AVT Guppy

Technical Manual

V7.1.0

07 May 2009

Allied Vision Technologies GmbH
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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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Contents

Contacting Allied Vision Technologies 9

Introduction 10

Document history 10

Manual overview 18

Conventions used in this manual 20

Styles 20

Symbols 20

More information 21

Before operation 21

Guppy cameras 23

Declarations of conformity 24

Filter and lenses 26

IR cut filter 26

Camera lenses 27

Specifications 29

Guppy F-033B/C 29

Guppy F-033B/C BL (board level) 31

Guppy F-036B/C 33

Guppy F-038B/C 35

Guppy F-038B/C NIR 37

Guppy F-044B/C 39

Guppy F-044B/C NIR 41

Guppy F-046B/C 43

Guppy F-080B/C 45

Guppy F-080B/C BL (board level) 47

Guppy F-146B/C 49

Guppy F-503B/C 51

Spectral sensitivity 53

Camera dimensions 63

Guppy standard housing (old CS-/C-Mounting) 64

Guppy standard housing (new CS-/C-Mounting) 65

Guppy board level: dimensions 66

Guppy board level: CS-Mount 67

Guppy board level: C-Mount 68

Guppy board level: M12-Mount 69

Tripod adapter 70

Cross section: C-Mount 71

Cross section: CS-Mount ... 72

Camera interfaces ... 73

IEEE 1394a port pin assignment ... 73
Board level camera: IEEE 1394a port pin assignment ... 74
Camera I/O connector pin assignment ... 75
GUPPY (housing) ... 76
GUPPY (board level) ... 77
Status LEDs ... 78
On LED (green) ... 78
Status LED ... 78
Control and video data signals ... 80
Inputs ... 80
Triggers ... 80
Input/output pin control ... 80
Input modes ... 81
Trigger delay ... 81
Outputs ... 84
IO_OUTP_CTRL 1-3 ... 86
Output modes ... 87
Board level cameras: inputs and outputs ... 89
Board level cameras: pulse-width modulation ... 90
PWM: minimal and maximal periods and frequencies ... 91
PWM: Examples in practice ... 91
Pixel data ... 93
Video data formats (IIDC V1.3 and AVT) ... 94
<Y (Mono) format> ... 94
<Y (Mono16) format> ... 94
<Y (Mono12) format> (AVT) ... 95
Data structure (IIDC V1.3 and AVT) ... 95
<Y, R, G, B> ... 95
<U, V> ... 96
<Y (Mono16> ... 96
<Y (Mono12)> (AVT) ... 97

Description of the data path ... 98

Block diagrams of the cameras ... 98
Black and white cameras (CCD and CMOS) ... 99
Color cameras (CCD and CMOS) ... 100
Readout schemes: GUPPY interlaced models (F-038, F-038 NIR, F-044, F-044 NIR, F-025, F-029) ... 101
Interlaced and field integration (Format_7 Mode_0) ... 102
Interlaced and frame integration (Format_7 Mode_1) ... 104
Non-interlaced and field integration (Format_7 Mode_2) only b/w cameras ... 106
Complementary colors and demosaicing ... 108

How demosaicing works ... 108
Format_7 Mode_0: sensor readout and color ... 110
Format_7 Mode_1: sensor readout and color ... 112
Color correction (only interlaced GUPPYs) ... 113
Horizontal and vertical mirror function
(only Guppy F-036/F-503) ... 114
White balance ... 114
White balance and interlaced GUPPYs ... 118
One-push white balance ... 119
Auto white balance (AWB) ... 120
Manual gain ... 122
Auto gain ... 124
Brightness (black level or offset) ... 126
Auto shutter ... 128
Look-up table (LUT) and gamma function ... 131
Loading an LUT into the camera ... 132
Defect pixel correction (only Guppy F-503B/C) ... 133
Building defect pixel data ... 135
Grab an image with defect pixel data ... 135
Calculate defect pixel coordinates ... 135
Reset values (resolution, shutter, gain, brightness) ... 136
Activate/deactivate defect pixel correction ... 136
Store defect pixel data non-volatile ... 136
Load non-volatile stored defect pixel data ... 136
Send defect pixel data to the host ... 137
Receive defect pixel data from the host ... 137
DPC data: storing mechanism ... 137
Binning
(only Guppy F-036B and Guppy F-503B/C) ... 138
2 x and 4 x binning ... 138
2 x vertical binning and 4 x vertical binning ... 139
2 x horizontal binning and 4 x horizontal binning ... 141
2 x full binning and 4 x full binning ... 143
Sub-sampling (only Guppy F-503B/C) ... 145
What is sub-sampling? ... 145
Which Guppy models have sub-sampling? ... 145
Description of sub-sampling ... 145
Binning and sub-sampling access
(only Guppy F-503) ... 151
Packed 12-Bit Mode ... 153
HDR (high dynamic range) (GUPPY F-036 only) ... 154
HDR overview (HiDy sensor) ... 154
Pixel operations in detail ... 155
Single knee point vs. two knee points ... 156
Effects of a HiDy sensor ... 157
Advanced registers for high dynamic range mode (HDR) (GUPPY F-036 only) ... 158
BAYER pattern (raw data output) ... 159
Serial interface ... 162

Controlling image capture 167
Global shutter (CCD cameras only) 167
Pipelined global shutter (only Guppy F-036) 168
Electronic rolling shutter (ERS) and global reset release shutter (GRR) (only Guppy F-503) 169
Trigger modes 170
Trigger_Mode_0 (edge mode) and Trigger_Mode_1 (level mode) 171
Guppy F-503, Trigger_Mode_0, electronic rolling shutter 172
Guppy F-503, Trigger_Mode_0, global reset release shutter 174
Trigger_Mode_15 (bulk trigger) 175
Trigger delay 178
Trigger delay advanced register 179
Exposure time (shutter) and offset 181
Exposure time of GUPPY F-036 (CMOS) 181
Exposure time of GUPPY F-503 (CMOS) 181
GUPPY F-503 row time for global reset release shutter (GRR) 181
GUPPY F-503 row time for electronic rolling shutter (ERS) 181
Minimum shutter time of GUPPY F-036 182
Example GUPPY F-036 182
Example GUPPY F-503 182
Exposure time offset 182
Example GUPPY F-033 183
Extended shutter 183
One-Shot 184
One-shot command on the bus to start of exposure 185
End of exposure to first packet on the bus 185
Multi-shot 186
ISO_Enable / free-run 187
Asynchronous broadcast 187
Jitter at start of exposure 188
User profiles 189

Video formats, modes and bandwidth 190
Guppy F-033B / Guppy F-033C
and board level versions F-033B BL / F-033C BL 191
Guppy F-036B / Guppy F-036C 192
Guppy F-038B / Guppy F-038C 193
Guppy F-038B NIR / Guppy F-038C NIR 193
Guppy F-044B / Guppy F-044C 194
Guppy F-044B NIR / Guppy F-044C NIR 194
Guppy F-046B / Guppy F-046C 195
Guppy F-080B / Guppy F-080C
and board level versions F-080B BL / F-080C BL 196
Guppy F-146B / Guppy F-146C 197
Guppy F-503B / Guppy F-503C 198
Area of interest (AOI) 200
Autofunction AOI (not interlaced GUPPYs) 202
Frame rates 203
Frame rates Format_7 204

GUPPY F-033 and board level versions:
AOI frame rates 205
GUPPY F-036: AOI frame rates 207
GUPPY F-038 / GUPPY F-038 NIR
(only F7M0 and F7M1): AOI frame rates 208
GUPPY F-044 / GUPPY F-044 NIR
(only F7M0 and F7M1): AOI frame rates 210
GUPPY F-046: AOI frame rates 212
GUPPY F-080 and board level versions:
AOI frame rates 214
GUPPY F-146: AOI frame rates 216
GUPPY F-503: AOI frame rates 217

How does bandwidth affect the frame rate? 219

Test images 221
Loading test images 221
Test images b/w cameras (progressive and interlaced) 221
Test images for color cameras 222
Test image 1 (Mono8 mode) progressive 222
Test image 2 (Mono8 mode) progressive 223
Test image 1 and 2 (Mono8 mode) interlaced 223

Configuration of the camera 224

Camera_Status_Register 224
Example 225
Sample program 226
Configuration ROM 227
Implemented registers (IIDC V1.3) 230
Camera initialize register 230
Inquiry register for video format 230
Inquiry register for video mode 231
Inquiry register for video frame rate and base address 232
Inquiry register for basic function 241
Inquiry register for feature presence 242
Inquiry register for feature elements 244
Inquiry register for absolute value CSR offset address 247
Status and control register for feature 248
Feature control error status register 251
Video mode control and status registers for Format_7 252
Quadlet offset Format_7 Mode_0 252
Quadlet offset Format_7 Mode_1 252
Format_7 control and status register (CSR) 252
Advanced features (AVT-specific) 254
Advanced registers summary 254
Extended version information register 257
Advanced feature inquiry 259
Camera status 261
Maximum resolution 262
Time base 262
Extended shutter 264

Test images 265
Look-up tables (LUT) 266
Defect pixel correction (only Guppy F-503) 268
Input/output pin control........ 270
Delayed Integration Enable (IntEna) 270
Auto shutter control 271
Auto gain control 272
Autofunction AOI 273
Trigger delay 274
Mirror image (only Guppy F-036) 275
Pulse-width modulation (board level cameras only) 275
Soft reset 276
User profiles 277
Error codes 278
Reset of error codes 278
Stored settings 279
Format_7 mode mapping (only Guppy F-503) 280
Additional Format_7 modes 280
Example 281
Low noise binning mode (2 x and 4 x binning)
(only Guppy F-503) 281
Global reset release shutter
(only Guppy F-503) 282
GPDATA_BUFFER 283
Little endian vs. big endian byte order 283

Firmware update 284
Extended version number (FPGA/µC) 284

Appendix 285
Sensor position accuracy of AVT cameras 285

Index 286

Contacting Allied Vision Technologies

Info

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  support@alliedvisiontec.com
  phone (for Germany): +49 (0)36428 677-270
  phone (for USA): +1 978-225-2030
  outside Germany/USA: Please check the link for your local dealer.
  http://www.alliedvisiontec.com/partner.html

- **Ordering and commercial information:**
  customer-care@alliedvisiontec.com
  phone (for Germany): +49 (0)36428 677-230
  phone (for USA): +1 978-225-2030
  outside Germany/USA: Please check the link for your local dealer.
  http://www.alliedvisiontec.com/partner.html
  Please note order number/text given in the **AVT Modular Camera Concept**.

