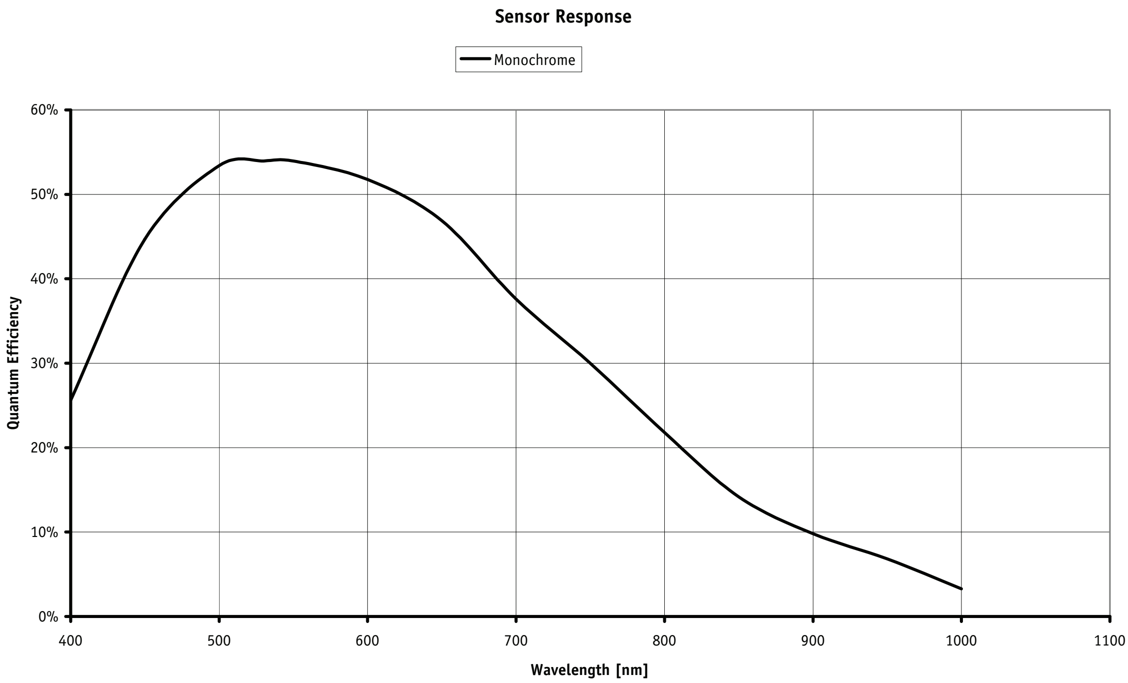


Figure 18: Spectral sensitivity of Stingray F-145B

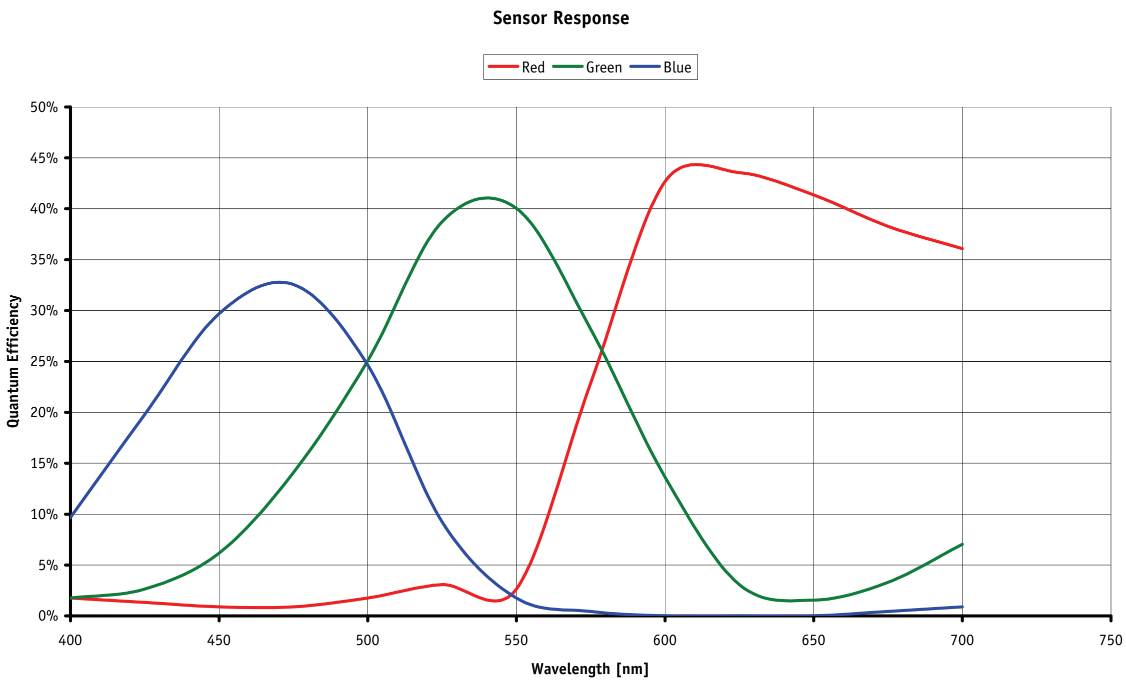


Figure 19: Spectral sensitivity of Stingray F-145C (without IR cut filter)

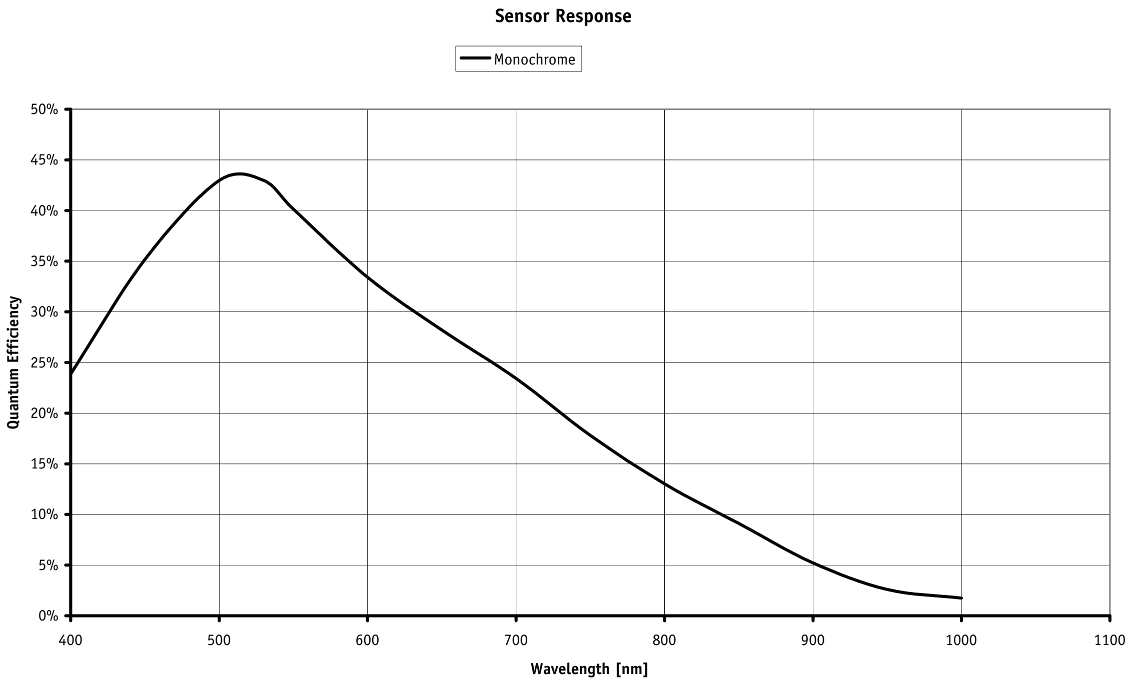


Figure 20: Spectral sensitivity of Stingray F-146B

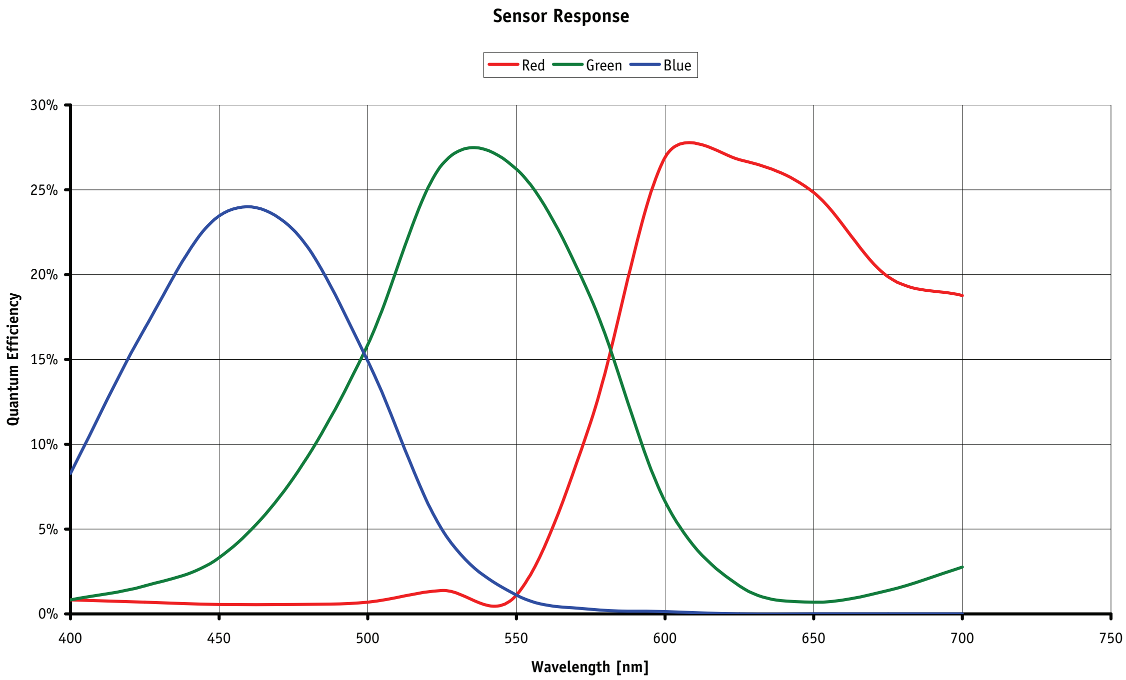


Figure 21: Spectral sensitivity of Stingray F-146C (without IR cut filter)

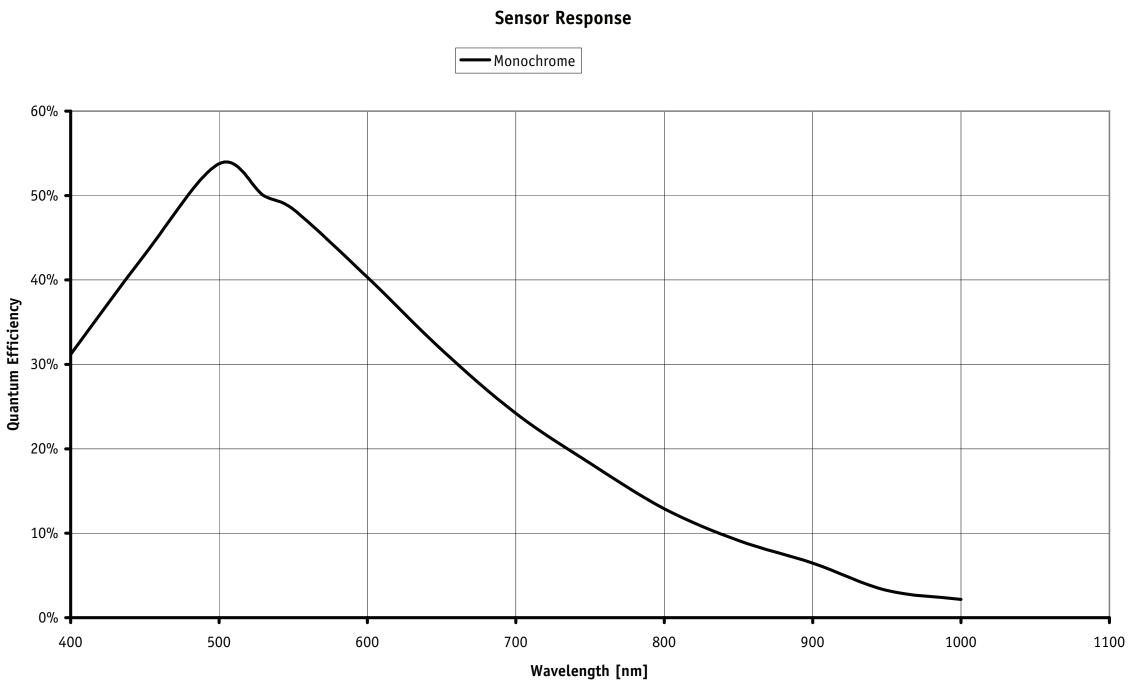


Figure 22: Spectral sensitivity of Stingray F-201B

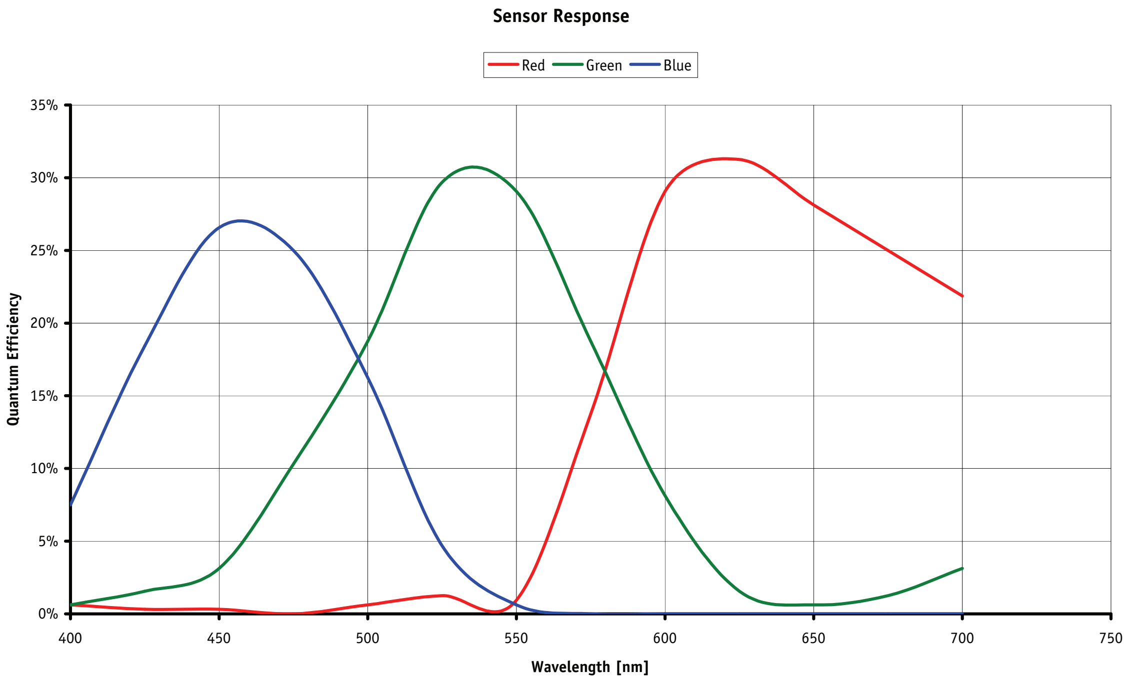


Figure 23: Spectral sensitivity of Stingray F-201C (without IR cut filter)

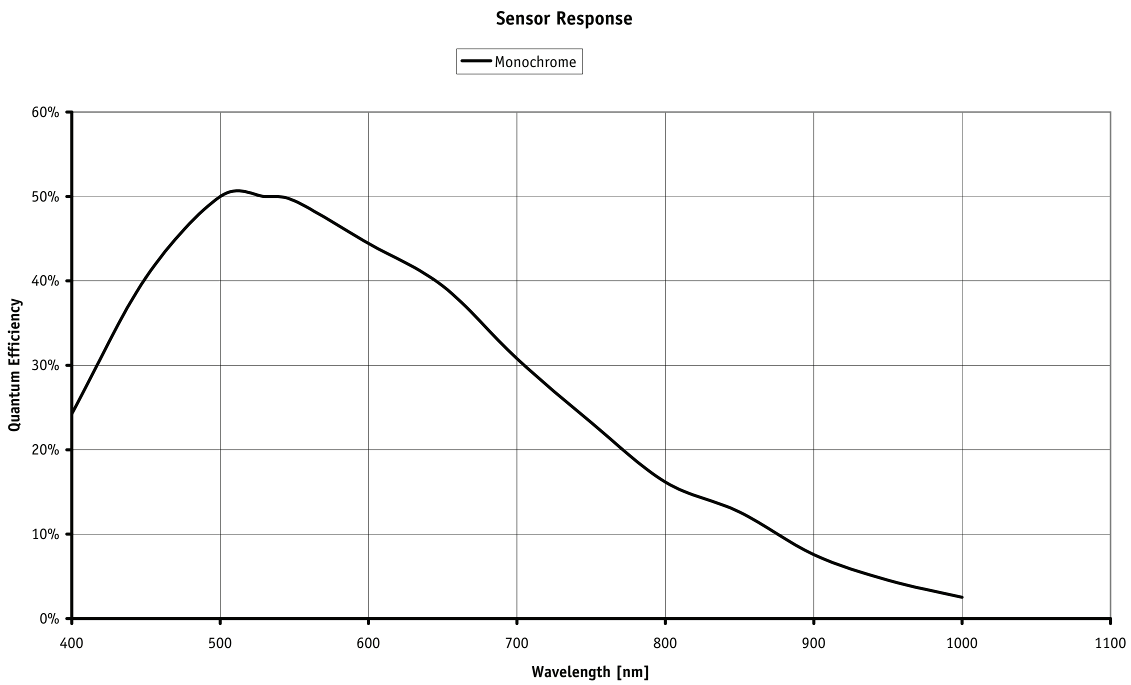


Figure 24: Spectral sensitivity of Stingray F-504B

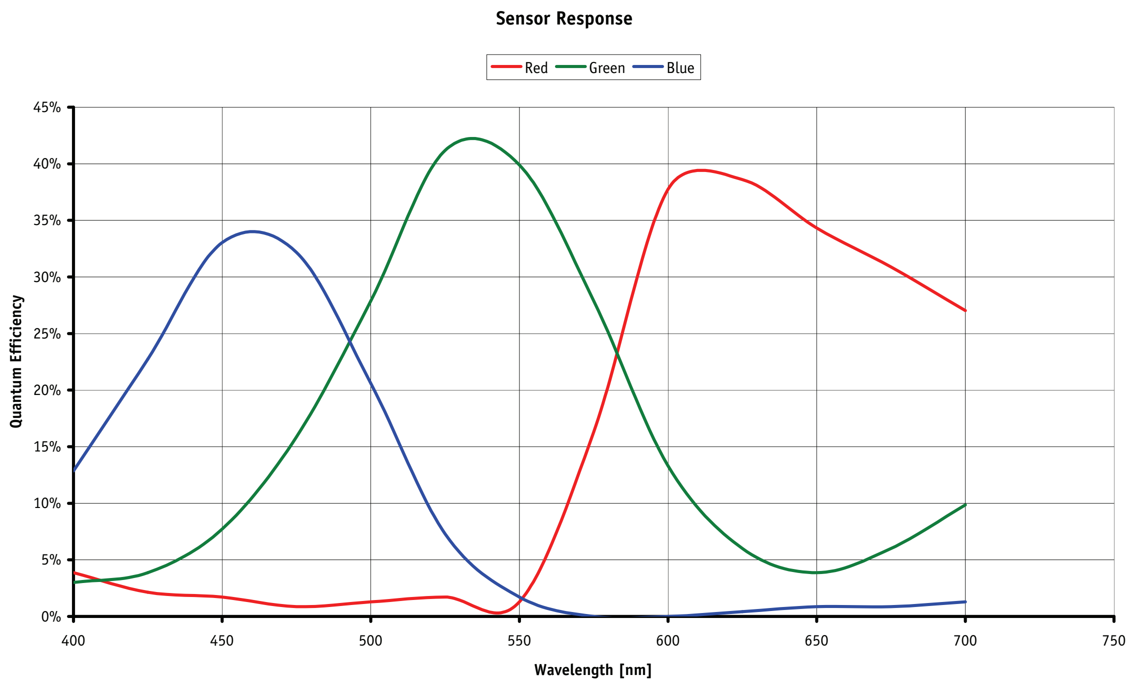


Figure 25: Spectral sensitivity of Stingray F-504C (without IR cut filter)

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 AVT GigE cameras* on page 346.

For information on the Stingray Compact (modular concept) see xxxx and Modular Concept.

Serial numbers for starting new front flange

Camera model	E-number	Starting ...
Stingray F-046B ASG	E0010003	... from SN: 09/17-285843839
Stingray F-046C IRF	E0010004	... from SN: 09/17-285843873
Stingray F-125C IRF	E0010063	... from SN: 09/17-285843866
Stingray F-201B ASG	E0010007	... from SN: 09/17-285843801
Stingray F-201C IRF	E0010008	... from SN: 09/17-285843904

Table 20: Starting serial numbers for new front flange

STINGRAY standard housing (2 x 1394b copper)

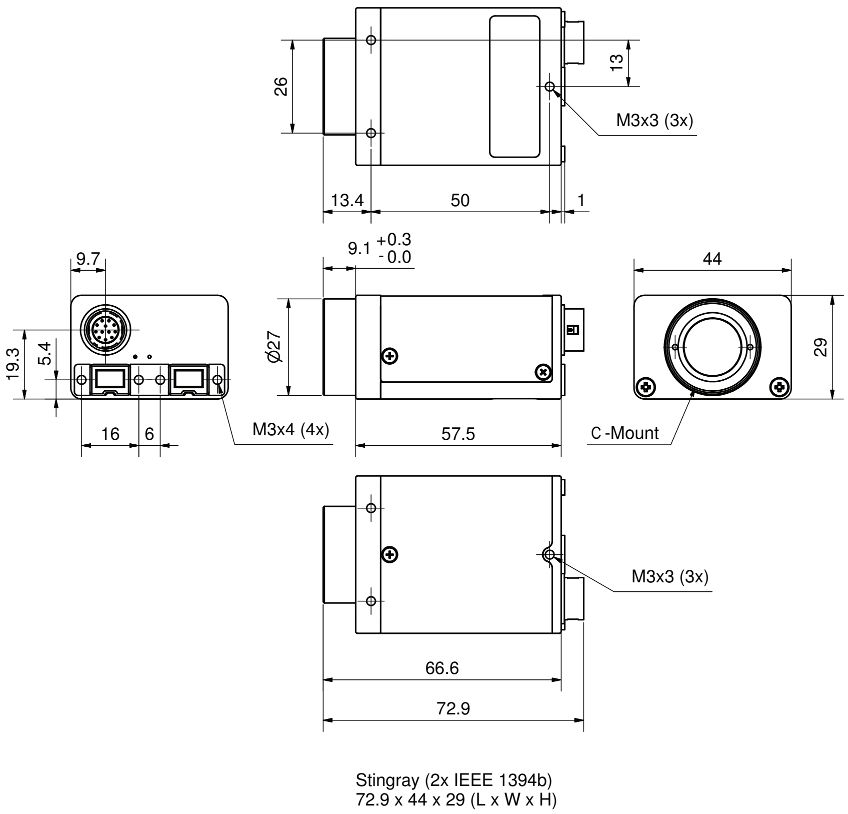


Figure 26: Camera dimensions (2 x 1394b copper)

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

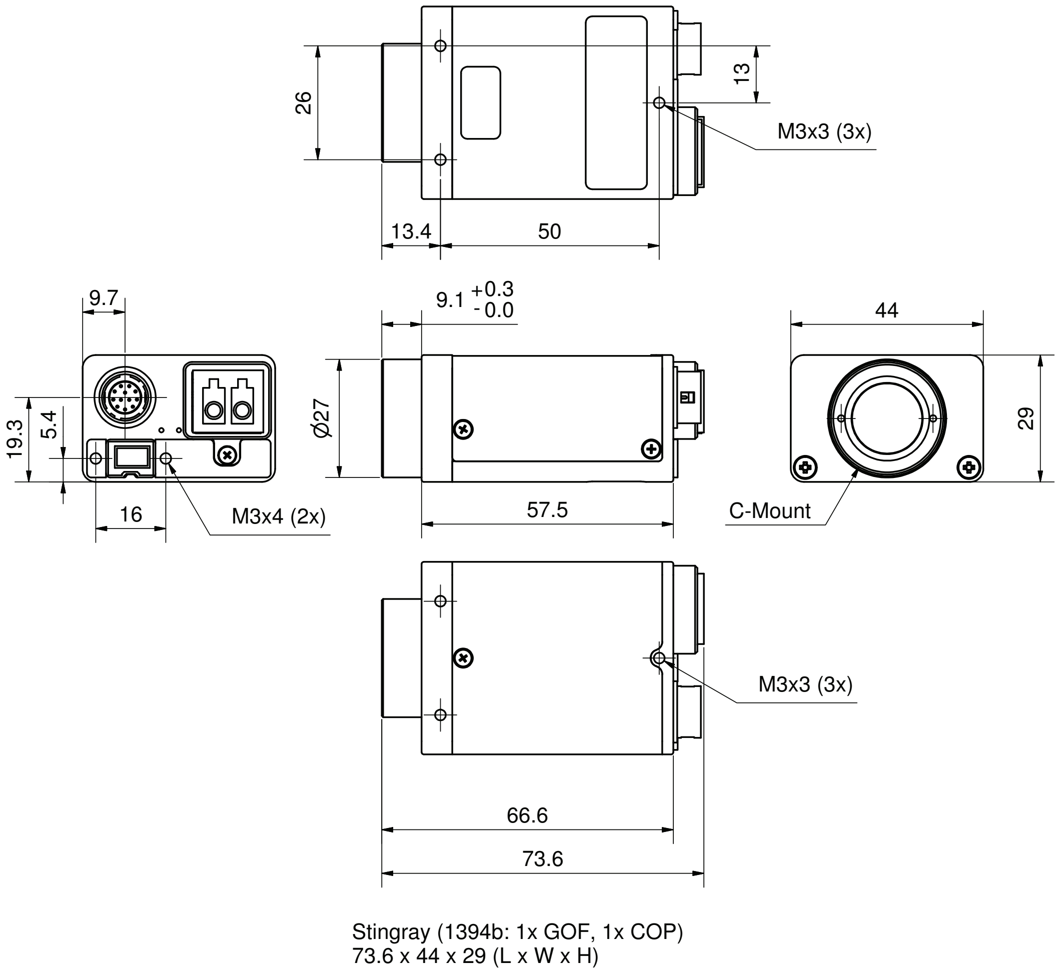


Figure 27: Camera dimensions (1394b: 1 x GOF, 1 x copper)

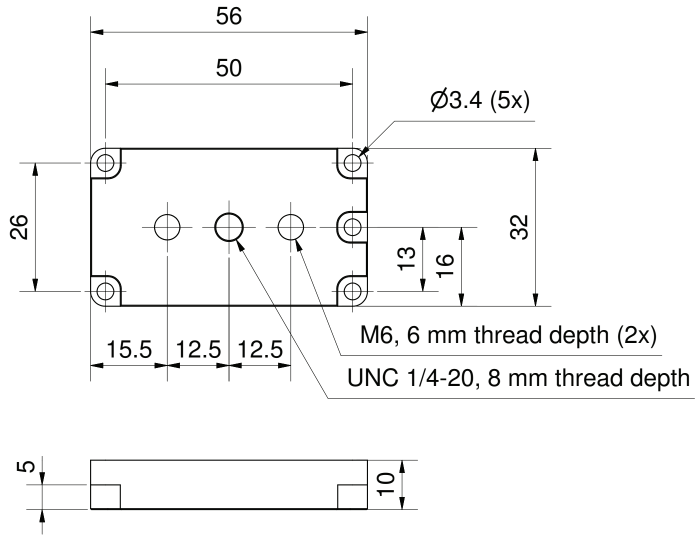
Tripod adapter

This five hole tripod adapter (AVT order number E 5000007) ...

- ... can be used for Stingray as well as for Marlin. The original four hole adapter of the Marlin should not be used with Stingray.
- ... is only designed for standard housings, but not for the angled head versions.

Note

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



Body size: 56 mm x 32 mm x 10 mm (L x W x H)

Figure 28: Tripod dimensions

Stingray W90 (2 x 1394b copper)

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

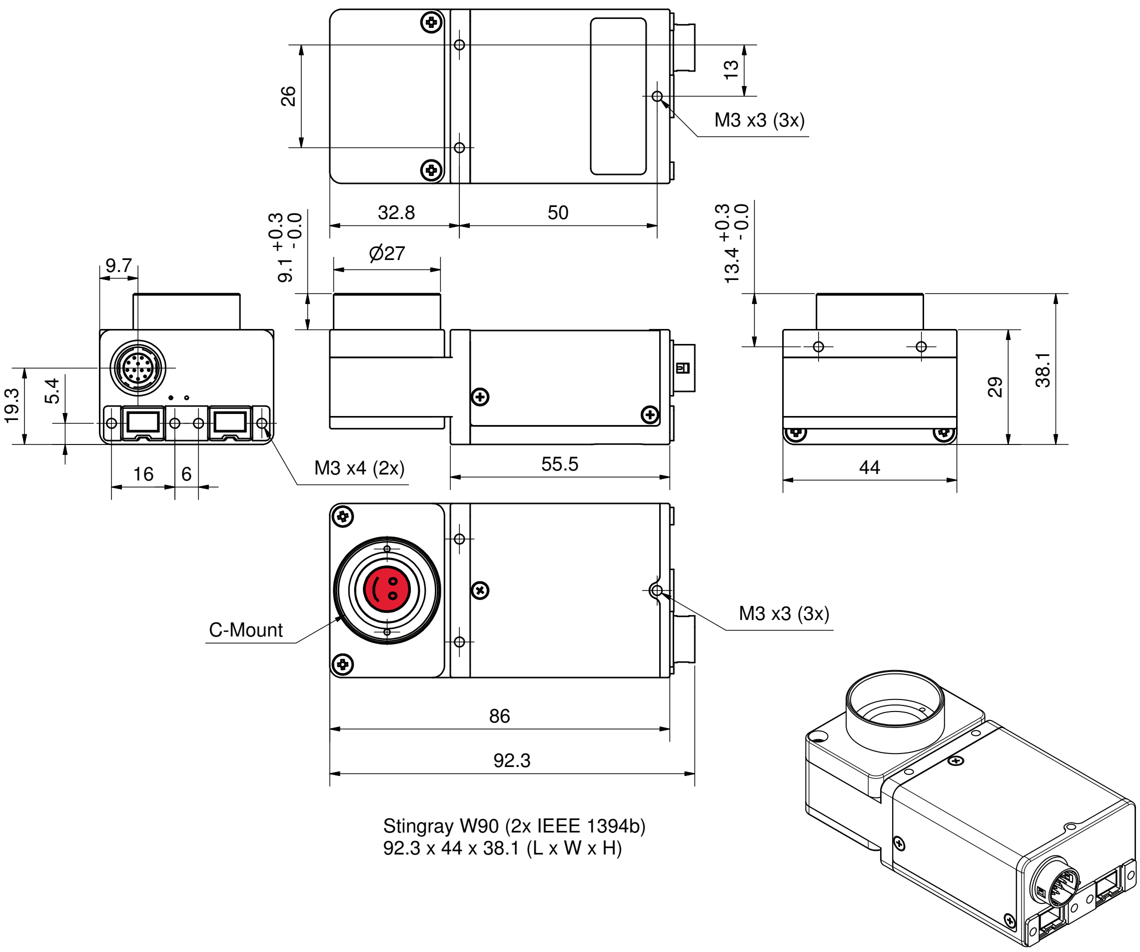


Figure 29: Stingray W90 (2 x 1394b copper)

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

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

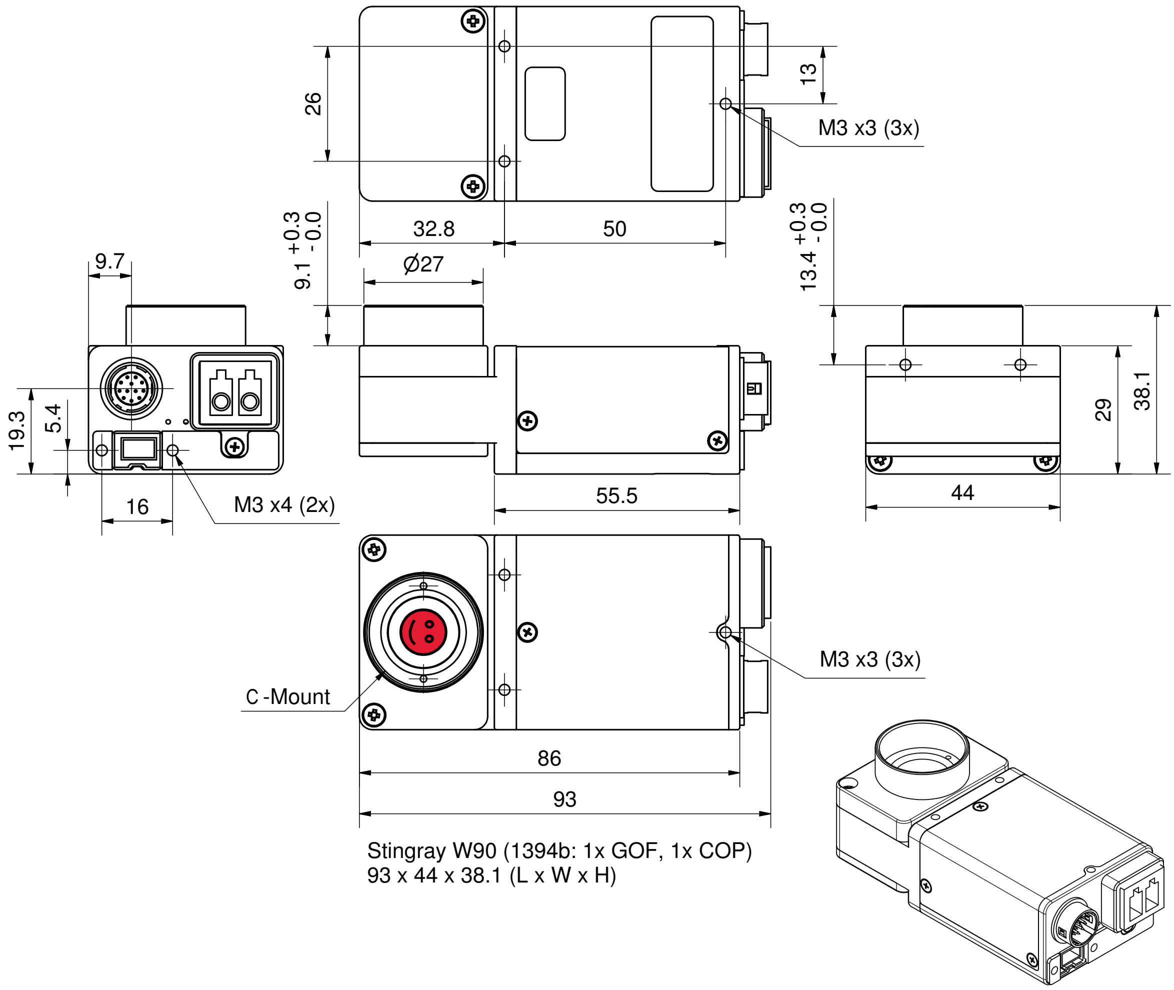


Figure 30: Stingray W90 (1394b: 1 x GOF, 1 x copper)

Stingray W90 S90 (2 x 1394b copper)

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

The sensor is also rotated by 90 degrees clockwise.

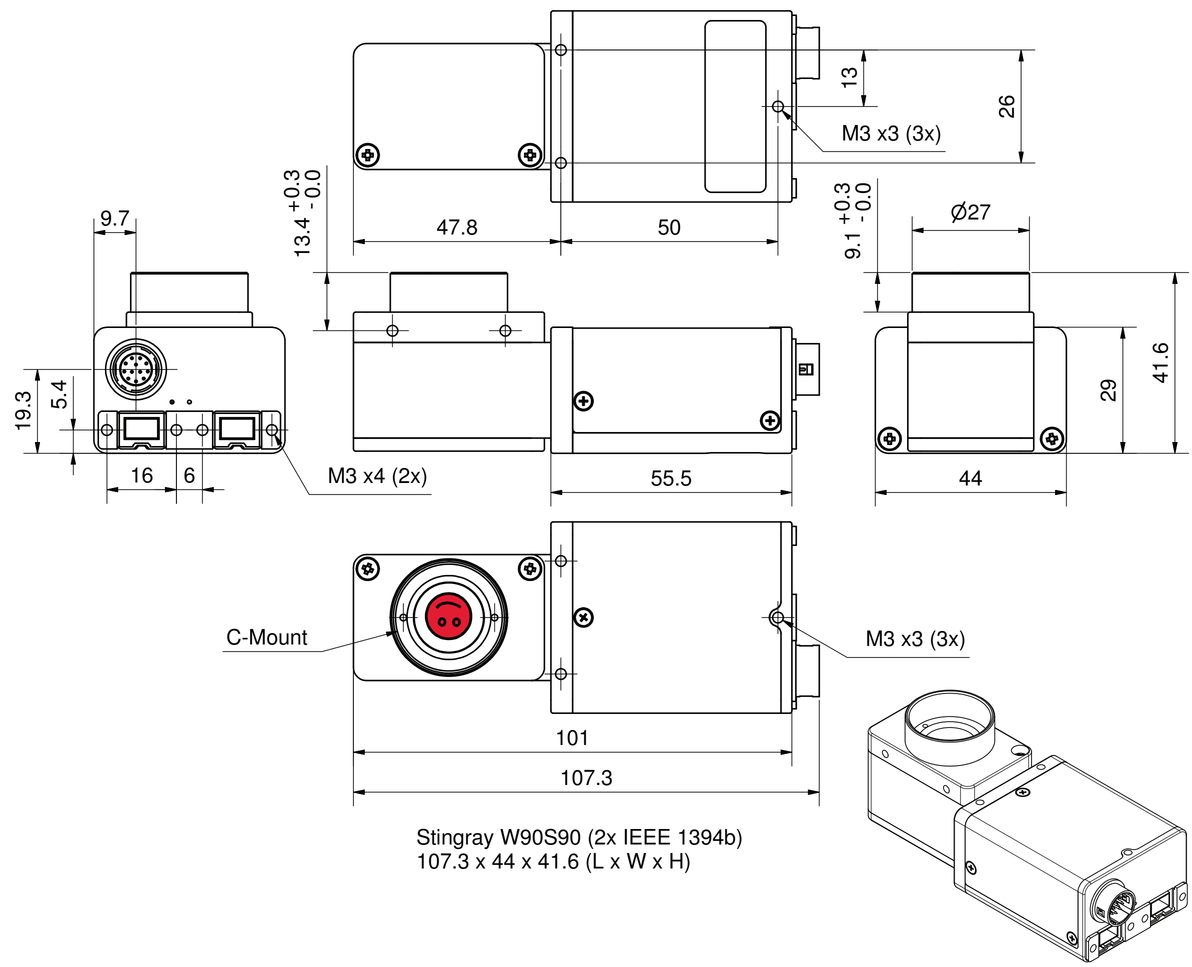


Figure 31: Stingray W90 S90 (2 x 1394b copper)

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

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

The sensor is also rotated by 90 degrees clockwise.