Introduction

This **GUPPY 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	06.04.2006	New Manual - RELEASE status
V2.0.1	28.06.2006	RoHS conformity; minor corrections
PRE_V3.0.0	30.10.2006	Minor corrections Input characteristics: Added description to input voltage Added Guppy F-036B/C Correction in Chapter Multi-shot on page 186 New CAD drawing in Figure 23: Camera dimensions (new CS-/C-Mounting) on page 65. New CAD drawing in Figure 29: Guppy C-Mount dimensions on page 71. New CAD drawing in Figure 30: Guppy CS-Mount dimensions on page 72.
to be continued on next page		

Table 1: Document history

Version	Date	Remarks
		continued from last page
PRE_V3.0.0 [continued]	30.10.2006 [continued]	New CS-Mount and C-Mount adapter in Chapter Guppy cameras on page 23. Added Guppy F-33B/C BL (board level version) Changed camera status register (Table 113: Advanced register: Camera status on page 261) Added Guppy F-146
PRE_V4.0.0	26.01.2007	Minor corrections Added Guppy F-080B/C BL (board level version) Added new features Guppy-F036B/C
V4.0.1	02.02.2007	Minor corrections Guppy F-146: new frame rates
PRE_V5.0.0	09.05.2007	Minor corrections Added interlaced GUPPYs F-038B/C, F038B/C NIR, F-044B/C, F-044B/C NIR Added **Value** field in Table 46: CSR: Shutter on page 129 Added detailed description of BRIGHTNESS (800h) in Table 106: Feature control register on page 248 Added detailed description of WHITE-BALANCE (80Ch) in Table 106: Feature control register on page 248 et seq.
V5.0.1	09.05.2007	RELEASE status
V6.0.0	01.06.2007	Added interlaced GUPPYs F-025 and GUPPY F-029 Added description of sensor readout and color: Chapter Format_7 Mode_0: sensor readout and color on page 110 and Chapter Format_7 Mode_1: sensor readout and color on page 112
V6.0.1	08.06.2007	Corrected image device type and diag. of Guppy F-025B/C and Guppy F-029B/C
		to be continued on next page

Table 1: Document history

Version	Date	Remarks
		continued from last page
V6.0.2	31.03.08	**Minimum shutter time** of Guppy F-036B/C is now **180 µs**: see Chapter Guppy F-036B/C on page 33 and Chapter Minimum shutter time of GUPPY F-036 on page 182. Added note: Guppy F-036 supports only Trigger_Mode_0. See Chapter Trigger modes on page 170. Corrected drawing in Figure 60: Format_7 Mode_0: Sensor readout on page 110 (lines of the first field are merged above those of the second field) Moved AVT Glossary from Appendix of GUPPY Technical Manual to AVT Website. New M3 x 3 (2x) in Figure 23: Camera dimensions (new CS-/C-Mounting) on page 65
V6.1.0	09.07.08	New ordering numbers of I/O cables K1200196 (2 m) and K1200197 (5 m) in Chapter Camera I/O connector pin assignment on page 75 New board level CAD drawing and marked Pin 1 with blue color in Figure 32: Board level camera: IEEE 1394 FireWire connector 1 (view on pins) on page 74 Restructuring of Guppy Technical Manual: • Added Chapter Contacting Allied Vision Technologies on page 9 • Added Chapter Manual overview on page 18 • Restructured Chapter Guppy types and highlights to Chapter Guppy cameras on page 23. – Infos from Guppy camera types table moved to Chapter Specifications on page 29 – Safety instructions moved to Hardware Installation Guide, Chapter Safety instructions and AVT camera cleaning instructions – Environmental conditions moved to Guppy Instruction Leaflet and Guppy Board Level Instruction Leaflet – Infos on CS-/C-Mounting moved to Hardware Installation Guide, Chapter GUPPY: changing filters safety instructions – Infos on System components moved to Guppy Instruction Leaflet and Guppy Board Level Instruction Leaflet
		to be continued on next page

Table 1: Document history

Version	Date	Remarks
		continued from last page
V6.1.0 [continued]	09.07.08 [continued]	**Restructuring of Guppy Technical Manual [continued]:** – Infos on *System components* and *Environmental conditions* moved to *Guppy Instruction Leaflet* and *Guppy Board Level Instruction Leaflet* – Infos on *IR cut filter* and *Lenses* moved to Chapter Filter and lenses on page 26 – Removed infos on old CS-/C-Mounting in Chapter Specifications on page 29 – Moved binning explanation from Chapter Specifications on page 29 to Chapter Video formats, modes and bandwidth on page 190 – Binning / sub-sampling modes and color modes are only listed in Chapter Video formats, modes and bandwidth on page 190 – Moved detailed description of the camera interfaces (FireWire, I/O connector), ordering numbers and operating instructions to the *Hardware Installation Guide*. – Revised Chapter Description of the data path on page 98 – Revised Chapter Controlling image capture on page 167; added Table 59: Trigger modes on page 170 – Revised Chapter Video formats, modes and bandwidth on page 190 – Revised Chapter How does bandwidth affect the frame rate? on page 219 – Revised Chapter Configuration of the camera on page 224 – Revised Chapter Firmware update on page 284 – Added Chapter Sensor position accuracy of AVT cameras on page 285 – Revised Chapter Index on page 286 Changed provisions directive to 2004/108/EG in Chapter Declarations of conformity on page 24 Added Chapter Packed 12-Bit Mode on page 153 Added tables Table 34: Packed 12-Bit Mode (mono and raw) Y12 format from AVT on page 95 and Table 35: Data structure of Packed 12-Bit Mode (mono and raw) from AVT on page 97.
		to be continued on next page

Table 1: Document history

Version	Date	Remarks
		continued from last page
V6.1.0 [continued]	09.07.08 [continued]	Added 30 fps as fixed frame rate in Table 17: Guppy F-146B/C on page 49 Added Vendor Unique Color_Coding in Table 108: Format_7 control and status register on page 252f Minimum delay time is 1µs in Table 64: Advanced CSR: trigger delay on page 179 Added Raw12 and Raw16 frame rates in Chapter GUPPY F-146: AOI frame rates on page 216 Added Format_7 Mode_3 in: • Table 73: Video formats Guppy F-038B / Guppy F-038C on page 193 • Table 74: Video formats Guppy F-038B NIR / Guppy F-038C NIR on page 193 • Table 75: Video formats Guppy F-044B / Guppy F-044C on page 194 • Table 76: Video formats Guppy F-044B NIR / Guppy F-044C NIR on page 194 Added Chapter Extended version number (FPGA/µC) on page 284 Added extended version registers (0xF1000014 and 0xF100001C) in Table 109: Advanced registers summary on page 254 Added **VERSION_INFOx_EX** registers and description in Chapter Extended version information register on page 257
		to be continued on next page

Table 1: Document history

Version	Date	Remarks
		continued from last page
V6.2.0	15.08.08	Added cross-reference from **upload LUT** to **GPDATA_BUFFER** in Chapter Loading an LUT into the camera on page 132 Added Guppy F-146 with Mono8 (8-bit format) and Mono12/16 (12-bit format) in Chapter Pixel data on page 93f. In 12-bit mode the data output is MSB aligned (12 significant bits). In 16-bit mode the data output is MSB aligned (also 12 significant bits). Added detailed level values of I/Os in Chapter GUPPY (housing) on page 76 and Chapter GUPPY (board level) on page 77. Added little endian vs. big endian byte order in Chapter GPDATA_BUFFER on page 283 Added RoHS in Chapter Declarations of conformity on page 24 Listed shutter speed with offset in Chapter Specifications on page 29ff. New measurement of IntEna signals, therefore new offsets in Chapter Exposure time (shutter) and offset on page 181f. and in Figure 104: Data flow and timing after end of exposure (Guppy F-038/044 also NIR) on page 186. New photo of LED positions in Figure 35: Status LEDs on page 78
		to be continued on next page

Table 1: Document history

Version	Date	Remarks
	continued from last page	
V7.0.0	31.10.08	Operating temperature changed from 50 °C to 45 °C for all Guppy types in Chapter Specifications on page 29ff. New Guppy camera photos with new camera naming font: • Title page New Guppy F-503B/C: Read information in the following sections: • Chapter Declarations of conformity on page 24f. • Table 5: Focal width vs. field of view (Guppy F-503) on page 27 • Chapter Specification Guppy F-503B/C on page 51f. • Chapter Horizontal and vertical mirror function (only Guppy F-036/F-503) on page 114 • Chapter White balance on page 114ff. • Chapter Manual gain on page 122 • Chapter Brightness (black level or offset) on page 126 • Chapter Look-up table (LUT) and gamma function on page 131f. • Chapter Binning (only Guppy F-036B and Guppy F-503B/C) on page 138ff. • Chapter Packed 12-Bit Mode on page 153. This mode is not yet available for Guppy F-503B/C. • Chapter Exposure time (shutter) and offset on page 181ff. • Table 65: Camera-specific exposure time offset on page 182 • Figure 104: Data flow and timing after end of exposure (Guppy F-038/044 also NIR) on page 186 • Table 70: Jitter at exposure start on page 188 • Table 80: Video formats Guppy F-503B / Guppy F-503C on page 198 • GUPPY F-503: AOI frame rates on page 217 • Table 111: Camera type ID list on page 258 For Guppy F-503B/C output switching times (tp and min. shutter) see **Hardware Installation Guide**, subsection *Guppy delay*.
	to be continued on next page	

Table 1: Document history

Version	Date	Remarks
	continued from last page	
V7.1.0	07.05.09	All advanced registers in 8-digit format beginning with 0xF1... in Chapter Advanced features (AVT-specific) on page 254ff. Firing a new trigger while IntEna is still active can result in **missing image** (not image corruption): see Caution on page 88. Revised Chapter White balance on page 114ff. **New Features: Guppy F-503:** • Defect pixel correction in Chapter Defect pixel correction (only Guppy F-503B/C) on page 133 and Table 120: Advanced register: Defect pixel correction on page 268 • More gain steps in Table 42: Manual gain range of the various GUPPY types (CCD and CMOS) on page 123 • Global reset release shutter in Chapter Electronic rolling shutter (ERS) and global reset release shutter (GRR) (only Guppy F-503) on page 169 • Format_7 mode mapping in Chapter Binning and sub-sampling access (only Guppy F-503) on page 151ff. and Chapter Format_7 mode mapping (only Guppy F-503) on page 280f. • Description of Trigger_Mode_0 with electronic rolling shutter and global reset release shutter in Chapter Trigger modes on page 170ff. • Changing between electronic rolling shutter (ERS) and global reset release shutter (GRR) in Table 133: Advanced register: Global reset release shutter on page 282 • Max. exposure time in Chapter Extended shutter on page 264 Changed sensor name from Micron to **Micron/Aptina** in Table 9: Specification Guppy F-036B/C on page 33 Changed sensor name from Micron to **Micron/Aptina** in Table 18: Specification Guppy F-503B/C on page 51 Changed sensor name from Micron to **Micron/Aptina** in Chapter HDR (high dynamic range) (GUPPY F-036 only) on page 154ff. Changed sensor name from Micron to **Micron/Aptina** in Chapter Controlling image capture on page 167
	to be continued on next page	

Table 1: Document history

Version	Date	Remarks
		continued from last page
V7.1.0 [continued]	07.05.09 [continued]	[continued] Offset of low noise binning mode changed from 0xF1000580 to 0xF10005B0 in Table 132: Advanced register: Low noise binning mode on page 281. Changed *Camera In 1 signal* U_{in}(high) from 2 V to **2.4 V** in Figure 33: GUPPY (housing): Camera I/O connector pin assignment on page 76 Corrected HUE and SATURATION in *Feature control register* to **Always 0 (for b/w and color cameras)** on page 251 (TestTrack Defect 605) Calculated **effective chip size** for all sensors (with resolution of Format_7 Mode_0) in Chapter Specifications on page 29ff. Due to discontinuation: removed Guppy F-025/029 cameras in • Chapter Guppy cameras on page 23 • Chapter Declarations of conformity on page 24f. • Chapter Specifications on page 29ff. • Chapter Video formats, modes and bandwidth on page 190ff. • Chapter Description of the data path on page 98ff. • Chapter Controlling image capture on page 167ff. Corrected drawing in Figure 121: Delayed integration timing on page 270

Table 1: Document history

Manual overview

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

- Chapter Contacting Allied Vision Technologies on page 9 lists AVT contact data for both:
  - technical information / ordering
  - commercial information
- Chapter Introduction on page 10 (this chapter) gives you the document history, a manual overview and conventions used in this manual (styles and symbols). Furthermore you learn how to get more information on **how to install hardware (Hardware Installation Guide)**, available **AVT software** (incl. documentation) and where to get it.
- Chapter Guppy cameras on page 23 gives you a short introduction to the GUPPY cameras with their FireWire technology. Links are provided to data sheets and brochures on AVT website.

- Chapter Declarations of conformity on page 24 gives you information about conformity of AVT cameras.
- Chapter Filter and lenses on page 26 describes the IR cut filter and suitable camera lenses.
- Chapter Specifications on page 29 lists camera details and spectral sensitivity diagrams for each camera type.
- Chapter Camera dimensions on page 63 provides CAD drawings of standard housing (copper) models and board level models, tripod adapter, cross sections of CS-Mount and C-Mount.
- Chapter Camera interfaces on page 73 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 98 describes in detail IIDC conformable as well as AVT-specific camera features.
- Chapter Controlling image capture on page 167 describes shutter and trigger modi, exposure time, one-shot/multi-shot/ISO_Enable features and jitter.
- Chapter Video formats, modes and bandwidth on page 190 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 219 gives some considerations on bandwidth details.
- Chapter Configuration of the camera on page 224 lists standard and advanced register descriptions of all camera features.
- Chapter Firmware update on page 284 explains where to get information on firmware updates.
- Chapter Appendix on page 285 lists the sensor position accuracy of AVT cameras.
- Chapter Index on page 286 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.

Caution-ESD

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

www

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

Example:

http://www.alliedvisiontec.com

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** on the product CD in the following directory:

products\cameras-general

www

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

www.alliedvisiontec.com/avt-products/software.html

All software packages are also on AVT's 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.

Guppy cameras

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

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

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

www

For further information on the highlights of GUPPY **types**, the GUPPY **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

Declarations of conformity

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

Category name	Model name
Digital camera (IEEE 1394)	Guppy F-033B
	Guppy F-033C
	Guppy F-033B BL (board level)
	Guppy F-033C BL (board level)
	Guppy F-036B
	Guppy F-036C
	Guppy F-038B
	Guppy F-038C
	Guppy F-038B NIR
	Guppy F-038C NIR
	Guppy F-044B
	Guppy F-044C
	Guppy F-044B NIR
	Guppy F-044C NIR
	Guppy F-046B
	Guppy F-046C
	Guppy F-080B
	Guppy F-080C
	Guppy F-080B BL (board level)
	Guppy F-080C BL (board level)
	Guppy F-146B
	Guppy F-146C
	Guppy F-503B
	Guppy F-503C

Table 3: Model names

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

- FCC Class B (Guppy board level cameras: prepared for FCC Class B)
- CE (Guppy board level cameras do not have CE)
  (following the provisions of 2004/108/EG directive)

- RoHS (2002/95/EC)

Note

Customer samples may not comply with above regulations.

Filter and lenses

IR cut filter

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

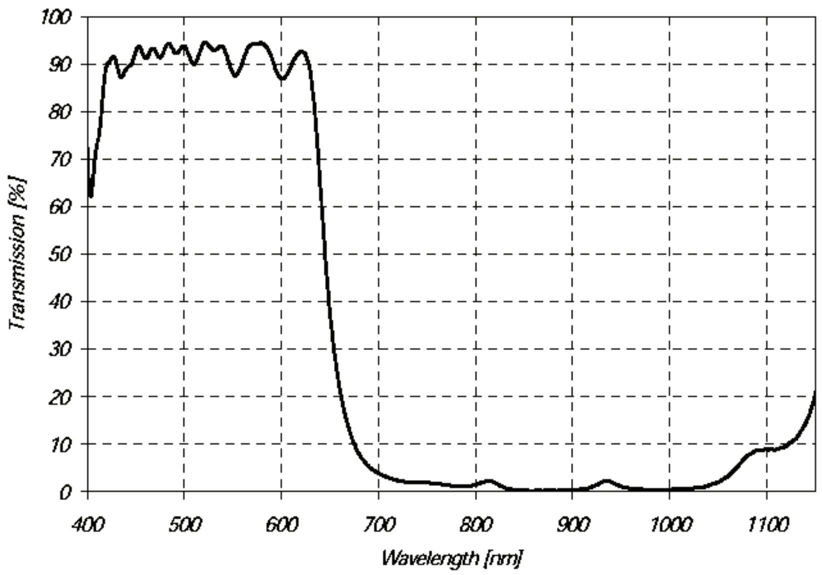


Figure 1: Spectral transmission of Jenofilt 217

Camera lenses

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

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

Table 4: Focal width vs. field of view (Guppy F-046)

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

Table 5: Focal width vs. field of view (Guppy F-503)

Focal Width for type 1/3 sensors Guppy F-033/036/080	**Distance = 0.5 m**	**Distance = 1 m**
4.8 mm	0.375 m x 0.5 m	0.75 m x 1 m
8 mm	0.22 m x 0.29 m	0.44 m x 0.58 m
12 mm	0.145 m x 0.19 m	0.29 m x 0.38 m
16 mm	11 cm x 14.7 cm	22 cm x 29.4 cm
25 mm	6.9 cm x 9.2 cm	13.8 cm x 18.4 cm
35 mm	4.8 cm x 6.4 cm	9.6 cm x 12.8 cm
50 mm	3.3 cm x 4.4 cm	6.6 cm x 8.8 cm

Table 6: Focal width vs. field of view (Guppy F-033/036/080)

Specifications

Note

For information on bit/pixel and byte/pixel for each color mode see Table 90: ByteDepth on page 219.

Guppy F-033B/C

Feature	Specification
Image device	Type 1/3 (diag. 6 mm) progressive scan SONY IT CCD ICX424AL/AQ with HAD microlens
Effective chip size	**4.9 mm x 3.7 mm**
Cell size	7.4 µm x 7.4 µm
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 29: Guppy C-Mount dimensions on page 71) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 30: Guppy CS-Mount dimensions on page 72)
Picture size (max.)	656 x 494 pixels (Format_7 Mode_0)
ADC	10 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps variable frame rates in Format_7 up to 58 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain (select. AOI)
Shutter speed	**129** µs … 67,108,864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, advanced feature: Trigger_Mode_15 (bulk); trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	• AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) **only color:** AWB (auto white balance) • one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s

Table 7: Specification Guppy F-033B/C

Feature	Specification
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 g (without lens)
Operating temperature	+ 5 °C ... + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2002/95/EC)
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter
Optional accessories	• Board level OEM version • **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	• AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 7: Specification Guppy F-033B/C

Note

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

Guppy F-033B/C BL (board level)

Feature	Specification
Image device	Type 1/3 (diag. 6 mm) progressive scan SONY IT CCD ICX424AL/AQ with HAD microlens
Effective chip size	**4.9 mm x 3.7 mm**
Cell size	7.4 µm x 7.4 µm
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 29: Guppy C-Mount dimensions on page 71) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 30: Guppy CS-Mount dimensions on page 72)
Picture size (max.)	656 x 494 pixels (Format_7 Mode_0)
ADC	14 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps variable frame rates in Format_7 up to 58 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain (select. AOI)
Shutter speed	**129** µs … 67,108,864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, advanced feature: Trigger_Mode_15 (bulk); trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	• AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) **only color:** AWB (auto white balance) • 4 free configurable inputs/outputs with pulse width modulation (PWM) for each, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, two ports (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 10-pin connector
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	35 mm x 35 mm (sensor board); 35 mm x 70 mm (main board); without lens
Mass	~30 g (without lens mount adapter, without lens)
Operating temperature	+ 5 °C … + 45 °C (without condensation)
Storage temperature	- 10 °C … + 60 °C ambient temperature (without condensation)

Table 8: Specification Guppy F-033B/C BL (board level)

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

Table 8: Specification Guppy F-033B/C BL (board level)

Note

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

Guppy F-036B/C

Feature	Specification
Image device	Type 1/3 (diag. 5.35 mm) progressive scan Micron/Aptina CMOS MT9V022 with microlens
Effective chip size	**4.5 mm x 2.9 mm**
Cell size	6.0 µm x 6.0 µm
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 29: Guppy C-Mount dimensions on page 71) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 30: Guppy CS-Mount dimensions on page 72)
Picture size (max.)	752 x 480 pixels (Format_7 Mode_0)
ADC	10 bit
Frame rates	15 fps; 30 fps; 60 fps variable frame rates in Format_7 from 10 fps up to 64 fps
Gain control	Manual: 0-12 dB (average ~0.25 dB/step) for details see Chapter Manual gain on page 122
Shutter speed	**179** µs … ~979 ms
External trigger shutter	Trigger_Mode_0, trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	• AGC (auto gain control), LUT (look-up table), mirror, **only b/w:** binning (average) **only color:** AWB (auto white balance) • one configurable input, three configurable outputs • RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 g (without lens)
Operating temperature	+ 5 °C … + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 60 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2002/95/EC)

Table 9: Specification Guppy F-036B/C

Feature	Specification
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter
Optional accessories	• **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	• AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 9: Specification Guppy F-036B/C

Note

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

Guppy F-038B/C

Feature	Specification
Image device	Type 1/2 (diag. 8 mm) interlaced SONY EIA/NTSC CCD ICX418ALL/AKL with HAD microlens
Effective chip size	**6.5 mm x 4.8 mm**
Cell size	8.4 µm x 9.8 µm
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 29: Guppy C-Mount dimensions on page 71) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 30: Guppy CS-Mount dimensions on page 72)
Picture size (max.)	768 x 492 pixels (Format_7 Mode_0)
ADC	12 bit
Frame rates	Variable frame rates in Format_7 from 0.15 fps up to 30 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain
Shutter speed	**62** µs … 67,108,864 µs (~67s); auto shutter
External trigger shutter	Trigger_Mode_0, Trigger_Mode_15, trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	• AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) **only color:** AWB (auto white balance) • one configurable input, three configurable outputs • RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 g (without lens)
Operating temperature	+ 5 °C … + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 60 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2002/95/EC)
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter

Table 10: Specification Guppy F-038B/C

Feature	Specification
Optional accessories	• **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	• AVT FirePackage (SDK and Viewer, 100% control the bus) • Only on request: AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • Only on request: AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 10: Specification Guppy F-038B/C