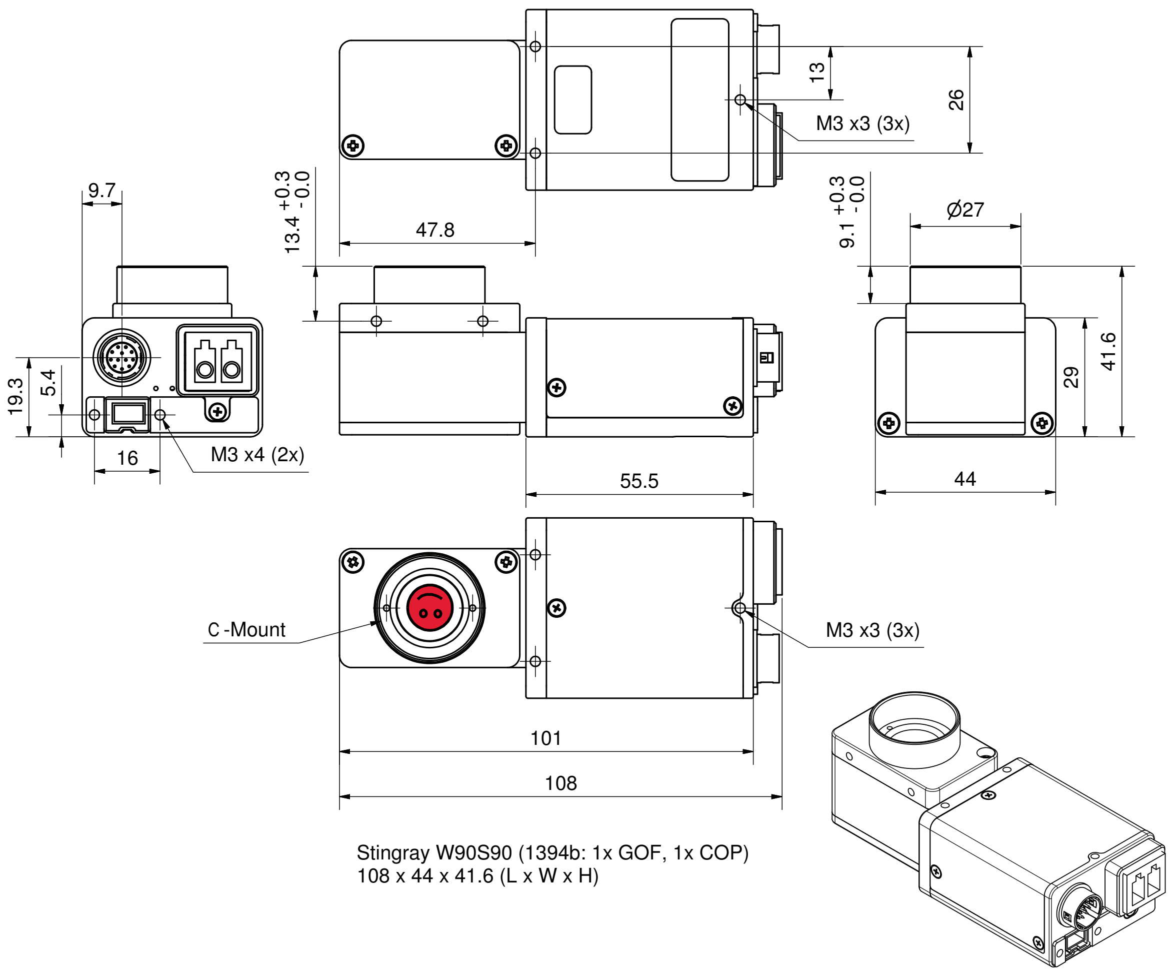


Figure 32: Stingray W90 S90 (1394b: 1 x GOF, 1 x copper)

Stingray W270 (2 x 1394b copper)

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

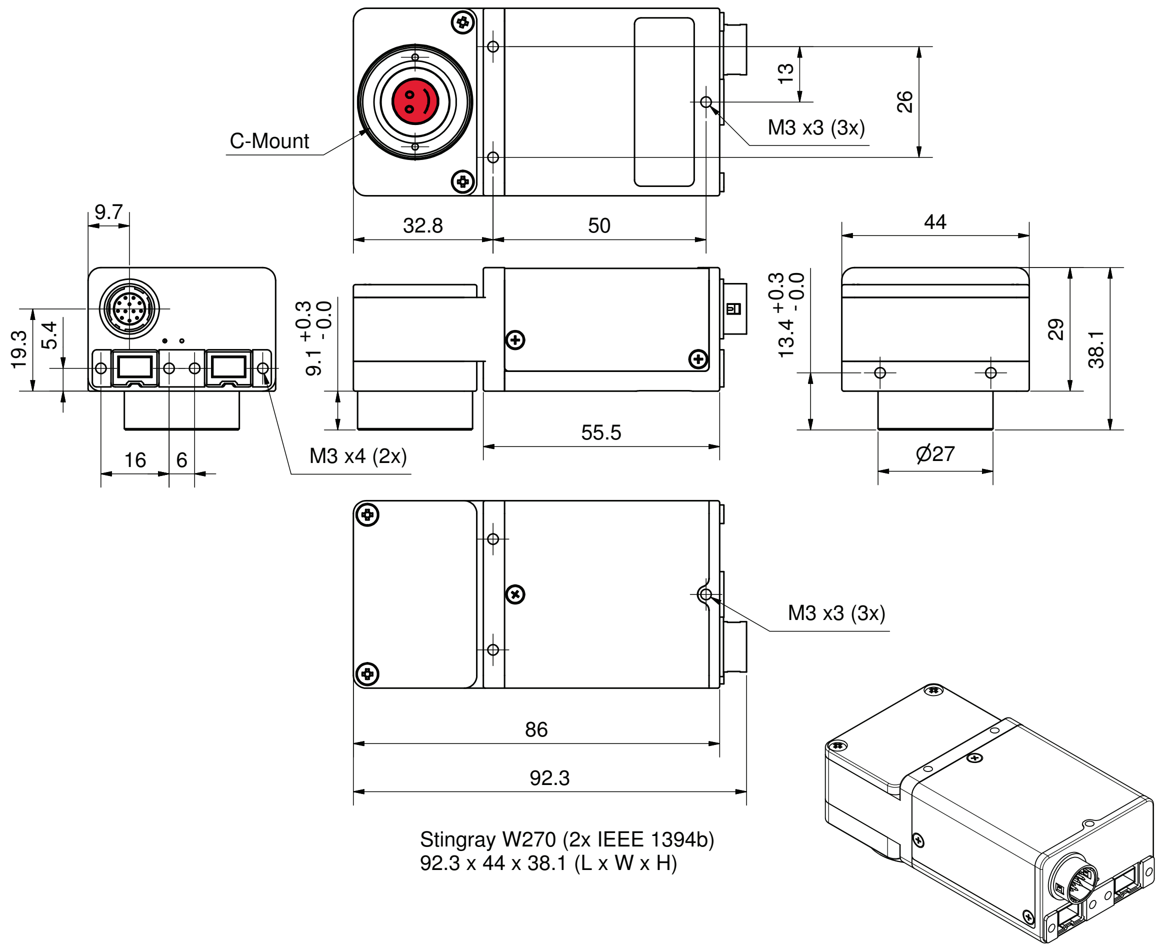


Figure 33: Stingray W270 (2 x 1394b copper)

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

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

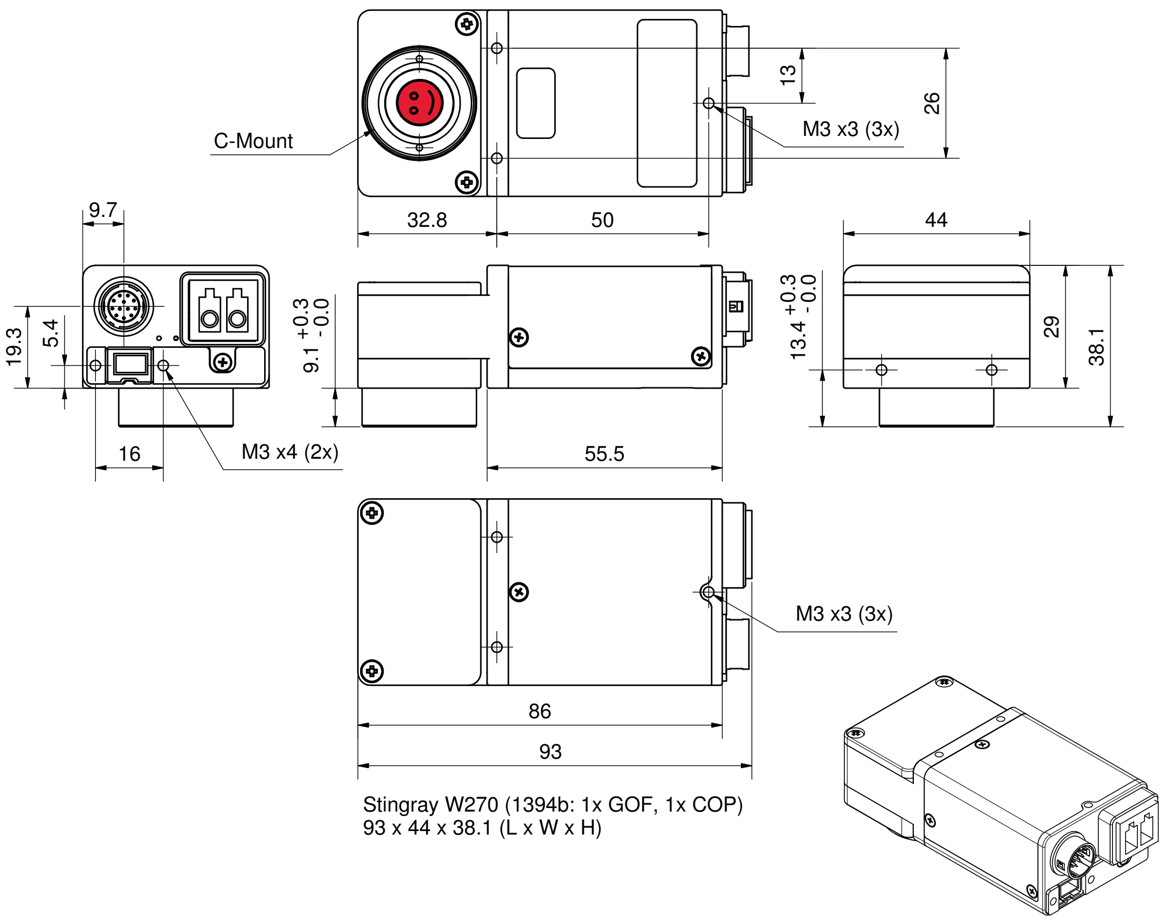


Figure 34: Stingray W270 (1394b: 1 x GOF, 1 x copper)

Stingray W270 S90 (2 x 1394b copper)

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

The sensor is also rotated by 90 degrees clockwise.

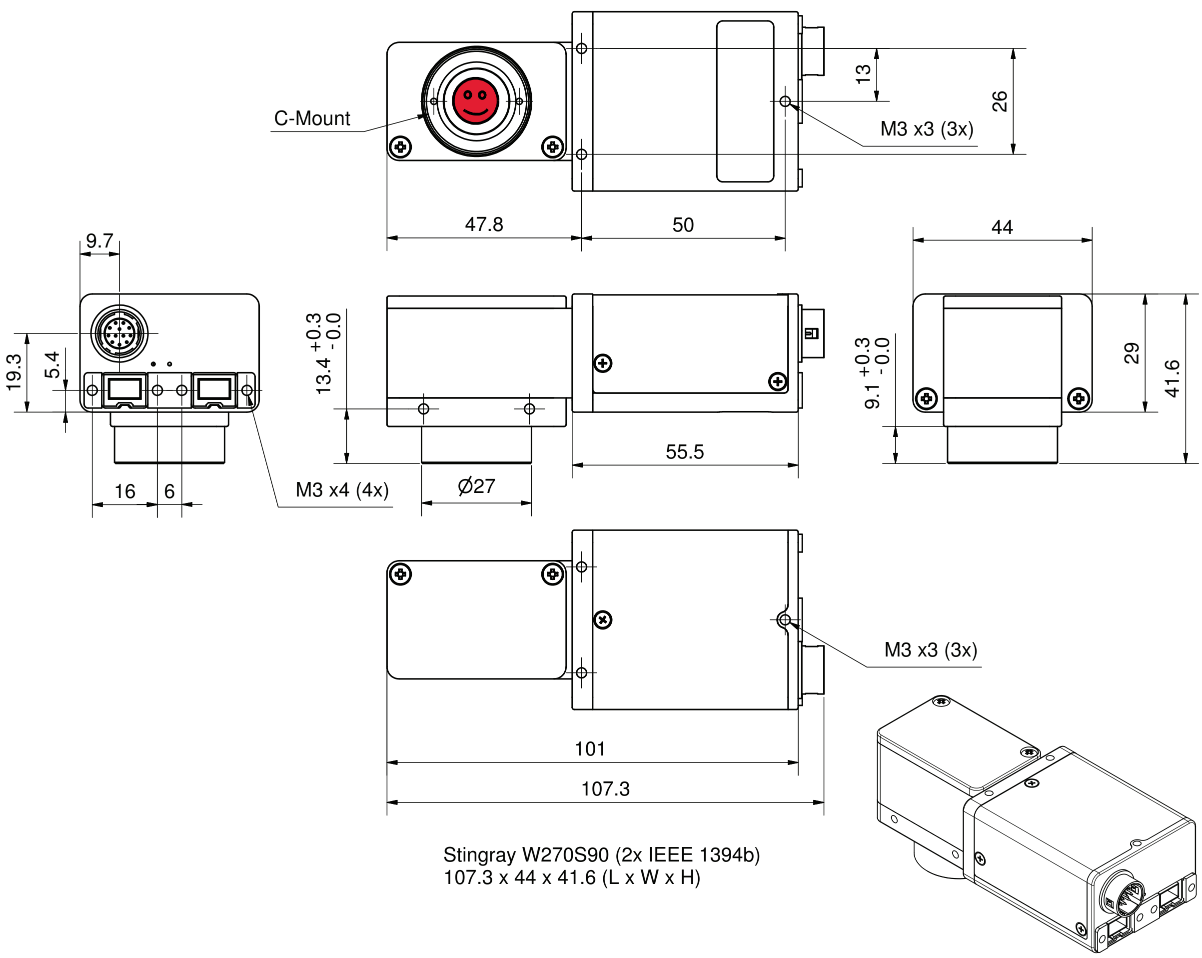


Figure 35: Stingray W270 S90 (2 x 1394b copper)

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

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

The sensor is also rotated by 90 degrees clockwise.

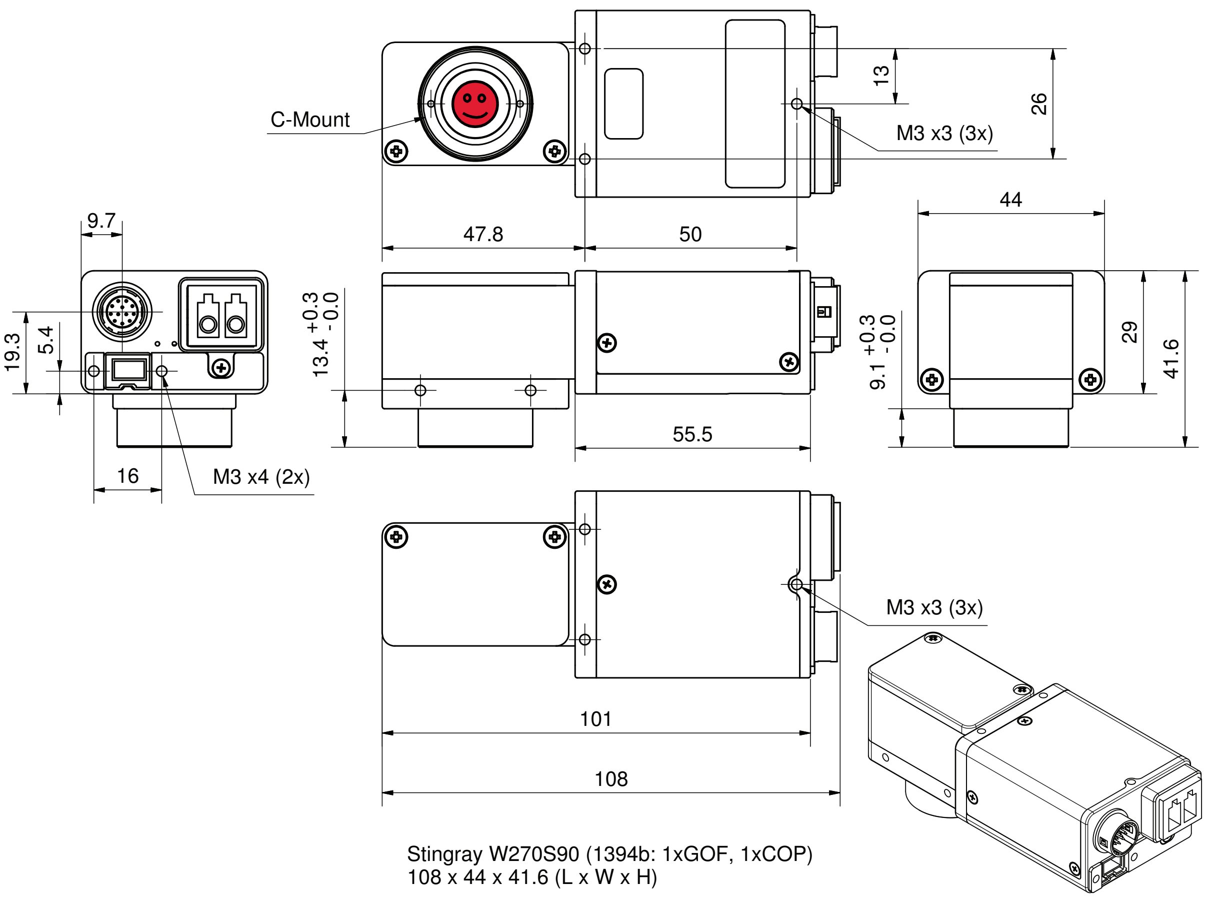


Figure 36: Stingray W270 S90 (1394b: 1 x GOF, 1 x copper)

Stingray Compact

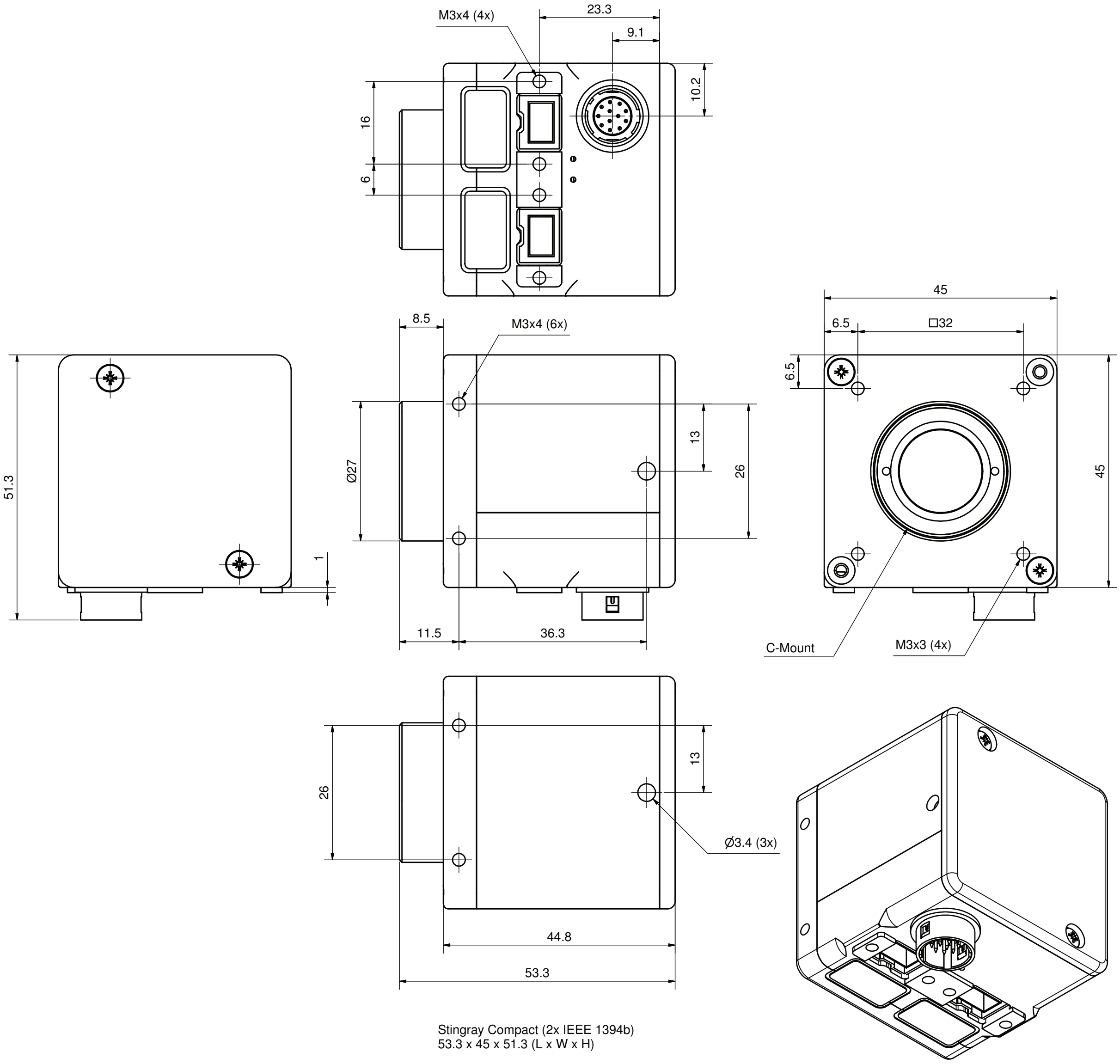


Figure 37: Stingray Compact (2 x 1394b copper. No angled heads. No fiber option. 145 g)

Cross section: CS-Mount

All Stingray cameras can be delivered with CS-Mount.

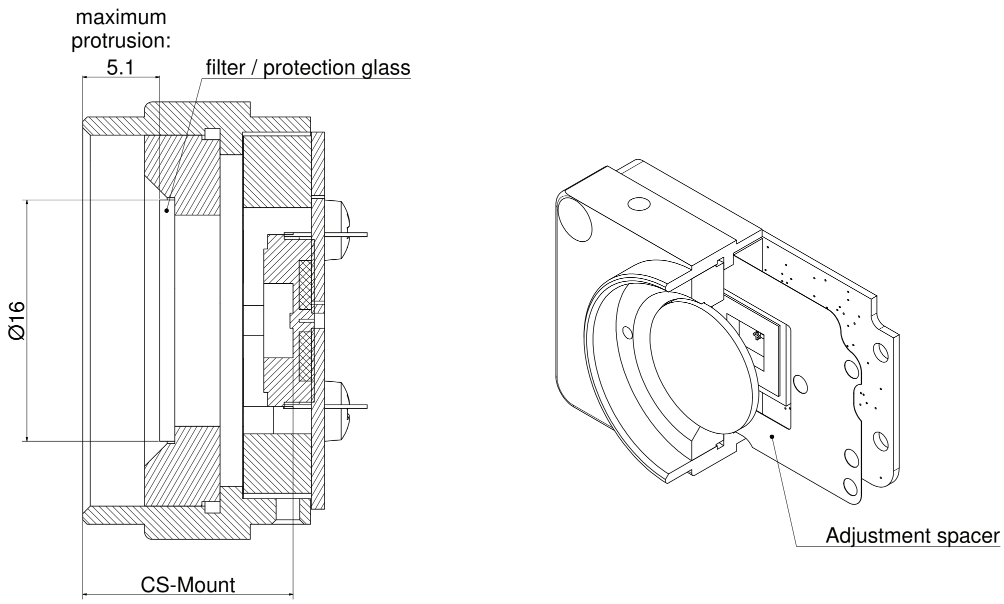


Figure 38: Stingray CS-Mount dimension

Note

Pay attention to the maximum sensor size of the applied CS-Mount lens.

Cross section: C-Mount

- All monochrome Stingrays are equipped with the same model of protection glass.
- All color Stingrays are equipped with the same model of IR cut filter.

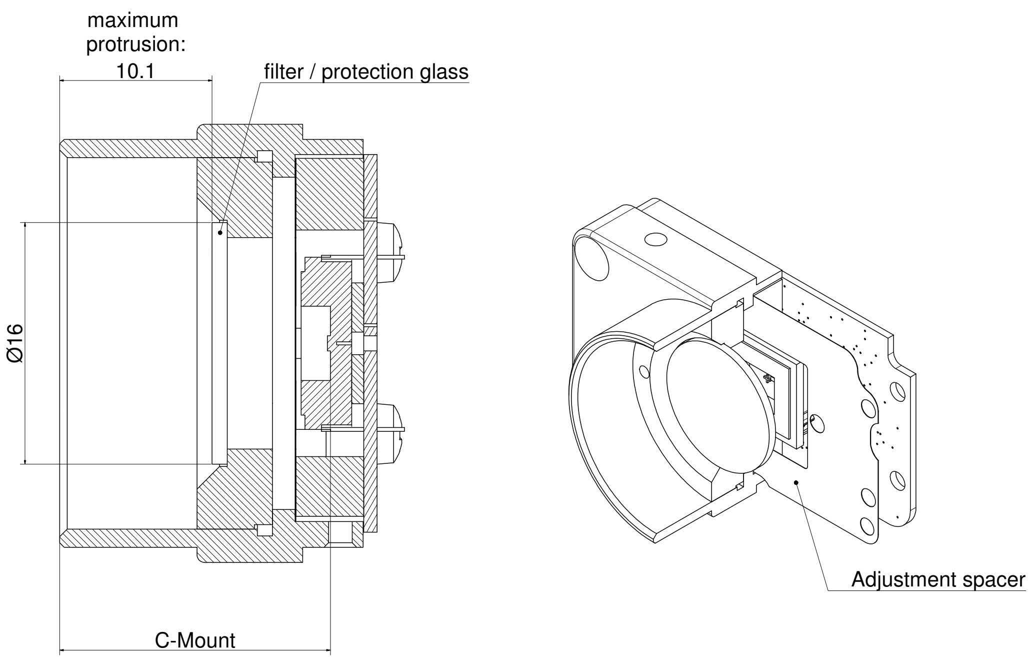


Figure 39: Stingray C-Mount dimensions

Adjustment of C-Mount and CS-Mount

The dimensional adjustment cannot be done any more by the customer. All **modifications** have to be done by the AVT factory.

If you need any modifications, please contact Customer Care: For phone numbers and e-mail: See Chapter *Contacting Allied Vision Technologies* on page 11.

Stingray board level: dimensions

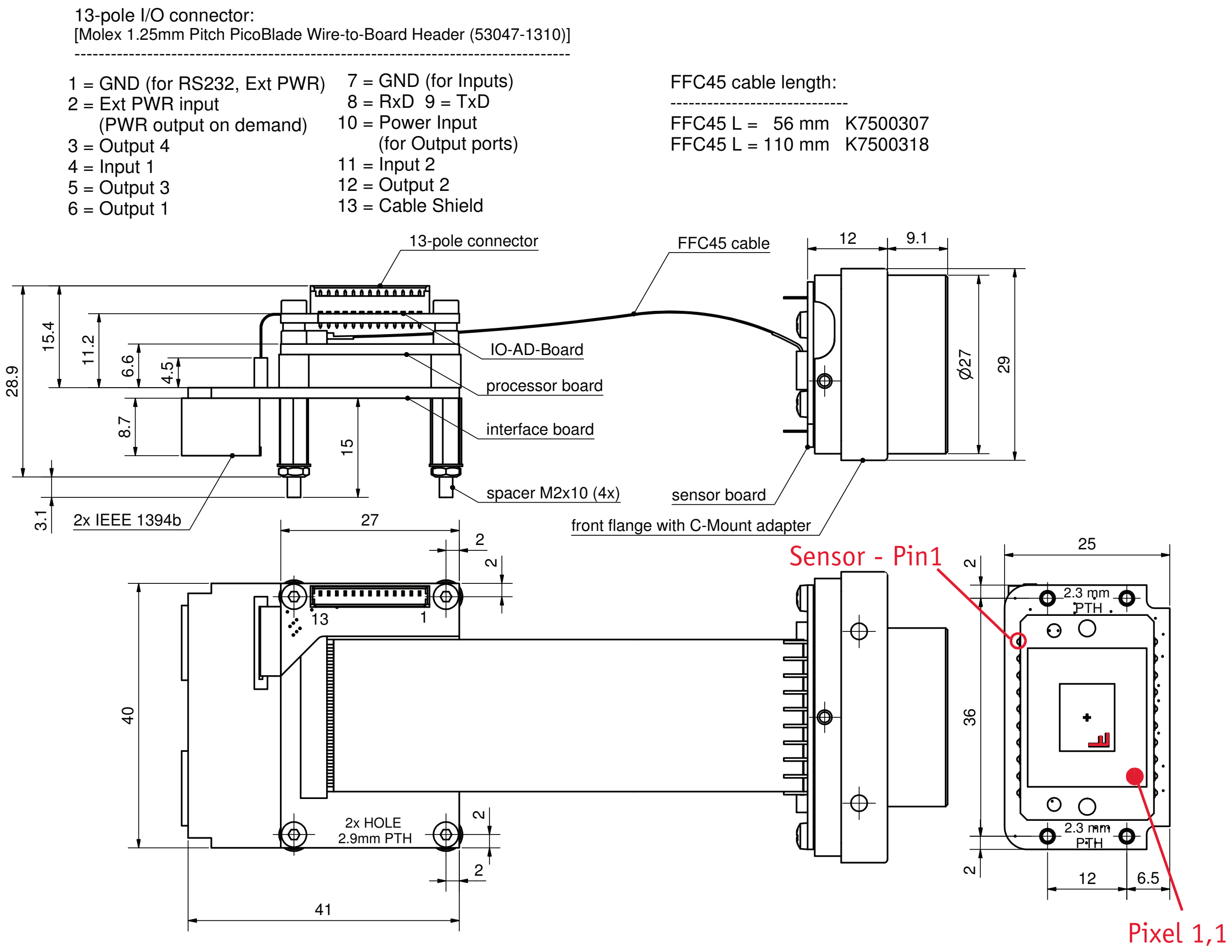


Figure 40: Stingray board level dimensions

Stingray board level: CS-Mount

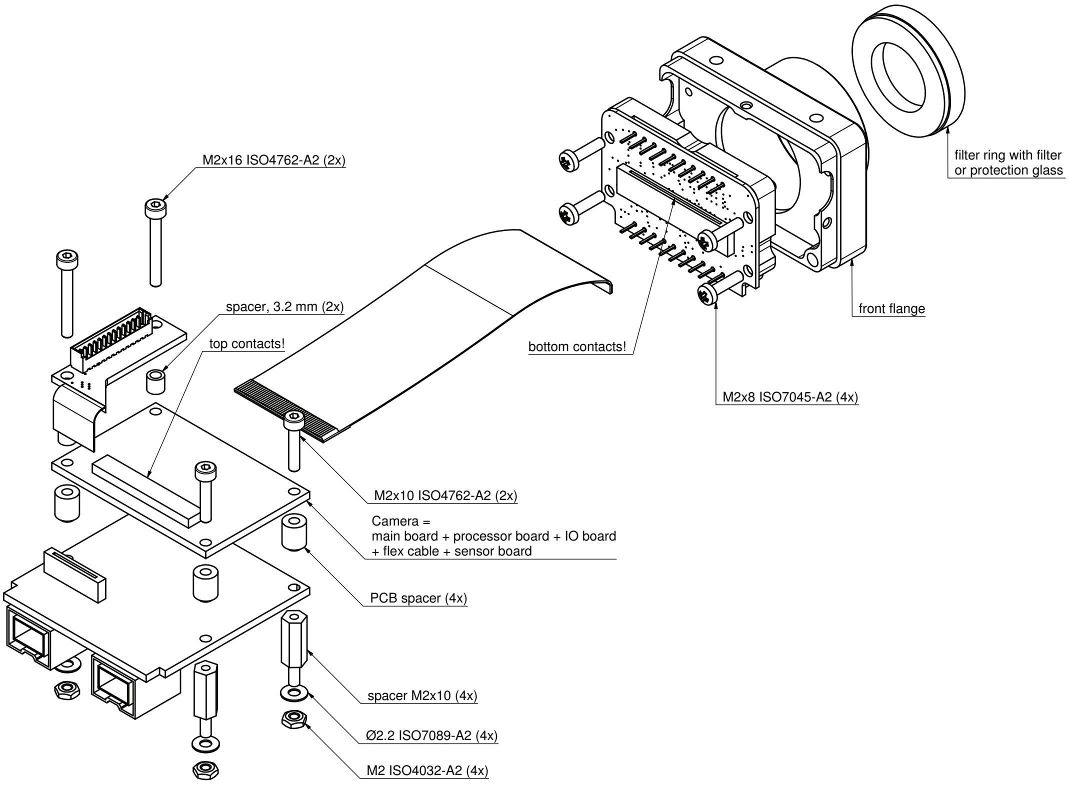


Figure 41: Stingray board level: CS-Mount

Stingray board level: C-Mount

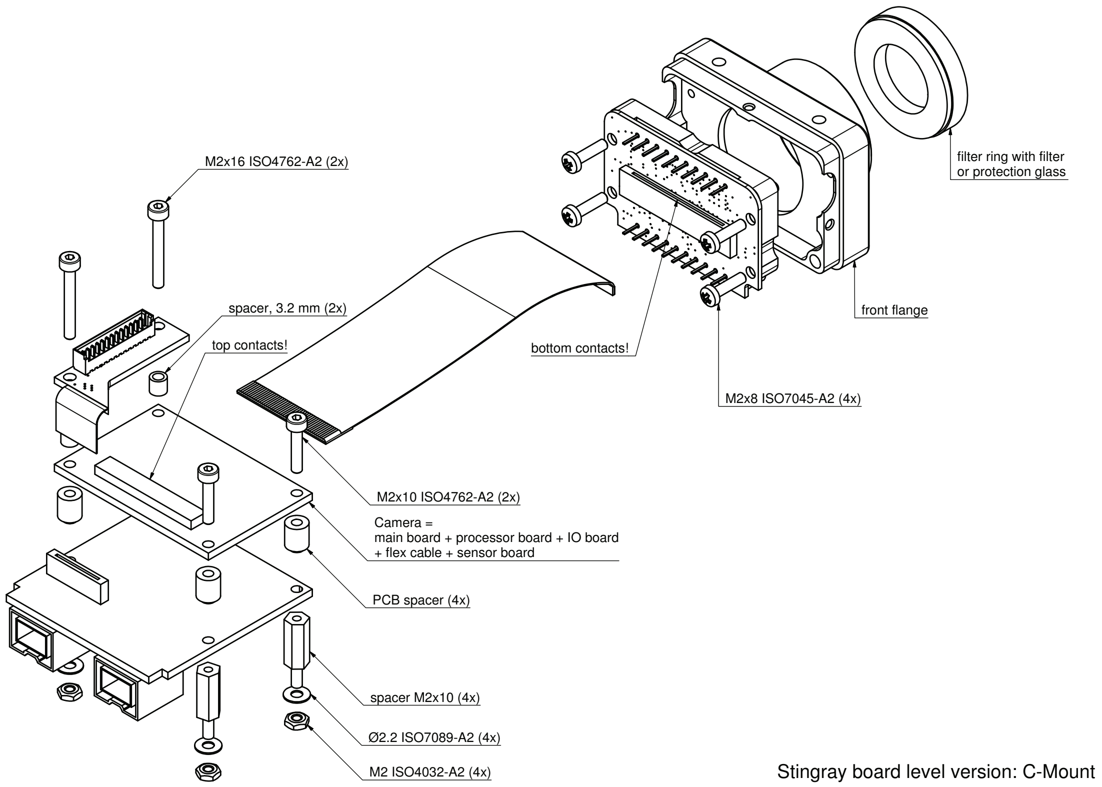


Figure 42: Stingray board level: C-Mount

Camera interfaces

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

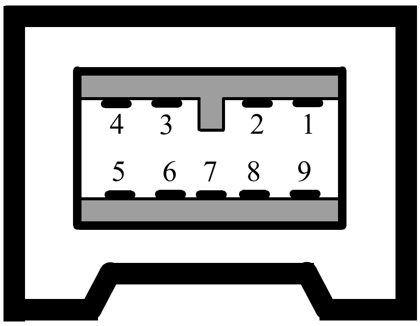
Note

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

Read all Notes and Cautions in the Hardware Installation Guide, before using any interfaces.

IEEE 1394b port pin assignment

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



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

Figure 43: IEEE 1394b connector

Note

- Both IEEE 1394b connectors with **screw lock** mechanism provide access to the IEEE 1394 bus and thus makes it possible to control the camera and output frames. Connect the camera by using either of the connectors. The other connector can be used to daisy chain a second camera.
- Cables with latching connectors on one or both sides can be used and are available with lengths of 5 m or 7.5 m. Ask your local dealer for more details.

www

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

http://www.alliedvisiontec.com/emea/products/accessories/firewire-accessories.html

Board level camera: IEEE 1394b port pin assignment

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

They have the same pin assignment as the STINGRAY housing cameras.

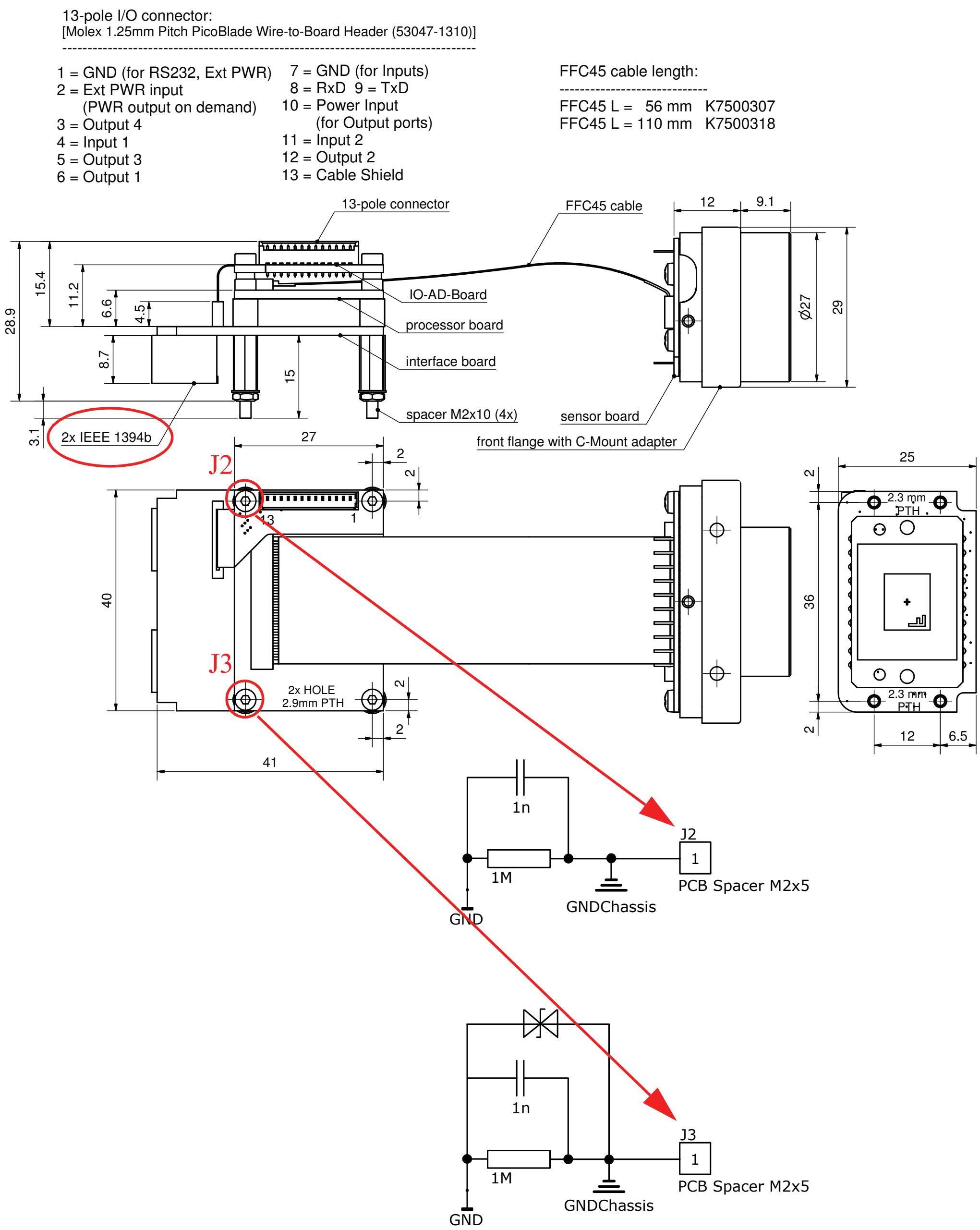
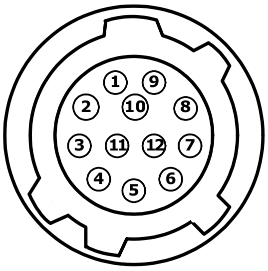


Figure 44: Board level camera: two IEEE 1394b FireWire connectors

Camera I/O connector pin assignment

(For board level see Chapter *Board level camera: I/O pin assignment* on page 97)



Pin	Signal	Direction	Level	Description
1	External GND		GND for RS232 and ext. power	External Ground for RS232 and external power
2	External Power		+8...+36 V DC	Power supply
3	Camera Out 4	Out	Open emitter	Camera Output 4 (GPOut4) default: -
4	Camera In 1	In	U_{in}(high) = 3 V...24 V U_{in}(low) = 0 V...1.5 V	Camera Input 1 (GPIn1) default: Trigger
5	Camera Out 3	Out	Open emitter	Camera Output 3 (GPOut3) default: Busy
6	Camera Out 1	Out	Open emitter	Camera Output 1 (GPOut1) default: IntEna
7	Camera In GND	In	Common GND for inputs	Camera Common Input Ground (In GND)
8	RxD RS232	In	RS232	Terminal Receive Data
9	TxD RS232	Out	RS232	Terminal Transmit Data
10	Camera Out Power	In	Common VCC for outputs max. 36 V DC	External Power for digital outputs (OutVCC)
11	Camera In 2	In	U_{in}(high) = 3 V...24 V U_{in}(low) = 0 V...1.5 V	Camera Input 2 (GPIn2) default: -
12	Camera Out 2	Out	Open emitter	Camera Output 2 (GPOut2) default: Follow CameraIn2

Figure 45: 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 Hardware Installation Guide, Chapter *STINGRAY input description*.

Read all Notes and Cautions in the Hardware Installation Guide, before using the I/O connector.