Guppy F-038B/C NIR

Feature	Specification
Image device	Type 1/2 (diag. 8 mm) interlaced SONY EIA/NTSC ICX428ALL/AKL with EXview HAD microlens for enhanced near infrared light sensitivity
Effective chip size	**6.5 mm x 4.8 mm**
Cell size	8.4 µm x 9.8 µm
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 29: Guppy C-Mount dimensions on page 71) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 30: Guppy CS-Mount dimensions on page 72)
Picture size (max.)	768 x 492 pixels (Format_7 Mode_0)
ADC	12 bit
Frame rates	variable frame rates in Format_7 from 0.15 fps up to 30 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain
Shutter speed	**62** µs … 67,108,864 µs (~67s); auto shutter
External trigger shutter	Trigger_Mode_0, Trigger_Mode_15, trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	• AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) **only color:** AWB (auto white balance) • one configurable input, three configurable outputs • RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 g (without lens)
Operating temperature	+ 5 °C … + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 60 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2002/95/EC)
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter

Table 11: Specification Guppy F-038B/C NIR

Feature	Specification
Optional accessories	• **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	• AVT FirePackage (SDK and Viewer, 100% control the bus) • Only on request: AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • Only on request: AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 11: Specification Guppy F-038B/C NIR

Note

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

Guppy F-044B/C

Feature	Specification
Image device	Type 1/2 (diag. 8 mm) interlaced SONY CCIR/PAL CCD ICX419ALL/AKL with HAD microlens
Effective chip size	**6.5 mm x 4.8 mm**
Cell size	8.6 µm x 8.3 µm
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 29: Guppy C-Mount dimensions on page 71) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 30: Guppy CS-Mount dimensions on page 72)
Picture size (max.)	752 x 580 (Format_7 Mode_0)
ADC	12 bit
Frame rates	Variable frame rates in Format_7 from 0.15 fps up to 25 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain
Shutter speed	**62** µs … 67,108,864 µs (~67s); auto shutter
External trigger shutter	Trigger_Mode_0, Trigger_Mode_15, trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	• AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) **only color:** AWB (auto white balance) • one configurable input, three configurable outputs • RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 g (without lens)
Operating temperature	+ 5 °C … + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 60 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2002/95/EC)
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter

Table 12: Specification Guppy F-044B/C

Feature	Specification
Optional accessories	• **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	• AVT FirePackage (SDK and Viewer, 100% control the bus) • Only on request: AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • Only on request: AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 12: Specification Guppy F-044B/C

Note

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

Guppy F-044B/C NIR

Feature	Specification
Image device	Type 1/2 (diag. 8 mm) interlaced SONY CCIR/PAL CCD ICX429ALL/AKL with EXview HAD microlens for enhanced near infrared light sensitivity
Effective chip size	**6.5 mm x 4.8 mm**
Cell size	8.6 µm x 8.3 µm
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 29: Guppy C-Mount dimensions on page 71) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 30: Guppy CS-Mount dimensions on page 72)
Picture size (max.)	752 x 580 (Format_7 Mode_0)
ADC	12 bit
Frame rates	Variable frame rates in Format_7 from 0.15 fps up to 25 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain
Shutter speed	**62** µs … 67,108,864 µs (~67s); auto shutter
External trigger shutter	Trigger_Mode_0, Trigger_Mode_15, trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	• AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) **only color:** AWB (auto white balance) • one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 g (without lens)
Operating temperature	+ 5 °C … + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 60 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2002/95/EC)
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter

Table 13: Specification Guppy F-044B/C NIR

Feature	Specification
Optional accessories	• **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	• AVT FirePackage (SDK and Viewer, 100% control the bus) • Only on request: AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • Only on request: AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 13: Specification Guppy F-044B/C NIR

Note

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

Guppy F-046B/C

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
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 29: Guppy C-Mount dimensions on page 71) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 30: Guppy CS-Mount dimensions on page 72)
Picture size (max.)	780 x 582 pixels (Format_7 Mode_0)
ADC	12 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps variable frame rates in Format_7 up to 49.4 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain (select. AOI)
Shutter speed	**42** µs … 67,108,864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, advanced feature: Trigger_Mode_15 (bulk); trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	• AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) **only color:** AWB (auto white balance) • one configurable input, three configurable outputs • RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 g (without lens)
Operating temperature	+ 5 °C … + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 60 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2002/95/EC)

Table 14: Specification Guppy F-046B/C

Feature	Specification
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter
Optional accessories	• Board level OEM version • **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	• AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 14: Specification Guppy F-046B/C

Note

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

Guppy F-080B/C

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
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 29: Guppy C-Mount dimensions on page 71) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 30: Guppy CS-Mount dimensions on page 72)
Picture size (max.)	1032 x 778 (Format_7 Mode_0)
ADC	12 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps variable frame rates in Format_7 up to 30 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain (select. AOI)
Shutter speed	**54** µs …67,108,864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, advanced feature: Trigger_Mode_15 (bulk); image transfer by command; trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	• AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) **only color:** AWB (auto white balance) • one configurable input, three configurable outputs, RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); without tripod and lens
Mass	50 g (without lens)
Operating temperature	+ 5 °C … + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 60 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2002/95/EC)

Table 15: Guppy F-080B/C

Feature	Specification
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter
Optional accessories	• Board level OEM version • **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	• AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 15: Guppy F-080B/C

Note

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

Guppy F-080B/C BL (board level)

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
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 26: Guppy board level version: C-Mount on page 68) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 25: Guppy board level: CS-Mount on page 67)
Picture sizes	1024 x 768 pixels (Format_1) supporting all smaller fixed formats 1032 x 778 (Format_7 Mode_0)
ADC	14 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps variable frame rates in Format_7 up to 30 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain (select. AOI)
Shutter speed	**54** µs …67,108,864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, advanced feature: Trigger_Mode_15 (bulk); image transfer by command; trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	• AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) **only color:** AWB (auto white balance) • 4 free configurable inputs/outputs with pulse width modulation (PWM) for each • RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, two ports (daisy chain)
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 10-pin connector
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	35 mm x 35 mm (sensor board); 35 mm x 70 mm (main board); without lens
Mass	~30 g (without lens mount adapter, without lens)
Operating temperature	+ 5 °C … + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 60 °C ambient temperature (without condensation)

Table 16: Guppy F-080B/C BL (board level)

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

Table 16: Guppy F-080B/C BL (board level)

Note

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

Guppy F-146B/C

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
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 29: Guppy C-Mount dimensions on page 71) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 30: Guppy CS-Mount dimensions on page 72)
Picture size (max.)	1392 x 1040 (Format_7 Mode_0)
ADC	12 bit
Frame rates	3.75 fps; 7.5 fps; 15 fps; 30 fps variable frame rates in Format_7 up to 17.7 fps
Gain control	Manual: 0-24 dB (0.035 dB/step); auto gain (select. AOI)
Shutter speed	**40** µs …67,108,864 µs (~67s); auto shutter (select. AOI)
External trigger shutter	Trigger_Mode_0, Trigger_Mode_1, advanced feature: Trigger_Mode_15 (bulk); image transfer by command; trigger delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	• AGC (auto gain control), AEC (auto exposure control), LUT (look-up table) **only color:** AWB (auto white balance) • one configurable input, three configurable outputs • RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); without tripod and lens
Mass	50 g (without lens)
Operating temperature	+ 5 °C … + 45 °C housing temperature (without condensation)
Storage temperature	- 10 °C … + 60 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2002/95/EC)

Table 17: Guppy F-146B/C

Feature	Specification
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter
Optional accessories	• Board level OEM version • **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter. • **color:** C/CS-Mount: protection glass available as CS-Mount adapter.
Software packages	• AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 17: Guppy F-146B/C

Note

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

Guppy F-503B/C

Feature	Specification
Image device	Type 1/2.5 (diag. 7.13 mm) Micron/Aptina CMOS MT9P031 with microlens • Electronic rolling shutter (ERS) • Global reset release shutter (GRR)
Effective chip size	**5.7 mm x 4.3 mm**
Cell size	2.2 µm x 2.2 µm
Lens mount	C-Mount: 17.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back to filter distance: 9.5 mm (see Figure 29: Guppy C-Mount dimensions on page 71) CS-Mount: 12.526 mm (in air), Ø 25.4 mm (32 tpi), mechanical flange back distance: 8 mm (see Figure 30: Guppy CS-Mount dimensions on page 72)
Picture size (max.)	2592 x 1944 pixels (Format_7 Mode_0)
ADC	12 bit
Frame rates	1.875 fps; 3.75 fps; 7.5 fps; 15 fps; 30 fps; 60 fps variable frame rates in Format_7 up to 6.5 fps
Gain control	Manual: 0-26 dB (average ~0.928 dB/step) for details see Chapter Manual gain on page 122
Shutter speed	**41.8** µs … ~2.3 s
External trigger shutter	Trigger_Mode_0, trigger delay, IntEna delay
Look-up table	One, user programmable (10 bit → 8 bit); gamma (0.5)
Smart functions	• AGC (auto gain control), LUT (look-up table), mirror (horizontal and vertical), defect pixel correction, 2x - 4x binning (horizontal: additive or average; vertical: average) or sub-sampling, multi-shot, separate reference AOI for auto features **only color:** AWB (auto white balance) • one configurable input, three configurable outputs • RS-232 port (serial port, IIDC V1.31)
Transfer rate	100 Mbit/s, 200 Mbit/s, 400 Mbit/s
Digital interface	IEEE 1394a IIDC V1.3, single port
Power requirements	DC 8 V - 36 V via IEEE 1394 cable or 8-pin HIROSE
Power consumption	Less than 2 watt (@ 12 V DC)
Dimensions	48.2 mm x 30 mm x 30 mm (L x W x H); w/o tripod and lens
Mass	50 g (without lens)
Operating temperature	+ 5 °C … + 45 °C housing temperature (without condensation)

Table 18: Specification Guppy F-503B/C

Feature	Specification
Storage temperature	- 10 °C ... + 60 °C ambient temperature (without condensation)
Regulations	FCC Class B, CE, RoHS (2002/95/EC)
Standard accessories	• **b/w:** C/CS-Mount with built-in protection glass • **color:** C/CS-Mount with built-in IR cut filter
Optional accessories	• **b/w:** C/CS-Mount: IR cut filter / IR pass filter available as CS-Mount adapter • **color:** C/CS-Mount: protection glass available as CS-Mount adapter
Software packages	• AVT FirePackage (SDK and Viewer, 100% control the bus) • AVT Direct FirePackage (SDK and Viewer, compatible to DirectX and WDM) • AVT Fire4Linux (SDK and Viewer, compatible to RedHat and Suse Distributions)

Table 18: Specification Guppy F-503B/C

Note

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

Spectral sensitivity

Note

The following quantum efficiency diagrams show typical values of the sensors.