Board level camera: I/O pin assignment

The following diagram shows the 13-pole I/O pin connector of a board level camera:

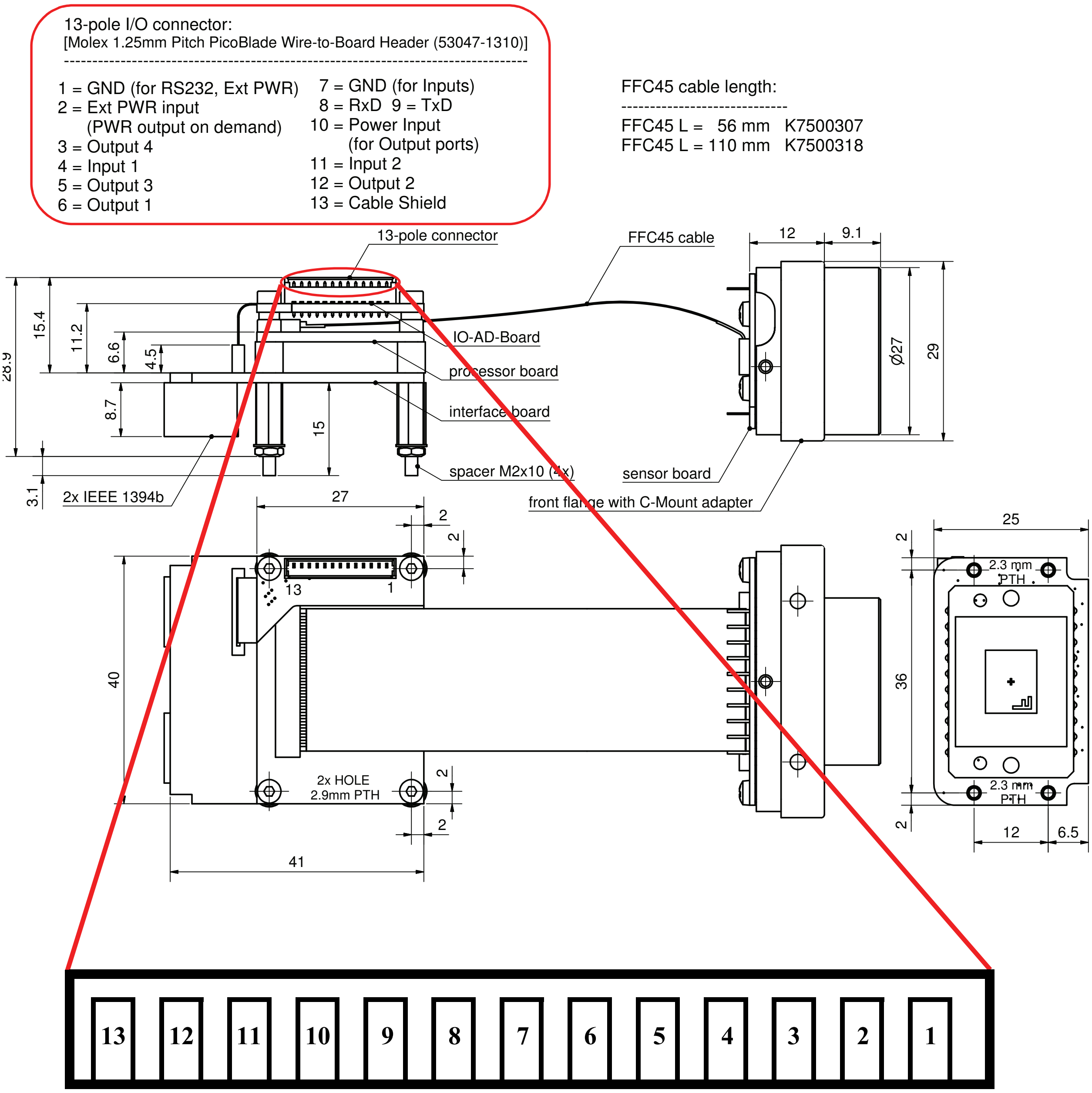


Figure 46: Board level camera: I/O pin assignment

Status LEDs

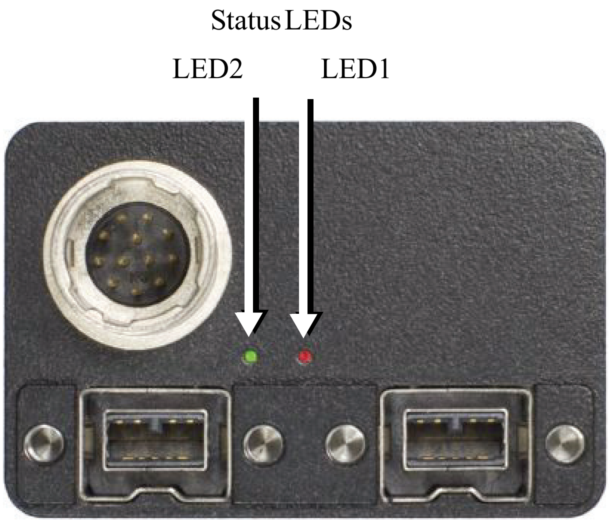


Figure 47: Position of status LEDs

Each of the two LEDs is tricolor, showing green, red or orange.

RED means: red LED permanent on

RED blinking means: red LED blinks fast

+RED pulsing means: red LED is switched on for a short time. If the red LED is already on, the LED will be switched off. The state of the other color of the same LED could be on or off.

GREEN means: green LED permanent on

GREEN blinking means: green LED blinks fast

+GREEN pulsing means: green LED is switched on for a short time. If the green LED is already on, the LED will be switched off. The state of the other color of the same LED could be on or off.

+GREEN pulsing (inverted) means: green LED is switched off for a short time.

Note

Both LEDs can be switched off by:

- Setting bit [17] to 1, see *Table 166: Advanced register: Software feature control (disable LEDs)* on page 340
- Activating **Disable LED functionality** check box in SmartView (**Adv3** tab).

Error conditions will be shown although LEDs are switched off.

Normal conditions

Event	LED1	LED2
Camera startup	During startup all LEDs are switched on consecutively to show the startup progress: Phase1: LED1 RED Phase2: LED1 RED + LED1 GREEN Phase3: LED1 RED + LED1 GREEN + LED2 RED Phase4: LED1 RED + LED1 GREEN + LED2 RED +LED2 GREEN	
Power on		GREEN
Bus reset		GREEN blinking
Asynchronous traffic	+GREEN pulsing	GREEN
Only GOF: asynchronous traffic	+GREEN pulsing (inverted)	GREEN
Only GOF: GOF signal detect	GREEN	GREEN
Isochronous traffic	+RED pulsing	GREEN
Waiting for external trigger	RED	GREEN
External trigger event	RED	+RED pulsing

Table 21: LEDs showing normal conditions

Error conditions

LED1 RED → LED2 GREEN ↓	Warning 1 pulse	DCAM 2 pulse	MISC 3 pulse	FPGA 4 pulse	Stack 5 pulse
FPGA boot error				1-5 pulse	
Stack setup					1 pulse
Stack start					2 pulse
No FLASH object			1 pulse		
No DCAM object		1 pulse			
Register mapping		3 pulse			
VMode_ERROR_STATUS	1 pulse				
FORMAT_7_ERROR_1	2 pulse				
FORMAT_7_ERROR_2	3 pulse				

Table 22: Error codes

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 Hardware Installation Guide, Chapter STINGRAY input description.

The optocoupler inverts all input signals. Inversion of the signal is controlled via the IO_INP_CTRL1..2 register (see *Table 23: Advanced register: Input control* on page 101).

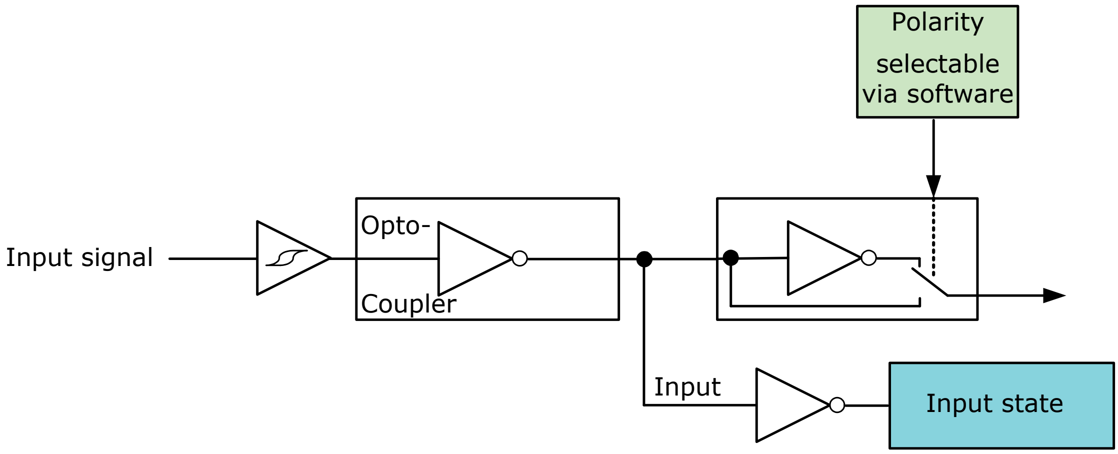


Figure 48: Input block diagram

Triggers

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

Input/output pin control

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

Register	Name	Field	Bit	Description
0xF1000300	IO_INP_CTRL1	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..6]	Reserved
		Polarity	[7]	0: Signal not inverted 1: Signal inverted
		---	[8..10]	Reserved
		InputMode	[11..15]	Mode see *Table 24: Input routing* on page 102
		---	[16..30]	Reserved
		PinState	[31]	RD: Current state of pin
0xF1000304	IO_INP_CTRL2	Same as IO_INP_CTRL1		

Table 23: Advanced register: **Input control**

IO_INP_CTRL 1-2

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

The **PinState** bit reads the inverting optocoupler status after an internal negation. See *Figure 48: Input block diagram* on page 100.

This means that an open input sets the **PinState** bit to **0**. (This is different to AVT Marlin/Dolphin/Oscar, where an open input sets **PinState** bit to **1.**)

ID	Mode	Default
0x00	Off	
0x01	Reserved	
0x02	Trigger input	Input 1
0x03	Reserved	
0x06	Sequence Step	
0x07	Sequence Reset	
0x08..0x1F	Reserved	

Table 24: Input routing

Note

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

Trigger delay

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

With IIDC V1.31 there is a standard CSR at Register F0F00534/834h to control a delay up to FFFh x time base value.

The following table explains the inquiry register and the meaning of the various bits.

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

Table 25: 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 Read: Status of the feature ON=1 OFF=0
		---	[7..19]	Reserved
		Value	[20..31]	Value

Table 26: Trigger Delay CSR

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

Trigger delay advanced register

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

Table 27: Trigger delay advanced CSR

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

Note

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

Outputs

Note

For a general description of the outputs and warnings see the Hardware Installation Guide, Chapter STINGRAY output description.

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

The main features of output signals are described below:

Signal	Description
IntEna (Integration Enable) signal	This signal displays the time in which exposure was made. By using a register this output can be delayed by up to 1.05 seconds.
Fval (Frame valid) signal	This feature signals readout from the sensor. This signal Fval follows IntEna.
Busy signal	This signal appears when: • the exposure is being made or • the sensor is being read out or • data transmission is active. The camera is busy.
PulseWidthMod (pulse-width modulation) signal	Each output has pulse-width modulation (PWM) capabilities, which can be used for motorized speed control or autofocus control. See Chapter *Pulse-width modulation (Stingray housing and Stingray board level models)* on page 110ff.
WaitingForTrigger signal	This signal is available and useful for the outputs in **Trigger Edge Mode.** (In level mode it is available but useless, because exposure time is unknown. (Signal always =0)) In edge mode it is useful to know if the camera can accept a new trigger (without overtriggering). See *Table 30: Output routing* on page 108 and *Figure 50: Output impulse diagram* on page 109

Table 28: Output signals

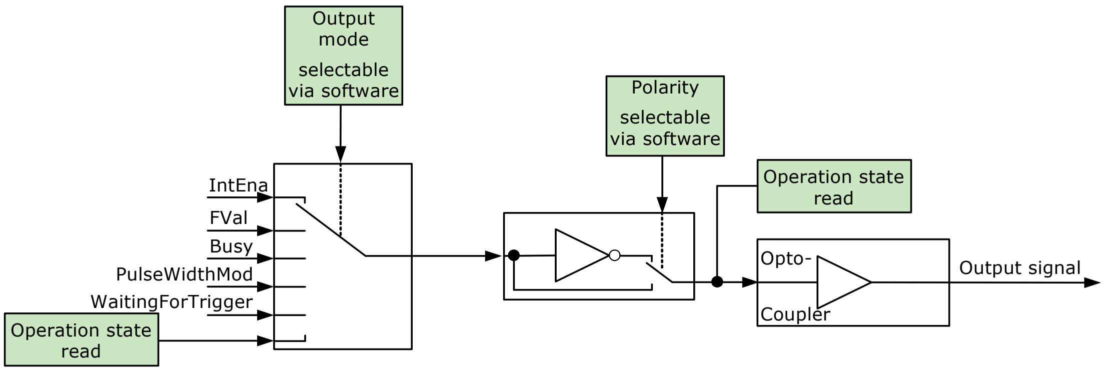


Figure 49: Output block diagram

IO_OUTP_CTRL 1-4

The outputs (Output mode, Polarity) are controlled via 4 advanced feature registers (see *Table 29: Advanced register: Output control* on page 107).

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

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

Note

Outputs in Direct Mode:

For correct functionality the Polarity should always be set to 0 (SmartView: Trig/IO tab, Invert=No).

Register	Name	Field	Bit	Description
0xF1000320	IO_OUTP_CTRL1	Presence_Inq	[0]	Indicates presence of this feature (read only)
		PWMCapable	[1]	All Stingray cameras (housing and board level): Indicates if an output pin supports the PWM feature. See *Table 31: PWM configuration registers* on page 110.
		---	[2..6]	Reserved
		Polarity	[7]	0: Signal not inverted 1: Signal inverted
		---	[8..10]	Reserved
		Output mode	[11..15]	Mode see *Table 30: Output routing* on page 108
		---	[16..30]	Reserved
		PinState	[31]	RD: Current state of pin WR: New state of pin
0xF1000324	IO_OUTP_CTRL2	Same as IO_OUTP_CTRL1		

Table 29: Advanced register: **Output control**

Register	Name	Field	Bit	Description
0xF1000328	IO_OUTP_CTRL3	Same as IO_OUTP_CTRL1		
0xF100032C	IO_OUTP_CTRL4	Same as IO_OUTP_CTRL1		

Table 29: Advanced register: **Output control**

Output modes

ID	Mode	Default / description
0x00	Off	
0x01	Output state follows **PinState** bit	Using this mode, the Polarity bit has to be set to 0 (not inverted). This is necessary for an error free display of the output status.
0x02	Integration enable	Output 1
0x03	Reserved	
0x04	Reserved	
0x05	Reserved	
0x06	FrameValid	
0x07	Busy	Output 2
0x08	Follow corresponding input (Inp1→ Out1, Inp2 → Out2)	
0x09	PWM (=pulse-width modulation)	Stingray housing and board level models
0x0A	**WaitingForTrigger**	Only in **Trigger Edge Mode.** All other Mode = 0 **WaitingForTrigger** is useful to know, if a new trigger will be accepted.
0x0B..0x1F	Reserved	

Table 30: Output routing

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

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

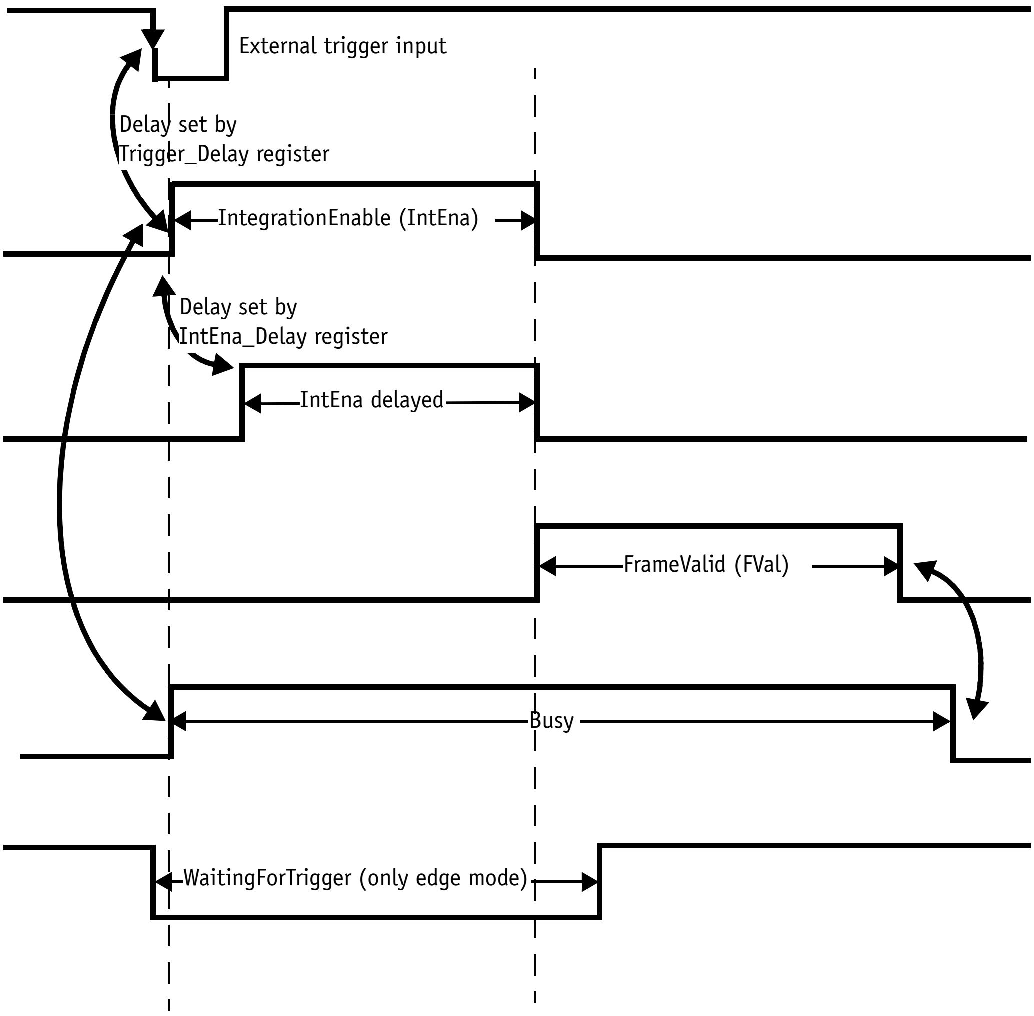


Figure 50: Output impulse diagram

Note

The signals can be inverted.

Caution

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

Note

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

Pulse-width modulation (Stingray housing and Stingray board level models)

The 2 inputs and 4 outputs are independent. Each output has pulse-width modulation (PWM) capabilities, which can be used (with additional external electronics) for motorized speed control or autofocus control.

Period (in µs) and pulse width (in µs) are adjustable via the following registers (see also examples in Chapter *PWM: Examples in practice* on page 112):

Register	Name	Field	Bit	Description
0xF1000800	IO_OUTP_PWM1	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1]	Reserved
		---	[2..3]	Reserved
		MinPeriod	[4..19]	Minimum PWM period in µs (read only)
		---	[20..27]	Reserved
		---	[28..31]	Reserved
0xF1000804		PulseWidth	[0..15]	PWM pulse width in µs
		Period	[16..31]	PWM period in µs
0xF1000808	IO_OUTP_PWM2	Same as IO_OUTP_PWM1		
0xF100080C				
0xF1000810	IO_OUTP_PWM3	Same as IO_OUTP_PWM1		
0xF1000814				
0xF1000818	IO_OUTP_PWM4	Same as IO_OUTP_PWM1		
0xF100081C				

Table 31: PWM configuration registers

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

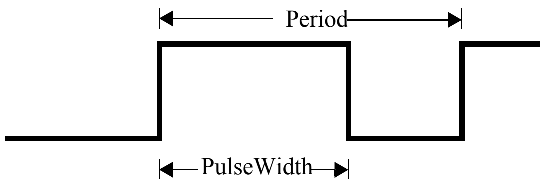


Figure 51: PulseWidth and Period definition

Note

Note the following conditions:

- PulseWidth < Period
- Period ≥ MinPeriod

PWM: minimal and maximal periods and frequencies

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

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

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

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

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

Formula 1: Minimal/maximal period and frequency

PWM: Examples in practice

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

Example 1:

Set PWM with 1kHz at 30% pulse width.

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

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

Formula 2: PWM example 1

Example 2:

Set PWM with 250 Hz at 12% pulse width.

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

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

Formula 3: PWM example 2

Pixel data

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

sync bit

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

Table 32: Isochronous data block packet format. Source: IIDC V1.31

Field	Description
data_length	Number of bytes in the data field
tg	**Tag field** shall be set to zero
channel	**Isochronous channel number**, as programmed in the iso_channel field of the cam_sta_ctrl register
tCode	**Transaction code** shall be set to the isochronous data block packet tCode
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 33: Description of data block packet format

- The video data for each pixel are output in either 8-bit or 14-bit format (**Packed 12-Bit Mode**: 12-bit format).
- Each pixel has a range of 256 or 16384 (**Packed 12-Bit Mode**: 4096) shades of gray.
- The digital value 0 is black and 255 or 16383 (**Packed 12-Bit Mode**: 4095) is white. In 16-bit mode the data output is MSB aligned.

The following tables provide a description of the video data format for the different modes. (Source: IIDC V1.31; packed 12-bit mode: AVT)

<YUV8 (4:2:2) format>

Each component has 8-bit data.

<YUV8 (4:2:2) format>			
$U_{(K+0)}$	$Y_{(K+0)}$	$V_{(K+0)}$	$Y_{(K+1)}$
$U_{(K+2)}$	$Y_{(K+2)}$	$V_{(K+2)}$	$Y_{(K+3)}$
$U_{(K+4)}$	$Y_{(K+4)}$	$V_{(K+4)}$	$Y_{(K+5)}$
$U_{(K+Pn-6)}$	$Y_{(K+Pn-6)}$	$V_{(K+Pn-6)}$	$Y_{(K+Pn-5)}$
$U_{(K+Pn-4)}$	$Y_{(K+Pn-4)}$	$V_{(K+Pn-4)}$	$Y_{(K+Pn-3)}$
$U_{(K+Pn-2)}$	$Y_{(K+Pn-2)}$	$V_{(K+Pn-2)}$	$Y_{(K+Pn-1)}$

Table 34: YUV8 (4:2:2) format: Source: IIDC V1.31

<YUV8 (4:1:1 format)

Each component has 8-bit data.

<YUV8 (4:1:1) format>			
$U_{(K+0)}$	$Y_{(K+0)}$	$Y_{(K+1)}$	$V_{(K+0)}$
$Y_{(K+2)}$	$Y_{(K+3)}$	$U_{(K+4)}$	$Y_{(K+4)}$
$Y_{(K+5)}$	$V_{(K+4)}$	$Y_{(K+6)}$	$Y_{(K+7)}$
$U_{(K+Pn-8)}$	$Y_{(K+Pn-8)}$	$Y_{(K+Pn-7)}$	$V_{(K+Pn-8)}$
$Y_{(K+Pn-6)}$	$Y_{(K+Pn-5)}$	$U_{(K+Pn-4)}$	$Y_{(K+Pn-4)}$
$Y_{(K+Pn-3)}$	$V_{(K+Pn-4)}$	$Y_{(K+Pn-2)}$	$Y_{(K+Pn-1)}$

Table 35: YUV8 (4:1:1) format: Source: IIDC V1.31

<Y (Mono8/Raw8) format>

Y component has 8-bit data.

<Y (Mono8/Raw8) format>			
$Y_{(K+0)}$	$Y_{(K+1)}$	$Y_{(K+2)}$	$Y_{(K+3)}$
$Y_{(K+4)}$	$Y_{(K+5)}$	$Y_{(K+6)}$	$Y_{(K+7)}$
$Y_{(K+Pn-8)}$	$Y_{(K+Pn-7)}$	$Y_{(K+Pn-6)}$	$Y_{(K+Pn-5)}$
$Y_{(K+Pn-4)}$	$Y_{(K+Pn-3)}$	$Y_{(K+Pn-2)}$	$Y_{(K+Pn-1)}$

Table 36: Y (Mono8) format: Source: IIDC V1.31 / Y (Raw8) format: AVT

<Y (Mono16/Raw16) format>

Y component has 16-bit data.

<Y (Mono16) format>			
High byte	Low byte		
$Y_{(K+0)}$		$Y_{(K+1)}$	
$Y_{(K+2)}$		$Y_{(K+3)}$	
$Y_{(K+Pn-4)}$		$Y_{(K+Pn-3)}$	
$Y_{(K+Pn-2)}$		$Y_{(K+Pn-1)}$	

Table 37: Y (Mono16) format: Source: IIDC V1.31

<Y (Mono12/Raw12) format>

<Y (Mono12) format>			
$Y_{(K+0)}$ [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 38: **Packed 12-Bit Mode** (mono and raw) Y12 format (AVT)

<Y(Mono8/Raw8), RGB8>

Each component (Y, R, G, B) has 8-bit data. The data type is *Unsigned Char*.

Y, R, G, B	Signal level (decimal)	Data (hexadecimal)
Highest	255	0xFF
	254	0xFE
	.	.
	.	.
	1	0x01
Lowest	0	0x00

Figure 52: Data structure of Mono8, RGB8; Source: IIDC V1.31 / Y(Mono8/Raw8) format: AVT

<YUV8>

Each component (Y, U, V) has 8-bit data. The Y component is the same as in the above table.

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

Figure 53: Data structure of YUV8; Source: IIDC V1.31

<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 54: Data structure of Y(Mono16); Source: IIDC V1.31

<Y(Mono12)>

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 39: Data structure of **Packed 12-Bit Mode** (mono and raw) (AVT)

Description of the data path

Block diagrams of the cameras

The following diagrams illustrate the data flow and the bit resolution of image data after being read from the CCD sensor chip in the camera. The individual blocks are described in more detail in the following paragraphs. For sensor data see Chapter *Specifications* on page 50.

Black and white cameras

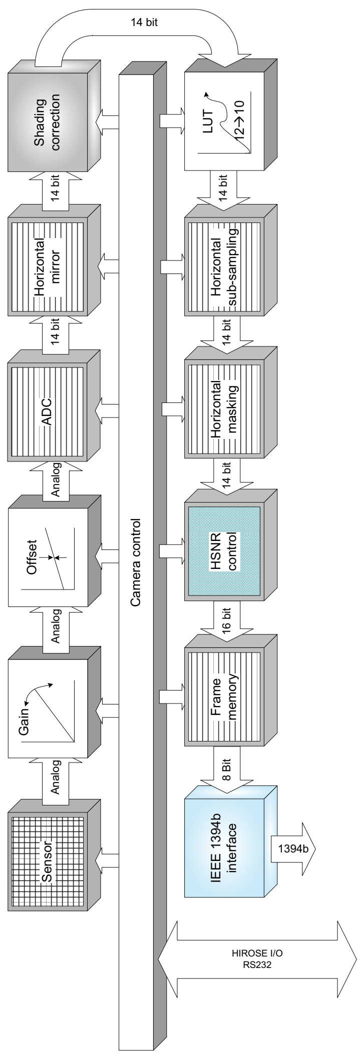


Figure 55: Block diagram b/w camera

Setting LUT = OFF effectively makes full use of the 14 bit by bypassing the LUT circuitry; setting LUT = ON means that the most significant 12 bit of the 14 bit are used and further down converted to 10 bit.

Color cameras

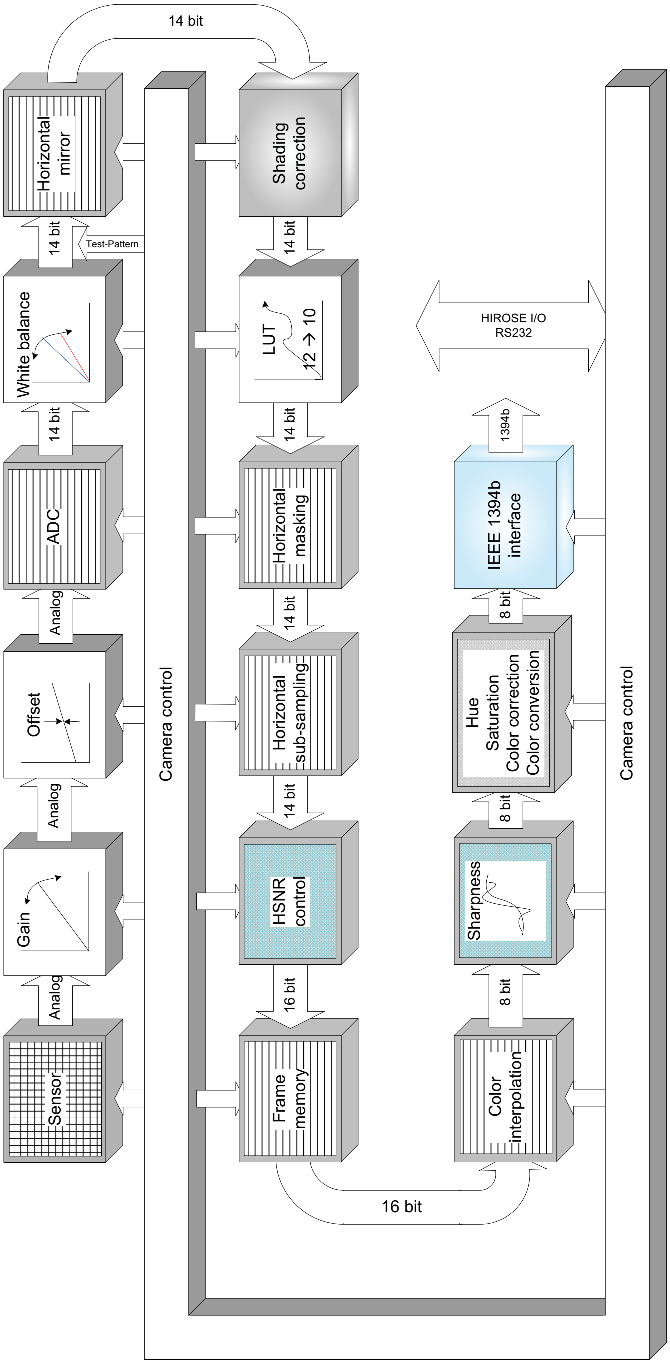


Figure 56: Block diagram color camera

Setting LUT = OFF effectively makes full use of the 14 bit by bypassing the LUT circuitry; setting LUT = ON means that the most significant 12 bit of the 14 bit are used and further down converted to 10 bit.

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

Stingray 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.

From the user's point, the white balance settings are made in register 80Ch of IIDC V1.31. This register is described in more detail below.

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

Table 40: 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.

Note

While lowering both U/B and V/R registers from 284 towards 0, the lower one of the two effectively controls the green gain.

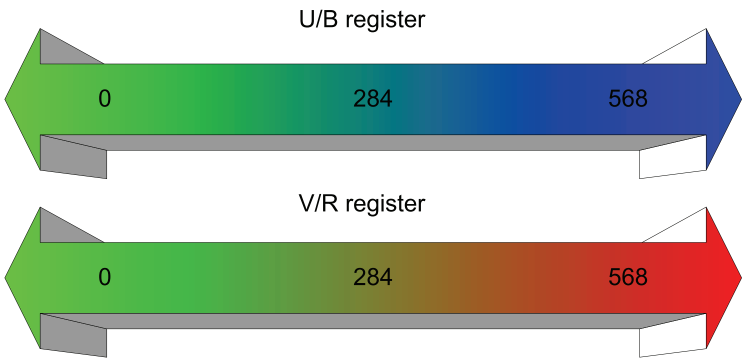


Figure 57: U/V slider range

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

Table 41: Manual gain range of the various Stingray types

The increment length is ~0.0353 dB/step.

One-push white balance

Note

Configuration

To configure this feature in control and status register (CSR): See ***Table 40: White balance register*** **on page 122.**

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

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

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

Note

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

- There are no stringent or special requirements on the image content, it requires only the presence of monochrome pixels in the image.

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.

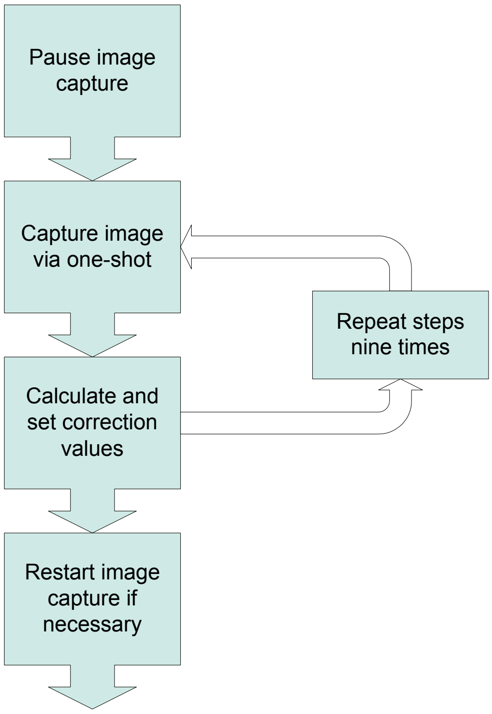


Figure 58: **One-push white balance** sequence

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.

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

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

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 147: Advanced register: Autofunction AOI* on page 322.**

AUTOFNC_AOI affects the auto shutter, auto gain and auto white balance features and is independent of the Format_7 AOI settings. If this feature is switched off the work area position and size will follow the current active image size.

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

The following drawing illustrates the AUTOFNC_AOI settings in greater detail.

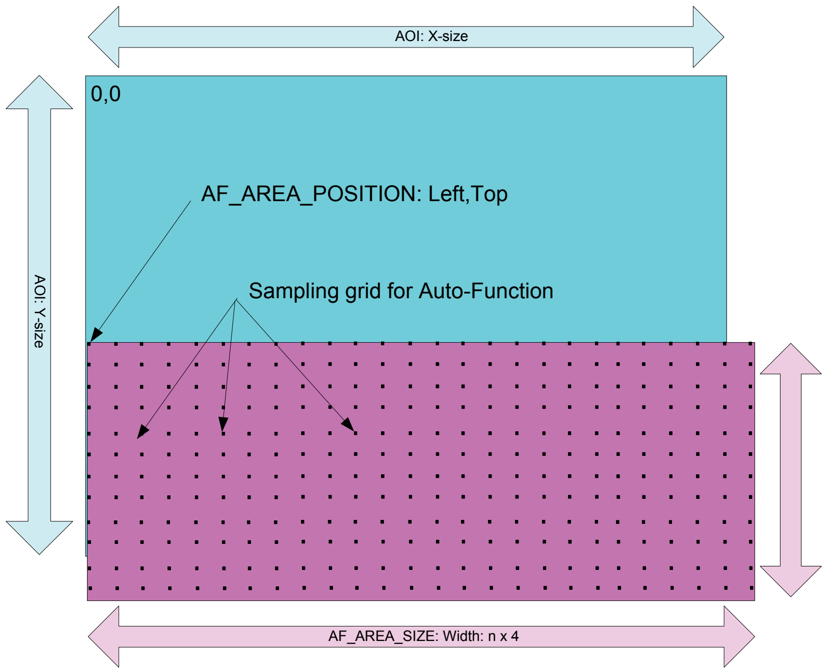


Figure 59: AUTOFNC_AOI positioning

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

Auto shutter

In combination with auto white balance, Stingray cameras are equipped with **auto shutter** feature.

When enabled, the auto shutter adjusts the shutter within the default shutter limits or within those set in advanced register F1000360h in order to reach the reference brightness set in auto exposure register.

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 zero overshot.

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

Register	Name	Field	Bit	Description
0xF0F0081C	SHUTTER	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the **Value** field 1: Control with value in the **Absolute** value CSR If this bit=1, the value in the **Value** field will be ignored.
		---	[2..4]	Reserved
		One_Push	[5]	Write 1: begin to work (self-cleared after operation) Read: 1: in operation 0: not in operation If A_M_Mode = 1, this bit will be ignored.
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF 1: ON
		A_M_MODE	[7]	Write: set mode Read: read current mode 0: MANUAL 1: AUTO
		---	[8..19]	Reserved
		Value	[20..31]	Read/Write Value This field is ignored when writing the value in Auto or OFF mode. If readout capability is not available, reading this field has no meaning.

Table 42: CSR: **Shutter**

Note

Configuration

To configure this feature in an advanced register: See *Table 145: Advanced register: Auto shutter control* on page 320.

Auto gain

All Stingray cameras are equipped with **auto gain** feature.

Note	Configuration
	To configure this feature in an advanced register: See *Table 146: Advanced register: Auto gain control* **on page 321.**

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 tables show 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 43: 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 44: CSR: **Auto Exposure**

Note

Configuration

To configure this feature in an advanced register: See *Table 146: Advanced register: Auto gain control* **on page 321.**

Note

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

Manual gain

Stingray 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
Stingray color cameras	0 … 680	0 … 24.4 dB	~0.0359 dB/step
Stingray b/w cameras	0 … 680	0 … 24.4 dB	

Table 45: Manual gain range of the various Stingray types

Note

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

Brightness (black level or offset)

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

0 … +16 gray values (@ 8 bit)

Increments are in 1/64 LSB (@ 8 bit)

Note

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

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

The following table shows the BRIGHTNESS register:

Register	Name	Field	Bit	Description
0xF0F00800	BRIGHTNESS	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the value field 1: Control with value in the absolute value CSR If this bit= 1 the value in the value field has to be ignored
		---	[2..4]	Reserved
		One_Push	[5]	Write: Set bit high to start Read: Status of the feature: Bit high: WIP Bit low: Ready
		ON_OFF	[6]	Write: ON or OFF this feature 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 avail-able reading this field has no meaning.

Table 46: CSR: **Brightness**

Horizontal mirror function

All Stingray cameras are equipped with an **electronic mirror function**, which mirrors pixels from the left side of the image to the right side and vice versa.

The mirror is centered to the current **FOV** center and can be combined with all image manipulation functions, like **binning** and **shading**.

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

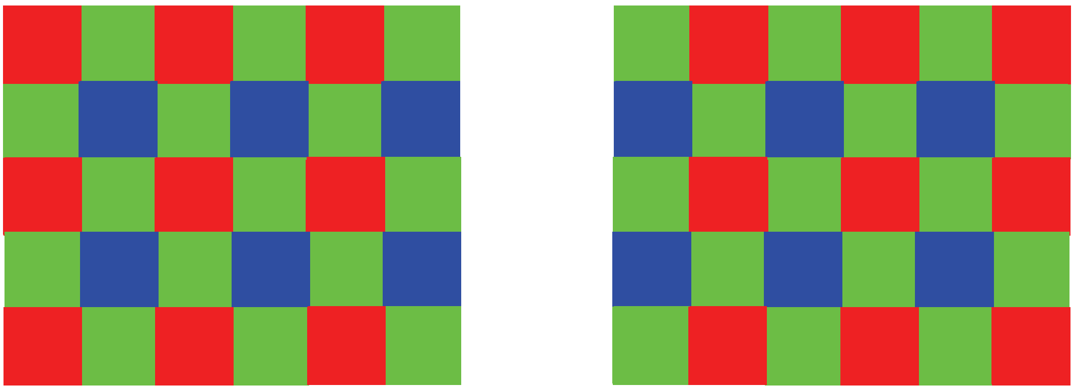
Note

Configuration

To configure this feature in an advanced register: See ***Table 150: Advanced register: Mirror*** **on page 324.**

Note

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



Mirror OFF: R-G-G-B (all Stingray color cameras) **Mirror ON: G-R-B-G** (all Stingray color cameras)

Figure 60: Mirror and Bayer order

Note

During switchover one image may be temporarily corrupted.

Shading correction

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

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

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

Note

- Shading correction does not support the mirror function.
- If you use shading correction with mirror function, activate the mirror before building shading image.
- Due to binning and sub-sampling in the Format_7 modes read the following hints to build shading image in Format_7 modes.

Building shading image in Format_7 modes

horizontal Binning/sub-sampling is always done after shading correction. Shading is always done on full horizontal resolution. Therefore shading image has always to be built in **full horizontal resolution**.

vertical Binning, sub-sampling and mirror are done before shading correction. Therefore shading image has to be built in the **correct vertical resolution** and with needed mirror settings.

Note

- **Build shading image** always with the **full horizontal resolution**
  (0 x horizontal binning / 0 x horizontal sub-sampling), but with the **desired vertical binning/sub-sampling/ mirror.**
- **Shading correction in F7 mode 0 (Mono8) is only available up to S400.**

First example

4 x horizontal binning, 2 x vertical binning
⇨ build shading image with 0 x horizontal binning and 2 x vertical binning

Second example

2 out of 8 horizontal sub-sampling, 2 out of 8 vertical sub-sampling
⇨ build shading image with 0 x horizontal sub-sampling and 2 out of 8 vertical sub-sampling

How to store shading image

There are two storing possibilities:

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

The following pictures describe the process of automatic generation of correction data. Surface plots and histograms were created using the **ImageJ** program.