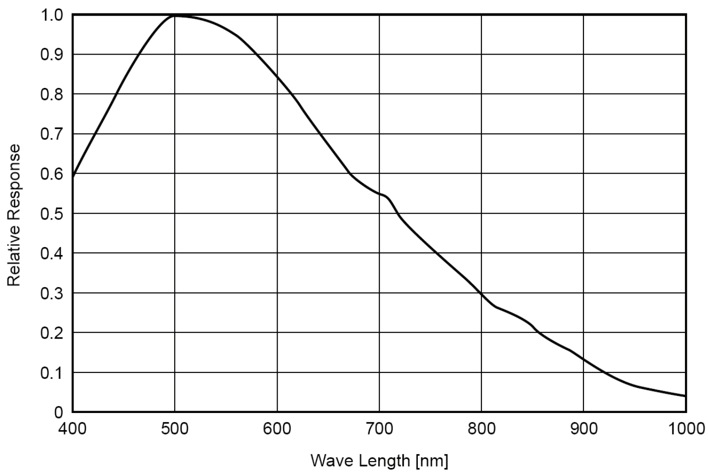


Figure 2: Spectral sensitivity of Guppy F-033B without cut filter and optics

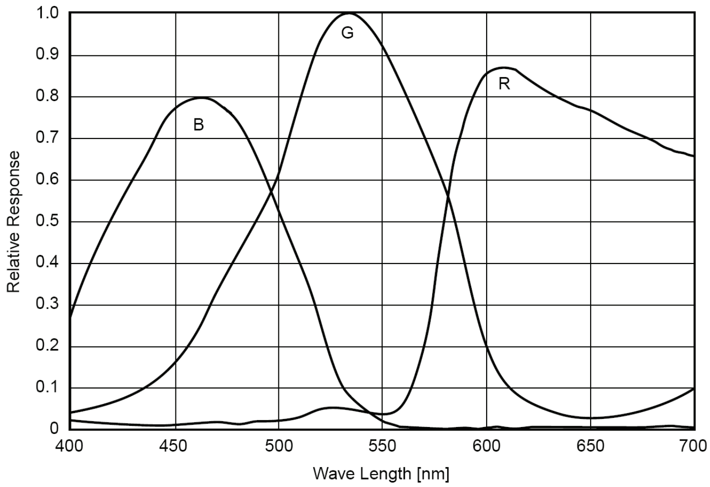


Figure 3: Spectral sensitivity of Guppy F-033C without cut filter and optics

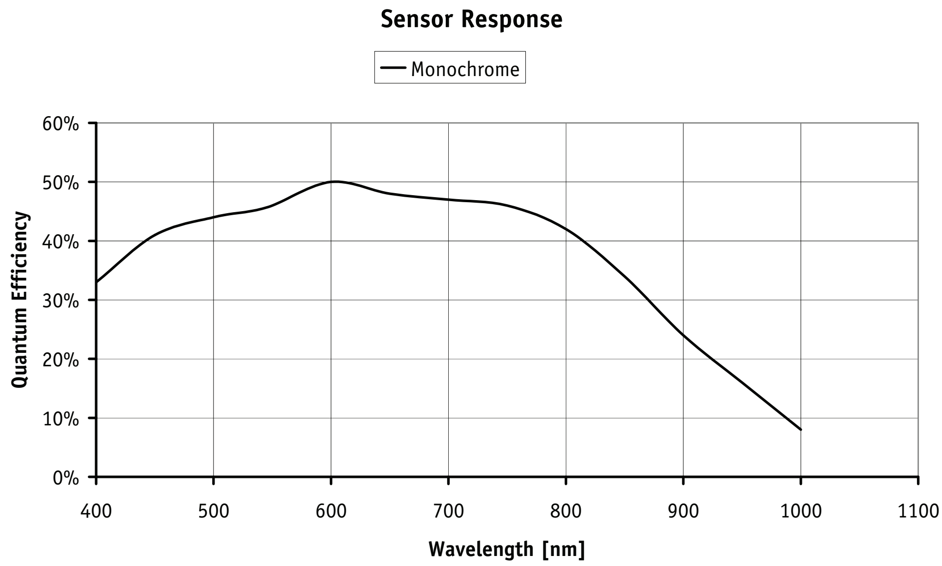


Figure 4: Spectral sensitivity of Guppy F-036B without cut filter and optic

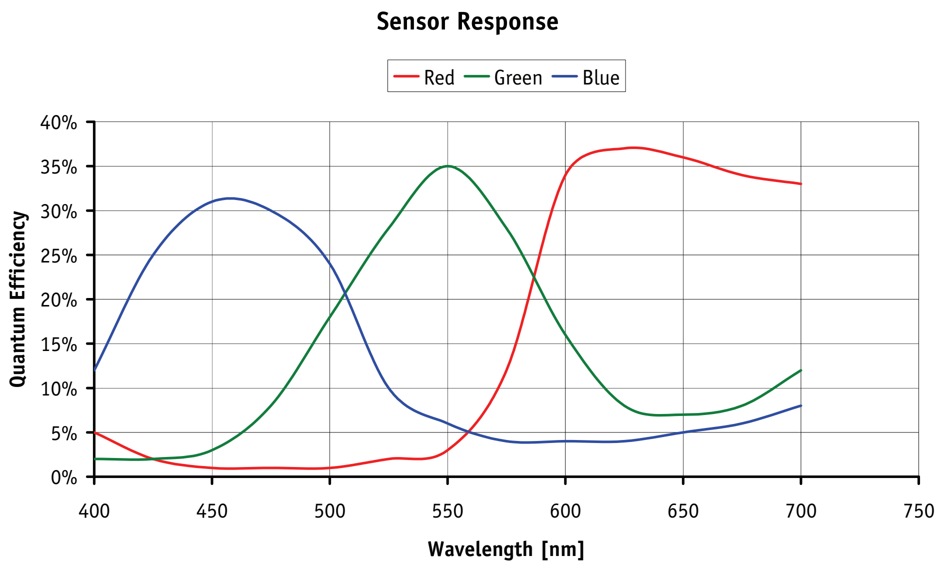


Figure 5: Spectral sensitivity of Guppy F-036C without cut filter and optics

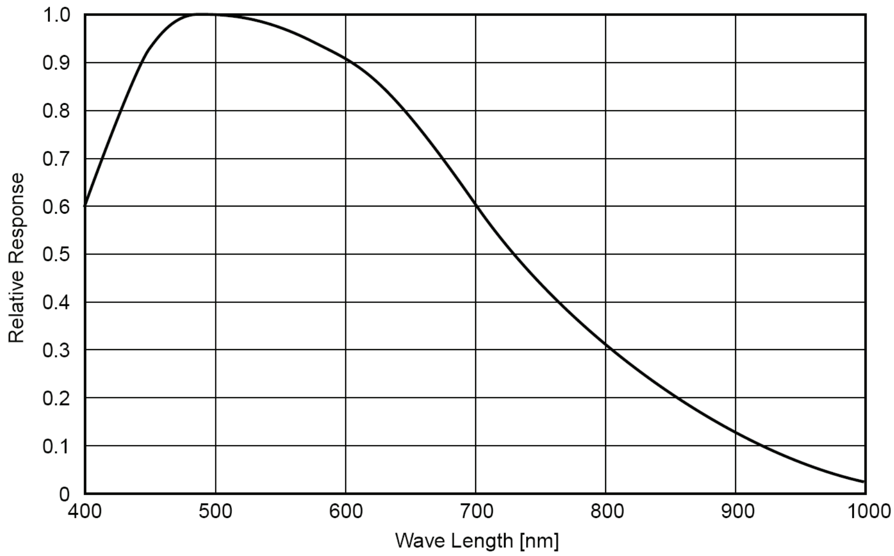


Figure 6: Spectral sensitivity of Guppy F-038B without cut filter and optics

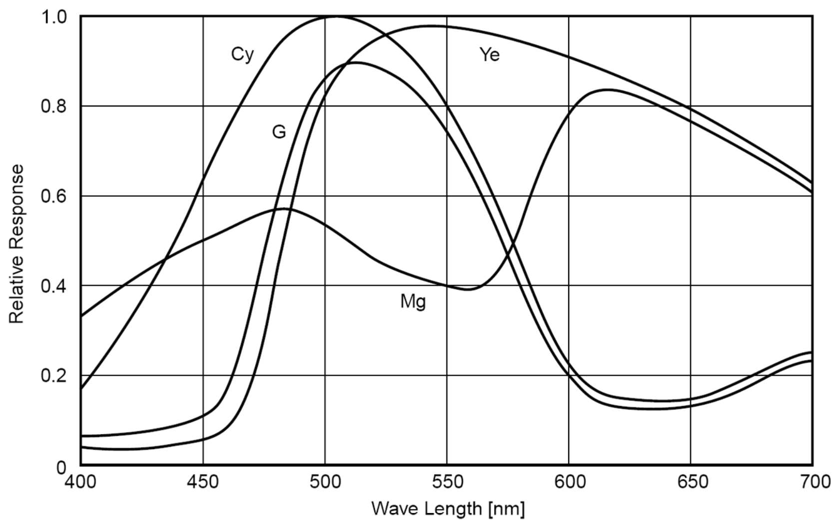


Figure 7: Spectral sensitivity of Guppy F-038C without cut filter and optics