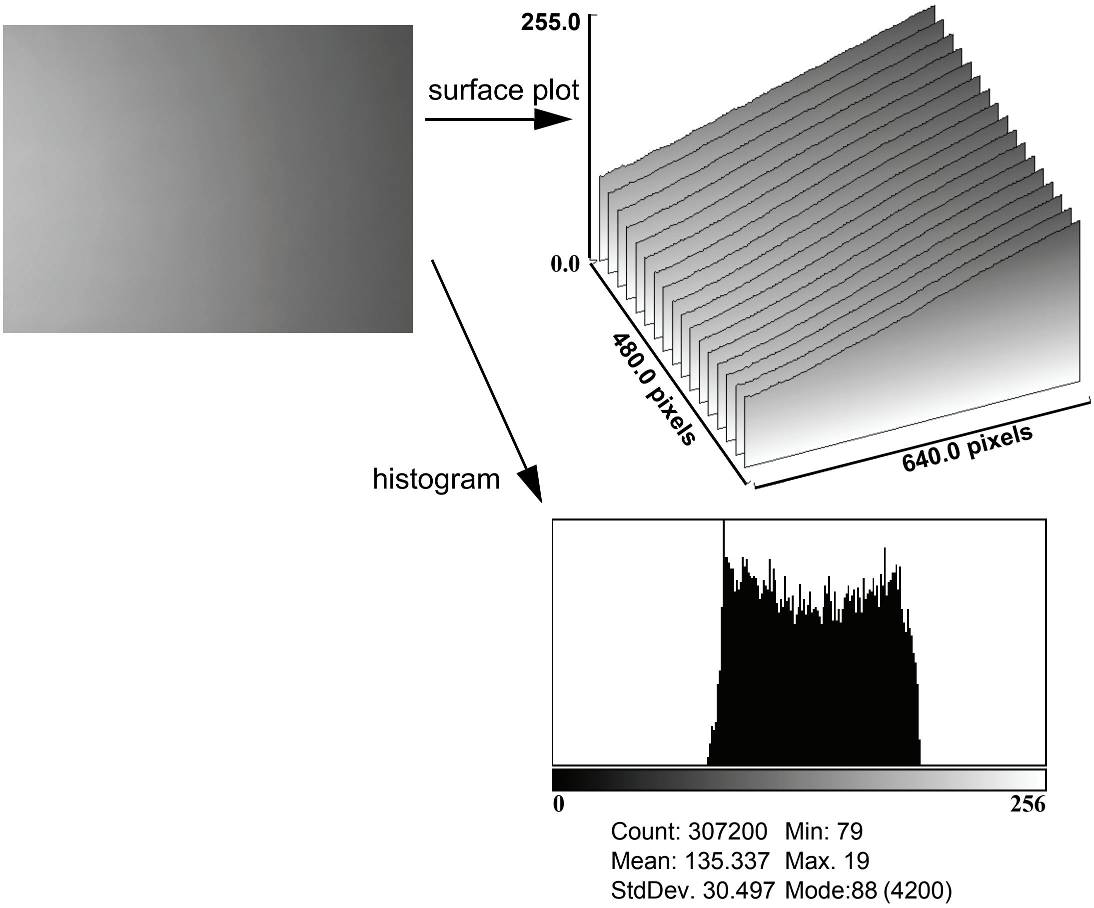


Figure 61: Shading correction: Source image with non-uniform illumination

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

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

Automatic generation of correction data

Requirements

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

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

Algorithm

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

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

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

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

How to proceed:

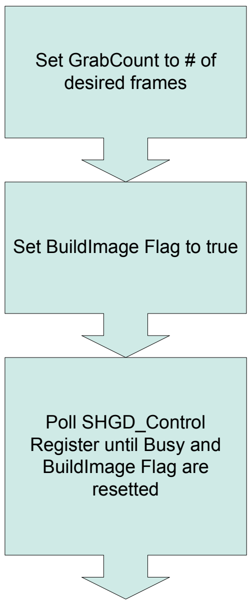


Figure 62: Automatic generation of a shading image

Note

Configuration

To configure this feature in an advanced register: See *Table 139: Advanced register: Shading* **on page 312.**

Note

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

Note

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

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

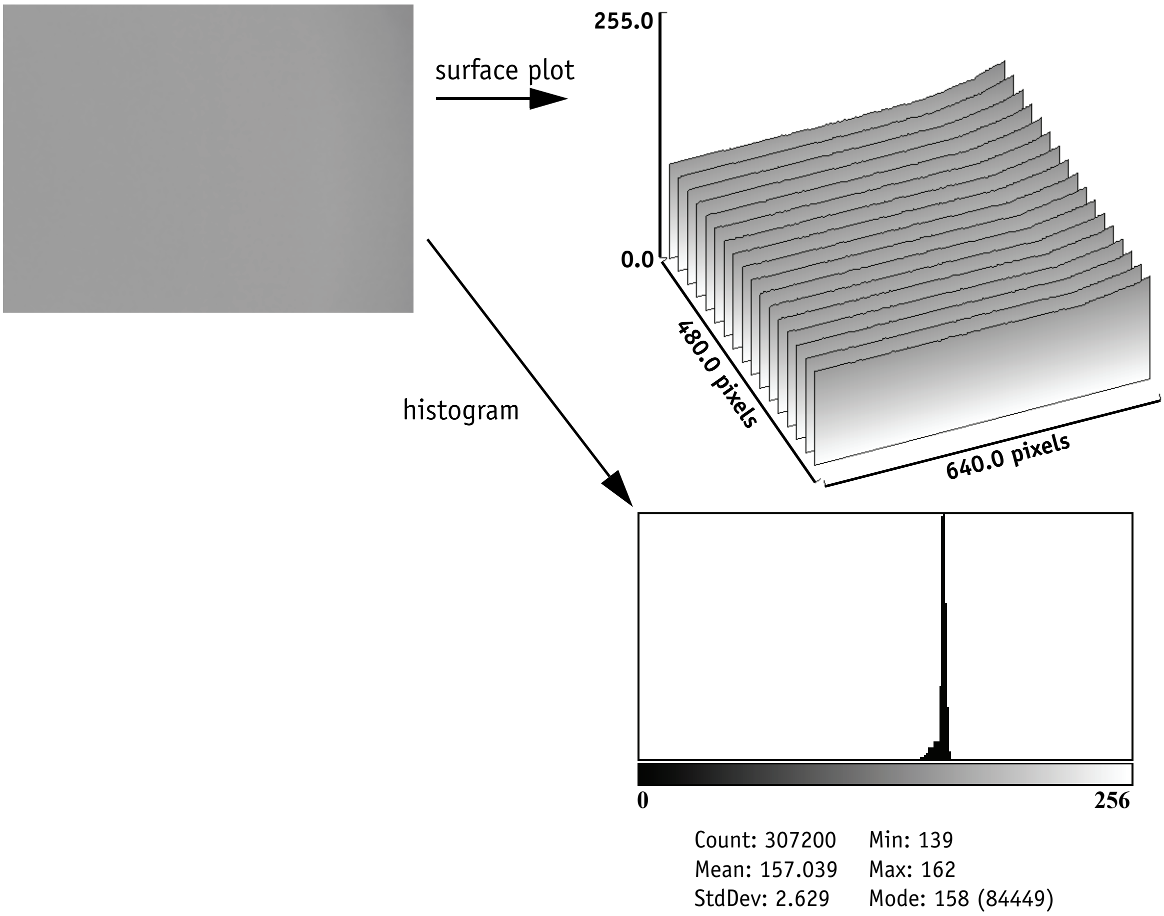


Figure 63: Example of shaded image

- On the left you see the image after shading correction.
- The surface plot on the right clearly shows nearly no more gradient of the brightness (0: brightest → 255: darkest pixels). The remaining gra-

dient is related to the fact that the source image is lower than 50% on the right hand side.

- The histogram shows a peak with very few different gray values.

Loading a shading image out of the camera

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

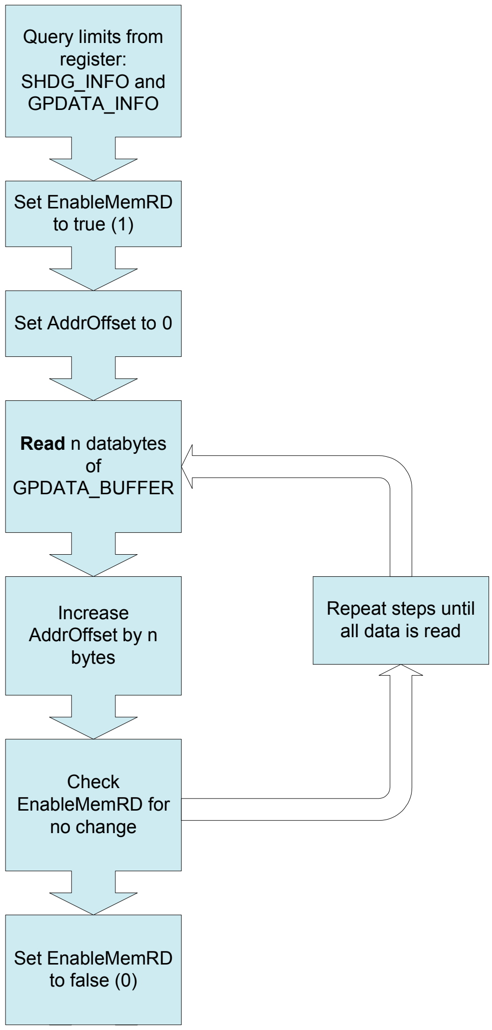


Figure 64: Uploading shading image to host

Note

Configuration

- To configure this feature in an advanced register: See *Table 139: Advanced register: Shading* on page 312.
- For information on GPDATA_BUFFER: See Chapter *GPDATA_BUFFER* on page 345.

Loading a shading image into the camera

GPDATA_BUFFER is used to load a shading image *into* the camera. Because the size of a shading image is larger than GPDATA_BUFFER, input must be handled in several steps (see also Chapter *Reading or writing shading image from/into the camera* on page 313):

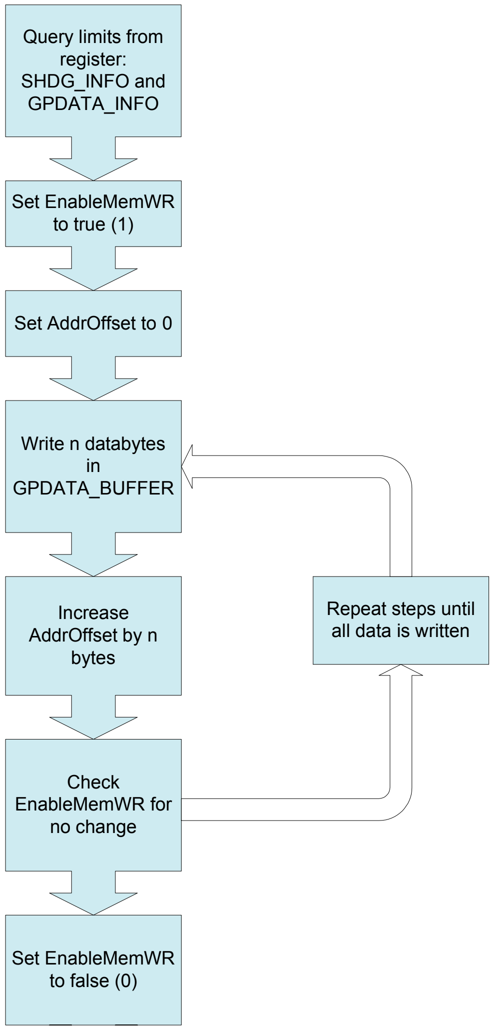


Figure 65: Loading the shading reference image

Note **Configuration**

- To configure this feature in an advanced register: See *Table 139: Advanced register: Shading* on page 312.
- For information on GPDATA_BUFFER: See Chapter *GPDATA_BUFFER* on page 345.

Look-up table (LUT) and gamma function

The AVT Stingray 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 to be applied on the individual pixels of an image at run-time.

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

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

One example of using an LUT is the gamma LUT:

There is one gamma LUT (gamma=0.45)

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

This gamma LUT is used with all Stingray models.

Gamma is known as compensation for the nonlinear brightness response of many displays e.g. CRT monitors. The look-up table converts the incoming **12 bit** from the digitizer to outgoing **10 bit**.

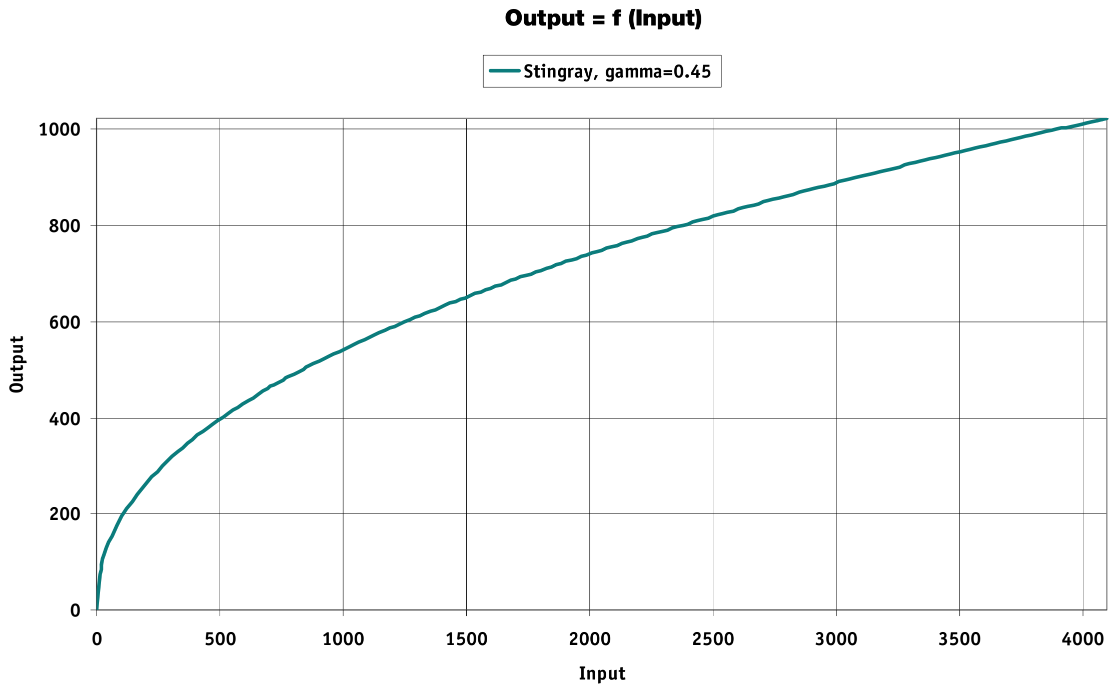


Figure 66: LUT with gamma=0.45

Note

- The input value is the most significant **12-bit** value from the digitizer.
- Gamma 1 (gamma=0.45) switches on the LUT. After overriding the LUT with a user defined content, gamma functionality is no longer available until the next full initialization of the camera.
- LUT content is volatile if you do not use the user profiles to save the LUT.

Loading an LUT into the camera

Loading the LUT is carried out through the data exchange buffer called GPDATA_BUFFER. As this buffer can hold a maximum of 2 kB, and a complete LUT at **4096 x 10 bit** is **5 kByte**, programming can not take place in a one block write step because the size of an LUT is larger than GPDATA_BUFFER. Therefore input must be handled in several steps. The flow diagram below shows the sequence required to load data into the camera.

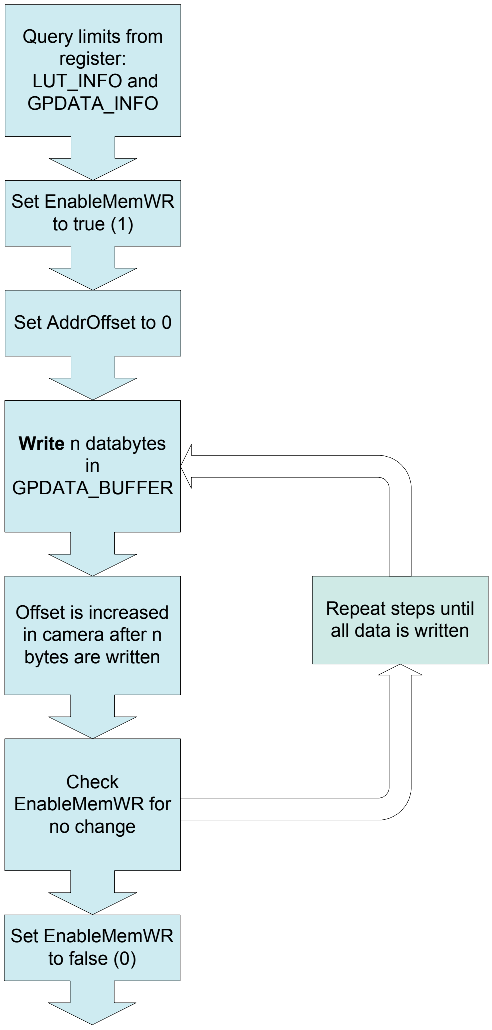


Figure 67: Loading an LUT

Note

Configuration

- To configure this feature in an advanced register: See *Table 138: Advanced register: LUT* on page 310.
- For information on GPDATA_BUFFER: See Chapter *GPDATA_BUFFER* on page 345.

Defect pixel correction

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.

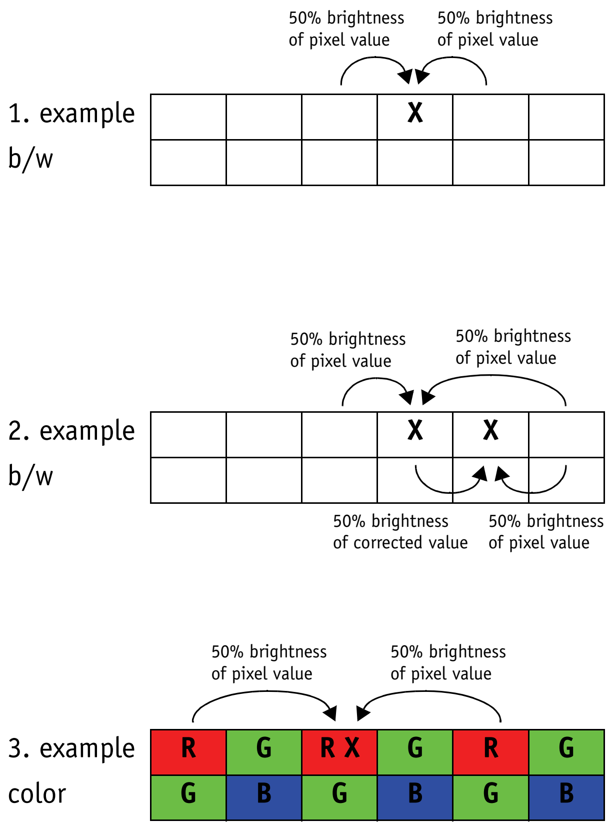


Figure 68: Mechanisms of defect pixel correction

Building defect pixel correction image in Format_7 modes

horizontal Binning/sub-sampling is always done after defect pixel correction. Defect pixel correction is always done on full horizontal resolution. Therefore defect pixel detection has always to be done in **full horizontal resolution**.

vertical Binning/sub-sampling is done in the sensor, before defect pixel correction. Therefore defect pixel detection has to be done in the **correct vertical resolution**.

Note

Detect defect pixels always with the full horizontal resolution
(0 x horizontal binning / 0 x horizontal sub-sampling), but with the desired vertical binning/sub-sampling.

First example

4 x horizontal binning, 2 x vertical binning
⇨ detect defect pixels with 0 x horizontal binning and 2 x vertical binning

Second example

2 out of 8 horizontal sub-sampling, 2 out of 8 vertical sub-sampling
⇨ detect defect pixels with 0 x horizontal sub-sampling and 2 out of 8 vertical sub-sampling

Flow diagram of defect pixel correction

The following flow diagram illustrates the defect pixel detection:

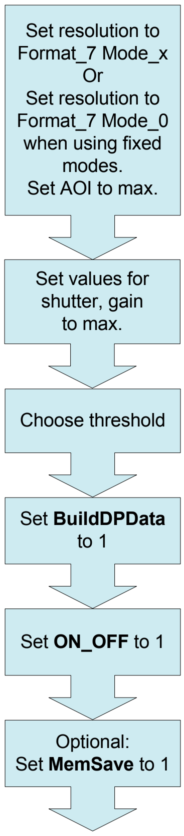


Figure 69: Defect pixel correction: build and store

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 a non-volatile memory (Set MemSave to 1).

Note

Configuration

To configure this feature in an advanced register: See *Table 143: Advanced register: Defect pixel correction* on page 317.

Building defect pixel data

Note

- Defect pixel detection is **only possible in Mono8/ Raw8** modes. In all other modes you get an error message in advanced register 0xF1000298 bit [1] see *Table 143: Advanced register: Defect pixel correction* on page 317.
- Using Format_7 Mode_x: Defect pixel detection is done in **Format_7 Mode_x**.
- Using a fixed format (Format_0, Format_1 or Format_2): Defect pixel detection 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 detection.
- Optional: To improve the quality of defect pixel detection, activate **HSNR mode** additionally.
- There is a maximum of 256 defect pixels that can be found. If the algorithm detects more defect pixels, then it will end with an error. For more details, see *DPDataSize* register on page 318.

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 and gain to max.
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 is grabbed internal.

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

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 143: Advanced register: Defect pixel correction* on page 317.

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
- Start-up camera / initialize camera:
  ⇨ 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

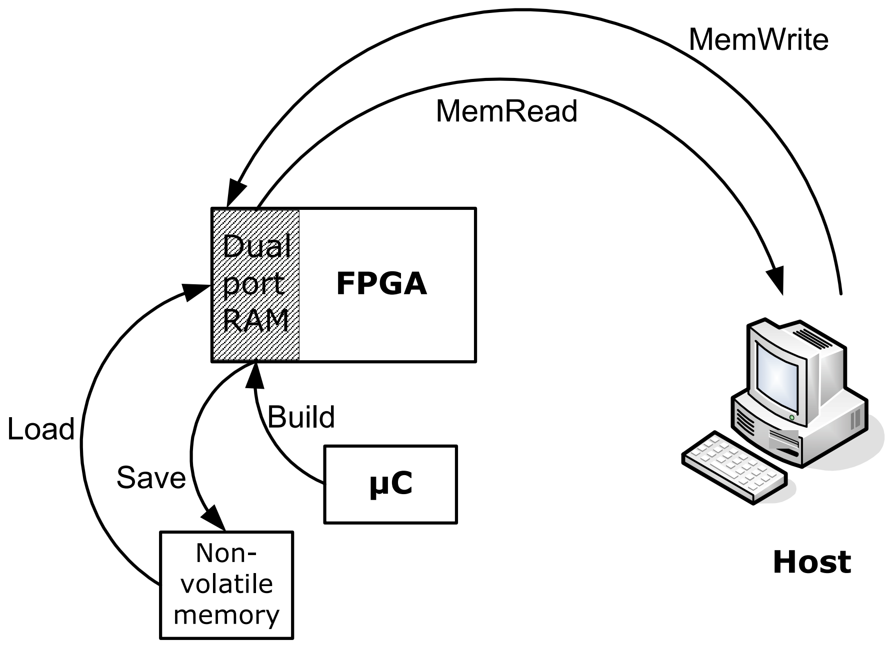


Figure 70: DPC data: storing mechanism

Binning (only Stingray b/w and F-201C/504C)

2 x / 4 x / 8 x binning (F-201C only 2 x vertical binning)

Definition

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

Note

- Only **Stingray b/w cameras** and **Stingray F-201C/ F-504C** have this feature.
- Stingray F-201C: color binning
- Stingray F-504C: usual binning (no color binning)
- Binning does not change offset, brightness or black-level.

Binning is used primarily for 3 reasons:

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

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

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

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

Only Format_7

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

Note

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

Types

In general, we distinguish between the following types of binning (H=horizontal, V=vertical):

- 2 x H-binning
- 2 x V-binning
- 4 x H-binning
- 4 x V-binning
- 8 x H-binning
- 8 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)
- 8 x full binning (a combination of 8 x H-binning and 8 x V-binning)

Vertical binning

Vertical binning increases the light sensitivity of the camera by a factor of two (4 or 8) by adding together the values of two (4 or 8) adjoining vertical pixels output as a single pixel. This is done directly in the horizontal shift register of the sensor.

Format_7 Mode_2

By default and without further remapping use **Format_7 Mode_2** for 2 x vertical binning.

This reduces vertical resolution, depending on the model.

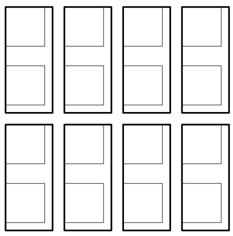
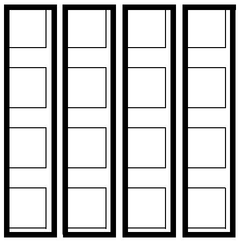
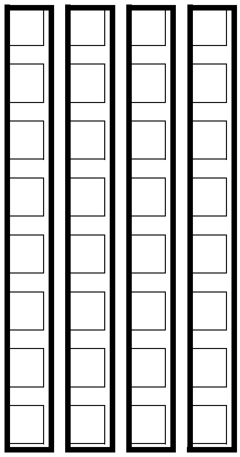


Figure 71: 2 x vertical binning



4 x vertical binning (not F-201C, but F-504C)

Figure 72: 4 x vertical binning



8 x vertical binning (not F-201C, but F-504C)

Figure 73: 8 x vertical binning

Note

Vertical resolution is reduced, but signal-to noise ratio (SNR) is increased by about 3, 6 or 9 dB (2 x, 4 x or 8 x binning).

Note

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

Note

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

Horizontal binning (F-201C only 2 x horizontal binning)

F-504C has 2x/4x/8x horizontal binning (no color binning)

Definition

In **horizontal binning** adjacent horizontal pixels in a line are combined digitally in the FPGA of the camera without accumulating the black level:

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

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

8 x horizontal binning: 8 pixel signals from 8 horizontal neighboring pixels are combined.

Light sensitivity

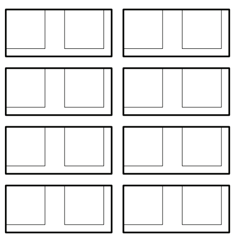
This means that in horizontal binning the **light sensitivity** of the camera is also increased by a factor of two (**6 dB**), 4 (**12 dB**) or 8 (**18 dB**). Signal-to-noise separation improves by approx. 3, 6 or 9 dB.

Horizontal resolution

Horizontal resolution is lowered, depending on the model.

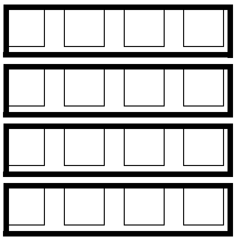
Format_7 Mode_1

By default and without further remapping use **Format_7 Mode_1** for 2 x horizontal binning.



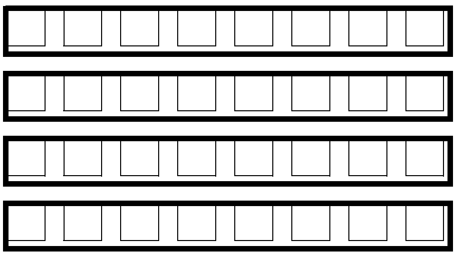
2 x horizontal binning

Figure 74: 2 x horizontal binning



4 x horizontal binning (not F-201C, but F-504C)

Figure 75: 4 x horizontal binning



8 x horizontal binning (not F-201C, but F-504C)

Figure 76: 8 x horizontal binning

Note

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

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

2 x full binning/4 x full binning/8 x full binning (F-201C only 2 x full binning)

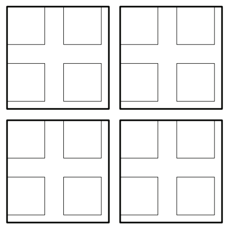
F-504C has 2x/4x/8x full binning (no color binning)

If horizontal and vertical binning are combined, every 4 (16 or 64) pixels are consolidated into a single pixel. At first two (4 or 8) vertical pixels are put together and then combined horizontally.

Light sensitivity This increases light sensitivity by a total of a factor of 4 (16 or 64) and at the same time signal-to-noise separation is improved by about 6 (12 or 18) dB.

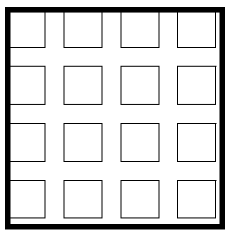
Resolution Resolution is reduced, depending on the model.

Format_7 Mode_3 By default and without further remapping use **Format_7 Mode_3** for 2 x full binning.



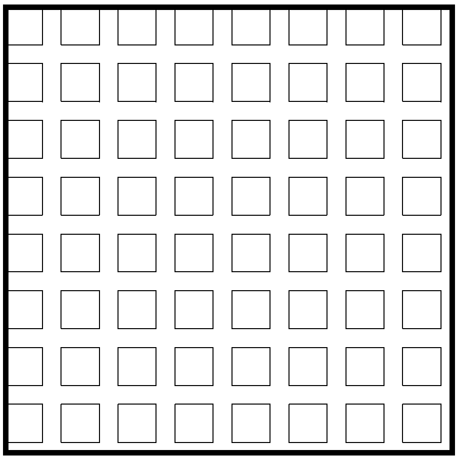
2 x full binning

Figure 77: 2 x full binning



4 x full binning (not F-201C, but F-504C)

Figure 78: 4 x full binning



8 x full binning (not F-201C, but F-504C)

Figure 79: 8 x full binning

Sub-sampling (Stingray b/w and color)

What is sub-sampling?

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

Which Stingray models have sub-sampling?

All Stingray 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.

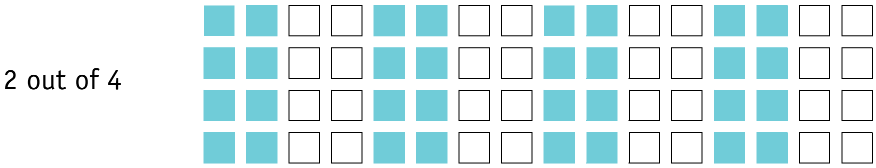


Figure 80: Horizontal sub-sampling 2 out of 4 (**b/w**)

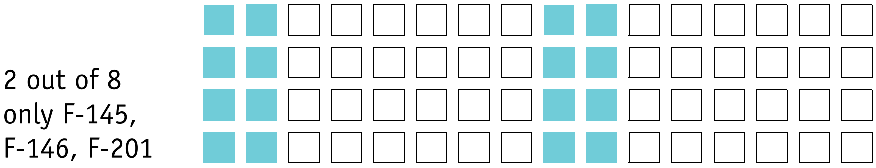


Figure 81: Horizontal sub-sampling 2 out of 8 (**b/w**)

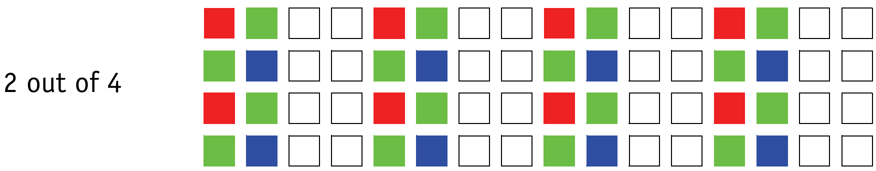


Figure 82: Horizontal sub-sampling 2 out of 4 (**color**)

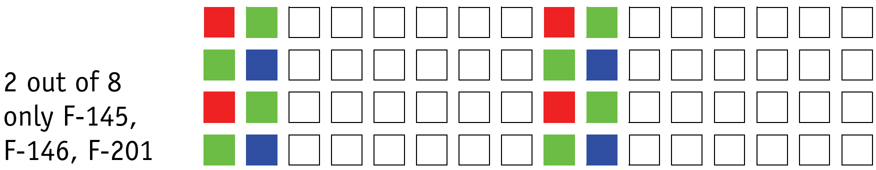


Figure 83: Horizontal sub-sampling 2 out of 8 (**color**)

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.

2 out of 4 2 out of 8 (only F-145, F-146, F-201)

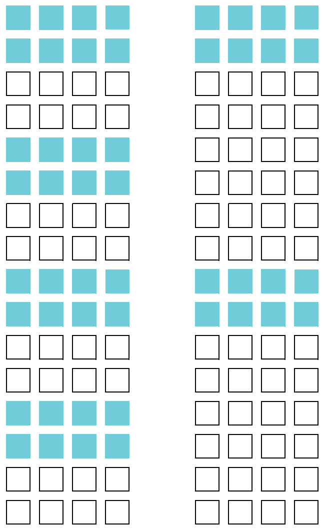


Figure 84: Vertical sub-sampling (**b/w**)

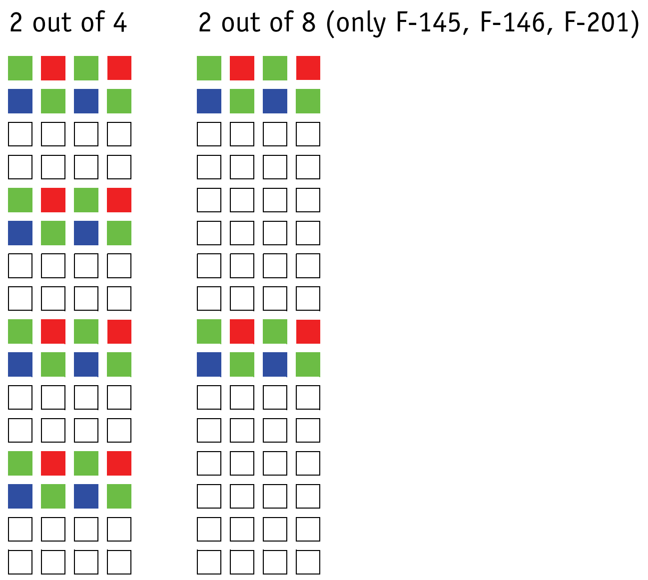


Figure 85: Vertical sub-sampling (**color**)

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.

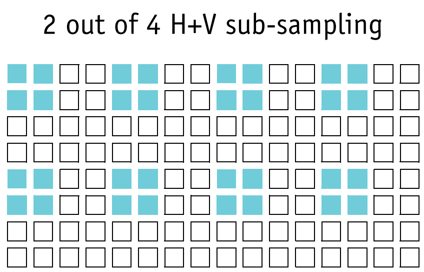


Figure 86: 2 out of 4 H+V sub-sampling (**b/w**)

2 out of 8 H+V sub-sampling (only F-145, F-146, F-201)

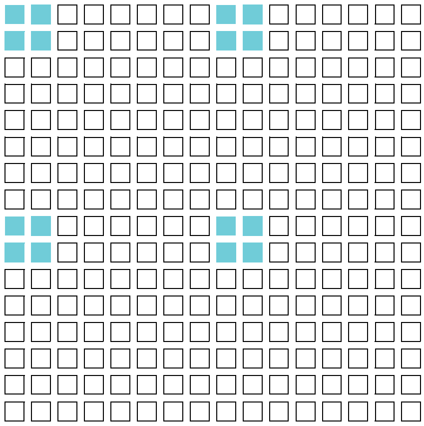


Figure 87: 2 out of 8 H+V sub-sampling (**b/w**)

2 out of 4 H+V sub-sampling

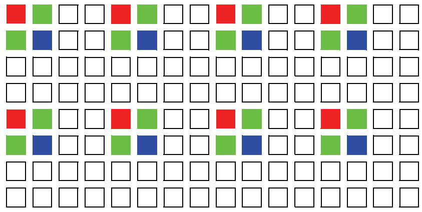


Figure 88: 2 out of 4 H+V sub-sampling (**color**)

2 out of 8 H+V sub-sampling (only F-145, F-146, F-201)

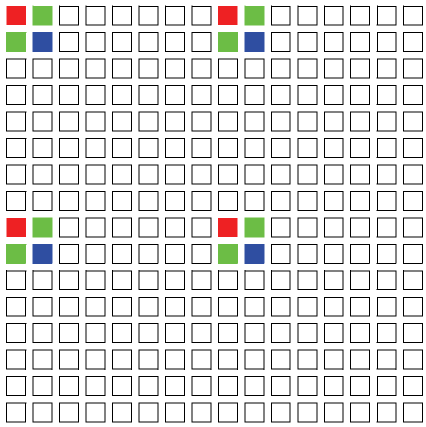


Figure 89: 2 out of 8 H+V sub-sampling (**color**)

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

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 AVT modes can be mapped to **Format_7 Mode_1** to **Mode_7**
  (see *Figure 90: Mapping of possible Format_7 modes to F7M1...F7M7* on page 164)
- Mappings can be stored via register (see Chapter *Format_7 mode mapping* on page 332) 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	Stingray monochrome cameras Format_7	Stingray color cameras Format_7
Mode_0	full resolution, no binning, no sub-sampling	full resolution, no sub-sampling
Mode_1	2 x **horizontal** binning	**Only F-201C/F-504C:** 2 x **horizontal** binning
Mode_2	2 x **vertical** binning	**Only F-201C/F-504C:** 2 x **vertical** binning
Mode_3	2 x **full** binning	**Only F-201C/F-504C:** 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 47: 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...27 in the binning / sub-sampling list on page 164 do **not** correspond to any of the Format_7 modes.

F7 modes according to IIDC 1394

F7M0 (no change)
F7M1
F7M2
F7M3
F7M4
F7M5
F7M6
F7M7

mapping of each of 27 modes to F7M1..F7M7 possible

Format_ID (see p332) AVT modes

Format_ID	Horizontal	Vertical	
0	0 x horizontal	0 x vertical	binning (only b/w cameras + F-201C/F-504C)
1	2 x horizontal		
2	4 x horizontal		
3	8 x horizontal		
4	0 x horizontal	2 x vertical	
5	2 x horizontal		
6	4 x horizontal		
7	8 x horizontal		
8	0 x horizontal	4 x vertical (not F-201C, but F-504C)	
9	2 x horizontal		
10	4 x horizontal		
11	8 x horizontal		
12	0 x horizontal	8 x vertical (not F-201C, but F-504C)	
13	2 x horizontal		
14	4 x horizontal		
15	8 x horizontal		
16	---	2 out of 2 vertical	sub-sampling (color and b/w)
17	2 out of 4 horizontal		
18	2 out of 8 horizontal		
19	2 out of 16 horizontal		
20	2 out of 2 horizontal	2 out of 4 vertical	
21	2 out of 4 horizontal		
22	2 out of 8 horizontal		
23	2 out of 16 horizontal		
24	2 out of 2 horizontal	2 out of 8 vertical (only F-145, F-146, F-201)	
25	2 out of 4 horizontal		
26	2 out of 8 horizontal		
27	2 out of 16 horizontal		

Figure 90: Mapping of possible Format_7 modes to F7M1...F7M7

Note

Configuration

To configure this feature in an advanced register: See *Table 158: Advanced register: Format_7 mode mapping* on page 332.

Quick parameter change timing modes

Why new timing modes?

For readers familiar with PIKE and MARLIN cameras: Former timing of the PIKE cameras showed the same behavior as MARLIN cameras (All STINGRAY cameras have already the new timing modes implemented):

- Frame rate or transfer rate is always constant (precondition: shutter < transfer time)
- The delay from shutter update until the change takes place: up to 3 frames. *Figure 91: Former standard timing* on page 165 demonstrates this behavior. It shows that the camera receives a shutter update command while the sensor is currently integrating (Sync is low) with shutter setting 400. The camera continues to integrate and this image is output with the next FVal. The shutter change command becomes effective with the next falling edge of sync and finally the image taken with shutter 200 is output with a considerable delay.
- Parameters that are sent to the camera faster than the max. frame rate per second are stored in a FIFO and are activated in consecutive images.

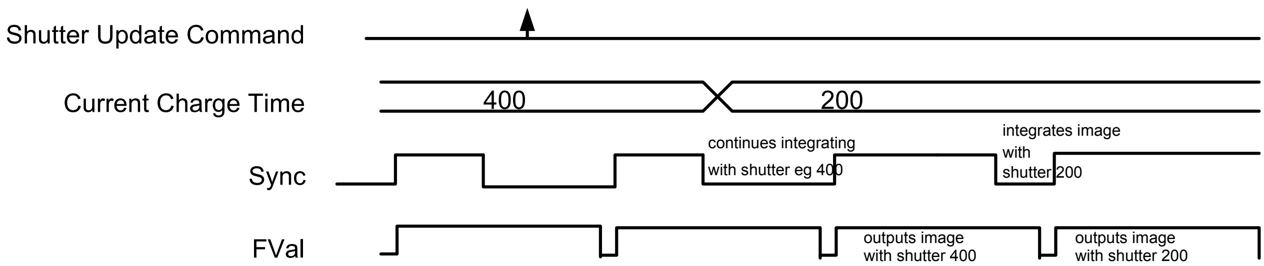


Figure 91: Former standard timing

Principally a Stingray camera is not able to recognize how many parameter the user will change. Due to the fact that communication between host and camera is asynchronous, it may happen that one part of parameter changes is done in image n+1 and the other part is done in image n+2.

To optimize the transfer of parameter changes there is a new timing mode called **Quick Format Change Mode**, which effectively resets the current shutter.

Therefore you can choose between the following update timing modes:

- **Standard Parameter Update Timing**
- New: **Quick Format Change Mode**

In the following you find a short description of both timing modes:

Standard Parameter Update Timing

The **Standard Parameter Update Timing** keeps the frame rate constant and does not create any gaps between two image transfers via bus (precondition: exposure (shutter) time must be smaller than transfer time).

- Frame rate / transfer rate is always constant
  (if shutter time < transfer time)
- Delay from shutter update until change takes place is always 2 frames (delay from update command reception by FPGA and not by microcontroller)
- Parameters sent to the camera faster than max. frame rate are no longer stored in a FIFO. The last sent parameter will be activated for the next image. All others will be dropped. This ensures that the last image is shot with the last shutter setting.

New: Quick Format Change Mode (QFCM)

The **Quick Format Change Mode** creates gaps between two images. Current exposure is interrupted and the new exposure is started immediately with new parameters if during exposure (integration/shutter) an new shutter command is received.

- Frame rate / transfer rate can be *interrupted*. This is shown in the diagram below whenever FVal goes low after a reception of a new shutter command while Sync was low.
- Shutter will be interrupted, if the update command is received while camera integrates
- Delay from shutter update until change takes place is always 1 frame (the delay is calculated from update command reception by FPGA and not by microcontroller)

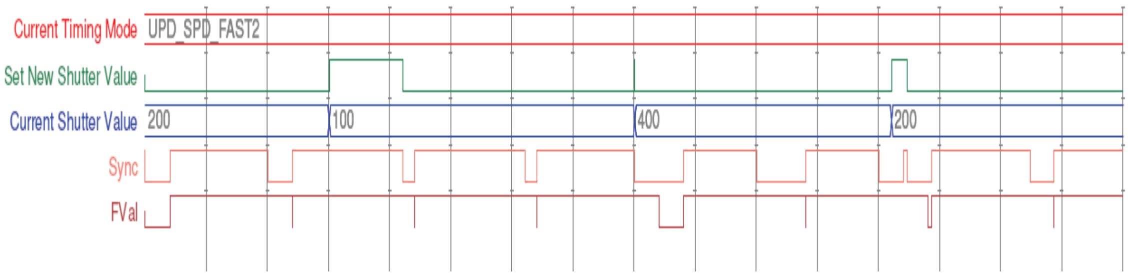


Figure 92: **Quick Format Change Mode**

How to transfer parameters to the camera

The following 3 variants of transferring the parameters are available:

Transfer mode	Advantage ☺	Disadvantage ☹
Encapsulated Update (begin/ end)	☺ easy to use (standard quad writes in camera register is possible)	☹ one write access per register access
Parameter-List Update	☺ only one write access for all parameters ☺ fastest host→camera transfer (from 5 parameters on faster than encapsulated mode) ☺ handling of parameter list easy	☹ not so easy to use (block writes) ☹ max. 64 entries for parameter list
Standard Update (IIDC)	☺ compliant with IIDC V1.31	☹ non deterministic change of parameters

Table 48: Comparison of 3 transfer modes

In the following you find a short description of each variant:

Encapsulated Update (begin/end)

The **Encapsulated Update (begin/end)** has the following characteristics:

- Host will set a parameter update begin flag in the camera (UpdActive Field in Register 0xF1000570, see *Table 155: Advanced register: Update timing modes* on page 329)
- Host will send several parameters to the camera and then signalize end by resetting the flag
- All parameters will become active for the same next image
- Dependent on timing mode, the camera
  - (standard Update): uses the previous parameters until the update flag is reset
  - (**Quick Format Change Mode**): waits until the update flag is reset.

In the **Encapsulated Update (begin/end)** the exact sequence is:

1. Parameter update begin (advanced feature register)
2. Standard IIDC register update (1..N register) (standard feature register)
3. Parameter update end (advanced feature register)

Camera timing behavior is like this:

Fast Parameter Update Timing	Quick Format Change Mode
After the parameter update stop command all changed parameters are valid for the available next image. Frame rate is constant.	After the parameter update start command a current transfer is interrupted. A started exposure will be interrupted until the next parameter update stop command. Exposure of the next image with new parameters is started. There may be a gap between two succeeding images but images are always transmitted compeletely.

Table 49: **Encapsulated Update (begin/end)**: comparison of standard timing and fast timing 2

If after end of time-out (10 seconds after **Quick Format Change Mode**) no **parameter update end** is sent, all changes will become valid.

A new write event of **parameter update begin** starts time-out again.

Parameter-List Update

In the **Parameter-List Update** mode a complete list with IIDC addresses and values of up to 64 parameters is sent to the camera.