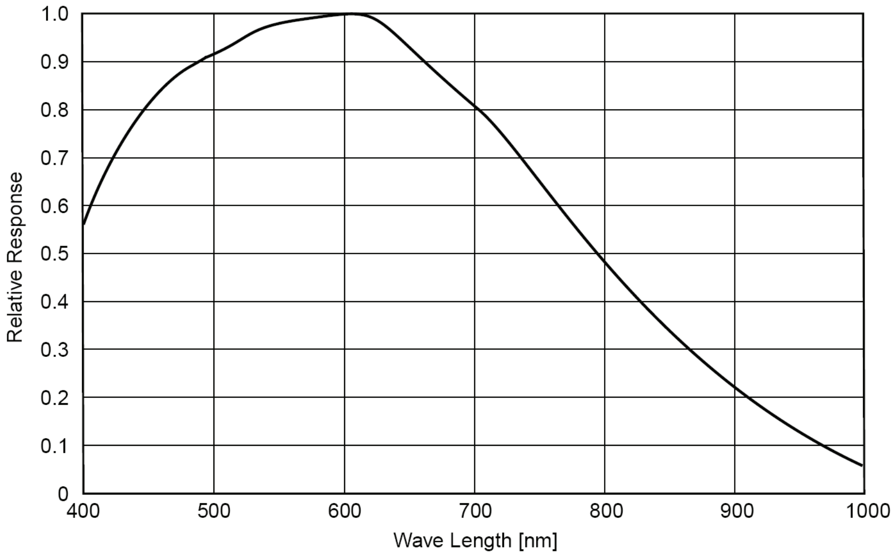


Figure 8: Spectral sensitivity of Guppy F-038B NIR without cut filter and optics

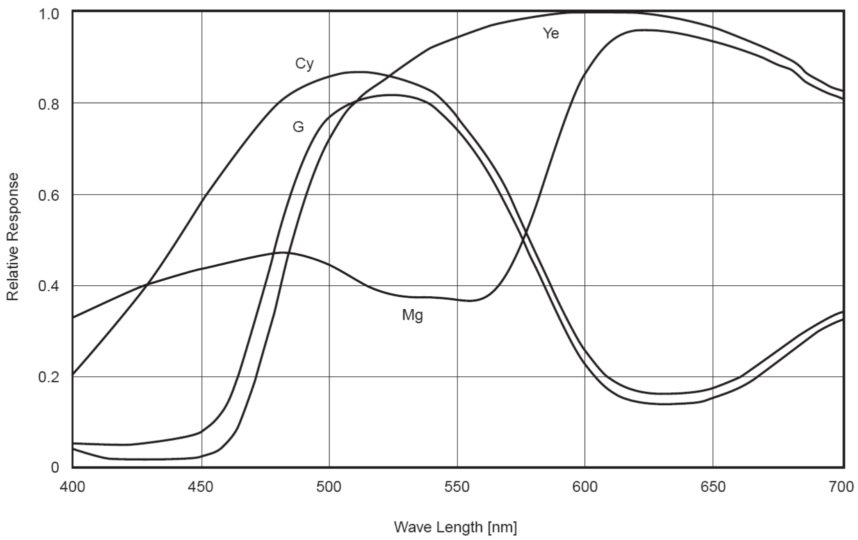


Figure 9: Spectral sensitivity of Guppy F-038C NIR without cut filter and optics

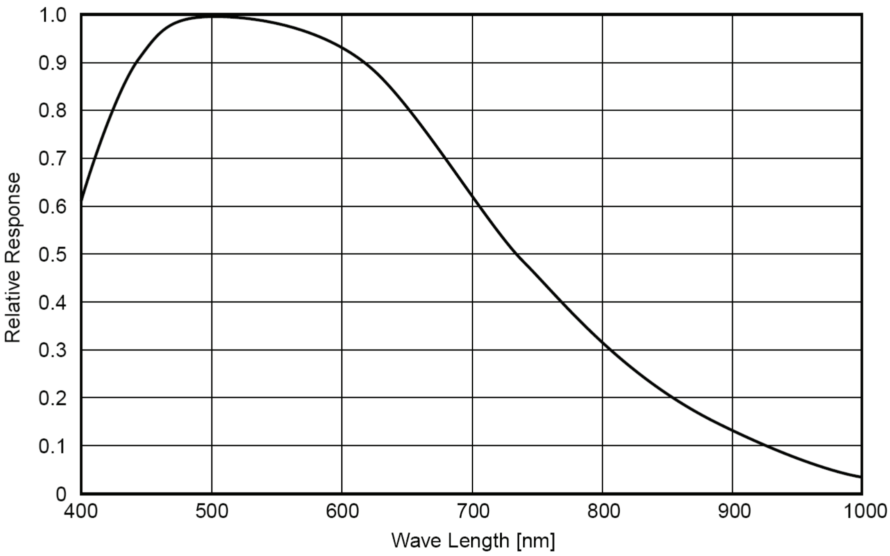


Figure 10: Spectral sensitivity of Guppy F-044B without cut filter and optics

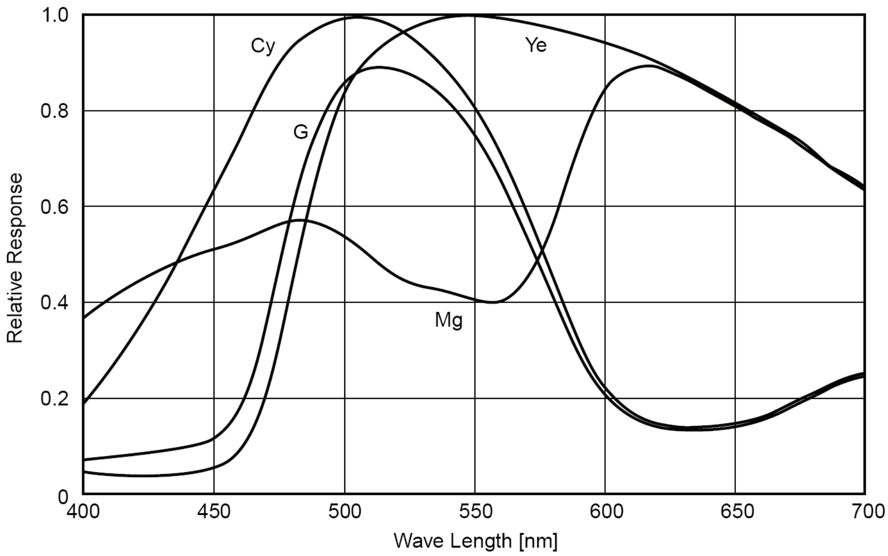


Figure 11: Spectral sensitivity of Guppy F-044C without cut filter and optics

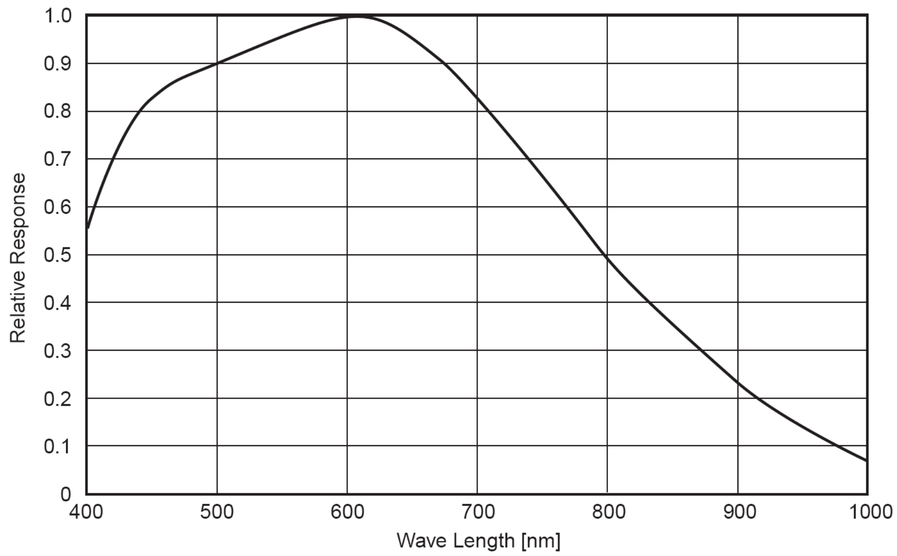


Figure 12: Spectral sensitivity of Guppy F-044B NIR without cut filter and optics

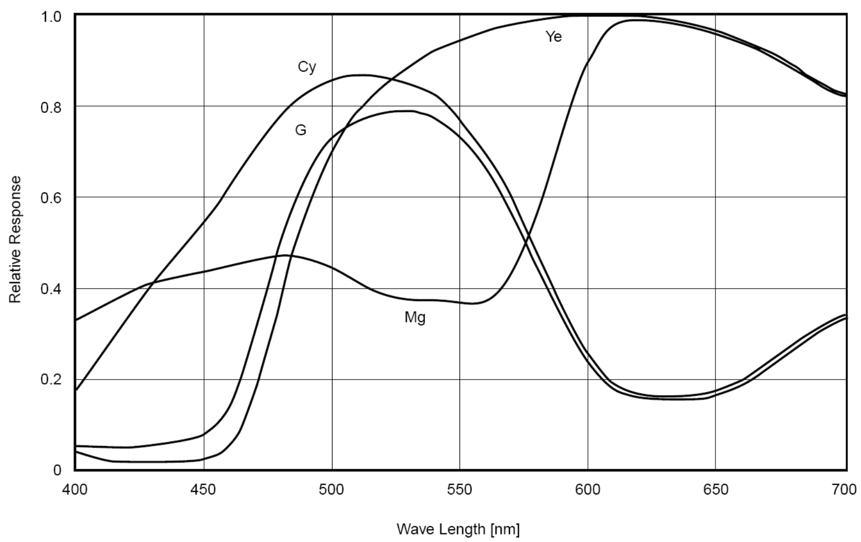


Figure 13: Spectral sensitivity of Guppy F-044C NIR without cut filter and optics

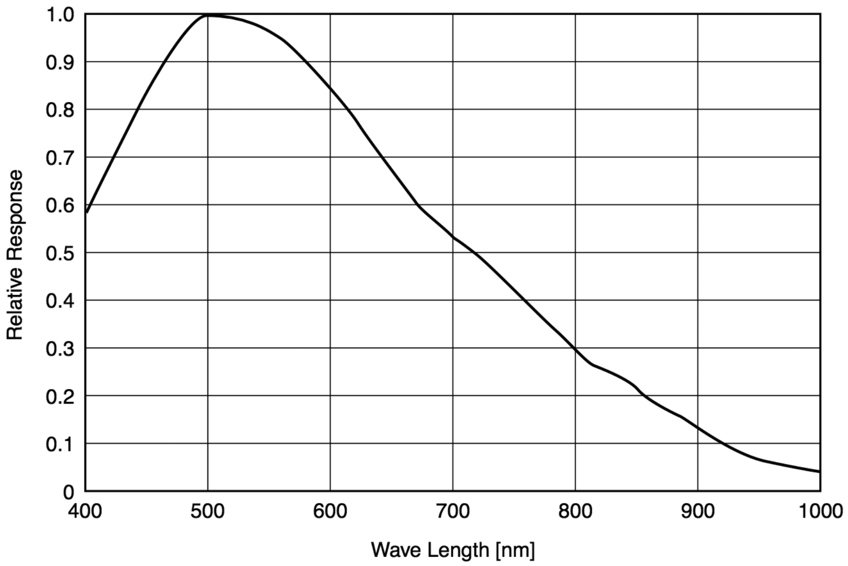


Figure 14: Spectral sensitivity of Guppy F-046B without cut filter and optics

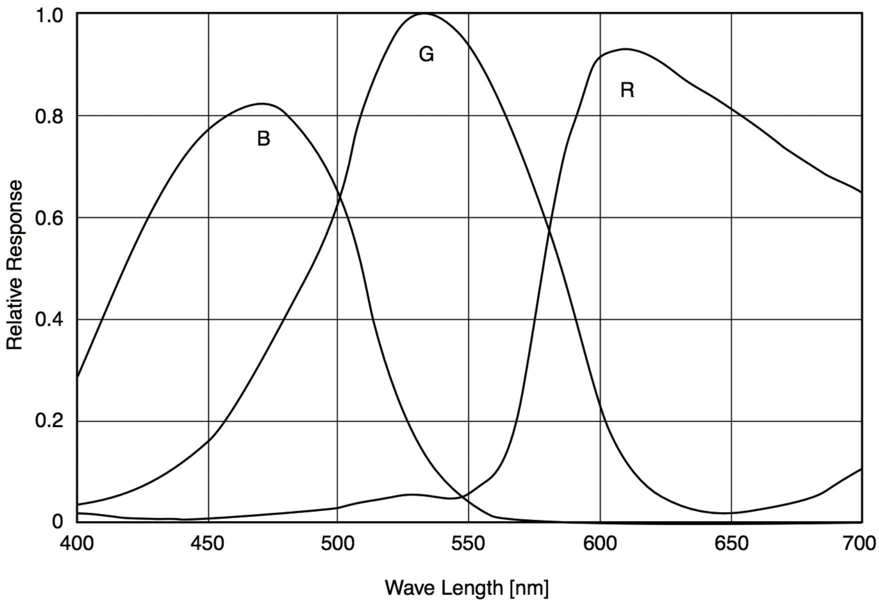


Figure 15: Spectral sensitivity of Guppy F-046C without cut filter and optics

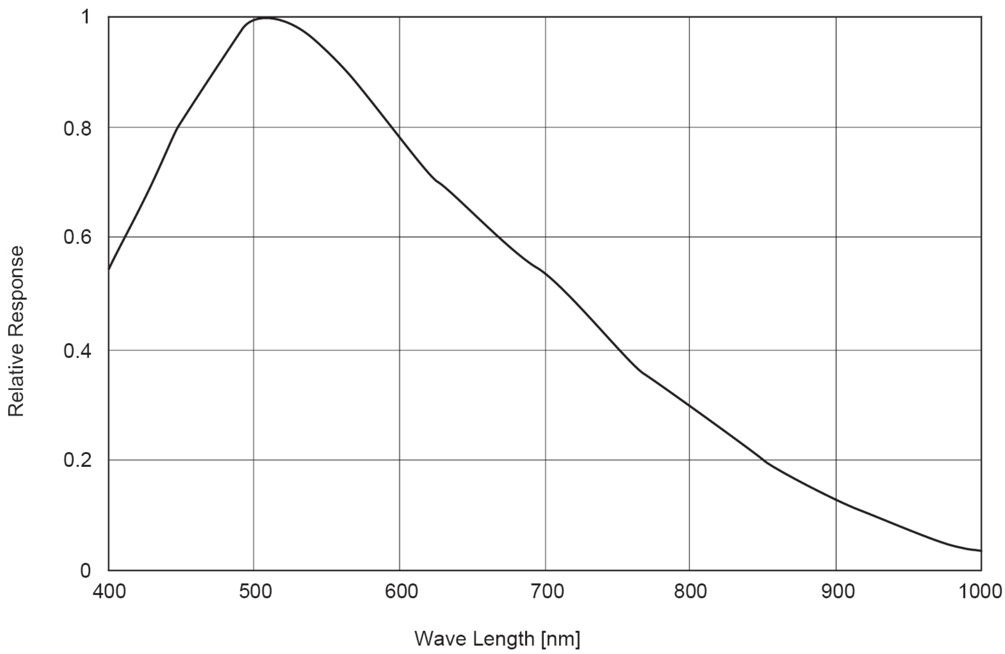


Figure 16: Spectral sensitivity of Guppy F-080B without cut filter and optics

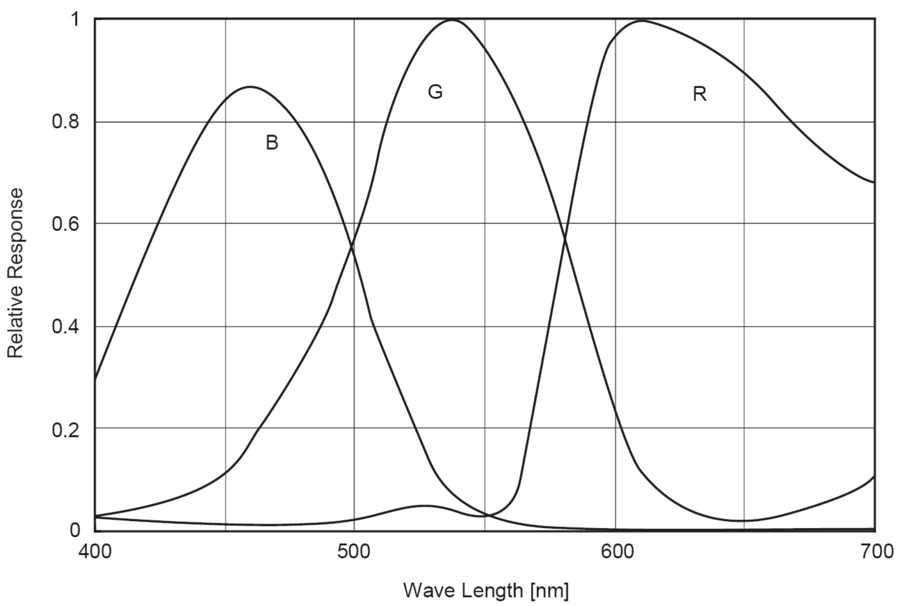


Figure 17: Spectral sensitivity of Guppy F-080C without cut filter and optics

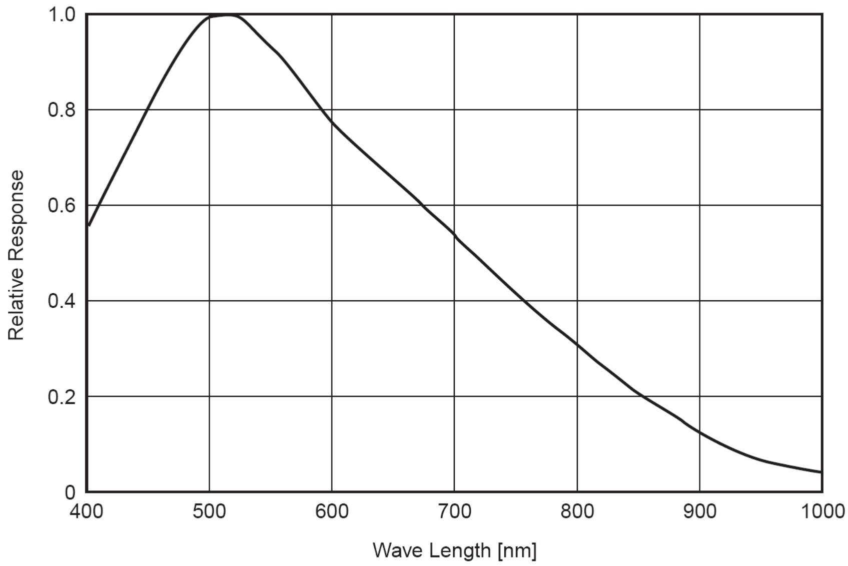


Figure 18: Spectral sensitivity of Guppy F-146B without cut filter and optics

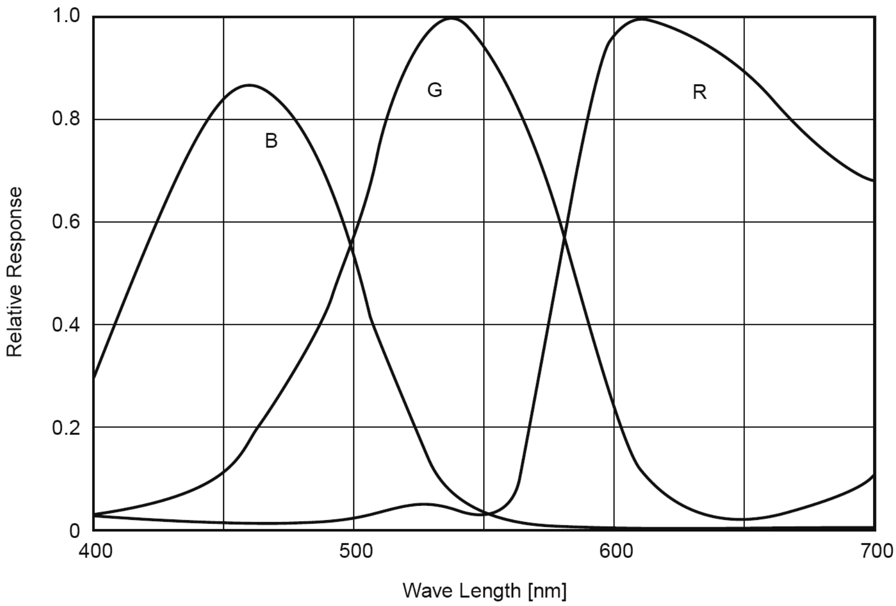


Figure 19: Spectral sensitivity of Guppy F-146C without cut filter and optics

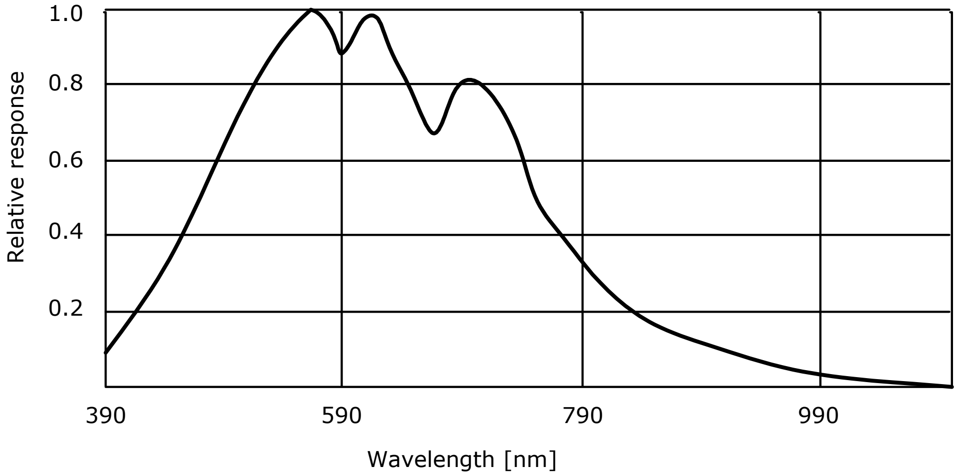


Figure 20: Spectral sensitivity of Guppy F-503B without cut filter and optics

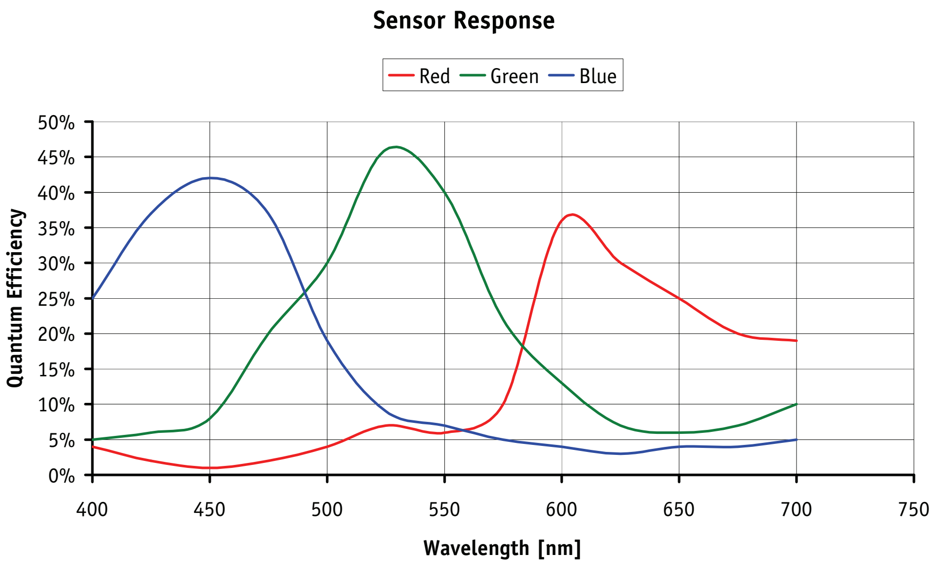


Figure 21: Spectral sensitivity of Guppy F-503C without cut filter and optics