- Host sends a list with parameters to the camera (advanced feature space)
- Microcontroller processes that list
- All parameters will become active for the same image
- Dependent on timing mode, the camera will:
  - **Standard Format Change Mode**: use the previous parameters until the new parameter set is copied to the FPGA
  - **Quick Format Change Mode (QFCM)**: waits until all parameters have been copied to the FPGA and may interrupt an already started integration for a new integration with the new settings

Example of parameter list:

Address	Value
0xF0F0081C	0x80000100
0xF0F00820	0x800000ac
0xF0F00818	0x82000001
...	...

Table 50: Example of parameter list

The exact sequence is:

Block-write (this needs to be a functionality of the underlying software stack (e.g. AVT FirePackage). It may not be available for third party IIDC software stacks.) of list to advanced feature address

Camera timing behavior is like this:

Fast Parameter Update Timing	Quick Format Change Mode (QFCM)
After block write command is processed in the camera all changed parameters are valid for the available next image. Frame rate is constant.	After transfer of the parameter list via block write a current transfer will be finished. A started exposure will be interrupted until the microcontroller has processed the list and copied it into the FPGA. Exposure of the next image with new parameters is started. There may be a gap between two images.

Table 51: **Parameter-List Update**: comparison of standard timing and **QFCM**

Standard Update (IIDC)

In the **Standard Update (IIDC)** mode single parameter are sent to the camera.

- **Standard Update (IIDC)** shows same behavior as MARLIN
- Parameter will be sent from host to camera and will be activated as soon as possible without interruption of the transfer
- If the host updates more than one parameter (without block write) the parameters may become active in different images
- **Standard Update (IIDC)** can be combined with the new parameter update timing modes

Camera timing behavior is like this:

Fast Parameter Update Timing	Quick Format Change Mode (QFCM)
After sending a new parameter value, the changed parameter value is valid for the available next image. Frame rate is constant.	After sending a new parameter value, the changed parameter value is valid for the available next image. A running exposure will be interrupted and the image is dropped. There may be a gap between two consecutive image transfers.

Table 52: **Standard Update (IIDC)**: comparison of **Standard Format Change Mode** and **QFCM**

Packed 12-Bit Mode

All Stingray cameras 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 53: **Packed 12-Bit Mode**

Note

For data block packet format see **Table 34: Packed 12-Bit Mode (mono and raw) Y12 format on page 114.**

For data structure see ***Table 39: Data structure of Packed 12-Bit Mode (mono and raw) (AVT)* on page 118.**

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 126: Format_7 control and status register* on page 294.

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

Table 54: **Packed 12-Bit Mode**: color coding

High SNR mode (High Signal Noise Ratio)

Note **Configuration**

To configure this feature in an advanced register: See *Table 152: Advanced register: High Signal Noise Ratio (HSNR)* **on page 326.**

In this mode the camera grabs and averages a set number of images and outputs one image with the same bit depth and the same brightness. This means that the camera will output an 8-bit averaged image when an 8-bit image format is selected (although the internal calculations are done with 14 bit).

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

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

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

Note

- The averaged image is output at a lower frame rate roughly equivalent to fps_old/N, where N is the number of images averaged. In fact, due to camera internal conditions, and according to which format and mode settings are in use, it can vary slightly to be closer sometimes to 1/ ((N/fps_old) + T_shutter). It's impractical to express in a formula or tables, across all camera models and modes. But these notes should be sufficient to help each user determine that the camera behaves as described.
- The camera must be in idle before turning this feature on.
- The potential SNR enhancement may be lower when using more than 8-bit original bit depth.
- Select 16-bit image format in order to take advantage of the full potential SNR and DNR (**D**y**N**amic **R**ange) enhancements.
- For 8-bit video modes, the internal HSNR calculations are done with 14 bit.

Frame memory and deferred image transport

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

Deferred image transport

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

Stingray cameras are equipped with 32 MByte of RAM (Stingray F-504: 64 MByte). The table below shows how many frames can be stored by each model. The memory operates according to the FIFO (first in, first out) principle. This makes addressing for individual images unnecessary.

Model	Memory size
Stingray F-033B/C Stingray F-033B/C fiber	**32 MB memory: 50 frames**
Stingray F-046B/C Stingray F-046B/C fiber	**32 MB memory: 35 frames**
Stingray F-080B/C Stingray F-080B/C fiber	**32 MB memory: 19 frames**
Stingray F-125B/C Stingray F-125B/C fiber	**32 MB memory: 12 frames**
Stingray F-145B/C Stingray F-145B/C fiber	**32 MB memory: 10 frames**
Stingray F-146B/C Stingray F-146B/C fiber	**32 MB memory: 10 frames**
Stingray F-201B/C Stingray F-201B/C fiber	**32 MB memory: 7 frames**
Stingray F-504B/C Stingray F-504B/C fiber	**64 MB memory: 5 frames**

Table 55: FIFO memory size

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

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

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

Note

Configuration

To configure this feature in an advanced register: See *Table 141: Advanced register: Deferred image transport* **on page 315.**

HoldImg mode

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

Note

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

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

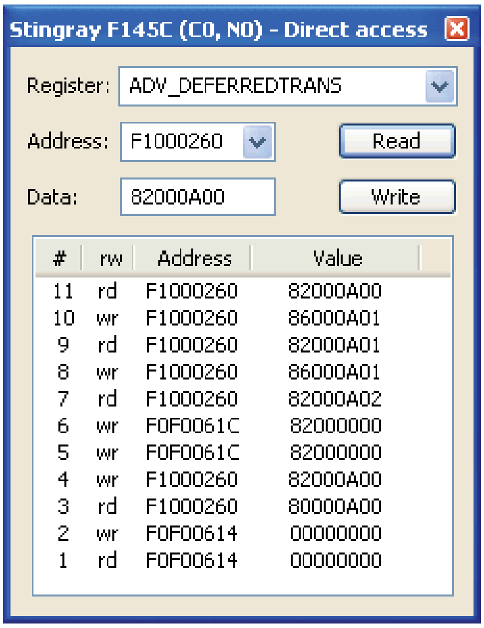


Figure 93: Example: Controlling deferred mode (SmartView - Direct Access; Stingray F-145C)

For a description of the commands see the following table:

#	rw	Address	Value	Description
11	rd	F1000260	82006900h	Check how many images are left in FIFO
10	wr	F1000260	86006901h	Read out the second image of FIFO
9	rd	F1000260	82006901h	Check how many images are left in FIFO
8	wr	F1000260	86006901h	Read out the first image of FIFO
7	rd	F1000260	82006902h	Check that two images are in FIFO
6	wr	F0F0061C	82000000h	Do second one-shot
5	wr	F0F0061C	82000000h	Do first one-shot
4	wr	F1000260	82000A00h	Switch deferred mode on
3	rd	F1000260	80000A00h	Check pres. of deferred mode and FIFO size (0Ah → 10 frames)
2	wr	F0F00614	00000000h	Stop continuous mode of camera
1	rd	F0F00614	00000000h	Starting SmartView

Table 56: Example: Controlling deferred mode (SmartView - Direct Access; Stingray F-145C)

FastCapture mode

Note **This mode can be activated only in Format_7.**

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

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

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

Color interpolation (BAYER demosaicing)

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

In color interpolation a red, green or blue value is determined for each pixel. An AVT proprietary BAYER demosaicing algorithm is used for this interpolation (2x2), optimized for both sharpness of contours as well as reduction of false edge coloring.

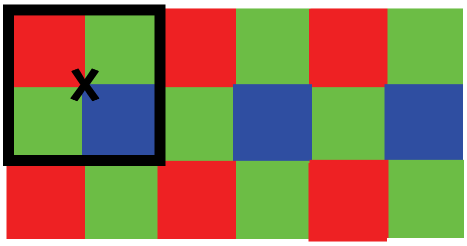


Figure 94: BAYER demosaicing (example of 2x2 matrix)

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

RAW mode is primarily used to

- save bandwidths on the IEEE 1394 bus
- achieve higher frame rates
- use different BAYER demosaicing algorithms on the PC (for all Stingray models the first pixel of the sensor is RED).

Note

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

In color interpolation a red, green or blue value is determined for each pixel. Only two lines are needed for this interpolation:

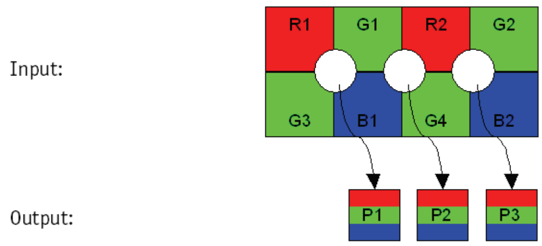


Figure 95: BAYER demosaicing (interpolation)

$$P1_{red} = R1 \qquad P2_{red} = R2 \qquad P3_{red} = R2$$

$$P1_{green} = \frac{G1 + G3}{2} \qquad P2_{green} = \frac{G1 + G4}{2} \qquad P3_{green} = \frac{G2 + G4}{2}$$

$$P1_{blue} = B1 \qquad P2_{blue} = B1 \qquad P3_{blue} = B2$$

Formula 4: BAYER demosaicing

Note

Please note that on the color camera, a wrongly colored border of one or two pixel wide forms on the left and right image borders. This is also a consequence of BAYER demosaicing as the image width displayed on the color camera is not scaled down.

Sharpness

The Stingray color models are equipped with a four-step sharpness control, applying a discreet horizontal high pass in the Y channel as shown in the next five line profiles.

Sharpness 0, 1, 2, 3, 4 is calculated with the following scheme:

Sharpness value				Description
0	+0.25	+0.5	+0.25	Least sharp
1	+0.125	+0.75	+0.125	Less sharp
2	0	1	0	Default: no sharpness applied in either direction
3	-0.25	+1.5	-0.25	Some sharp
4	-0.5	2	-0.5	Most sharp

Table 57: Sharpness scheme

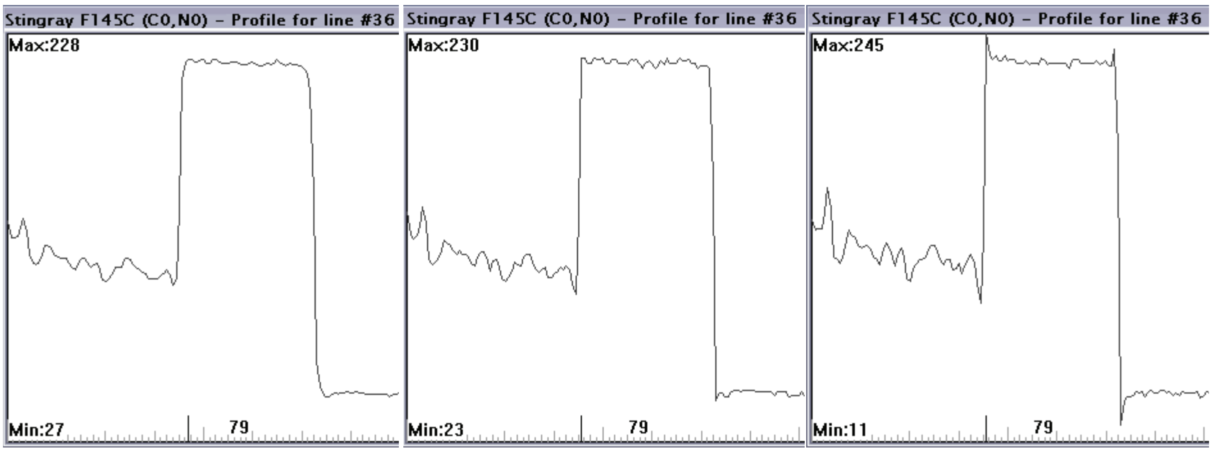


Figure 96: Sharpness: left: 2, middle: 3, right: 4

Note

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

Note

Configuration

To configure this feature in feature control register: See *Table 124: Feature control register* **on page 290.**

Hue and saturation

Stingray CCD color models are equipped with **hue** and **saturation** registers.

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

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

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

Note

Configuration

To configure this feature in feature control register: See *Table 124: Feature control register* **on page 290.**

Note

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

Color correction

Why color correction?

The spectral response of a CCD is different of those of an output device or the human eye. This is the reason for the fact that perfect color reproduction is not possible. In each Stingray camera there is a factory setting for the color correction coefficients, see Chapter *GretagMacbeth ColorChecker* on page 181.

Color correction is needed to eliminate the overlap in the color channels. This overlap is caused by the fact that:

- Blue light: is seen by the red and green pixels on the CCD
- Red light: is seen by the blue and green pixels on the CCD
- Green light: is seen by the red and blue pixels on the CCD

The color correction matrix subtracts out this overlap.

Color correction in AVT cameras

In AVT cameras the color correction is realized as an additional step in the process from the sensor data to color output.

Color correction is used to harmonize colors for the human eye.

Stingray cameras have the so-called color correction matrix. This means: you are able to manipulate the color-correction coefficients yourself.

Color correction: formula

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

red* = Crr ¥ red + Cgr ¥ green + Cbr ¥ blue
green* = Crg ¥ red + Cgg ¥ green + Cbg ¥ blue
blue* = Crb ¥ red + Cgb ¥ green + Cbb ¥ blue

Formula 5: Color correction

GretagMacbeth ColorChecker

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

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

Changing color correction coefficients

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

Note

- A number of 1000 equals a color correction coefficient of 1.
- To obtain an identity matrix set values of 1000 for the diagonal elements and 0 for all others. As a result you get colors like in the RAW modes.
- The sums of all rows should be equal to each other. If not, you get tinted images.
- Color correction values range -1000 ... +2000 and are signed 32 bit.
- In order for white balance to work properly ensure that the row sum equals 1000.
- Each row should sum up to 1000. If not, images are less or more colorful.
- The maximum row sum is limited to 2000.

Note

Configuration

To configure the color-correction coefficients in an advanced register: See ***Table 148: Advanced register: Color correction*** **on page 323.**

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

Switch color correction on/off

Color correction can also be switched off in YUV mode:

Note

Configuration

To configure this feature in an advanced register: See ***Table 148: Advanced register: Color correction*** **on page 323.**

Note

Color correction is deactivated in RAW mode.

Color conversion (RGB → YUV)

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

$$\begin{aligned} Y &= 0.3 \times R + 0.59 \times G + 0.11 \times B \\ U &= -0.169 \times R - 0.33 \times G + 0.498 \times B + 128\ (@\ 8\ \text{bit}) \\ V &= 0.498 \times R - 0.420 \times G - 0.082 \times B + 128\ (@\ 8\ \text{bit}) \end{aligned}$$

Formula 6: RGB to YUV conversion

Note

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

Bulk Trigger

See Chapter *Trigger modi* on page 190 and the following pages.

Level Trigger

See Trigger Mode 1 in Chapter *Trigger modi* on page 190.

Serial interface

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

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

Note

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

Base address for the function is: F0F02100h.

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

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

Table 58: Serial input/output control and status register (SIO CSR)

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

Table 58: Serial input/output control and status register (SIO CSR)

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

Table 58: Serial input/output control and status register (SIO CSR)

To read data:

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

To write data:

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

Note

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

Controlling image capture

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

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

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.

Software trigger Stingray cameras know also a trigger initiated by software (status and control register *62Ch* on page 288 or in SmartView by **Trig/IO** tab, **Stop trigger** button).

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

Trigger modi

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

Trigger mode	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 59: Trigger modi

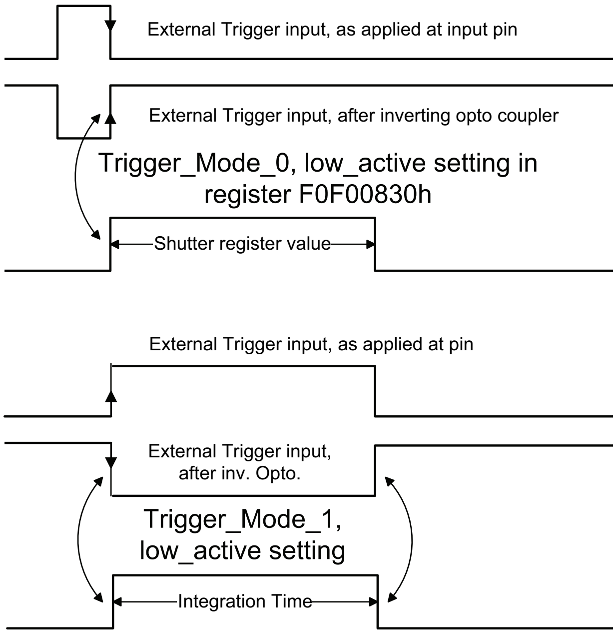


Figure 97: Trigger_Mode_0 and 1

Bulk trigger (Trigger_Mode_15)

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

This is especially useful for:

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

The figure below illustrates this mode.

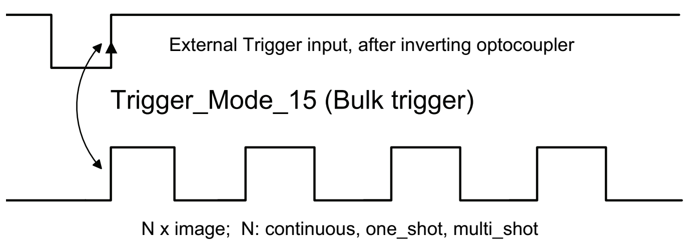


Figure 98: Trigger_Mode_15 (bulk trigger)

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

Register	Name	Field	Bit	Description
0xF0F00830	TRIGGER_MODE	Presence_Inq	[0]	Presence of this feature: 0: N/A 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the **Value** field 1: Control with value in the **Absolute** value CSR If this bit = 1 the value in the **Value** field has to be ignored.
		---	[2..5]	Reserved
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF 1: ON 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 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 60: Trigger_Mode_15 (Bulk trigger)

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

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

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

Table 61: Description: using Trigger_Mode_15: continuous, one-shot, multi-shot

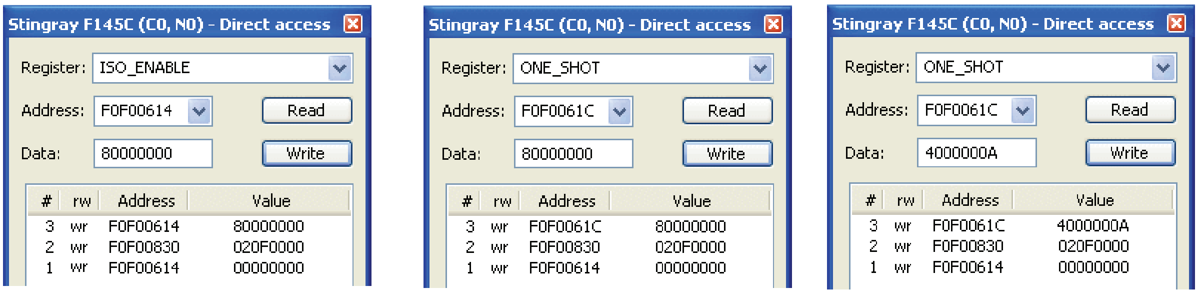


Figure 99: Using Trigger_Mode_15: continuous, one-shot, multi-shot

Note **Shutter for the images is controlled by shutter register.**

Trigger delay

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

With IIDC V1.31 there is a standard CSR at register F0F00534/834h to control a delay up to FFFh x time base value.

The following table explains the Inquiry register and the meaning of the various bits.

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

Table 62: 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 Read: read a status 0: OFF 1: ON If this bit = 0, other fields will be read only.
		---	[7..19]	Reserved
		Value	[20..31]	Value If you write the value in OFF mode, this field will be ignored. If **ReadOut** capability is not available, then the read value will have no meaning.

Table 63: CSR: **trigger delay**

Trigger delay advanced register

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

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

Table 64: Advanced CSR: **trigger delay**

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

Note

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

Software trigger

A software trigger is an external signal that is controlled via a status and control register: *62Ch* on page 288: to activate software trigger set bit [0] to 1.

The behavior is different dependent on the trigger mode used:

- **Edge mode, programmable mode:** trigger is automatically reset (self cleared).
- **Level mode:** trigger is active until software trigger register is reset manually
  ⇨ in advanced register *62Ch* on page 288: set bit [0] to 0
  ⇨ in SmartView: **Trig/IO** tab, **Stop trigger** button

Debounce

Only for input ports:

There is an adjustable debounce time for trigger: separate for each input pin. The debounce time is a waiting period where no new trigger is allowed. This helps you to set exact one trigger.

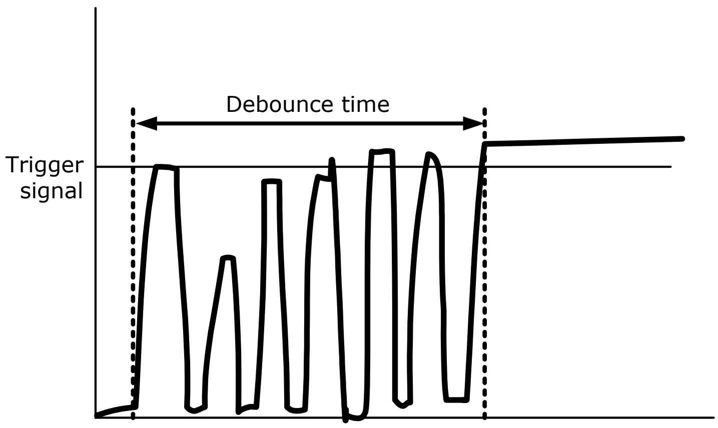


Figure 100: Example of debounce time for trigger

To set this feature in an advanced register: see Chapter *Debounce time* on page 198.

To set this feature in SmartView: **Trig/IO** tab, **Input pins** table, **Debounce** column.

Debounce time

This register controls the debounce feature of the cameras input pins. The debounce time can be set for each available input separately.

Increment is 500 ns

Debounce time is set in Time x 500 ns

Minimum debounce time is 1.5 µs ⇨ 3 x 500 ns

Maximum debounce time is ~16 ms ⇨ $(2^{15}-1)$ x 500 ns

Offset	Name	Field	Bit	Description
0xF1000840	IO_INP_DEBOUNCE_1	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[2..7]	Reserved
		Time	[8..31]	Debounce time in steps of 500 ns (24 bit) see examples above
0xF1000844		MinValue	[0..31]	Minimum debounce time
0xF1000848		MaxValue	[0..31]	Maximum debounce time
0xF100084C		---	[0..31]	Reserved
0xF1000850	IO_INP_DEBOUNCE_2			same as IO_INP_DEBOUNCE_1
0xF1000860	IO_INP_DEBOUNCE_3			same as IO_INP_DEBOUNCE_1
0xF1000870	IO_INP_DEBOUNCE_4			same as IO_INP_DEBOUNCE_1
0xF1000880				Reserved
0xF1000890				Reserved
0xF10008A0				Reserved
0xF10008B0				Reserved

Table 65: Advanced register: **Debounce time for input ports**

Note

- The camera corrects invalid values automatically.
- This feature is not stored in the user settings.

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 time base + offset

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

The shutter register value is multiplied by the time base register value (see *Table 135: Time base ID* on page 307). The default value here is set to 20 µs.

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

Exposure time offset

Camera model	Exposure time offset
Stingray F-033	27 µs
Stingray F-046	27 µs
Stingray F-080	45 µs
Stingray F-125	21 µs
Stingray F-145	70 µs
Stingray F-146	35 µs
Stingray F-201	44 µs
Stingray F-504	38 µs

Table 66: Camera-specific exposure time offset

Minimum exposure time

Camera model	Minimum exposure time	Effective min. exp. time = Min. exp. time + offset
Stingray F-033	4 µs	4 µs + 27 µs = 31 µs
Stingray F-046	4 µs	4 µs + 27 µs = 31 µs
Stingray F-080	4 µs	4 µs + 45 µs = 49 µs
Stingray F-125	4 µs	4 µs + 21 µs = 25 µs
Stingray F-145	4 µs	4 µs + 70 µs = 74 µs
Stingray F-146	4 µs	4 µs + 35 µs = 39 µs

Table 67: Camera-specific minimum exposure time

Camera model	Minimum exposure time	Effective min. exp. time = Min. exp. time + offset
Stingray F-201	4 µs	4 µs + 44 µs = 48 µs
Stingray F-504	4 µs	4 µs + 38 µs = 42 µs

Table 67: Camera-specific minimum exposure time

Example: Stingray F-033

Camera	Register value	Time base (default)
Stingray F-033	100	20 µs

Table 68: Register value and time base for **Stingray F-033**

register value x time base = exposure time

100 x 20 µs + 27 µs = 2027 µs exposure time

The minimum adjustable exposure time set by register is 4 µs. → The real minimum exposure time of **Stingray F-033** is then:
4 µs + 27 µs = 31 µs

Extended shutter

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

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

Table 69: Advanced register: **Extended shutter**

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

The lowest possible value of **ExpTime** is camera-specific (see *Table 67: Camera-specific minimum exposure time* on page 199).

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

Stingray cameras 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 205), 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.

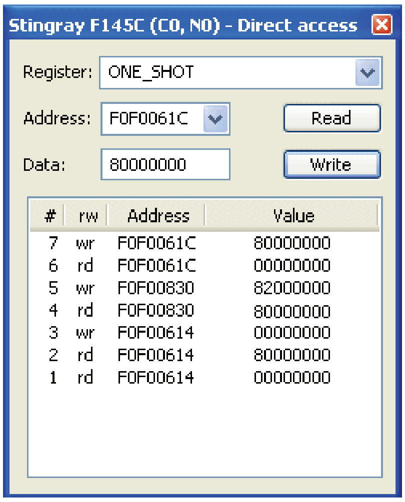


Figure 101: One-shot control (SmartView)

#	Read = rd Write = wr	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 70: 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	≤ 150 µs (processing time in the microcontroller)
µC-Sync/ExSync → integration start	8 µs

Table 71: Values for one-shot

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

End of exposure to first packet on the bus

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

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

710 µs ± 62.5 µs

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

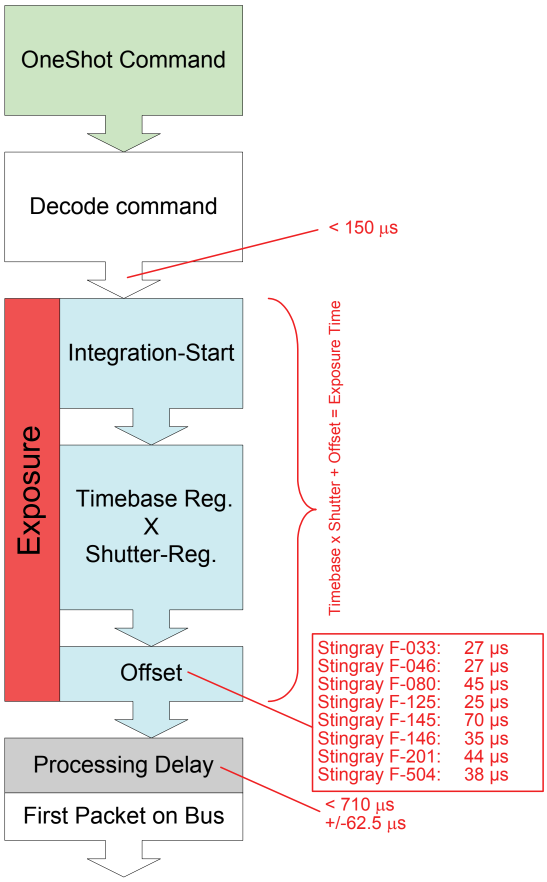


Figure 102: Data flow and timing after end of exposure

Multi-shot

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

The number is indicated in bits 16 to 31. If the camera is put into **ISO_Enable** mode (see Chapter *ISO_Enable / free-run* on page 205), this flag is ignored and deleted automatically once all the images have been recorded.

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

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

ISO_Enable / free-run

Setting the MSB (bit 0) in the 614h register (ISO_ENA) puts the camera into **ISO_Enable mode** or **Continuous_Shot (free-run)**. 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 206.

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

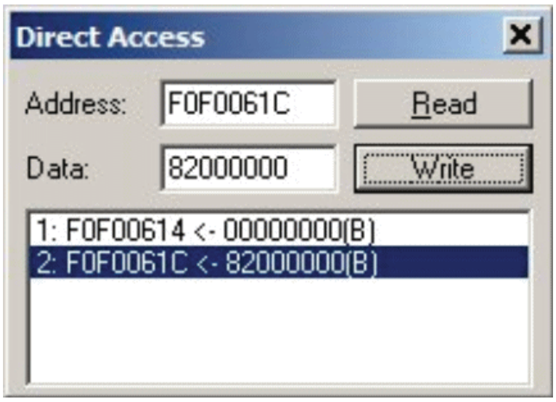


Figure 103: Broadcast one-shot

- 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 Stingray CCD models when either a hardware or software trigger is generated, until the actual image exposure starts.

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

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

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

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

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

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

Model	Exposure start jitter (while FVal)	Exposure start jitter (while camera idle)
Stingray F-033	± 9.75 µs	± 1.30 µs
Stingray F-046	± 11.59 µs	± 1.30 µs
Stingray F-080	± 15.29 µs	± 3.33 µs
Stingray F-125	± 13.50 µs	± 3.10 µs
Stingray F-145	± 23.20 µs	± 5.40 µs
Stingray F-146	± 23.20 µs	± 5.87 µs
Stingray F-201	± 22.61 µs	± 3.56 µs
Stingray F-504	± 20.46 µs	± 5.81 µs

Table 72: Jitter at exposure start (no binning, no sub-sampling)

Note

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

Sequence mode

Generally all AVT Stingray cameras enable certain image settings to be modified on the fly, e.g. gain and shutter can be changed by the host computer by writing into the gain and shutter register even while the camera is running. An uncertainty of up to 3 images remains because normally the host does not know (especially with external trigger) when the next image will arrive.

Sequence mode is a different concept where the camera holds a set of different image parameters for a sequence of images. The parameter set is stored volatile in the camera for each image to be recorded. This sequence of parameter sets is simply called a sequence. The advantage is that the camera can easily synchronize this parameter set with the images so that no uncertainty can occur. All AVT Stingray cameras support 32 different sequence parameters.

Additionally to the sequence mode known from Marlin cameras, the Stingray cameras have:

- Repeat counter per sequence item
- Incrementing list pointer on input status (on/off)
- Pointer reset (software command; on input pin)

Examples

For a sequence of images, each image can be recorded with a different shutter or gain to obtain different brightness effects.

The image area (AOI) of a sequence of images can automatically be modified, thus creating a panning or sequential split screen effect.

The following registers can be modified to affect the individual steps of the sequence. Different configurations can be accessed via e.g a footswitch which is connected to an input.

Mode	this registers can be modified...
All modes	Cur_V_Mode, Cur_V_Format, ISO_Channel, ISO_Speed, Brightness, White_Balance (color cameras only), Shutter, Gain, LUT, TestImage, Image-Mirror, HSNR, Output-Ctrl, ColorCorrection matrix (color cameras only), ISO-Channel, Shading-Ctrl, Sequence-Stepping Mode, SIS_UserValue
Fixed modes only	Cur_V_Frm_Rate
Format_7 only	Image_Position (AOI-Top, AOI-Left), Image_Size (AOI-Width, AOI-Height), Color_Coding_ID*, Binning*, Sub-Sampling*, Byte_Per_Packet *hidden in video formats and video modes

Table 73: Registers to be modified within a sequence

Note

Sequence mode requires special care if changing image size, Color_Coding_ID and frame rate related parameters. This is because these changes not only affect settings in the camera but also require corresponding settings in the receiving software in the PC.

Caution

- Incorrect handling may lead to **image corruption** or **loss of subsequent images**.
- **Please ask for detailed support if you want to use this feature.**

How is sequence mode implemented?

There is a FIFO (first in first out) memory for each of the IIDC V1.31 registers listed above. The depth of each FIFO is fixed to 32(dec) complete sets. Functionality is controlled by the following advanced registers.

Register	Name	Field	Bit	Description
0xF1000220	SEQUENCE_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	Reserved
		AutoRewind	[5]	
		ON_OFF	[6]	Enable/disable this feature
		SetupMode	[7]	Sequence setup mode
		---	[8..15]	Reserved
		MaxLength	[16..23]	Maximum possible length of a sequence (read only)
		SeqLength	[24..31]	Length of the sequence (32 dec for all CCD models)
0xF1000224	SEQUENCE_PARAM	---	[0..4]	Reserved
		ApplyParameters	[5]	Apply settings to selected image of sequence; auto reset
		---	[6..7]	Reserved
		SeqStepMode	[8..15]	Sequence stepping mode
		ImageRepeat	[16..23]	Image repeat counter
		ImageNo	[24..31]	Number of image within a sequence

Table 74: Advanced register: **Sequence mode**

Register	Name	Field	Bit	Description
0xF1000228	SEQUENCE_STEP	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	Reserved
		PerformStep	[5]	Sequence is stepped one item forward
		PerformReset	[6]	Reset the sequence to start position
		---	[7..23]	Reserved
		SeqPosition	[24..31]	Get the current sequence position

Table 74: Advanced register: **Sequence mode**

Enabling this feature turns the camera into a special mode. This mode can be used to set up a bunch of parameter sets for up to **MaxLength** consecutive images.

Note

The sequence mode of the Stingray series behaves slightly different than the sequence mode of e.g. the Marlin series and implements some new controlling features. You may use a sequence with internal or external trigger and with the Deferred Transport feature.

Setup mode

The **SetupMode** flag allows you to set up a sequence while capturing images. Using this flag you get a visual feedback of the settings.

Set **SetupMode** flag when setting up the sequence and reset the flag before using the sequence.

Sequence step mode

The SeqMode field selects the signal source for stepping the sequence one parameter set further.

SeqMode description

Sequence mode	Description
0x80	This mode is the **default sequence mode** and stepping the sequence is compatible to e.g. the Marlin series. With each image integration start the sequence is stepped one item further and the new parameter set becomes active for the next image.
0x82	Stepping of the sequence is controlled by a **rising edge** of an **external signal**. The new parameter set becomes active with the next integration start. When using this mode select the suitable input mode of the input lines.
0x84	Stepping of the sequence is controlled by a **high level** of an **external signal**. The new parameter set becomes active with the next integration start. When using this mode select the suitable input mode of the input lines.
Other mode	Choosing any other mode value, automatically defaults to mode 0x80.

Table 75: Sequence mode description

Note

It is also possible, that a sequence consists of parameter sets with different sequence modes. This can be achieved by using the SeqMode and the ImageNo fields within the Sequence_Param register.

Sequence repeat counter

For each parameter set one can define an image repeat counter. Using the image repeat counter means that a parameter set can be used for n consecutive images before the next parameter set is applied.

Setting the **ImageRepeat** field to 0 has the same effect like setting this field to 1.

Manual stepping & reset

A sequence can be stepped further with a software command. To use manual stepping use stepping mode 0x82 or 0x84, but don't setup any input pin for external sequence stepping.

Every time the **PerformStep** flag is set the sequence will be stepped one parameter set further. Manual stepping observes the repeat counter also.

For some application it could be useful to reset the sequence during runtime. Simply set the **PerformReset** flag to one: the sequence starts over with the very first parameter set.

The following flow diagram shows how to set up a sequence.

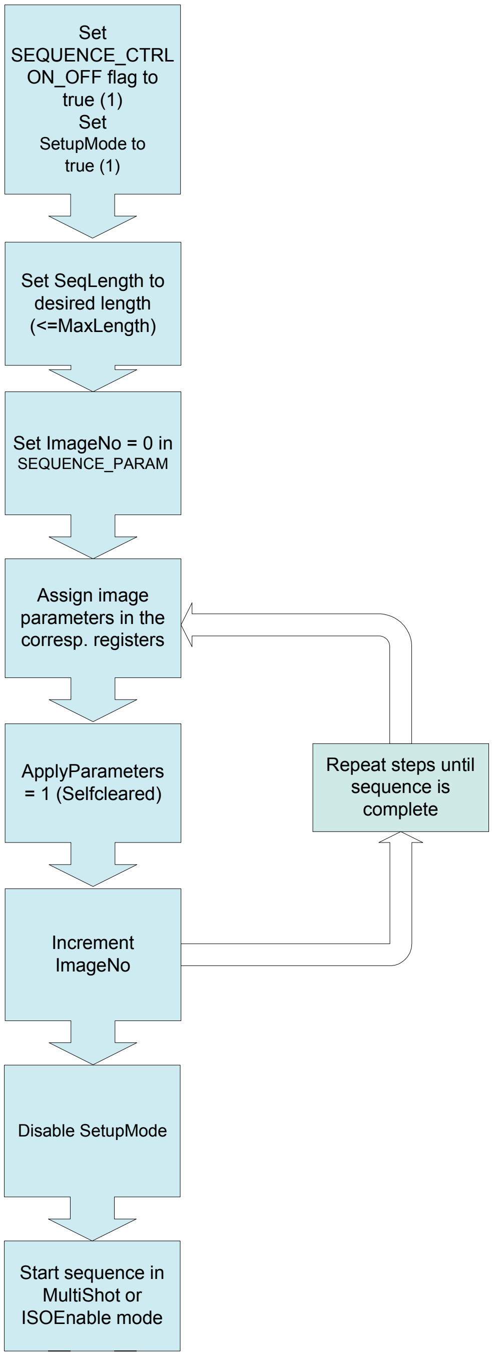


Figure 104: Sequence mode flow diagram

During sequencing, the camera obtains the required parameters, image by image, from the corresponding FIFOs (e.g. information for exposure time).

Which sequence mode features are available?

- Repeat one step of a sequence n times where n can be set by the variable **ImageRepeat** in SEQUENCE_PARAM.
- Define one or two hardware inputs in Input mode field of IO_INP_CTRL as:
  - Sequence step input (if two are set as input, they are AND gated) or
  - Sequence reset input

Note

From now on:

sequence step is I/O controlled sequence stepping mode

sequence reset is I/O controlled sequence pointer reset

Setup mode

The **SetupMode** flag allows you to set up a sequence while capturing images. Using this flag you get a visual feedback of the settings. Set this flag when setting up the sequence and reset the flag before using the sequence.

I/O controlled sequence stepping mode

The I/O controlled sequence stepping mode can be done level controlled or edge controlled:

Level controlled	Edge controlled
• As long as the input is in high state the sequence pointer will be incremented from image to image. • Can be combined with **Quick Format Change Modes**. See Chapter *Standard Parameter Update Timing* on page 166 and Chapter *New: Quick Format Change Mode (QFCM)* on page 166. • Level change is asynchronous to image change.	• A rising edge on the input will cause one pointer increment immediately. • Can be combined with **Quick Format Change Modes**. See Chapter *Standard Parameter Update Timing* on page 166 and Chapter *New: Quick Format Change Mode (QFCM)* on page 166.

Table 76: Description of sequence stepping control

The I/O controlled sequence stepping mode can be set for every single sequence entry. Thus a sequence can be controlled in a very flexible manner.

I/O controlled sequence pointer reset

I/O controlled sequence pointer reset is always edge controlled. A rising edge on the input pin resets the pointer to the first entry.

I/O controlled sequence pointer reset can be combined with **Quick Format Change Modes**. See Chapter *Standard Parameter Update Timing* on page 166 and Chapter *New: Quick Format Change Mode (QFCM)* on page 166.

I/O controlled sequence stepping mode and I/O controlled sequence pointer reset via software command

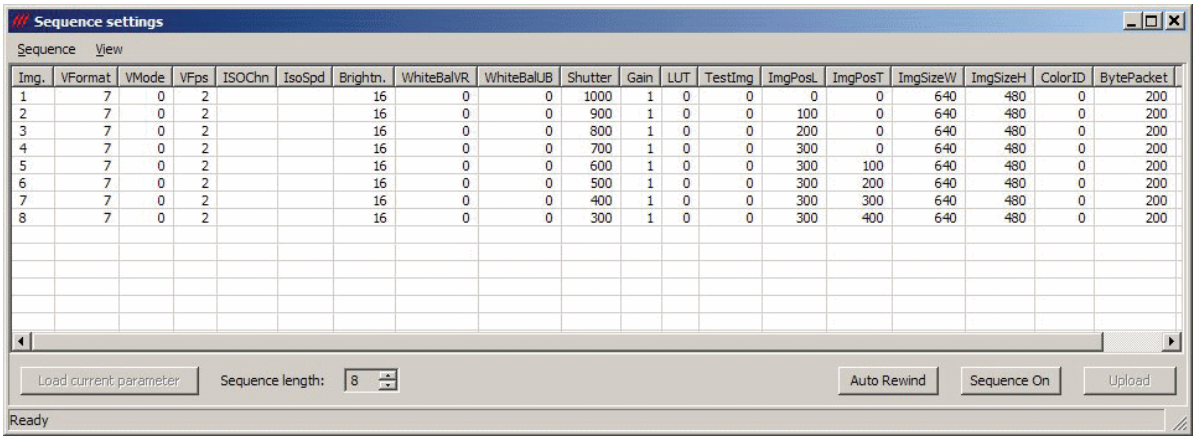
Both sequence modes can be controlled via software command.

Points to pay attention to when working with a sequence

Note

- If more images are recorded than defined in **SeqLength**, the settings for the last image remain in effect.
- If **sequence** mode is cancelled, the camera can use the FIFO for other tasks. For this reason, a sequence must be loaded back into the camera after **sequence** mode has been cancelled.
- To repeat the sequence, stop the camera and send the **multi-shot** or **IsoEnable** command again. Each of these two commands resets the sequence.
- Using **single-shot** mode in combination with a sequence does not make sense, because **single-shot** mode restarts the sequence every time.
- The sequence may not be active when setting the AutoRewind flag. For this reason it is important to set the flag before the **multi-shot** or **IsoEnable** commands.
- If the sequence is used with the **deferred transport** feature, the number of images entered in **Seq_Length** may not be exceeded.

The following screenshot shows an example of a sequence for eight different image settings. It uses the **AVT Firetool program** as graphical representation. Please note the changes in the shutter time; that creates descending image brightness, and the change in the image position; which creates a panning effect.



Sequence settings

Sequence View

Img.	VFormat	VMode	VFps	ISOChn	IsoSpd	Brightn.	WhiteBalVR	WhiteBalUB	Shutter	Gain	LUT	TestImg	ImgPosL	ImgPosT	ImgSizeW	ImgSizeH	ColorID	BytePacket
1	7	0	2			16	0	0	1000	1	0	0	0	0	640	480	0	200
2	7	0	2			16	0	0	900	1	0	0	100	0	640	480	0	200
3	7	0	2			16	0	0	800	1	0	0	200	0	640	480	0	200
4	7	0	2			16	0	0	700	1	0	0	300	0	640	480	0	200
5	7	0	2			16	0	0	600	1	0	0	300	100	640	480	0	200
6	7	0	2			16	0	0	500	1	0	0	300	200	640	480	0	200
7	7	0	2			16	0	0	400	1	0	0	300	300	640	480	0	200
8	7	0	2			16	0	0	300	1	0	0	300	400	640	480	0	200

Load current parameter Sequence length: 8 Auto Rewind Sequence On Upload

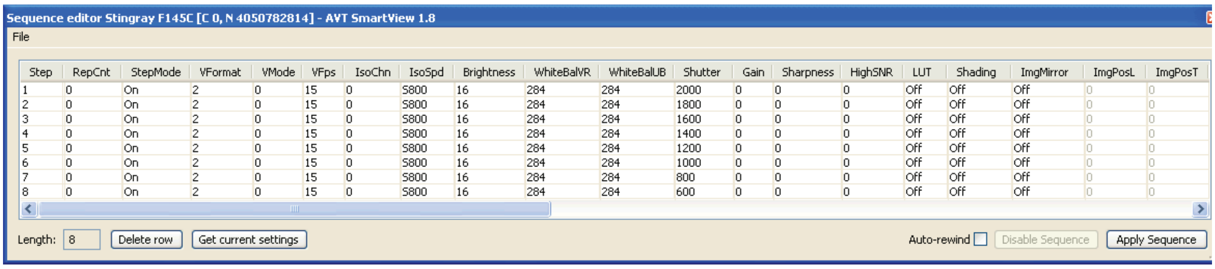
Ready

Figure 105: Example of sequence mode settings with AVT Firetool

Instead of **Firetool** you also can use **SmartView** (Version 1.8.0 or greater), but image and transfer formats have to be unchanged (height, width, ColorID).

To open the **Sequence editor** in SmartView:

1. Click **Extras → Sequence dialog**

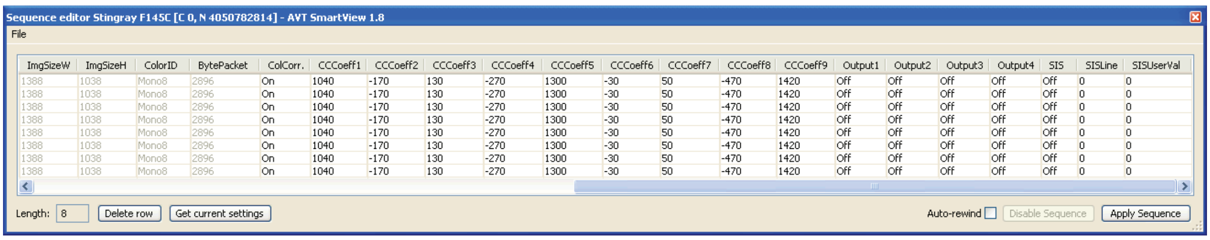


Sequence editor Stingray F145C [C 0, N 4050782814] - AVT SmartView 1.8

File

Step	RepCnt	StepMode	VFormat	VMode	VFps	IsoChn	IsoSpd	Brightness	WhiteBalVR	WhiteBalUB	Shutter	Gain	Sharpness	HighSNR	LUT	Shading	ImgMirror	ImgPosL	ImgPosT
1	0	On	2	0	15	0	5800	16	284	284	2000	0	0	0	Off	Off	Off	0	0
2	0	On	2	0	15	0	5800	16	284	284	1800	0	0	0	Off	Off	Off	0	0
3	0	On	2	0	15	0	5800	16	284	284	1600	0	0	0	Off	Off	Off	0	0
4	0	On	2	0	15	0	5800	16	284	284	1400	0	0	0	Off	Off	Off	0	0
5	0	On	2	0	15	0	5800	16	284	284	1200	0	0	0	Off	Off	Off	0	0
6	0	On	2	0	15	0	5800	16	284	284	1000	0	0	0	Off	Off	Off	0	0
7	0	On	2	0	15	0	5800	16	284	284	800	0	0	0	Off	Off	Off	0	0
8	0	On	2	0	15	0	5800	16	284	284	600	0	0	0	Off	Off	Off	0	0

Length: 8 Delete row Get current settings Auto-rewind Disable Sequence Apply Sequence



Sequence editor Stingray F145C [C 0, N 4050782814] - AVT SmartView 1.8

File

ImgSizeW	ImgSizeH	ColorID	BytePacket	ColCorr.	CCCoeff1	CCCoeff2	CCCoeff3	CCCoeff4	CCCoeff5	CCCoeff6	CCCoeff7	CCCoeff8	CCCoeff9	Output1	Output2	Output3	Output4	SIS	SISLine	SISUserVal
1388	1038	Mono8	2896	On	1040	-170	130	-270	1300	-30	50	-470	1420	Off	Off	Off	Off	Off	0	0
1388	1038	Mono8	2896	On	1040	-170	130	-270	1300	-30	50	-470	1420	Off	Off	Off	Off	Off	0	0
1388	1038	Mono8	2896	On	1040	-170	130	-270	1300	-30	50	-470	1420	Off	Off	Off	Off	Off	0	0
1388	1038	Mono8	2896	On	1040	-170	130	-270	1300	-30	50	-470	1420	Off	Off	Off	Off	Off	0	0
1388	1038	Mono8	2896	On	1040	-170	130	-270	1300	-30	50	-470	1420	Off	Off	Off	Off	Off	0	0
1388	1038	Mono8	2896	On	1040	-170	130	-270	1300	-30	50	-470	1420	Off	Off	Off	Off	Off	0	0
1388	1038	Mono8	2896	On	1040	-170	130	-270	1300	-30	50	-470	1420	Off	Off	Off	Off	Off	0	0
1388	1038	Mono8	2896	On	1040	-170	130	-270	1300	-30	50	-470	1420	Off	Off	Off	Off	Off	0	0

Length: 8 Delete row Get current settings Auto-rewind Disable Sequence Apply Sequence

Figure 106: SmartView: **Extras → Sequence dialog**

Changing the parameters within a sequence

To change the parameter set for one image, it is not necessary to modify the settings for the entire sequence. The image can simply be selected via the **ImageNo** field and it is then possible to change the corresponding IIDC V1.31 registers.

Points to pay attention to when changing the parameters

Note

- If the **ApplyParameters** flag is used when setting the parameters, all not-configured values are set to default values. As changing a sequence normally affects only the value of a specific register, and all other registers should not be changed, the **ApplyParameters** flag may not be used here.
- The values stored for individual images can no longer be read.
- If the camera is switched into **sequence mode**, the changes to the IIDC V1.31 registers for the image specified in **ImageNo** take immediate effect.
- Sequence mode requires special care if changing image size and frame rate related parameters. This is because these changes not only affect settings in the camera but also require corresponding settings in the receiving software in the PC (e.g. FirePackage).

Caution

- Incorrect handling may lead to **image corruption** or **loss of subsequent images**.
- **Please ask for detailed support if you want to use this feature.**

Secure image signature (SIS): definition and scenarios

Note

For all customers who know SIS from Marlin cameras:

- Stingray cameras have **additional SIS features**: AOI, exposure/gain, input/output state, index of sequence mode and serial number.
- Read carefully the following chapter.

SIS: Definition

Secure image signature (SIS) is the synonym for data, which is inserted into an image to improve or check image integrity.

All Stingray models can insert

- Cycle time (1394 bus cycle time at the beginning of integration)
- Trigger counter (external trigger seen only)
- Frame counter (frames read out of the sensor)
- AOI (x, y, width, height)
- Exposure (shutter) and gain
- Input and output state on exposure start
- Index of sequence mode
- Serial number
- User value

into a selectable line position within the image. Furthermore the trigger counter and the frame counter are available as advanced registers to be read out directly.

SIS: Scenarios

The following scenarios benefit from this feature:

- Assuming camera runs in **continuous mode**, the check of monotonically changing bus cycle time is a simple test that no image was skipped or lost in the camera or subsequently in the image processing chain.
- In (synchronized) **multi-camera applications**, SIS can be used to identify those images, shot at the same moment in time.
- The cross-check of the frame counter of the camera against the frame counter of the host system also identifies any **skipped or lost images** during transmission.
- The cross-check of the trigger counter against the frame counter in the camera can identify a **trigger overrun** in the camera.
- AOI can be inserted in the image if it was set as a variable e.g. in a sequence.
- Exposure/gain scenario parameters can be inserted in the image if set as a variable in e.g. sequence mode to identify the imaging conditions.
- Inserting input and output state on exposure start can be helpful when working with input and output signals.
- Index of sequence mode is inserted automatically if SIS is used together with sequence mode.
- Serial number inserted in the image helps to document/identify the camera in e.g. multi-camera applications.

Note

- **FirePackage** offers additional and independent checks to be performed for the purpose of image integrity. Details can be found in the respective documentation.

Note

More information:

The handling of the SIS feature is fully described in the Chapter ***Secure image signature (SIS)*** **on page 334.**

Video formats, modes and bandwidth

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

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

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

Note

- The maximum frame rates can only be achieved with shutter settings lower than 1/framerate. This means that with default shutter time of 40 ms, a camera will not achieve frame rates higher than 25 frames/s. In order to achieve higher frame rates, please reduce the shutter time proportionally.
- **The following tables assume that bus speed is 800 Mbit/s.** With lower bus speeds (e.g. 400, 200 or 100 Mbit/s) not all frame rates may be achieved.
- For information on bit/pixel and byte/pixel for each color mode see *Table 105: ByteDepth* on page 259.

Note

The following Format_7 tables show default Format_7 modes without Format_7 mode mapping.

For information on Format_7 mode mapping ...

- ... see Chapter *Mapping of possible Format_7 modes to F7M1...F7M7* on page 164
- ... see Chapter *Format_7 mode mapping* on page 332

Note

H-binning means horizontal binning.

V-binning means vertical binning.

Full binning (H+V) 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.

Stingray F-033B / Stingray F-033C and board level F-033B BL / F-033C BL

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

Table 77: Video fixed formats Stingray F-033B / F-033C

*: Color camera outputs Mono8 interpolated image.

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

Note

The following table shows default Format_7 modes without Format_7 mode mapping.

For information on Format_7 mode mapping ...

- ... see Chapter *Mapping of possible Format_7 modes to F7M1...F7M7* on page 164
- ... see Chapter *Format_7 mode mapping* on page 332

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes
7	0	656 x 492	Mono8 Mono12 Mono16	84 fps 84 fps 84 fps
		656 x 492	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8 Raw12	84 fps 84 fps 84 fps 67 fps 84 fps
	1	328 x 492	Mono8 Mono12 Mono16	84 fps 2x H-binning 84 fps 2x H-binning 84 fps 2x H-binning
	2	656 x 246	Mono8 Mono12 Mono16	149 fps 2x V-binning 149 fps 2x V-binning 149 fps 2x V-binning
	3	328 x 246	Mono8 Mono12 Mono16	149 fps 2x H+V binning 149 fps 2x H+V binning 149 fps 2x H+V binning
	4	328 x 492	Mono8 Mono12 Mono16	84 fps 2 out of 4 H-sub-sampling 84 fps 2 out of 4 H-sub-sampling 84 fps 2 out of 4 H-sub-sampling
		328 x 492	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8 Raw12	84 fps 2 out of 4 H-sub-sampling 84 fps 2 out of 4 H-sub-sampling 84 fps 2 out of 4 H-sub-sampling 84 fps 2 out of 4 H-sub-sampling 84 fps 2 out of 4 H-sub-sampling
	5	656 x 246	Mono8 Mono12 Mono16	108 fps 2 out of 4 V-sub-sampling 108 fps 2 out of 4 V-sub-sampling 108 fps 2 out of 4 V-sub-sampling
		656 x 246	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8 Raw12	108 fps 2 out of 4 V-sub-sampling 108 fps 2 out of 4 V-sub-sampling 108 fps 2 out of 4 V-sub-sampling 108 fps 2 out of 4 V-sub-sampling 108 fps 2 out of 4 V-sub-sampling
	6	328 x 246	Mono8 Mono12 Mono16	108 fps 2 out of 4 H+V sub-sampling 108 fps 2 out of 4 H+V sub-sampling 108 fps 2 out of 4 H+V sub-sampling
		328 x 246	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8 Raw12	108 fps 2 out of 4 H+V sub-sampling 108 fps 2 out of 4 H+V sub-sampling 108 fps 2 out of 4 H+V sub-sampling 108 fps 2 out of 4 H+V sub-sampling 108 fps 2 out of 4 H+V sub-sampling

Table 78: Video Format_7 default modes Stingray F-033B / Stingray F-033C

Stingray F-046B / Stingray F-046C and board level F-046B BL / F-046C BL

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

Table 79: Video fixed formats Stingray F-046B / F-046C

*: Color camera outputs Mono8 interpolated image.

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

Note

The following table shows default Format_7 modes without Format_7 mode mapping.

For information on Format_7 mode mapping ...

- ... see Chapter *Mapping of possible Format_7 modes to F7M1...F7M7* on page 164
- ... see Chapter *Format_7 mode mapping* on page 332

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes	
7	0	780 x 580	Mono8 Mono12 Mono16	61 fps 61 fps 61 fps	
		780 x 580	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8 Raw12	61 fps 61 fps 61 fps 48 fps 61 fps	
	1	388 x 580	Mono8 Mono12 Mono16	61 fps 61 fps 61 fps	2x H-binning 2x H-binning 2x H-binning
	2	780 x 290	Mono8 Mono12 Mono16	111 fps 111 fps 111 fps	2x V-binning 2x V-binning 2x V-binning
	3	388 x 290	Mono8 Mono12 Mono16	111 fps 111 fps 111 fps	2x H+V binning 2x H+V binning 2x H+V binning
	4	388 x 580	Mono8 Mono12 Mono16	61 fps 61 fps 61 fps	2 out of 4 H-sub-sampling 2 out of 4 H-sub-sampling 2 out of 4 H-sub-sampling
		388 x 580	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8 Raw12	61 fps 61 fps 61 fps 61 fps 61 fps	2 out of 4 H-sub-sampling 2 out of 4 H-sub-sampling 2 out of 4 H-sub-sampling 2 out of 4 H-sub-sampling 2 out of 4 H-sub-sampling
	5	780 x 290	Mono8 Mono12 Mono16	79 fps 79 fps 79 fps	2 out of 4 V-sub-sampling 2 out of 4 V-sub-sampling 2 out of 4 V-sub-sampling
		780 x 290	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8 Raw12	79 fps 79 fps 79 fps 79 fps 79 fps	2 out of 4 V-sub-sampling 2 out of 4 V-sub-sampling 2 out of 4 V-sub-sampling 2 out of 4 V-sub-sampling 2 out of 4 V-sub-sampling
	6	388 x 290	Mono8 Mono12 Mono16	79 fps 79 fps 79 fps	2 out of 4 H+V sub-sampling 2 out of 4 H+V sub-sampling 2 out of 4 H+V sub-sampling
		388 x 290	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8 Raw12	79 fps 79 fps 79 fps 79 fps 79 fps	2 out of 4 H+V sub-sampling 2 out of 4 H+V sub-sampling 2 out of 4 H+V sub-sampling 2 out of 4 H+V sub-sampling 2 out of 4 H+V sub-sampling

Table 80: Video Format_7 default modes Stingray F-046B / Stingray F-046C

Stingray F-080B / Stingray F-080C and board level F-080B BL / F-080C BL

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

Table 81: Video fixed formats Stingray F-080B / F-080C

*: Color camera outputs Mono8 interpolated image.

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

Note

The following table shows default Format_7 modes without Format_7 mode mapping.

For information on Format_7 mode mapping ...

- ... see Chapter *Mapping of possible Format_7 modes to F7M1...F7M7* on page 164
- ... see Chapter *Format_7 mode mapping* on page 332

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes	
7	0	1032 x 776	Mono8 Mono12 Mono16	31 fps 31 fps 31 fps	
		1032 x 776	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8 Raw12	31 fps 31 fps 31 fps 27 fps 31 fps	
	1	516 x 776	Mono8 Mono12 Mono16	31 fps 31 fps 31 fps	2x H-binning 2x H-binning 2x H-binning
	2	1032 x 388	Mono8 Mono12 Mono16	53 fps 53 fps 53 fps	2x V-binning 2x V-binning 2x V-binning
	3	516 x 388	Mono8 Mono12 Mono16	53 fps 53 fps 53 fps	2x H+V binning 2x H+V binning 2x H+V binning
	4	516 x 776	Mono8 Mono12 Mono16	31 fps 31 fps 31 fps	2 out of 4 H-sub-sampling 2 out of 4 H-sub-sampling 2 out of 4 H-sub-sampling
		516 x 776	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8 Raw12	31 fps 31 fps 31 fps 31 fps 31 fps	2 out of 4 H-sub-sampling 2 out of 4 H-sub-sampling 2 out of 4 H-sub-sampling 2 out of 4 H-sub-sampling 2 out of 4 H-sub-sampling
	5	1032 x 388	Mono8 Mono12 Mono16	39 fps 39 fps 39 fps	2 out of 4 V-sub-sampling 2 out of 4 V-sub-sampling 2 out of 4 V-sub-sampling
		1032 x 388	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8 Raw12	39 fps 39 fps 39 fps 39 fps 39 fps	2 out of 4 V-sub-sampling 2 out of 4 V-sub-sampling 2 out of 4 V-sub-sampling 2 out of 4 V-sub-sampling 2 out of 4 V-sub-sampling
	6	516 x 388	Mono8 Mono12 Mono16	39 fps 39 fps 39 fps	2 out of 4 H+V-sub-sampling 2 out of 4 H+V-sub-sampling 2 out of 4 H+V-sub-sampling
		516 x 388	YUV411 YUV422,Raw16 Mono8,Raw8 RGB8 Raw12	39 fps 39 fps 39 fps 39 fps 39 fps	2 out of 4 H+V-sub-sampling 2 out of 4 H+V-sub-sampling 2 out of 4 H+V-sub-sampling 2 out of 4 H+V-sub-sampling 2 out of 4 H+V sub-sampling

Table 82: Video Format_7 default modes Stingray F-080B / F-080C

Stingray F-125B / Stingray F-125C and board level F-125B BL / F-125C BL

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

Table 83: Video fixed formats Stingray F-125B / F-125C

*: Color camera outputs Mono8 interpolated image.

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

Note

The following table shows default Format_7 modes without Format_7 mode mapping.

- see Chapter *Mapping of possible Format_7 modes to F7M1...F7M7* on page 164
- see Chapter *Format_7 mode mapping* on page 332

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes	
7	0	1292 x 964	Mono8	30 fps	
			Mono12	30 fps	
			Mono16	26 fps	
		1292 x 964	YUV411	30 fps	
			YUV422,Raw16	26 fps	
			Mono8,Raw8	30 fps	
			RGB8	17 fps	
			Raw12	30 fps	
	1	644 x 964	Mono8	30 fps	2x H-binning
			Mono12	30 fps	2x H-binning
			Mono16	30 fps	2x H-binning
	2	1292 x 482	Mono8	53 fps	2x V-binning
			Mono12	53 fps	2x V-binning
			Mono16	52 fps	2x V-binning
	3	644 x 482	Mono8	53 fps	2x H+V binning
			Mono12	53 fps	2x H+V binning
			Mono16	53 fps	2x H+V binning
	4	644 x 964	Mono8	30 fps	2 out of 4 H-sub-sampling
			Mono12	30 fps	2 out of 4 H-sub-sampling
			Mono16	30 fps	2 out of 4 H-sub-sampling
		644 x 964	YUV411	30 fps	2 out of 4 H-sub-sampling
			YUV422,Raw16	30 fps	2 out of 4 H-sub-sampling
			Mono8,Raw8	30 fps	2 out of 4 H-sub-sampling
			RGB8	30 fps	2 out of 4 H-sub-sampling
			Raw12	30 fps	2 out of 4 H-sub-sampling
	5#	1292 x 482	Mono8	30 fps	2 out of 4 V-sub-sampling
			Mono12	30 fps	2 out of 4 V-sub-sampling
			Mono16	30 fps	2 out of 4 V-sub-sampling
		1292 x 482	YUV411	30 fps	2 out of 4 V-sub-sampling
			YUV422,Raw16	30 fps	2 out of 4 V-sub-sampling
			Mono8,Raw8	30 fps	2 out of 4 V-sub-sampling
			RGB8	30 fps	2 out of 4 V-sub-sampling
			Raw12	30 fps	2 out of 4 V-sub-sampling
	6#	644 x 964	Mono8	30 fps	2 out of 4 H+V-sub-sampling
			Mono12	30 fps	2 out of 4 H+V-sub-sampling
			Mono16	30 fps	2 out of 4 H+V-sub-sampling
		644 x 482	YUV411	30 fps	2 out of 4 H+V-sub-sampling
			YUV422,Raw16	30 fps	2 out of 4 H+V-sub-sampling
			Mono8,Raw8	30 fps	2 out of 4 H+V-sub-sampling
			RGB8	30 fps	2 out of 4 H+V-sub-sampling
			Raw12	30 fps	2 out of 4 H+V sub-sampling

Table 84: Video Format_7 default modes Stingray F-125B / F-125C

#: Vertical sub-sampling is done via digitally concealing certain lines, so the frame rate is not
frame rate = f (AOI height)
but
frame rate = f (2 x AOI height)

Stingray F-145B / Stingray F-145C and board level F-145B BL / F-145C BL

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

Table 85: Video fixed formats Stingray F-145B / F-145C

*: Color camera outputs Mono8 interpolated image.

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

Note

The following table shows default Format_7 modes without Format_7 mode mapping.

- see Chapter *Mapping of possible Format_7 modes to F7M1...F7M7* on page 164
- see Chapter *Format_7 mode mapping* on page 332

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes	
7	0	1388 x 1038	Mono8	16 fps	
			Mono12	16 fps	
			Mono16	16 fps	
		1388 x 1038	YUV411	16 fps	
			YUV422,Raw16	16 fps	
			Mono8,Raw8	16 fps	
			RGB8	15 fps	
			Raw12	16 fps	
	1	692 x 1038	Mono8	16 fps	2x H-binning
			Mono12	16 fps	2x H-binning
			Mono16	16 fps	2x H-binning
	2	1388 x 518	Mono8	27 fps	2x V-binning
			Mono12	27 fps	2x V-binning
			Mono16	27 fps	2x V-binning
	3	692 x 518	Mono8	27 fps	2x H+V binning
			Mono12	27 fps	2x H+V binning
			Mono16	27 fps	2x H+V binning
	4	692 x 1038	Mono8	16 fps	2 out of 4 H-sub-sampling
			Mono12	16 fps	2 out of 4 H-sub-sampling
			Mono16	16 fps	2 out of 4 H-sub-sampling
		692 x 1038	YUV411	16 fps	2 out of 4 H-sub-sampling
			YUV422,Raw16	16 fps	2 out of 4 H-sub-sampling
			Mono8,Raw8	16 fps	2 out of 4 H-sub-sampling
			RGB8	16 fps	2 out of 4 H-sub-sampling
			Raw12	16 fps	2 out of 4 H-sub-sampling
	5#	1388 x 518	Mono8	16 fps	2 out of 4 V-sub-sampling
			Mono12	16 fps	2 out of 4 V-sub-sampling
			Mono16	16 fps	2 out of 4 V-sub-sampling
		1388 x 518	YUV411	16 fps	2 out of 4 V-sub-sampling
			YUV422,Raw16	16 fps	2 out of 4 V-sub-sampling
			Mono8,Raw8	16 fps	2 out of 4 V-sub-sampling
			RGB8	16 fps	2 out of 4 V-sub-sampling
			Raw12	16 fps	2 out of 4 V-sub-sampling
	6#	692 x 518	Mono8	16 fps	2 out of 4 H+V-sub-sampling
			Mono12	16 fps	2 out of 4 H+V-sub-sampling
			Mono16	16 fps	2 out of 4 H+V-sub-sampling
		692 x 518	YUV411	16 fps	2 out of 4 H+V-sub-sampling
			YUV422,Raw16	16 fps	2 out of 4 H+V-sub-sampling
			Mono8,Raw8	16 fps	2 out of 4 H+V-sub-sampling
			RGB8	16 fps	2 out of 4 H+V-sub-sampling
			Raw12	16 fps	2 out of 4 H+V sub-sampling

Table 86: Video Format_7 default modes Stingray F-145B / F-145C

#: Vertical sub-sampling is done via digitally concealing certain lines, so the frame rate is not
frame rate = f (AOI height)
but
frame rate = f (2 x AOI height)

Stingray F-146B / Stingray F-146C and board level F-146B BL / F-146C BL

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

Table 87: Video fixed formats Stingray F-146B / F-146C

*: Color camera outputs Mono8 interpolated image.

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

Note

The following table shows default Format_7 modes without Format_7 mode mapping.

- see Chapter *Mapping of possible Format_7 modes to F7M1...F7M7* on page 164
- see Chapter *Format_7 mode mapping* on page 332

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes	
7	0	1388 x 1038	Mono8	15 fps	
			Mono12	15 fps	
			Mono16	15 fps	
		1388 x 1038	YUV411	15 fps	
			YUV422,Raw16	15 fps	
			Mono8,Raw8	15 fps	
			RGB8	15 fps	
			Raw12	15 fps	
	1	692 x 1038	Mono8	15 fps	2x H-binning
			Mono12	15 fps	2x H-binning
			Mono16	15 fps	2x H-binning
	2	1388 x 518	Mono8	26 fps	2x V-binning
			Mono12	26 fps	2x V-binning
			Mono16	26 fps	2x V-binning
	3	692 x 518	Mono8	26 fps	2x H+V binning
			Mono12	26 fps	2x H+V binning
			Mono16	26 fps	2x H+V binning
	4	692 x 1038	Mono8	15 fps	2 out of 4 H-sub-sampling
			Mono12	15 fps	2 out of 4 H-sub-sampling
			Mono16	15 fps	2 out of 4 H-sub-sampling
		692 x 1038	YUV411	15 fps	2 out of 4 H-sub-sampling
			YUV422,Raw16	15 fps	2 out of 4 H-sub-sampling
			Mono8,Raw8	15 fps	2 out of 4 H-sub-sampling
			RGB8	15 fps	2 out of 4 H-sub-sampling
			Raw12	15 fps	2 out of 4 H-sub-sampling
	5[#]	1388 x 518	Mono8	15 fps	2 out of 4 V-sub-sampling
			Mono12	15 fps	2 out of 4 V-sub-sampling
			Mono16	15 fps	2 out of 4 V-sub-sampling
		1388 x 518	YUV411	15 fps	2 out of 4 V-sub-sampling
			YUV422,Raw16	15 fps	2 out of 4 V-sub-sampling
			Mono8,Raw8	15 fps	2 out of 4 V-sub-sampling
			RGB8	15 fps	2 out of 4 V-sub-sampling
			Raw12	15 fps	2 out of 4 V-sub-sampling
	6[#]	692 x 518	Mono8	15 fps	2 out of 4 H+V-sub-sampling
			Mono12	15 fps	2 out of 4 H+V-sub-sampling
			Mono16	15 fps	2 out of 4 H+V-sub-sampling
		692 x 518	YUV411	15 fps	2 out of 4 H+V-sub-sampling
			YUV422,Raw16	15 fps	2 out of 4 H+V-sub-sampling
			Mono8,Raw8	15 fps	2 out of 4 H+V-sub-sampling
			RGB8	15 fps	2 out of 4 H+V-sub-sampling
			Raw12	15 fps	2 out of 4 H+V sub-sampling

Table 88: Video Format_7 default modes Stingray F-146B / F-146C

#: Vertical sub-sampling is done via digitally concealing certain lines, so the frame rate is not
frame rate = f (AOI height)
but
frame rate = f (2 x AOI height)

Stingray F-201B / Stingray F-201C and board level F-201B BL / F-201C BL

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

Table 89: Video fixed formats Stingray F-201B / F-201C

*: Color camera outputs Mono8 interpolated image.

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

Note

The following table shows default Format_7 modes without Format_7 mode mapping.

- see Chapter *Mapping of possible Format_7 modes to F7M1...F7M7* on page 164
- see Chapter *Format_7 mode mapping* on page 332

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes
7	0	1624 x 1234	Mono8	14 fps
			Mono12	14 fps
			Mono16	14 fps
		1624 x 1234	YUV411	14 fps
			YUV422,Raw16	14 fps
			Mono8,Raw8	14 fps
			RGB8	10 fps
			Raw12	14 fps
	1	812 x 1234	Mono8	14 fps 2x H-binning
			Mono12	14 fps 2x H-binning
			Mono16	14 fps 2x H-binning
		812 x 1234	YUV411	14 fps 2x H-binning
			YUV422,Raw16	14 fps 2x H-binning
			Mono8,Raw8	14 fps 2x H-binning
			RGB8	14 fps 2x H-binning
			Raw12	14 fps 2x H-binning
	2	1624 x 616	Mono8	26 fps 2x V-binning
			Mono12	26 fps 2x V-binning
			Mono16	26 fps 2x V-binning
		1624 x 614	YUV411	26 fps 2x V-binning
			YUV422,Raw16	26 fps 2x V-binning
			Mono8,Raw8	26 fps 2x V-binning
			RGB8	21 fps 2x V-binning
			Raw12	26 fps 2x V-binning
	3	812 x 616	Mono8	26 fps 2x H+V binning
			Mono12	26 fps 2x H+V binning
			Mono16	26 fps 2x H+V binning
		812 x 614	YUV411	26 fps 2x H+V binning
			YUV422,Raw16	26 fps 2x H+V binning
			Mono8,Raw8	26 fps 2x H+V binning
			RGB8	26 fps 2x H+V binning
			Raw12	26 fps 2x H+V binning
	4	812 x 1234	Mono8	14 fps 2 out of 4 H-sub-sampling
			Mono12	14 fps 2 out of 4 H-sub-sampling
			Mono16	14 fps 2 out of 4 H-sub-sampling
		812 x 1234	YUV411	14 fps 2 out of 4 H-sub-sampling
			YUV422,Raw16	14 fps 2 out of 4 H-sub-sampling
			Mono8,Raw8	14 fps 2 out of 4 H-sub-sampling
			RGB8	14 fps 2 out of 4 H-sub-sampling
			Raw12	14 fps 2 out of 4 H-sub-sampling

Table 90: Video Format_7 default modes Stingray F-201B / F-201C

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes	
7	5#	1624 x 616	Mono8	14 fps	2 out of 4 V-sub-sampling
			Mono12	14 fps	2 out of 4 V-sub-sampling
			Mono16	14 fps	2 out of 4 V-sub-sampling
		1624 x 616	YUV411	14 fps	2 out of 4 V-sub-sampling
			YUV422,Raw16	14 fps	2 out of 4 V-sub-sampling
			Mono8,Raw8	14 fps	2 out of 4 V-sub-sampling
			RGB8	14 fps	2 out of 4 V-sub-sampling
			Raw12	14 fps	2 out of 4 V-sub-sampling
	6#	812 x 616	Mono8	14 fps	2 out of 4 H+V sub-sampling
			Mono12	14 fps	2 out of 4 H+V sub-sampling
			Mono16	14 fps	2 out of 4 H+V sub-sampling
		812 x 616	YUV411	14 fps	2 out of 4 H+V sub-sampling
			YUV422,Raw16	14 fps	2 out of 4 H+V sub-sampling
			Mono8,Raw8	14 fps	2 out of 4 H+V sub-sampling
			RGB8	14 fps	2 out of 4 H+V sub-sampling
			Raw12	14 fps	2 out of 4 H+V sub-sampling

Table 90: Video Format_7 default modes Stingray F-201B / F-201C

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

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

Stingray F-504B / Stingray F-504C and board level F-504B BL / F-504C BL

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

Table 91: Video fixed formats Stingray F-504B / F-504C

*: Color camera outputs Mono8 interpolated image.

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

Note

The following table shows default Format_7 modes without Format_7 mode mapping.

- see Chapter *Mapping of possible Format_7 modes to F7M1...F7M7* on page 164
- see Chapter *Format_7 mode mapping* on page 332

Format	Mode	Resolution	Color mode	Maximal S800 frame rates for Format_7 modes
7	0	2452 x 2056 2452 x 2056	Mono8 Mono12 Mono16 YUV411 YUV422,Raw16 Mono8,Raw8 RGB8 Raw12	9 fps 8 fps 6 fps 8 fps 6 fps 9 fps 4 fps 8 fps
	1	1224 x 2056	Mono8 Mono12 Mono16	9 fps 2x H-binning 9 fps 2x H-binning 9 fps 2x H-binning
	2	2452 x 1028	Mono8 Mono12 Mono16	15 fps 2x V-binning 15 fps 2x V-binning 12 fps 2x V-binning
	3	1224 x 1028	Mono8 Mono12 Mono16	15 fps 2x H+V binning 15 fps 2x H+V binning 15 fps 2x H+V binning
	4	1224 x 2056 1224 x 2056	Mono8 Mono12 Mono16 YUV411 YUV422,Raw16 Mono8,Raw8 RGB8 Raw12	9 fps 2 out of 4 H-sub-sampling 9 fps 2 out of 4 H-sub-sampling 9 fps 2 out of 4 H-sub-sampling 9 fps 2 out of 4 H-sub-sampling 9 fps 2 out of 4 H-sub-sampling 9 fps 2 out of 4 H-sub-sampling 8 fps 2 out of 4 H-sub-sampling 9 fps 2 out of 4 H-sub-sampling
7	5#	2452 x 1028 2452 x 1028	Mono8 Mono12 Mono16 YUV411 YUV422,Raw16 Mono8,Raw8 RGB8 Raw12	9 fps 2 out of 4 V-sub-sampling 9 fps 2 out of 4 V-sub-sampling 9 fps 2 out of 4 V-sub-sampling 9 fps 2 out of 4 V-sub-sampling 9 fps 2 out of 4 V-sub-sampling 9 fps 2 out of 4 V-sub-sampling 8 fps 2 out of 4 V-sub-sampling 9 fps 2 out of 4 V-sub-sampling
	6#	1224 x 1028 1224 x 1028	Mono8 Mono12 Mono16 YUV411 YUV422,Raw16 Mono8,Raw8 RGB8 Raw12	9 fps 2 out of 4 H+V sub-sampling 9 fps 2 out of 4 H+V sub-sampling 9 fps 2 out of 4 H+V sub-sampling 9 fps 2 out of 4 H+V sub-sampling 9 fps 2 out of 4 H+V sub-sampling 9 fps 2 out of 4 H+V sub-sampling 9 fps 2 out of 4 H+V sub-sampling 9 fps 2 out of 4 H+V sub-sampling

Table 92: Video Format_7 default modes Stingray F-504B / F-504C

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

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

Area of interest (AOI)

The camera,Äôs 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

Pay attention to the increments entering in the UNIT_SIZE_INQ and UNIT_POSITION_INQ registers when configuring IMAGE_POSITION and IMAGE_SIZE.

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

Note

For more information see *Table 126: Format_7 control and status register* on page 294.

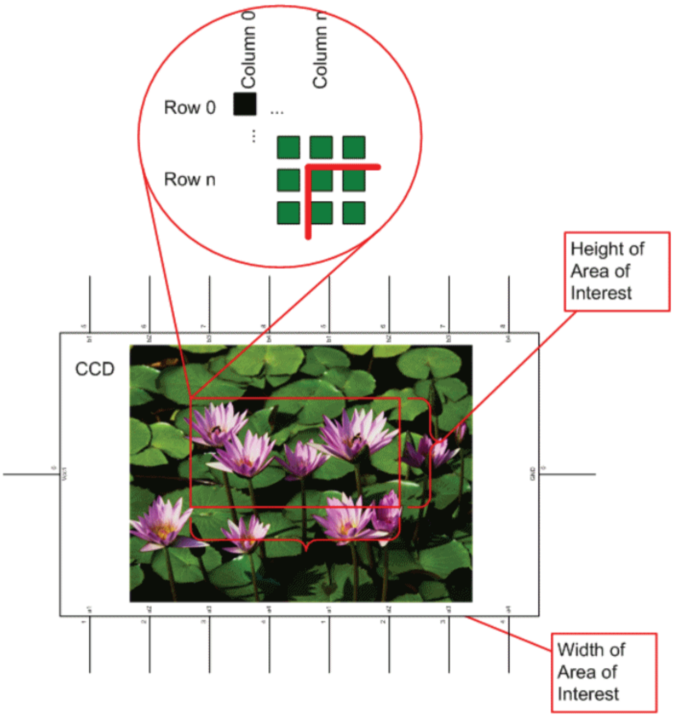


Figure 107: Area of interest (AOI)

Note

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

In addition to the 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,Ñ¢ bus
- The length of the exposure time.

Autofunction AOI

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

- Auto shutter
- Auto gain
- Auto white balance

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

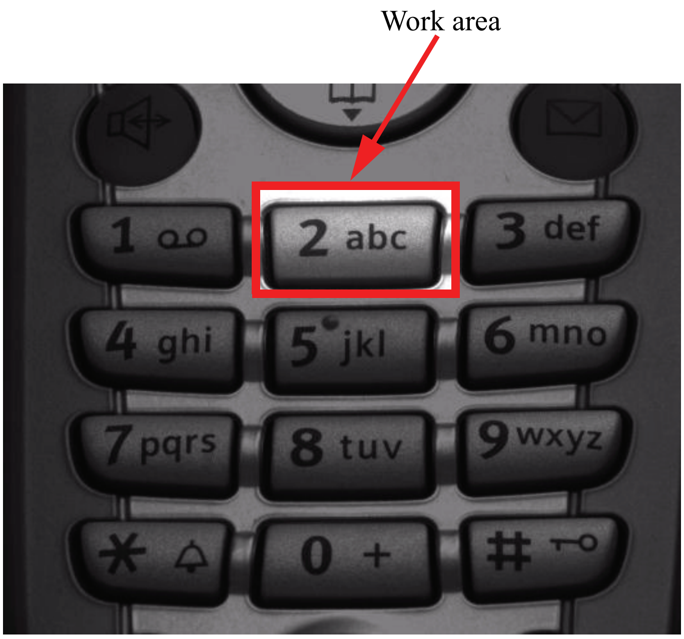


Figure 108: Example of autofunction AOI (*Show work area* is on)

Note

Autofunction AOI is independent from Format_7 AOI settings.

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

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

1. Uncheck **Show AOI** check box (SmartView **Ctrl2** tab).
2. Uncheck **Enable** check box (SmartView **Ctrl2** tab).

Switch off Auto modi (e.g. Shutter and/or Gain) (SmartView Ctrl2 tab).

As a reference it uses a grid of up to 65534 sample points equally spread over the AOI.

Note

Configuration

To configure this feature in an advanced register see Chapter *Autofunction AOI* on page 322.

Frame rates

An IEEE 1394 camera requires bandwidth to transport images.

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

Note

All bandwidth data is calculated with:

1 MByte = 1024 kByte

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

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

The tables are divided into three formats:

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

Table 93: Overview fixed formats

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

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

Table 94: Format_0

As an example, VGA Mono8 @ 60 fps requires four lines (640 x 4 = 2560 pixels/byte) to transmit every 125 µs: this is a consequence of the sensor's line time of about 30 µs, so that no data needs to be stored temporarily.

It takes 120 cycles (120 x 125 µs = 15 ms) to transmit one frame, which arrives every 16.6 ms from the camera. Again no data need to be stored temporarily.

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

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

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

Table 95: Format_1

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

Table 96: Format_2

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

Note

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

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

Frame rates Format_7

In video Format_7 frame rates are no longer fixed.

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.

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, RAW12/YUV411, RAW16/YUV422, RGB8 and max. frame rate of CCD
- Table with max. frame rates as function of AOI by constant width

Stingray F-033/F-033 BL: AOI frame rates

$$\text{max. frame rate of CCD} = \frac{1}{138\mu s + \text{AOI height} \times 23.62\mu s + (509 - \text{AOI height}) \times 2.64\mu s}$$

Formula 7: **Stingray F-033**: theoretical max. frame rate of CCD

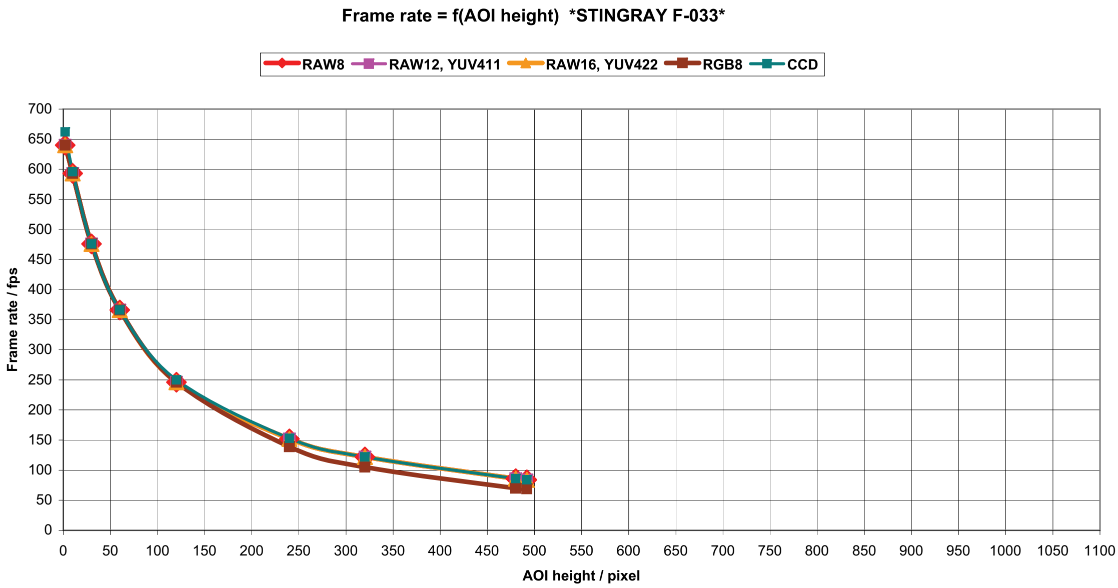


Figure 109: Frame rates **Stingray F-033** as function of AOI height [**width=656**]

AOI height	CCD*	Raw8	Raw12	Raw16	YUV411	YUV422	RGB8
492	84.00	84	84	84	84	84	69/84**
480	86.00	86	86	86	86	86	70/86**
320	122.00	122	122	122	122	122	105/122**
240	153.00	152	152	152	152	152	139/152**
120	250.00	246	246	246	246	246	246
60	366.00	366	366	366	366	366	366
30	476.00	476	476	476	476	476	476
10	596.00	593	593	593	593	593	593
2	662.00	640	640	640	640	640	640

Table 97: Frame rates (fps) of **Stingray F-033** as function of AOI height (pixel) [**width=658**]

* CCD = theoretical max. frame rate (in fps) of CCD according to given formula

**only with max BPP=1100; see Chapter *Maximum ISO packet size* on page 327

Stingray F-046/F-046 BL: AOI frame rates

$$\text{max. frame rate of CCD} = \frac{1}{136.22\mu s + \text{AOI height} \times 27.59\mu s + (597 - \text{AOI height}) \times 2.64\mu s}$$

Formula 8: **Stingray F-046**: theoretical max. frame rate of CCD

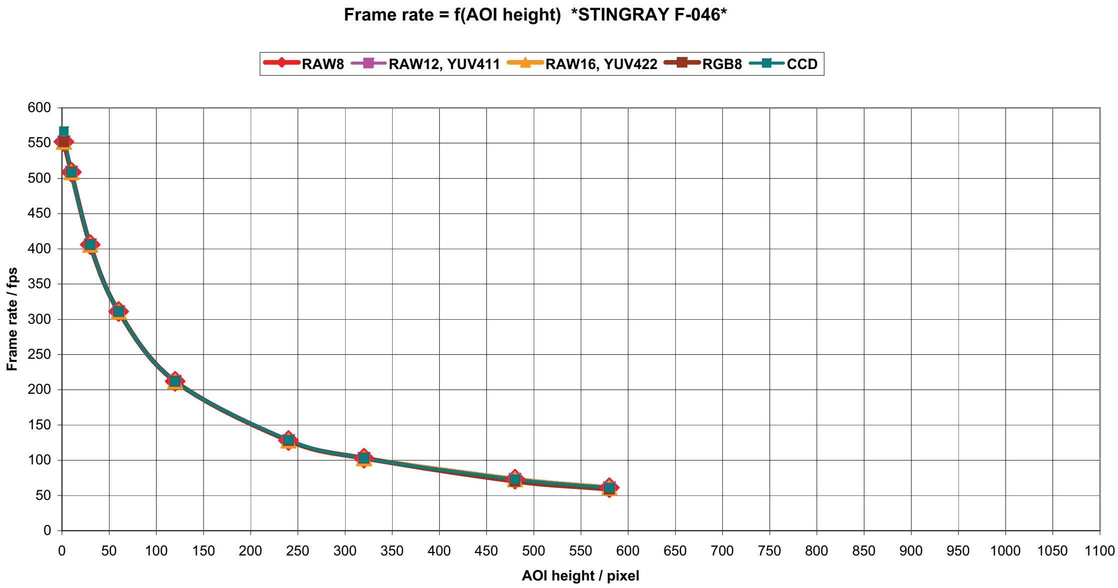


Figure 110: Frame rates **Stingray F-046** as function of AOI height [**width=780**]

AOI height	CCD*	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
580	61.00	61	61	61	61	61	59
480	73.00	73	73	73	73	73	70
320	103.00	103	103	103	103	103	103
240	129.00	128	128	128	128	128	128
120	212.00	212	212	212	212	212	212
60	311.00	311	311	311	311	311	311
30	406.00	406	406	406	406	406	406
10	509.00	509	509	509	509	509	509
2	567.00	552	552	552	552	552	552

Table 98: Frame rates (fps) of **Stingray F-046** as function of AOI height (pixel) [**width=782**]

* CCD = theoretical max. frame rate (in fps) of CCD according to given formula

Stingray F-080/F-080 BL: AOI frame rates

$$\text{max. frame rate of CCD} = \frac{1}{222\mu s + \text{AOI height} \times 40.50\mu s + (778 - \text{AOI height}) \times 7.00\mu s}$$

Formula 9: **Stingray F-080**: theoretical max. frame rate of CCD

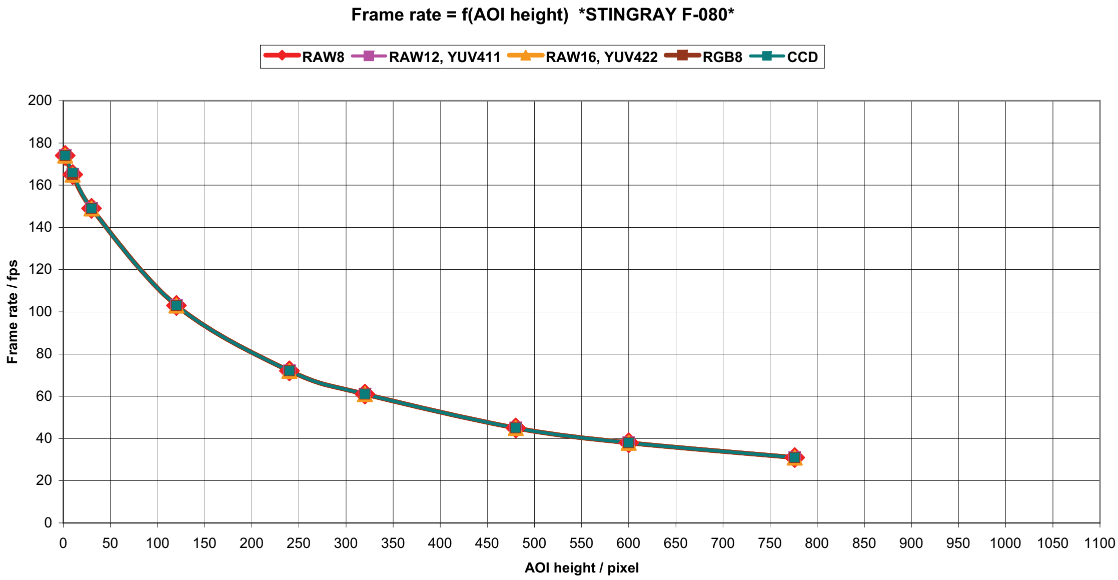


Figure 111: Frame rates **Stingray F-080** as function of AOI height [**width=1032**]

AOI height	CCD*	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
776	31.00	31	31	31	31	31	31
600	38.00	38	38	38	38	38	38
480	45.00	45	45	45	45	45	45
320	61.00	61	61	61	61	61	61
240	72.00	72	72	72	72	72	72
120	103.00	103	103	103	103	103	103
30	149.00	149	149	149	149	149	149
10	166.00	165	165	165	165	165	165
2	174.00	174	174	174	174	174	174

Table 99: Frame rates (fps) of **Stingray F-080** as function of AOI height (pixel) [**width=1034**]

* CCD = theoretical max. frame rate (in fps) of CCD according to given formula

Stingray F-125/F-125 BL: AOI frame rates

$$\text{max. frame rate of CCD} = \frac{1}{189.28\mu s + (977 - \text{AOI height}) \times 5.03\mu s + \text{AOI height} \times 33.19\mu s}$$

Formula 10: **Stingray F-125**: theoretical max. frame rate of CCD

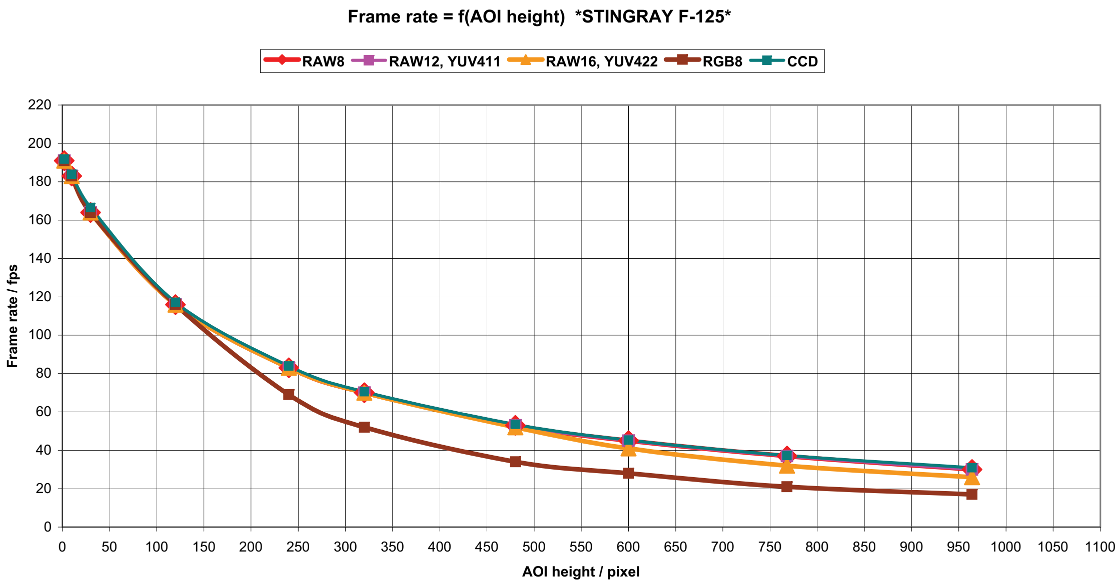


Figure 112: Frame rates **Stingray F-125** as function of AOI height [**width=1292**]

AOI height	CCD*	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
964	30.95	30	30	26	30	26	17
768	37.33	37	37	32	37	32	21
600	45.34	45	45	41	45	41	28
480	53.54	53	53	52	53	52	34
320	70.57	70	70	70	70	70	52
240	83.91	83	83	83	83	83	69
120	117.13	116	116	116	116	116	116
30	166.59	164	164	164	164	164	164
10	183.84	183	183	183	183	183	183
2	191.79	191	191	191	191	191	191

Table 100: Frame rates (fps) **Stingray F-125** as function of AOI height (pixel) [**width=1292**]

* CCD = theoretical max. frame rate (in fps) of CCD according to given formula

Stingray F-145/F-145 BL: AOI frame rates

$$\text{max. frame rate of CCD} = \frac{1}{450.00\mu s + \text{AOI height} \times 59.36\mu s + (1051 - \text{AOI height}) \times 10.92\mu s}$$

Formula 11: **Stingray F-145**: theoretical max. frame rate of CCD

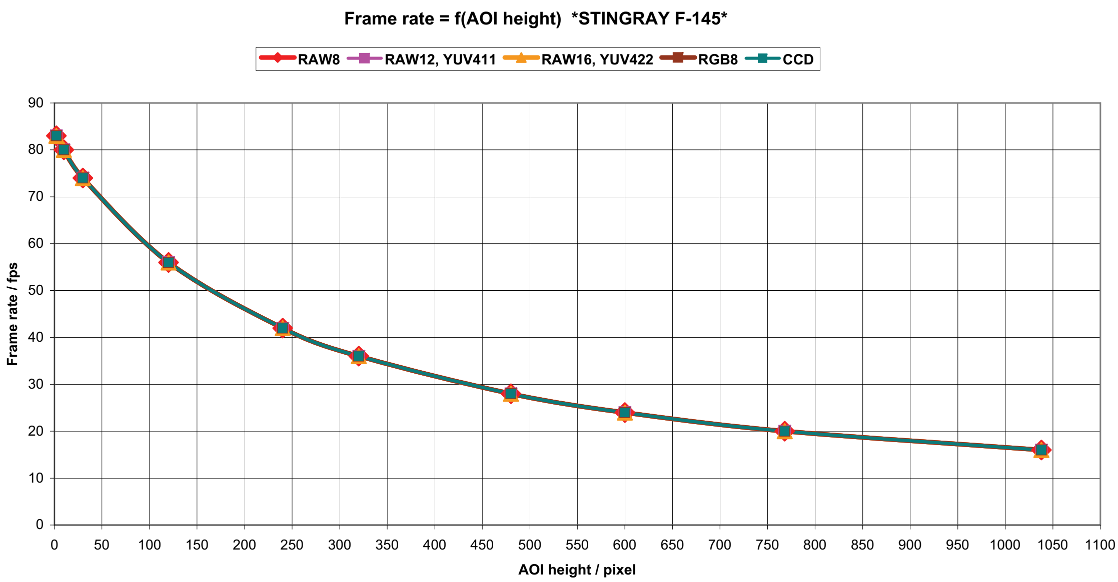


Figure 113: Frame rates **Stingray F-145** as function of AOI height [**width=1388**]

AOI height	CCD*	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
1038	16.00	16	16	16	16	16	16
768	20.00	20	20	20	20	20	20
600	24.00	24	24	24	24	24	24
480	28.00	28	28	28	28	28	28
320	36.00	36	36	36	36	36	36
240	42.00	42	42	42	42	42	42
120	56.00	56	56	56	56	56	56
30	74.00	74	74	74	74	74	74
10	80.00	80	80	80	80	80	80
2	83.00	83	83	83	83	83	83

Table 101: Frame rates (fps) **Stingray F-145** as function of AOI height (pixel) [**width=1392**]

* CCD = theoretical max. frame rate (in fps) of CCD according to given formula

Stingray F-146/F-146 BL: AOI frame rates

$$\text{max. frame rate of CCD} = \frac{1}{337.88\mu s + \text{AOI height} \times 60.25\mu s + (1051 - \text{AOI height}) \times 11.77\mu s}$$

Formula 12: **Stingray F-146**: theoretical max. frame rate of CCD

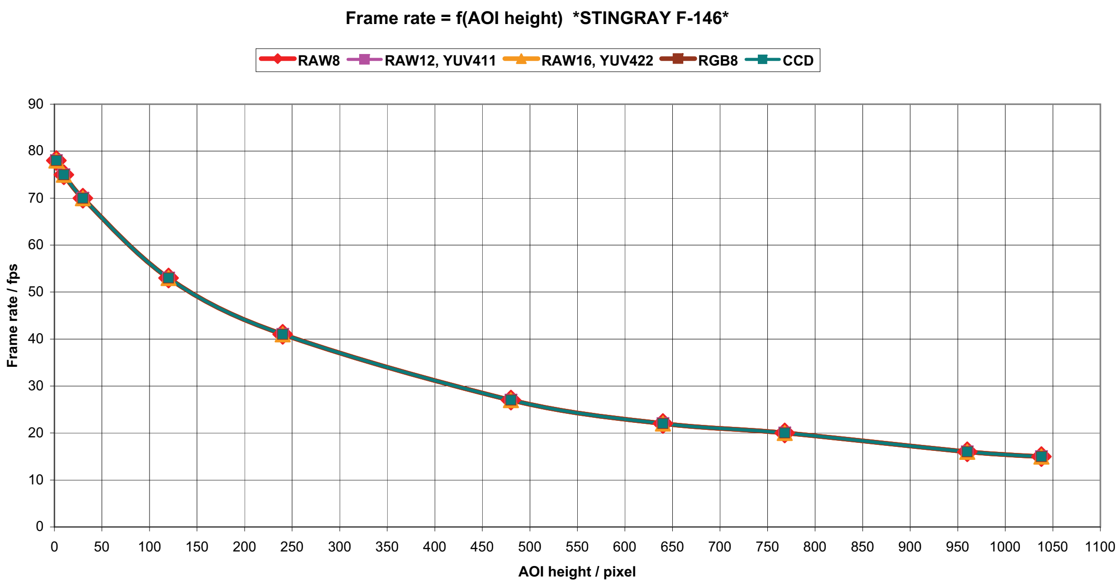


Figure 114: Frame rates **Stingray F-146** as function of AOI height [**width=1388**]

AOI height	CCD*	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
1038	15.00	15	15	15	15	15	15
960	16.00	16	16	16	16	16	16
768	20.00	20	20	20	20	20	20
640	22.00	22	22	22	22	22	22
480	27.00	27	27	27	27	27	27
240	41.00	41	41	41	41	41	41
120	53.00	53	53	53	53	53	53
30	70.00	70	70	70	70	70	70
10	75.00	75	75	75	75	75	75
2	78.00	78	78	78	78	78	78

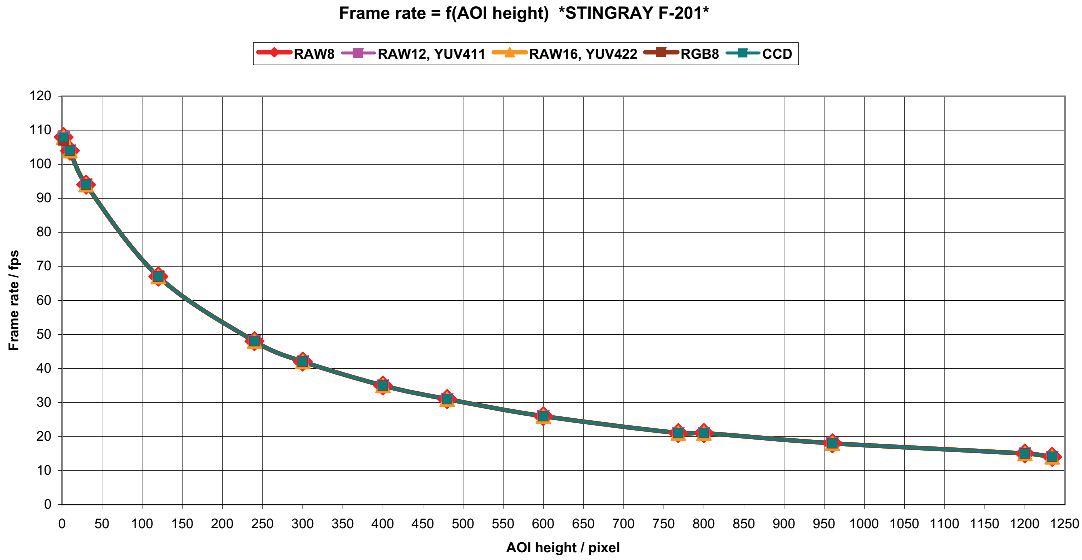
Table 102: Frame rates (fps) of **Stingray F-146** as function of AOI height (pixel) [**width=1392**]

* CCD = theoretical max. frame rate (in fps) of CCD according to given formula

Stingray F-201/F-201 BL: AOI frame rates

$$\text{max. frame rate of CCD} = \frac{1}{290\mu s + \text{AOI height} \times 54.81\mu s + (1238 - \text{AOI height}) \times 7.14\mu s}$$

Formula 13: **Stingray F-201**: theoretical max. frame rate of CCD



Formula 14: Frame rates **Stingray F-201** as function of AOI height [**width=1624**]

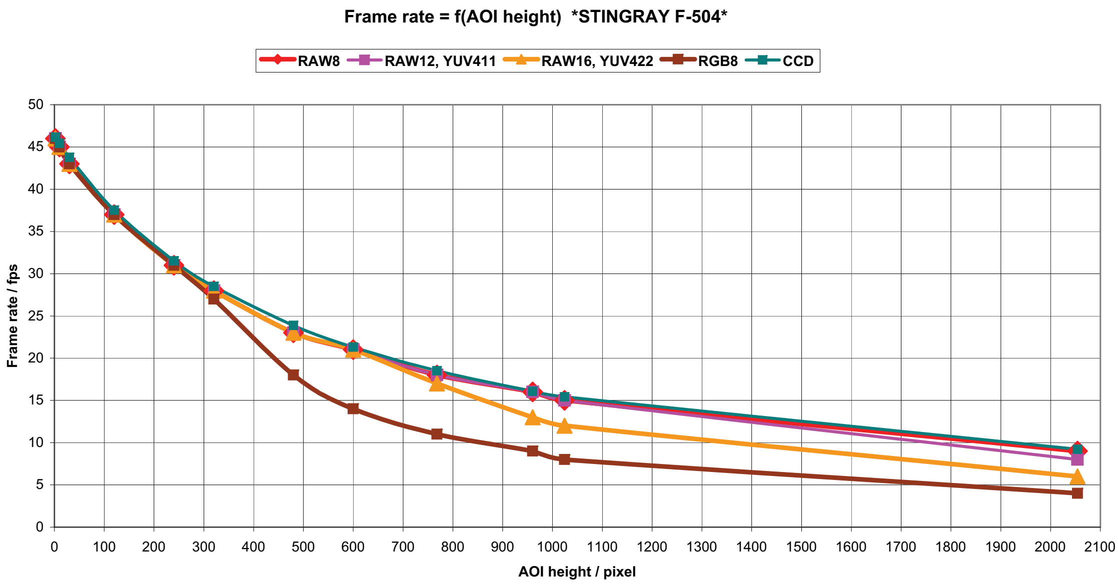
AOI height	CCD*	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
1234	14.00	14	14	14	14	14	14
1200	15.00	15	15	15	15	15	15
960	18.00	18	18	18	18	18	18
800	21.00	21	21	21	21	21	21
768	21.00	21	21	21	21	21	21
600	26.00	26	26	26	26	26	26
480	31.00	31	31	31	31	31	31
400	35.00	35	35	35	35	35	35
300	42.00	42	42	42	42	42	42
240	48.00	48	48	48	48	48	48
120	67.00	67	67	67	67	67	67
30	94.00	94	94	94	94	94	94
10	104.00	104	104	104	104	104	104
2	108.00	108	108	108	108	108	107

Table 103: Frame rates of **Stingray F-201** as function of AOI height [**width=1628**]
* CCD = theoretical max. frame rate (in fps) of CCD according to given formula

Stingray F-504/F-504 BL: AOI frame rates

$$\text{max. frame rate of CCD} = \frac{1}{292.80\mu s + (2069 - \text{AOI height}) \times 10.25\mu s + \text{AOI height} \times 52.53\mu s}$$

Formula 15: **Stingray F-504**: theoretical max. frame rate of CCD



Formula 16: Frame rates **Stingray F-504** as function of AOI height [**width=2452**]

AOI height	CCD*	RAW8	RAW12	RAW16	YUV411	YUV422	RGB8
2054	9.22	9	8	6	8	6	4
1024	15.41	15	15	12	15	12	8
960	16.08	16	16	13	16	13	9
768	18.50	18	18	17	18	17	11
600	21.30	21	21	21	21	21	14
480	23.88	23	23	23	23	23	18
320	28.48	28	28	28	28	28	27
240	31.51	31	31	31	31	31	31
120	37.51	37	37	37	37	37	37
30	43.76	43	43	43	43	43	43
10	45.44	45	45	45	45	45	45
2	46.15	46	46	46	46	46	46

Table 104: Frame rates of **Stingray F-504** as function of AOI height [**width=2452**]

* CCD = theoretical max. frame rate (in fps) of CCD according to given formula

How does bandwidth affect the frame rate?

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

Note

Certain cameras may offer, depending on their settings in combination with the use of AVT FirePackage higher packet sizes.

Consult your local dealer's support team, if you require additional information on this feature.

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

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

Formula 17: Byte_per_Packet calculation (only Format_7)

If the value for **BYTE_PER_PACKET** is greater than 8192 (the maximum data payload), the sought-after frame rate cannot be attained.

The attainable frame rate can be calculated using this formula:

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

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

Formula 18: Maximum frame rate calculation

ByteDepth is based on the following values:

Mode	bit/pixel	byte per pixel
Mono8, Raw8	8	1
Mono12, Raw12	12	1.5
Mono16, Raw16	14	2
Mono16, Raw16 (High SNR mode)	16	2
YUV4:2:2	16	2
YUV4:1:1	12	1.5
RGB8	24	3

Table 105: ByteDepth

Example formula for the b/w camera

Mono16, 1392 x 1040, 30 fps desired

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

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

Formula 19: Example maximum frame rate calculation

Test images

Loading test images

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

Table 106: Loading test images in different viewers

Test images for b/w cameras

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

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

Figure 115: Gray bar test image

Test images for color cameras

The color cameras have 1 test image:

YUV4:2:2 mode

Figure 116: Color test image

Mono8 (raw data)

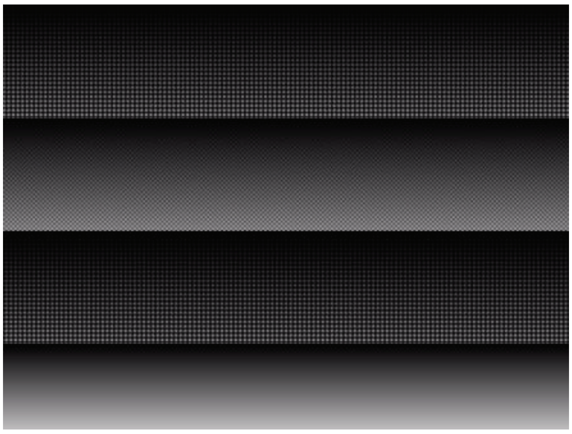


Figure 117: Bayer-coded test image

The color camera outputs Bayer-coded raw data in Mono8 instead of (as described in IIDC V1.31) a real Y signal.

Note

The first pixel of the image is always the red pixel from the sensor. (Mirror must be switched off.)

Configuration of the camera

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

This applies to:

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

Camera_Status_Register

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

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

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

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

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

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 107: 32-bit register

Example

This requires, for example, that to enable **ISO_Enabled mode** (see Chapter *ISO_Enable / free-run* on page 205), (bit 0 in register 614h), the value 80000000 h must be written in the corresponding register.

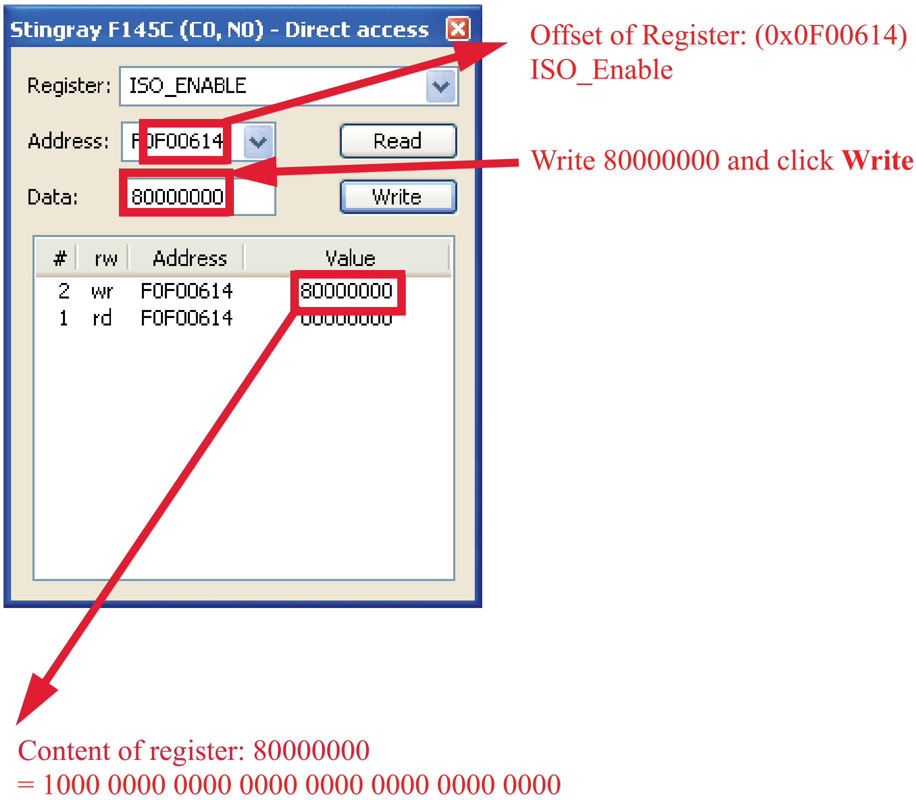


Figure 118: Enabling ISO_Enable

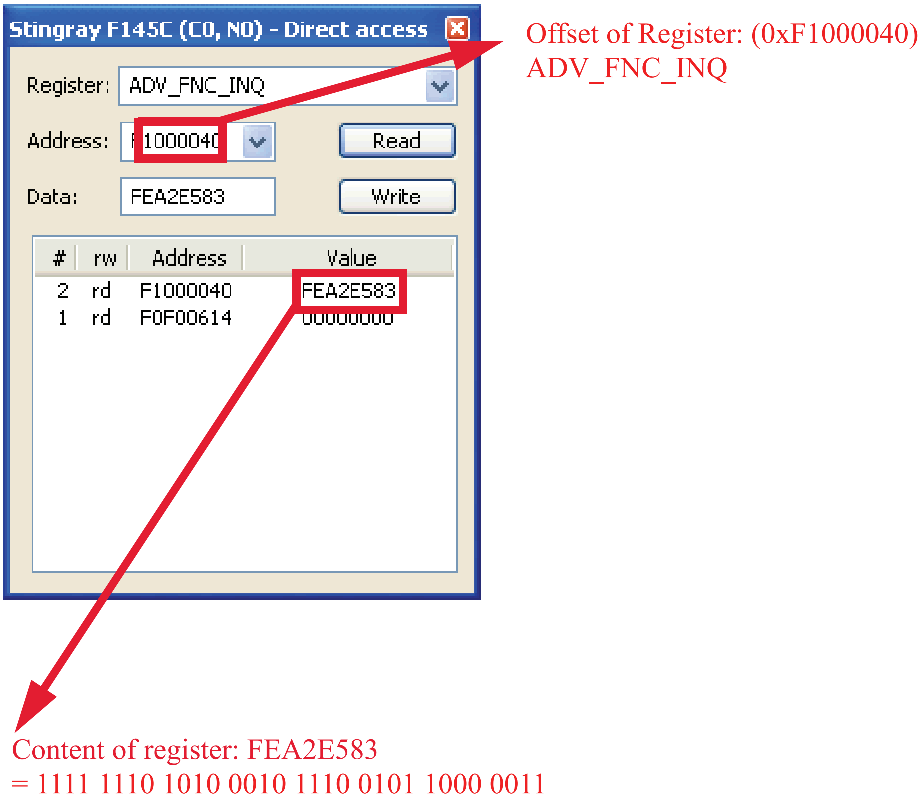


Table 108: Configuring the camera (Stingray F-145C)

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

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

Table 109: Configuring the camera: registers

Sample program

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

Example FireGrab

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

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

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

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

…
```

Example FireStack API

```
…
// Set framerate

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

  // Set mode
  if(Result)

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

  // Set format
  if(Result)

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

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

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


…
```

Configuration ROM

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

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

Note

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

F0F00000h + Offset

The **configuration ROM** is divided into

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

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

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

Table 110: Configuration ROM

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

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

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

Table 111: Computing effective start address

420h + 000002h x 4 = 428h

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

Table 112: Configuration 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 x 4 = 434h

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

Table 113: Configuration ROM

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

440h + 0000xx * 4 = 444h

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

Table 114: Configuration ROM

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

FFFF F0000000h + 3C0000h x 4 = FFFF F0F00000h

The base address of the camera control register is thus:

FFFF F0F00000h

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

Implemented registers (IIDC V1.31)

The following tables show how standard registers from IIDC V1.31 are implemented in the camera:

- Base address is F0F00000h
- Differences and explanations can be found in the **Description** column.

Camera initialize register

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

Table 115: **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 116: **Format** inquiry register

Inquiry register for video mode

Offset	Name	Field	Bit	Description	Color mode
180h	V_MODE_INQ (Format_0)	Mode_0	[0]	160 x 120	YUV 4:4:4
		Mode_1	[1]	320 x 240	YUV 4:2:2
		Mode_2	[2]	640 x 480	YUV 4:1:1
		Mode_3	[3]	640 x 480	YUV 4:2:2
		Mode_4	[4]	640 x 480	RGB
		Mode_5	[5]	640 x 480	MONO8
		Mode_6	[6]	640 x 480	MONO16
		Mode_X	[7]	Reserved	
		---	[8..31]	Reserved (zero)	
184h	V_MODE_INQ (Format_1)	Mode_0	[0]	800 x 600	YUV 4:2:2
		Mode_1	[1]	800 x 600	RGB
		Mode_2	[2]	800 x 600	MONO8
		Mode_3	[3]	1024 x 768	YUV 4:2:2
		Mode_4	[4]	1024 x 768	RGB
		Mode_5	[5]	1024 x 768	MONO8
		Mode_6	[6]	800 x 600	MONO16
		Mode_7	[7]	1024 x 768	MONO16
		---	[8..31]	Reserved (zero)	
188h	V_MODE_INQ (Format_2)	Mode_0	[0]	1280 x 960	YUV 4:2:2
		Mode_1	[1]	1280 x 960	RGB
		Mode_2	[2]	1280 x 960	MONO8
		Mode_3	[3]	1600 x 1200	YUV 4:2:2
		Mode_4	[4]	1600 x 1200	RGB
		Mode_5	[5]	1600 x 1200	MONO8
		Mode_6	[6]	1280 x 960	MONO16
		Mode_7	[7]	1600 x 1200	MONO16
		---	[8..31]	Reserved (zero)	
18Ch … 197h	**Reserved for other V_MODE_INQ_x for Format_x.**			**Always 0**	
198h	V_MODE_INQ_6 (Format_6)			Always 0	

Table 117: **Video mode** inquiry register

Offset	Name	Field	Bit	Description	Color mode
19Ch	V_MODE_INQ	Mode_0	[0]	Format_7 Mode_0	
	(Format_7)	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 117: **Video mode** inquiry register

Inquiry register for video frame rate and base address

Offset	Name	Field	Bit	Description
200h	V_RATE_INQ	FrameRate_0	[0]	Reserved
	(Format_0, Mode_0)	FrameRate_1	[1]	Reserved
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	120 fps (V1.31)
		FrameRate_7	[7]	240 fps (V1.31)
		---	[8..31]	Reserved (zero)
204h	V_RATE_INQ	FrameRate_0	[0]	1.875 fps
	(Format_0, Mode_1)	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 118: **Frame rate** inquiry register

Offset	Name	Field	Bit	Description
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)
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)

Table 118: **Frame rate** inquiry register

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

Table 118: **Frame rate** inquiry register

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

Table 118: **Frame rate** inquiry register

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

Table 118: **Frame rate** inquiry register

Offset	Name	Field	Bit	Description
23Ch	V_RATE_INQ	FrameRate_0	[0]	1.875 fps
	(Format_1, 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]	120 fps (V1.31)
		FrameRate_7	[7]	Reserved
		---	[8..31]	Reserved (zero)
240h	V_RATE_INQ	FrameRate_0	[0]	1.875 fps
	(Format_2, Mode_0)	FrameRate_1	[1]	3.75 fps
		FrameRate_2	[2]	7.5 fps
		FrameRate_3	[3]	15 fps
		FrameRate_4	[4]	30 fps
		FrameRate_5	[5]	60 fps
		FrameRate_6	[6]	Reserved
		FrameRate_7	[7]	Reserved
		---	[8..31]	Reserved (zero)
244h	V_RATE_INQ	FrameRate_0	[0]	1.875 fps
	(Format_2, Mode_1)	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 118: **Frame rate** inquiry register

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

Table 118: **Frame rate** inquiry register

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

Table 118: **Frame rate** inquiry register

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

Table 118: **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]	Reserved
		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 capa-bility
		Multi_Shot_Inq	[20]	Multi-shot transmission capa-bility
		---	[21..27]	Reserved
		Memory_Channel	[28..31]	Maximum memory channel number (N) If 0000, no user memory available

Table 119: **Basic function** inquiry register

Inquiry register for feature presence

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

Table 120: **Feature presence** inquiry register

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

Table 120: **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]	Minimum value for this feature
		Max_Value	[20..31]	Maximum value for this feature
504h	AUTO_EXPOSURE_INQ	**Same definition as Brightness_inq.**		
508h	SHARPNESS_INQ	**Same definition as Brightness_inq.**		
50Ch	WHITE_BAL_INQ	**Same definition as Brightness_inq.**		
510h	HUE_INQ	**Same definition as Brightness_inq.**		
514h	SATURATION_INQ	**Same definition as Brightness_inq.**		
518h	GAMMA_INQ	**Same definition as Brightness_inq.**		
51Ch	SHUTTER_INQ	**Same definition as Brightness_inq.**		
520h	GAIN_INQ	**Same definition as Brightness_inq.**		
524h	IRIS_INQ	**Always 0**		
528h	FOCUS_INQ	**Always 0**		
52Ch	TEMPERATURE_INQ	**Same definition as Brightness_inq.**		

Table 121: **Feature elements** inquiry register

Register	Name	Field	Bit	Description
530h	TRIGGER_INQ	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Abs_Control_Inq	[1]	Capability of control with absolute value
		---	[2..3	Reserved
		Readout_Inq	[4]	Capability of reading out the value of this feature
		ON_OFF	[5]	Capability of switching this feature ON and OFF
		Polarity_Inq	[6]	Capability of changing the polarity of the trigger input
		Value_Read_Inq	[7]	Capability of reading raw trigger input Here you can read if trigger is active. In case of external trigger, you can read a combined signal.
		Trigger_Source0_Inq	[8]	Presence of Trigger Source 0 ID=0 Indicates usage of standard inputs.
		---	[9..15]	Reserved
		Software_Trigger_Inq	[15]	Presence of Software Trigger ID=7
		Trigger_Mode0_Inq	[16]	Presence of Trigger_Mode 0
		Trigger_Mode1_Inq	[17]	Presence of Trigger_Mode 1
		Trigger_Mode2_Inq	[18]	Presence of Trigger_Mode 2
		Trigger_Mode3_Inq	[19]	Presence of Trigger_Mode 3
		---	[20..31	Reserved

Table 121: **Feature elements** inquiry register

Register	Name	Field	Bit	Description
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 Controlled automatically by the camera once)
		Readout_Inq	[4]	Capability of reading out the value of this feature
		ON_OFF	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto Mode (Controlled automatically by the camera)
		Manual_Inq	[7]	Manual Mode (Controlled by user)
		Min_Value	[8..19]	Minimum value for this feature
		Max_Value	[20..31]	Maximum value for this feature
538 .. 57Ch	**Reserved for other FEATURE_HI_INQ**			
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 FEATURE_LO_INQ**	**Always 0**		
5C0h	CAPTURE_SIZE_INQ	**Always 0**		
5C4h	CAPTURE_QUALITY_INQ	**Always 0**		
5C8h .. 5FCh	**Reserved for other FEATURE_LO_INQ**	**Always 0**		

Table 121: **Feature elements** inquiry register

Status and control registers for camera

Register	Name	Field	Bit	Description
600h	CUR-V-Frm_RATE/Revision	Bit [0..2] for the frame rate		
604h	CUR-V-MODE	Bit [0..2] for the current video mode		
608h	CUR-V-FORMAT	Bit [0..2] for the current video format		
60Ch	ISO-Channel	Bit [0..3] for channel, [6..7] for ISO speed		
610h	Camera_Power	**Always 0**		
614h	ISO_EN/Continuous_Shot	Bit 0: 1 for start continuous shot; 0 for stop continuos shot		
618h	Memory_Save	**Always 0**		
61Ch	One_Shot, Multi_Shot, Count Number	**See Chapter *One-shot* on page 202** **See Chapter *Multi-shot* on page 205**		
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**		
62Ch	**Software_Trigger**	Software trigger Write: 0: Reset software trigger 1: Set software trigger (self cleared, when using edge mode; must be set back to 0 manually, when using level mode) Read: 0: Ready (meaning: it's possible to set a software trigger) 1: Busy (meaning: no trigger possible)		

Table 122: **Status and control** registers for camera

Inquiry register for absolute value CSR offset address

Offset	Name	Description
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 123: **Absolute value** inquiry register

Status and control register for one-push

The **OnePush** feature, WHITE_BALANCE, is currently implemented. If this flag is set, the feature becomes immediately active, even if no images are being input (see Chapter *One-push white balance* on page 123).

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 124: **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 124: **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 124: **Feature** control register

Offset	Name	Field	Bit	Description
810h	HUE			See above Always 0 for Mono
814h	SATURATION			See above Always 0 for Mono
818h	GAMMA			See above
81Ch	SHUTTER			See Advanced Feature time base See *Table 42: CSR: Shutter* on page 127
820h	GAIN			See above
824h	IRIS			Always 0
828h	FOCUS			Always 0
82Ch	TEMPERATURE			See *Table 127: CSR: Temperature* on page 296
830h	TRIGGER_MODE			Can be effected via advanced feature IO_INP_CTRLx.
834h .. 87Ch	**Reserved for other FEATURE_HI**			**Always 0**
880h	Zoom			Always 0
884h	PAN			Always 0
888h	TILT			Always 0
88Ch	OPTICAL_FILTER			Always 0
890h .. 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 124: **Feature** control register

Feature control error status register

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

Table 125: **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 118: Frame rate inquiry register* on page 273) gives 003C2000h.

4 x 3C2000h = F08000h so that the base address for the latter (*Table 126: Format_7 control and status register* on page 294) equals F0000000h + F08000h = F0F08000h.

Quadlet offset Format_7 Mode_1

The quadlet offset to the base address for **Format_7 Mode_1**, which can be read out at F0F002E4h (according to *Table 118: Frame rate inquiry register* on page 273) gives 003C2400h.

4 x 003C2400h = F09000h so that the base address for the latter (*Table 126: Format_7 control and status register* on page 294) equals F0000000h + F09000h = F0F09000h.

Format_7 control and status register (CSR)

Offset	Name	Description
000h	MAX_IMAGE_SIZE_INQ	According to IIDC V1.31
004h	UNIT_SIZE_INQ	According to IIDC V1.31
008h	IMAGE_POSITION	According to IIDC V1.31
00Ch	IMAGE_SIZE	According to IIDC V1.31
010h	COLOR_CODING_ID	See note
014h	COLOR_CODING_INQ	According to IIDC V1.31

Table 126: **Format_7** control and status register

Offset	Name	Description
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 171.
034h	PIXEL_NUMER_INQ	According to IIDC V1.31
038h	TOTAL_BYTES_HI_INQ	According to IIDC V1.31
03Ch	TOTAL_BYTES_LO_INQ	According to IIDC V1.31
040h	PACKET_PARA_INQ	See note
044h	BYTE_PER_PACKET	According to IIDC V1.31

Table 126: **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 V1.31, registers relevant to Format_7 are refreshed on each access. The **Setting_1** bit is automatically cleared after each access.
- When **ErrorFlag_1** or **ErrorFlag_2** are set and Format_7 is configured, no image capture is started.
- Contrary to IIDC V1.31, COLOR_CODING_ID is set to a default value after an INITIALIZE or **reset**.
- Contrary to IIDC V1.31, the **UnitBytePerPacket** field is already filled in with a fixed value in the PACKET_PARA_INQ register.

Temperature register

The temperature is implemented with Presence_Inq=1 (available) and ON_OFF [6] always ON according to IIDC V1.31:

Register	Name	Field	Bit	Description
0xF0F0082C	TEMPERATURE	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 1: begin to work (self cleared after operation) Read: Value=1 in operation Read: Value=0 not in operation If A_M_Mode=1, this bit is ignored
		ON_OFF	[6]	Write: ON or OFF this feature Always 1 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]	Temperature at the present time (read only) Read out temperature value and divide by 10: this is the temperature at sensor in degree Celsius. **Info:** 50 °C at sensor is approximately 45 °C at camera housing. So never run the camera with more than 50 °C at sensor. • min. displayed temperature: -55 °C • max. displayed temperature: 150 °C • Increment: 0.25 °C/step

Table 127: CSR: **Temperature**

From -10 °C to +65 °C the temperature accuracy is: +1.5 °C / -2.0 °C

Advanced features (AVT-specific)

The camera has a variety of extended features going beyond the possibilities described in IIDC V1.31. The following chapter summarizes all available (AVT-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 119
- Links given in the table below

Advanced registers summary

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

Register	Register name	Description
0xF1000010	VERSION_INFO1	See *Table 129: Advanced register: Extended version information* on page 301
0xF1000014	VERSION_INFO1_EX	
0xF1000018	VERSION_INFO3	
0xF100001C	VERSION_INFO3_EX	
0xF1000040	ADV_INQ_1	See *Table 131: Advanced register: Advanced feature inquiry* on page 303 In ADV_INQ_3 there is a new field F7MODE_MAPPING [3] Low Noise Binning [9]
0xF1000044	ADV_INQ_2	
0xF1000048	ADV_INQ_3	
0xF100004C	ADV_INQ_4	
0xF1000100	CAMERA_STATUS	See *Table 132: Advanced register: Camera status* on page 305
0xF1000200	MAX_RESOLUTION	See *Table 133: Advanced register: Maximum resolution inquiry* on page 306
0xF1000208	TIMEBASE	See *Table 134: Advanced register: Time base* on page 306
0xF100020C	EXTD_SHUTTER	See *Table 136: Advanced register: Extended shutter* on page 308
0xF1000210	TEST_IMAGE	See *Table 137: Advanced register: Test images* on page 309
0xF1000220	SEQUENCE_CTRL	See *Table 74: Advanced register: Sequence mode* on page 209
0xF1000224	SEQUENCE_PARAM	
0xF1000228	SEQUENCE_STEP	

Table 128: **Advanced registers** summary

Register	Register name	Description
0xF1000240	LUT_CTRL	See *Table 138: Advanced register: LUT* on page 310
0xF1000244	LUT_MEM_CTRL	
0xF1000248	LUT_INFO	
0xF1000250	SHDG_CTRL	See *Table 139: Advanced register: Shading* on page 312
0xF1000254	SHDG_MEM_CTRL	
0xF1000258	SHDG_INFO	
0xF1000260	DEFERRED_TRANS	See *Table 141: Advanced register: Deferred image transport* on page 315
0xF1000270	FRAMEINFO	See *Table 142: Advanced register: Frame information* on page 316
0xF1000274	FRAMECOUNTER	
0xF1000298	DPC_CTRL	See *Table 143: Advanced register: Defect pixel correction* on page 317
0xF100029C	DPC_MEM	
0xF10002A0	DPC_INFO	
0xF1000300	IO_INP_CTRL1	STINGRAY housing and board level cameras See *Table 23: Advanced register: Input control* on page 101
0xF1000304	IO_INP_CTRL2	
0xF1000320	IO_OUTP_CTRL1	STINGRAY housing and board level cameras See *Table 29: Advanced register: Output control* on page 107
0xF1000324	IO_OUTP_CTRL2	
0xF1000328	IO_OUTP_CTRL3	
0xF100032C	IO_OUTP_CTRL4	
0xF1000340	IO_INTENA_DELAY	See *Table 144: Advanced register: Delayed Integration Enable (IntEna)* on page 319
0xF1000360	AUTOSHUTTER_CTRL	See *Table 145: Advanced register: Auto shutter control* on page 320
0xF1000364	AUTOSHUTTER_LO	
0xF1000368	AUTOSHUTTER_HI	
0xF1000370	AUTOGAIN_CTRL	See *Table 146: Advanced register: Auto gain control* on page 321
0xF1000390	AUTOFNC_AOI	See *Table 147: Advanced register: Autofunction AOI* on page 322
0xF1000394	AF_AREA_POSITION	
0xF1000398	AF_AREA_SIZE	
0xF10003A0	COLOR_CORR	Stingray color cameras only See *Table 148: Advanced register: Color correction* on page 323

Table 128: **Advanced registers** summary

Register	Register name	Description
0xF10003A4	COLOR_CORR_COEFFIC11 = Crr	**Stingray color cameras only** **See *Table 148: Advanced register: Color correction* on page 323**
0xF10003A8	COLOR_CORR_COEFFIC12 = Cgr	
0xF10003AC	COLOR_CORR_COEFFIC13 = Cbr	
0xF10003B0	COLOR_CORR_COEFFIC21 = Crg	
0xF10003B4	COLOR_CORR_COEFFIC22 = Cgg	
0xF10003B8	COLOR_CORR_COEFFIC23 = Cbg	
0xF10003BC	COLOR_CORR_COEFFIC31 = Crb	
0xF10003C0	COLOR_CORR_COEFFIC32 = Cgb	
0xF10003C4	COLOR_CORR_COEFFIC33 = Cbb	
0xF1000400	TRIGGER_DELAY	See *Table 149: Advanced register: Trigger delay* on page 324
0xF1000410	MIRROR_IMAGE	See *Table 150: Advanced register: Mirror* on page 324
0xF1000510	SOFT_RESET	See *Table 151: Advanced register: Soft reset* on page 325
0xF1000520	HIGH_SNR	See *Table 152: Advanced register: High Signal Noise Ratio (HSNR)* on page 326
0xF1000550	USER PROFILES	See *Table 167: Advanced register: User profiles* on page 341
0xF1000570	PARAMUPD_TIMING	See *Table 155: Advanced register: Update timing modes* on page 329
0xF1000580	F7MODE_MAPPING	See *Table 158: Advanced register: Format_7 mode mapping* on page 332
0xF1000610	FRMCNT_STAMP	See *Table 163: Advanced register: Frame counter* on page 337
0xF1000620	TRIGGER_COUNTER	See *Table 164: Advanced register: Trigger counter* on page 338
0xF1000630	SIS	See *Table 160: Advanced register: secure image signature (SIS)* on page 334
0xF1000640	SWFEATURE_CTRL	See *Table 166: Advanced register: Software feature control (disable LEDs)* on page 340

Table 128: **Advanced registers** summary

Register	Register name	Description
0xF1000800 0xF1000804	IO_OUTP_PWM1	Stingray housing and board level cameras: See *Table 31: PWM configuration registers* on page 110
0xF1000808 0xF100080C	IO_OUTP_PWM2	
0xF1000810 0xF1000814	IO_OUTP_PWM3	
0xF1000818 0xF100081C	IO_OUTP_PWM4	
0xF1000840	IO_INP_DEBOUNCE_1	See *Table 65: Advanced register: Debounce time for input ports* on page 198
0xF1000850	IO_INP_DEBOUNCE_2	
0xF1000860	IO_INP_DEBOUNCE_3	
0xF1000870	IO_INP_DEBOUNCE_4	
0xF1000FFC	GPDATA_INFO	See *Table 170: Advanced register: GPData buffer* on page 345
0xF1001000 ... 0xF100nnnn	GPDATA_BUFFER	
0xF1100000	PARRAMLIST_INFO	See *Table 156: Advanced register: Parameter-List Update: parameter list* on page 331
0xF1101000	PARAMLIST_BUFFER	

Table 128: **Advanced registers** summary

Note

Advanced features should always be activated before accessing them.

Note

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

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 130: Camera type ID list* on page 302.
		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 129: 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 (BL = board level):

ID	Camera type
401	STINGRAY F-033B (BL)
402	STINGRAY F-033C (BL)
403	---
404	---
405	STINGRAY F-046B (BL)
406	STINGRAY F-046C (BL)
407	STINGRAY F-080B (BL)
408	STINGRAY F-080C (BL)
409	STINGRAY F-125B (BL)
410	STINGRAY F-125C (BL)
413	STINGRAY F-145B (BL)
414	STINGRAY F-145C (BL)
415	STINGRAY F-146B (BL)
416	STINGRAY F-146C (BL)
417	STINGRAY F-201B (BL)
418	STINGRAY F-201C (BL)
419	---
420	---
423	STINGRAY F-504B (BL)
424	STINGRAY F-504C (BL)

Table 130: Camera type ID list

Advanced feature inquiry

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

Note

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

Register	Name	Field	Bit	Description
0xF1000040	ADV_INQ_1	MaxResolution	[0]	
		TimeBase	[1]	
		ExtdShutter	[2]	
		TestImage	[3]	
		FrameInfo	[4]	
		Sequences	[5]	
		VersionInfo	[6]	
		---	[7]	Reserved
		Look-up tables	[8]	
		Shading	[9]	
		DeferredTrans	[10]	
		HDR mode	[11]	
		---	[12]	Reserved
		---	[13]	Reserved
		TriggerDelay	[14]	
		Mirror image	[15]	
		Soft Reset	[16]	
		High SNR	[17]	
		Color correction	[18]	
		---	[19..20]	Reserved
		User Sets	[21]	
		---	[22..29]	Reserved
		Paramlist_Info	[30]	
		GP_Buffer	[31]	

Table 131: Advanced register: **Advanced feature inquiry**

Register	Name	Field	Bit	Description
0xF1000044	ADV_INQ_2	Input_1	[0]	
		Input_2	[1]	
		---	[2..7]	Reserved
		Output_1	[8]	
		Output_2	[9]	
		Output_3	[10]	
		Output_4	[11]	
		---	[12..15]	Reserved
		IntEnaDelay	[16]	
		---	[17..23]	Reserved
		Output 1 PWM	[24]	STINGRAY housing and board level cameras
		Output 2 PWM	[25]	
		Output 3 PWM	[26]	
		Output 4 PWM	[27]	
		---	[28..31]	Reserved
0xF1000048	ADV_INQ_3	Camera Status	[0]	
		Max IsoSize	[1]	
		Paramupd_Timing	[2]	
		F7 mode mapping	[3]	
		Auto Shutter	[4]	
		Auto Gain	[5]	
		Auto FNC AOI	[6]	
		---	[7..31]	Reserved
0xF100004C	ADV_INQ_4	---	[0]	
		---	[1]	
		---	[2]	
		---	[18..31]	Reserved

Table 131: 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 and does not send any images (but images might be present in the image FIFO).

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

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

Note

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

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

Table 132: 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 50ff.

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

Table 133: Advanced register: **Maximum 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 you can enter a value in the range of 1 to 4095.

Stingray 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 135: Time base ID* on page 307.

Table 134: Advanced register: **Time base**

The time base IDs 0-9 are in bit [28] to [31]. See *Table 135: Time base ID* on page 307. 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 66: Camera-specific exposure time offset* on page 199) 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 135: Time base ID

Note

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

Extended shutter

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

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

Table 136: 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.

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

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

Bit [8] to [14] indicate which test images are saved. Setting bit [28] to [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 137: Advanced register: **Test image**s

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]	
		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 138: 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 LUT entries (gray levels): that is 2^n with n=number of bits read from sensor.

Note

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

Note

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

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

Loading a look-up table into the camera

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

To load a lookup table into the camera:

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

Shading correction

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

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

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

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

Note

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

Register	Name	Field	Bit	Description
0xF1000250	SHDG_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		BuildError	[1]	Could not built shading image
		---	[2..3]	Reserved
		ShowImage	[4]	Show shading data as image
		BuildImage	[5]	Build a new shading image
		ON_OFF	[6]	Shading on/off
		Busy	[7]	Build in progress
		---	[8..15]	Reserved
		MemChannelError	[16..19]	Indicates memory channel error. See *Table 140: Memory channel error description* on page 314.
		MemoryChannel	[20..23]	Set memory channel number for save and load operations
		GrabCount	[24..31]	Number of images

Table 139: Advanced register: **Shading**

Register	Name	Field	Bit	Description
0xF1000254	SHDG_MEM_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	Reserved
		EnableMemWR	[5]	Enable write access
		EnableMemRD	[6]	Enable read access
		---	[7]	Reserved
		AddrOffset	[8..31]	In bytes
0xF1000258	SHDG_INFO	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..3]	Reserved
		MaxMemChannel	[4..7]	Maximum number of available memory channels to store shading images
		MaxImageSize	[8..31]	Maximum shading image size (in bytes)

Table 139: Advanced register: **Shading**

Reading or writing shading image from/into the camera

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

To read or write a shading image:

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

Automatic generation of a shading image

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

To generate a shading image:

1. Set **GrabCount** to the number of the images to be averaged before the correction factors are calculated.
2. Set **BuildImage** to true.

3. Poll the SHDG_CTRL register until the **Busy** and **BuildImage** flags are reset automatically.

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

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

Memory channel error codes

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

Table 140: **Memory channel** error description

Deferred image transport

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

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

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

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

Table 141: Advanced register: **Deferred image transport**

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 142: 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

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 256 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 143: 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 256 defect pixels can be stored. In case of more than 256 defect pixels, DPDataSize is set to 257 and BuildError flag is set to 1. Defect pixel correction data is done with first 256 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 143: Advanced register: **Defect pixel correction**

Input/output pin control

Note

- See Chapter *Input/output pin control* on page 101
- See Chapter *IO_INP_CTRL 1-2* on page 102
- See Chapter *IO_OUTP_CTRL 1-4* on page 107
- See Chapter *Output modes* on page 108

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.

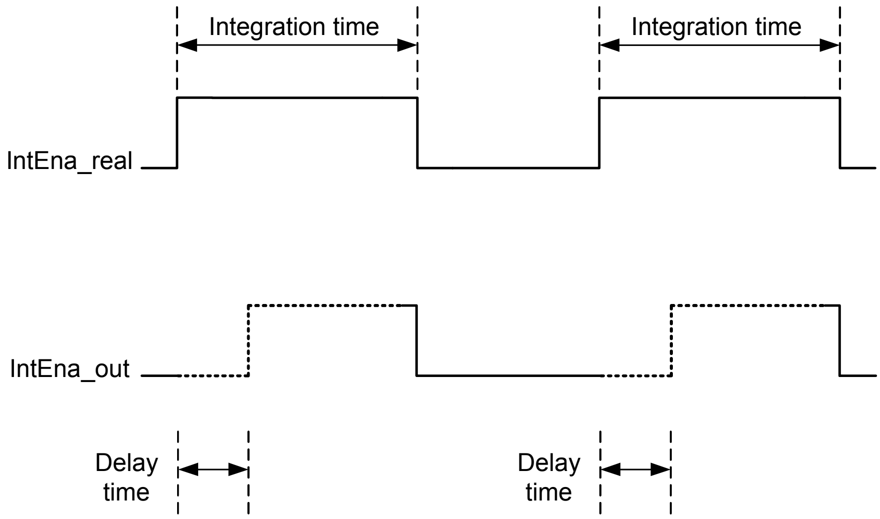


Figure 119: Delayed integration timing

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 144: 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 lowest possible value: 10 µs
0xF1000368	AUTOSHUTTER_HI	---	[0..5]	Reserved
		MaxValue	[6..31]	Maximum auto shutter value

Table 145: 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 146: Advanced register: **Auto gain control**

MinValue and **MaxValue** limits the range the auto gain feature is allowed to use for the regulation process. Both values are initialized with the minimum and maximum value defined in the standard GAIN_INQ register.

Changing the **auto gain range** might not affect the regulation, if the regulation is in a stable condition and no other condition affecting the image brightness is changed.

If both **auto gain** and **auto shutter** are enabled and if the gain is at its lower boundary and shutter regulation is in progress, decreasing the lower auto gain boundary has no effect on auto gain/shutter regulation as long as auto shutter regulation is active.

Both values can only be changed within the range defined by the standard GAIN_INQ register.

Autofunction AOI

The table below illustrates the advanced register for **autofunction AOI**.

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 147: 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.

Color correction

To switch off color correction in YUV mode: see bit [6]

Register	Name	Field	Bit	Description
0xF10003A0	COLOR_CORR	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Color correction on/off default: on Write: 02000000h to switch color correction **OFF** Write: 00000000h to switch color correction **ON**
		Reset	[7]	Reset to defaults
		---	[8..31]	Reserved
0xF10003A4	COLOR_CORR_COEFFIC11 = Crr		[0..31]	A number of 1000 equals a color correction coefficient of 1. Color correction values range -1000..+2000 and are **signed 32 bit.** In order for white balance to work properly ensure that the row sum equals to 1000. The maximum row sum is limited to 2000.
0xF10003A8	COLOR_CORR_COEFFIC12 = Cgr		[0..31]	
0xF10003AC	COLOR_CORR_COEFFIC13 = Cbr		[0..31]	
0xF10003B0	COLOR_CORR_COEFFIC21 = Crg		[0..31]	
0xF10003B4	COLOR_CORR_COEFFIC22 = Cgg		[0..31]	
0xF10003B8	COLOR_CORR_COEFFIC23 = Cbg		[0..31]	
0xF10003BC	COLOR_CORR_COEFFIC31 = Crb		[0..31]	
0xF10003C0	COLOR_CORR_COEFFIC32 = Cgb		[0..31]	
0xF10003C4	COLOR_CORR_COEFFIC33 = Cbb		[0..31]	
0xF10003A4 ... 0xF10003FC				Reserved for **testing purposes** **Don't touch!**

Table 148: Advanced register: **Color correction**

For an explanation of the color correction matrix and for further information read Chapter *Color correction* on page 181.

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 149: Advanced register: **Trigger delay**

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

Note **Trigger delay works with external trigger modes only.**

Mirror image

The table below illustrates the advanced register for **Mirror image**.

Register	Name	Field	Bit	Description
0xF1000410	MIRROR_IMAGE	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Mirror image on/off 1: on 0: off Default: off
		---	[7..31]	Reserved

Table 150: 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 151: 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.

High SNR mode (High Signal Noise Ratio)

With **High SNR** mode enabled the camera internally grabs **GrabCount** images and outputs a single averaged image.

Register	Name	Field	Bit	Description
0xF1000520	HIGH_SNR	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	High SNR mode on/off High SNR mode on requires a **minimum** GrabCount value of **2**.
		---	[7..22]	Reserved
		GrabCount	[23..31]	Enter number of images Permissible values are: 2, 4, 8, 16, 32, 64, 128, 256 If you enter a non-expected value, the firmware will round down to the first permitted value. Example: Enter 255, firmware will write 128 to the register.

Table 152: Advanced register: **High Signal Noise Ratio (HSNR)**

Note

- The camera must be idle to toggle this feature on/off. Idle means: no image acquisition, no trigger.
- Writing to the HIGH_SNR register while capture is active will accept the new value, but it will not become active. Even subsequently stopping and starting acquisition will not change this.
- Writing the HIGH_SNR register is **only effective** if done while the camera is not actively acquiring.

Maximum ISO packet size

Use this feature to increase the MaxBytePerPacket value of Format_7 modes. This overrides the maximum allowed isochronous packet size specified by IIDC V1.31.

Register	Name	Field	Bit	Description
0xF1000560	ISOSIZE_S400	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Enable/Disable S400 settings
		Set2Max	[7]	Set to maximum supported packet size
		---	[8..15]	Reserved
		MaxIsoSize	[16..31]	Maximum ISO packet size for S400
0xF1000564	ISOSIZE_S800	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	Enable/Disable S800 settings
		Set2Max	[7]	Set to maximum supported packet size
		---	[8..15]	Reserved
		MaxIsoSize	[16..31]	Maximum ISO packet size for S800

Table 153: Advanced register: **Maximum ISO packet size**

Example For isochronous packets at a speed of S800 the maximum allowed packet size (IIDC V1.31) is 8192 byte. This feature allows you to extend the size of an isochronous packet up to 11.000 byte at S800. Thus the isochronous bandwidth is increased from 64 MByte/s to approximately 84 MByte/s. You need either PCI Express or PCI-X (64 bit).

The **Maximum ISO packet size** feature ...

- ... reduces the asynchronous bandwidth available for controlling cameras by approximately 75%
- ... may lead to slower responses on commands
- ... is not covered by the IEEE1394 specification
- ... may not work with all available 1394 host adapters.

Note

We strongly recommend to use PCI-X (64 bit) or PCI Express adapter.

Restrictions Note the restrictions in the following table. When using software with an Isochronous Resource Manager (IRM): deactivate it.

Software	Restrictions
FireGrab	Deactivate Isochronous Resource Manager: SetParameter (FGP_USEIRMFORBW, 0)
FireStack/FireClass	No restrictions
SDKs using Microsoft driver (Active FirePackage, Direct FirePackage, ...)	n/a
Linux: libdc1394_1.x	No restrictions
Linux: libdc1394_2.x	Deactivate Isochronous Resource Manager: Set DC1394_CAPTURE_FLAGS_BANDWIDTH_ALLOC flag to 0
Third Party Software	Deactivate Isochronous Resource Manager

Table 154: Restrictions for feature: **Maximum ISO packet size**

Operation The maximum allowed isochronous packet size can be set separately for the ISO speeds S400 and S800. Check the associated **Presence_Inq** flag to see for which ISO speed this feature is available.

Setting the **Set2Max** flag to 1 sets the **MaxIsoSize** field to the maximum supported isochronous packet size. Use this flag to query the maximum supported size (may depend on the camera model).

Enable this feature by setting the **ON_OFF** flag to 1 and the **MaxIsoSize** field to a value greater than the default packet size.

The camera ensures:

- that the value of the **MaxIsoSize** field is a multiple of 4.
- that the value isn't lower than the value specified by the IEEE1394 specification.

The settings are stored in the user sets.

Note

Enabling this feature will not change the MaxBytePerPacket value automatically. The camera may not use the new isochronous packet size for the MaxBytePerPacket value until a write access to the desired Format_7 mode has been issued.

Quick parameter change timing modes

You can choose between the following update timing modes:

- **Standard Parameter Update Timing** (slightly modified from previous Stingray cameras)
- **Quick Format Change Mode**

Note

For a detailed description see Chapter *Quick parameter change timing modes* on page 165.

Register	Name	Field	Bit	Description
0xF1000570	PARAMUPD_TIMING	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		UpdActive	[6]	Update active see Chapter *Encapsulated Update (begin/end)* on page 168 0: (default); reset to 0 means **Encapsulated Update end** 1: set to 1 means **Encapsulated Update begin**
		---	[7..23]	Reserved
		UpdTiming	[24..31]	Update timing mode If set to 0: **Standard Parameter Update Timing** is active If set to 2: **Quick Format Change Mode** is active

Table 155: Advanced register: **Update timing modes**

Standard Parameter Update Timing

The camera behaves like older firmware versions without this feature. The **UpdActive** flag has no meaning.

Quick Format Change Mode

This mode behaves like **Standard Parameter Update Timing** mode with the following exception:

An already started image transport to the host will not be interrupted, but an already started integration will be interrupted.

To switch on **Quick Format Change Mode** do the following:

1. Set UpdTiming to 2.
2. Set UpdActive to 1.
3. Be aware that all parameter values have to be set within 10 seconds.

Automatic reset of the UpdActive flag

With **Quick Format Change Mode** you normally have to clear the **UpdActive** flag after all desired parameters have been set. Every time the **PARAMUPD_TIMING** register is written to with the **UpdActive** flag set to 1 a 10 second time-out is started / restarted. If the time-out passes before you clear the **UpdActive** flag, the **UpdActive** flag is cleared automatically and all parameter changes since setting the **UpdActive** flag to 1 become active automatically.

Parameter-List Update

The parameter list is an array of address/data pairs which can be sent to the camera in a single bus cycle.

Register	Name	Field	Bit	Description
0xF1100000	PARAMLIST_INFO	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..15]	Reserved
		BufferSize	[16..31]	Size of parameter list buffer in bytes
0xF1101000 ... 0xF1101nnn	PARAMLIST_BUFFER			

Table 156: Advanced register: **Parameter-List Update**: parameter list

Dependant on the parameter update mode the address/data pairs may become active one by one or after the processing of the complete parameter list. A parameter list may look like follows (the description is for your convenience):

Address offset	Data quadlet	Description
0xF0F00608	0xE0000000	Set video format 7
0xF0F00604	0x00000000	Set video mode 0
0xF0F08008	0x00000000	Set image position
0xF0F0800C	0x028001E0	Set image size
0xF0F08044	0x04840484	Set BytePerPacket value
0xF0F0080C	0x80000100	Set shutter to 0x100
0xF0F00820	0x80000080	Set gain to 0x80

Table 157: Example: **parameter list**

Note

- The PARAMLIST_BUFFER shares the memory with the GPDATA_BUFFER. Therefore it is not possible to use both features at the same time.
- Not all CSRs or features of a particular camera model can be used with the parameter list feature.

Format_7 mode mapping

With Format_7 mode mapping it is possible to map special binning and sub-sampling modes to F7M1..F7M7 (see *Figure 90: Mapping of possible Format_7 modes to F7M1...F7M7* on page 164).

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
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 158: Advanced register: **Format_7 mode mapping**

Additional Format_7 modes

Firmware 3.x adds additional Format_7 modes. Now you can add 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 7.
- Internal Format_7 modes are numbered from 0 to 27.

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_19 to the visible Format_7 Mode_1, write the decimal number 19 to the above listed F7MODE_1 register.

Note

For available Format_7 modes see ***Figure 90: Mapping of possible Format_7 modes to F7M1...F7M7*** **on page 164.**

Setting the F7MODE_x register to:

- -1 forces the camera to use the factory defined mode
- -2 disables the respective Format_7 mode (no mapping is applied)

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)

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 159: Advanced register: **Low noise binning mode**

Secure image signature (SIS)

Definition Secure image signature (SIS) is the synonym for data, which is inserted into an image to improve or check image integrity.

All Stingray models can insert

- **Cycle time** (1394 bus cycle time at the beginning of integration)
- **Frame counter** (frames read out of the sensor)
- **Trigger counter** (external trigger seen only)
- Various camera settings

into a selectable line position within the image. **Frame counter** and **trigger counter** are available as advanced registers to be read out directly.

Advanced register: SIS

The **SIS** feature is controlled by the following advanced feature register:

Note

This register is different to the Marlin time stamp (600) register!

Register	Name	Field	Bit	Description
0xF1000630	SIS	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	Reserved
		ON_OFF	[6]	SIS mode on/off
		---	[7.. 15]	Reserved
		LineNo	[16..31]	SIS data position inside an image
0xF1000634		UserValue	[0..31]	User provided value for sequence mode to be placed into the SIS area of an image

Table 160: Advanced register: **secure image signature (SIS)**

Enabling this feature, SIS data will be inserted into any captured image. The size of SIS data depends on the selected SIS format.

The **LineNo** field indicates at which line the SIS data will be inserted.

Enter a

- **positive value** from 0...HeightOfImage to specify a position relative to the top of the image. LinePos=0 specifies the very first image line.
- **negative value** from -1...-HeightOfImage to specify a position relative to the bottom of the image. LinePos=-1 specifies the very last image line.

SIS **UserValue** can be written into the camera's image. In sequence mode for every sequence entry an own SIS **UserValue** can be written.

Note

SIS outside the visible image area:

For certain Format_7 modes the image frame transported may contain padding (filling) data at the end of the transported frame. Setting LinePos=HeightOfImage places SIS in this padding data area, outside the visible area (invisible SIS).

If the transported image frame does not contain any padding data the camera will not relocate the SIS to the visible area automatically (no SIS).

Take in mind that the accuracy of SIS might be affected by asynchronous traffic – mainly if image settings are changed.

Note

- The IEEE 1394 **cycle time** will be inserted into the **very first 4 bytes of a line**.
- **Cycle time** is a structure and not really a counter in its first meaning.
- **Cycle time** has the three components:
  - Cycle offset
  - Cycles
  - Seconds
- **Cycle time** is therefore something like a nested counter: see table below.

Feature	Cycle offset	Cycles	Seconds
Bit depth	12 bit	13 bit	7 bit
Range	0 .. 3071 cycle offsets	0 .. 7999 cycles	0 .. 127 seconds
Frequency	24.576 MHz ⇨ 40.69 ns	8000 Hz ⇨ 125 µs	1 Hz ⇨ 1 s

Table 161: Structure of **cycle time**

Examples: cycle time

The following three examples allow you:

- A: to access cycle time either via UniAPI or via byte array
- B: to extract cycle offset, cycles and seconds
- C: to combine cycle offset/cycles/seconds to a valid time

Example	Example code and description

A	nCycleTime can be accessed:
	• using the SIS structure S_SIS_DATA of the UniAPI:
	`nCycleTime = * (UINT32 *) &Sis[0];`
	• using byte array: If you can access the image buffer as an array of bytes you can assemble the first four bytes of the image buffer (assuming that the SIS is in the first row):
	`nCycleTime = data[0] + (data[1]<<8) +`
	`(data[2]<<16) + (data[3]<<24);`

B	This Cycle time can be devided into its components:
	`nCtSeconds = ((nCycleTime & 0xFE000000) >> 25;`
	`nCtCycles  = ((nCycleTime & 0x01FFF000) >> 12;`
	`nCtOffset  =   nCycleTime & 0x00000FFF;`

C	These values can be combined
	`dTime = nCtSeconds +`
	`nCtCycles / 8000 +`
	`nCtOffset / 24576000;`

Table 162: Examples: cycle time

Advanced register: frame counter

Note

Different to Marlin SIS:

Register 610 is only to be used to reset the frame counter.

The **frame counter** feature is controlled by the following advanced feature register:

Register	Name	Field	Bit	Description
0xF1000610	FRMCNT_STAMP	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Reset	[1]	Reset frame counter
		---	[2..31]	Reserved
0xF1000614	FRMCNT		[0..31]	Frame counter

Table 163: Advanced register: **Frame counter**

Having this feature enabled, the current **frame counter** value (images read out of the sensor, equivalent to # FrameValid) will be inserted as a 32-bit integer value into any captured image.

Setting the **Reset** flag to 1 resets the frame counter to 0: the **Reset** flag is self-cleared.

Note

The 4 bytes of the frame counter value will be inserted as the 5th to 8th byte of a line.

Additionally there is a register for direct read out of the frame counter value.

Advanced register: trigger counter

The **trigger counter** feature is controlled by the following advanced feature register:

Register	Name	Field	Bit	Description
0xF1000620	TRIGGER_COUNTER	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Reset	[1]	Reset trigger counter
		---	[2..31]	Reserved
0xF1000624	TRGCNT	TriggerCounter	[0..31]	Trigger counter

Table 164: Advanced register: **Trigger counter**

Having this feature enabled, the current **trigger counter** value (external trigger seen by hardware) will be inserted as a 32-bit integer value into any captured image.

Setting the **Reset** flag to 1 resets the **trigger counter** to 0: the **Reset** flag is self-cleared.

The **ON_OFF** and **LinePos** fields are simply mirrors of the SIS feature. Settings of these fields are applied to all SIS features.

Note

The 4 bytes of the trigger counter value will be inserted as the 9th to 12th byte of a line.

Additionally there is a register for direct read out of the **trigger counter** value.

Where to find cycle time, frame counter and trigger counter in the image

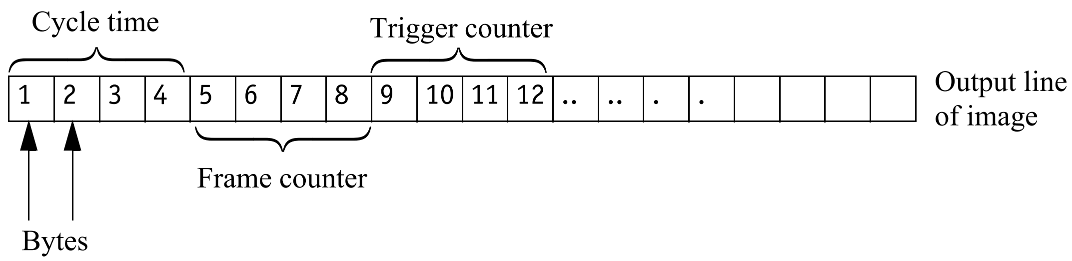


Figure 120: SIS in the image: cycle time, frame counter, trigger counter

Where to find all SIS values in the image

In the following table you find the position of all SIS values (byte for byte) including the endianness of SIS values. (Here SIS has 48 bytes.)

Cycle time [7..0]	Cycle time [15..8]	Cycle time [23..16]	Cycle time [31..24]
Byte 1	Byte 2	Byte 3	Byte 4
Frame counter [7..0]	Frame counter [15..8]	Frame counter [23..16]	Frame counter [31..24]
Byte 5	Byte 6	Byte 7	Byte 8
Trigger counter [7..0]	Trigger counter [15..8]	Trigger counter [23..16]	Trigger counter [31..24]
Byte 9	Byte 10	Byte 11	Byte 12
AOI left [7..0]	AOI left [15..8]	AOI top [7..0]	AOI top [15..8]
Byte 13	Byte 14	Byte 15	Byte 16
AOI width [7..0]	AOI width [15..8]	AOI height [7..0]	AOI height [15..8]
Byte 17	Byte 18	Byte 19	Byte 20
Shutter [7..0]	Shutter [15..8]	Shutter [23..16]	Shutter [31..24]
Byte 21	Byte 22	Byte 23	Byte 24
Gain [7..0]	Gain [15..8]	Reserved [NULL]	Reserved [NULL]
Byte 25	Byte 26	Byte 27	Byte 28
Output State_1 [7..0]	Output State_2 [7..0]	Output State_3 [7..0]	Output State_4 [7..0]
Byte 29	Byte 30	Byte 31	Byte 32
Input State_1 [7..0]	Input State_2 [7..0]	Reserved [NULL]	Reserved [NULL]
Byte 33	Byte 34	Byte 35	Byte 36
SequenceIndex [7..0]	Reserved [NULL]	ColorCoding [NULL]	Reserved [NULL]
Byte 37	Byte 38	Byte 39	Byte 40
Serial number [7..0]	Serial number [15..8]	Serial number [23..16]	Serial number [31..24]
Byte 41	Byte 42	Byte 43	Byte 44
SIS user value [7..0]	SIS user value [15..8]	SIS user value [23..16]	SIS user value [31..24]
Byte45	Byte46	Byte47	Byte48

Table 165: All SIS values (increasing order of transmitted pixels)

Software feature control (disable LEDs)

The software feature control register allows to enable/disable some features of the camera (e.g. disable LEDs). The settings are stored permanently within the camera and do not depend on any user set.

Register	Name	Field	Bit	Description
0xF1000640	SWFEATURE_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		BlankLED_Inq	[1]	Indicates presence of *Disable LEDs* feature.
		---	[2..15]	Reserved
		---	[16]	Reserved
		BlankLED	[17]	0: Behavior as described in Chapter *Status LEDs* on page 98ff. 1: Disable LEDs. (Only error codes are shown.)
		---	[18..31]	Reserved

Table 166: Advanced register: **Software feature control** (disable LEDs)

Disable LEDs

- To disable LEDs set bit [17] to 1.
- To disable LEDs in SmartView:
  Adv3 tab, activate *Disable LED functionality* check box.

The camera does not show any more the status indicators during normal operation:

Examples:

- Power on is not shown
- Isochronous traffic is not shown
- Asynchronous traffic is not shown

Note

During the startup of the camera and if an error condition is present, the LEDs behave as described in Chapter *Status LEDs* on page 98ff.

User profiles

Definition

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.

User profiles can be programmed with the following advanced feature register:

Offset	Name	Field	Bit	Description
0xF1000550	USER_PROFILE	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Error	[1]	An error occurred
		---	[2..6]	Reserved
		Busy	[7]	Save/Load in progress
		Save	[8]	Save settings to profile
		Load	[9]	Load settings from profile
		SetDefaultID	[10]	Set Profile ID as default
		---	[11..19]	Reserved
		ErrorCode	[20..23]	Error code See *Table 168: User profiles: Error codes* on page 342.
		---	[24..27]	Reserved
		ProfileID	[28..31]	ProfileID (memory channel)

Table 167: 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 V1.31 for details).

The **ProfileID** is equivalent to the memory channel number and specifies the profile number to store settings to or to restore settings from. In any case profile #0 is the hard-coded factory profile and cannot be overwritten.

After an initialization command, startup or reset of the camera, the **ProfileID** also indicates which profile was loaded on startup, reset or initialization.

Note

- The default profile is the profile that 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.

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 168: User profiles: **Error codes**

Reset of error codes

The **ErrorCode** field is set to zero on the next write access.

You may also reset the **ErrorCode**

- by writing to the **USER_PROFILE** register with the **SaveProfile**, **RestoreProfile** and **SetDefaultID** flag not set.
- by writing 00000000h to the **USER_PROFILE** register.

Stored settings

The following table shows the settings stored inside a profile:

Standard registers	Standard registers (Format_7)	Advanced registers
Cur_V_Frm_Rate Cur_V_Mode Cur_V_Format ISO_Channel ISO_Speed BRIGHTNESS AUTO_EXPOSURE (Target grey level) SHARPNESS WHITE_BALANCE (+ auto on/off) HUE (+ hue on) SATURATION (+ saturation on) GAMMA (+ gamma on) SHUTTER (+ auto on/off) GAIN TRIGGER_MODE TRIGGER_POLARITY TRIGGER_DELAY ABS_GAIN	IMAGE_POSITION (AOI) IMAGE_SIZE (AOI) COLOR_CODING_ID BYTES_PER_PACKET	TIMEBASE EXTD_SHUTTER IO_INP_CTRL IO_OUTP_CTRL IO_INTENA_DELAY AUTOSHUTTER_CTRL AUTOSHUTTER_LO AUTOSHUTTER_HI AUTOGAIN_CTRL AUTOFNC_AOI (+ on/off) COLOR_CORR (on/off + color correction coefficients) TRIGGER_DELAY MIRROR_IMAGE HIGH_SNR LUT_CTRL (LutNo; ON_OFF is not saved) SHDG_CTRL (on/off + ShowImage) DEFERRED_TRANS (HoldImg + NumOfImages)

Table 169: 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 startup. This can be especially helpful if third party software is used which may not give easy access to certain advanced features or may not provide efficient commands for quick writing of data blocks into the camera.

Note

- A profile save operation automatically disables capturing of images.
- A profile save or restore operation is an uninterruptable (atomic) operation. The write response (of the asynchronous write cycle) will be sent after completion of the operation.
- Restoring a profile will not overwrite other settings than listed above.
- If a restore operation fails or the specified profile does not exist, all registers will be overwritten with the hard-coded factory defaults (profile #0).
- Data written to this register will not be reflected in the standard memory channel registers.

Pulse-width modulation (PWM): Stingray housing and board level cameras

Note

See *Table 31: PWM configuration registers* on page 110.

GPDATA_BUFFER

GPDATA_BUFFER is a general purpose register that regulates the exchange of data between camera and host for:

- writing look-up tables (LUTs) into the camera
- uploading/downloading of the shading image

GPDATA_INFO Buffer size query

GPDATA_BUFFER indicates the actual storage range

Register	Name	Field	Bit	Description
0xF1000FFC	GPDATA_INFO	---	[0..15]	Reserved
		BufferSize	[16..31]	Size of GPDATA_BUFFER (byte)
0xF1001000 … 0xF10017FC	GPDATA_BUFFER			

Table 170: Advanced register: **GPData buffer**

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

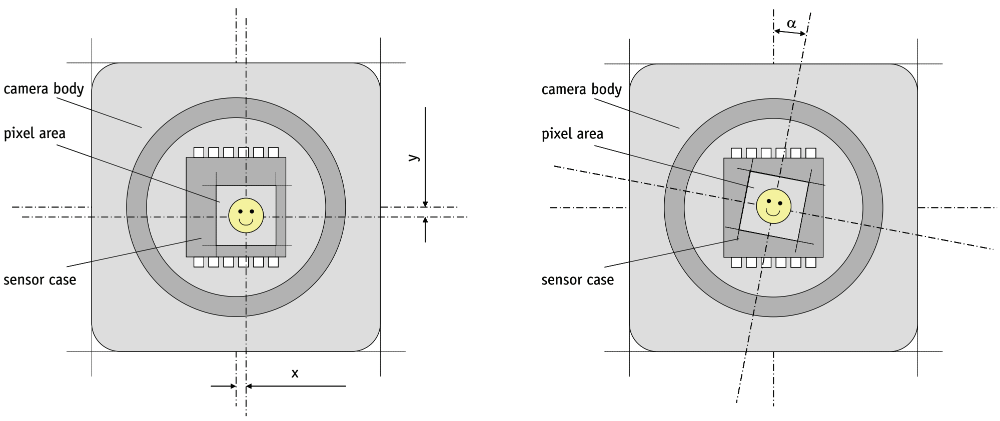
- Read/WriteBlock accesses to GPDATA_BUFFER are recommended, to read or write more than 4 byte data. This increases the transfer speed compared to accessing every single quadlet.
- The big endian byte order of the 1394 bus is unlike the little endian byte order of common operating systems (Intel PC). 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 171: Swapped first quadlet at address offset 0

Appendix

Sensor position accuracy of AVT GigE cameras



AVT Guppy Series

Method of Positioning:	Automated mechanical alignment of sensor into camera front module. (lens mount front flange)		
Reference points:	Sensor: Center of pixel area (photo sensitive cells). Camera: Center of camera front flange (outer case edges).		
Accuracy:	x/y:	+/- 0.25mm	(Sensor shift)
	z:	+50 / -100µm	(for SN > 84254727, optical back focal length)
		+0 / -100µm	(for SN > 252138124, optical back focal length)
	α:	+/- 1°	(Sensor rotation)

AVT Marlin, Oscar, Dolphin, Pike, Stingray

Method of Positioning:	Optical alignment of photo sensitive sensor area into camera front module. (lens mount front flange)		
Reference points:	Sensor: Center of pixel area (photo sensitive cells). Camera: Center of camera front flange (outer case edges).		
Accuracy:	x/y:	+/- 0.1mm	(Sensor shift)
	z:	+0 / -50µm	(Optical back focal length)
	α:	+/- 0.5°	(Sensor rotation)

Note: x/y - tolerances between c-Mount hole and pixel area may be higher.

Figure 121: AVT sensor position accuracy

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 AVT 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 172: New version number (microcontroller and FPGA)

Index

B

E

F

G

H

I

J

L

M

N

O

P

Q

R

S