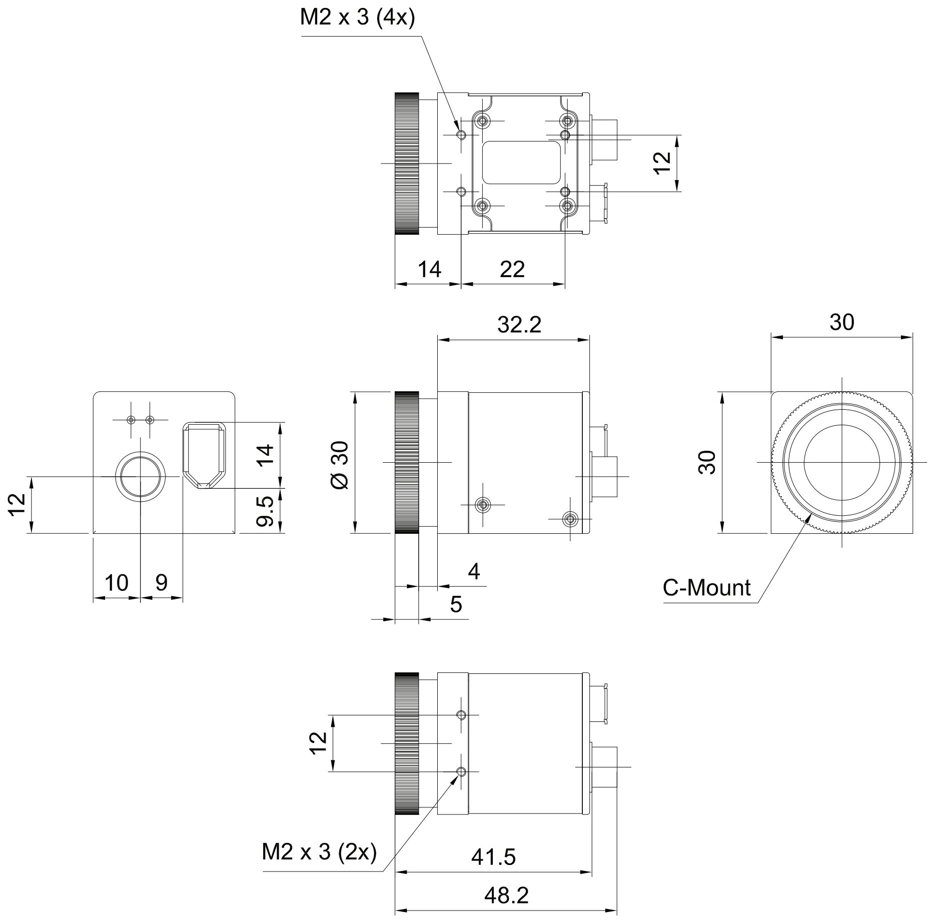
Camera dimensions

Note

For information on **sensor position accuracy:**

(sensor shift x/y, optical back focal length z and sensor rotation α) see Chapter Sensor position accuracy of AVT cameras on page 285.

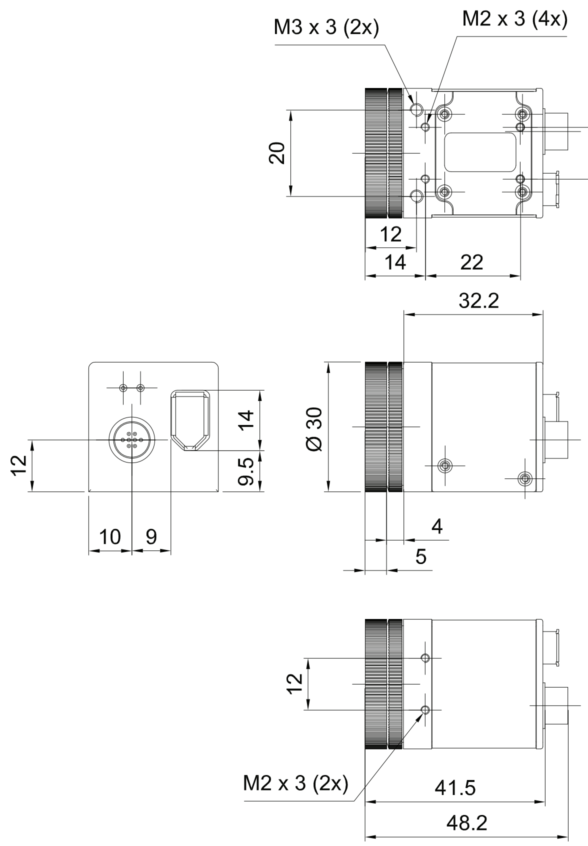
Guppy standard housing (old CS-/C-Mounting)



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

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

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



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

Figure 23: Camera dimensions (new CS-/C-Mounting)

Guppy board level: dimensions

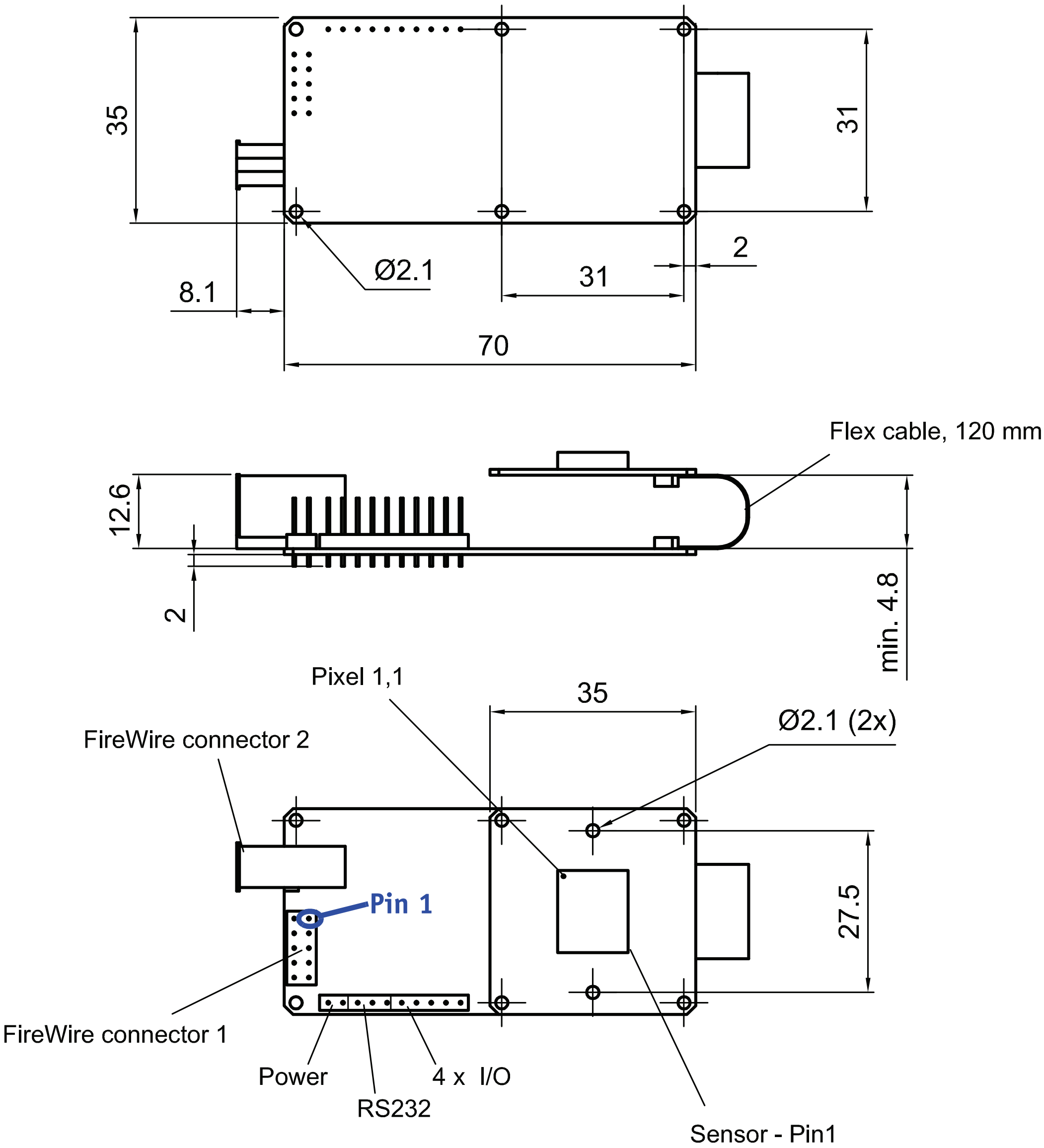


Figure 24: Guppy board level dimensions

Note

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

Guppy board level: CS-Mount

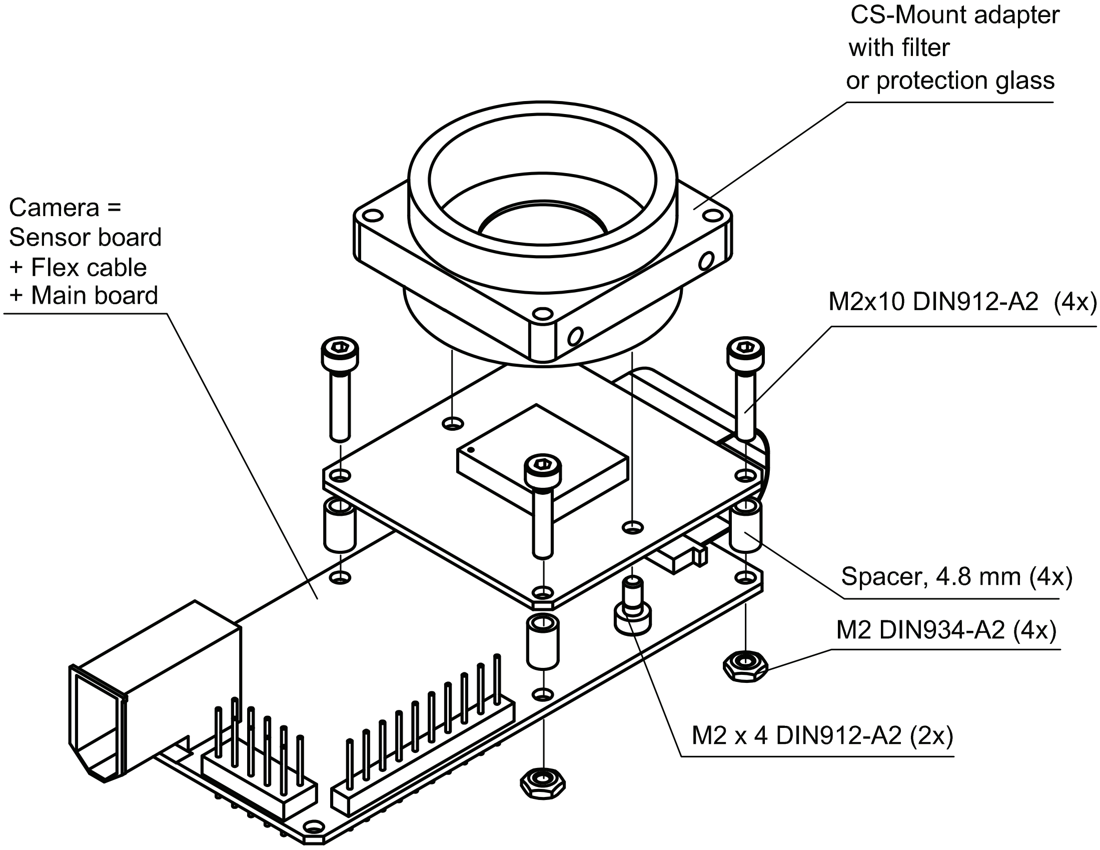


Figure 25: Guppy board level: CS-Mount

Guppy board level: C-Mount

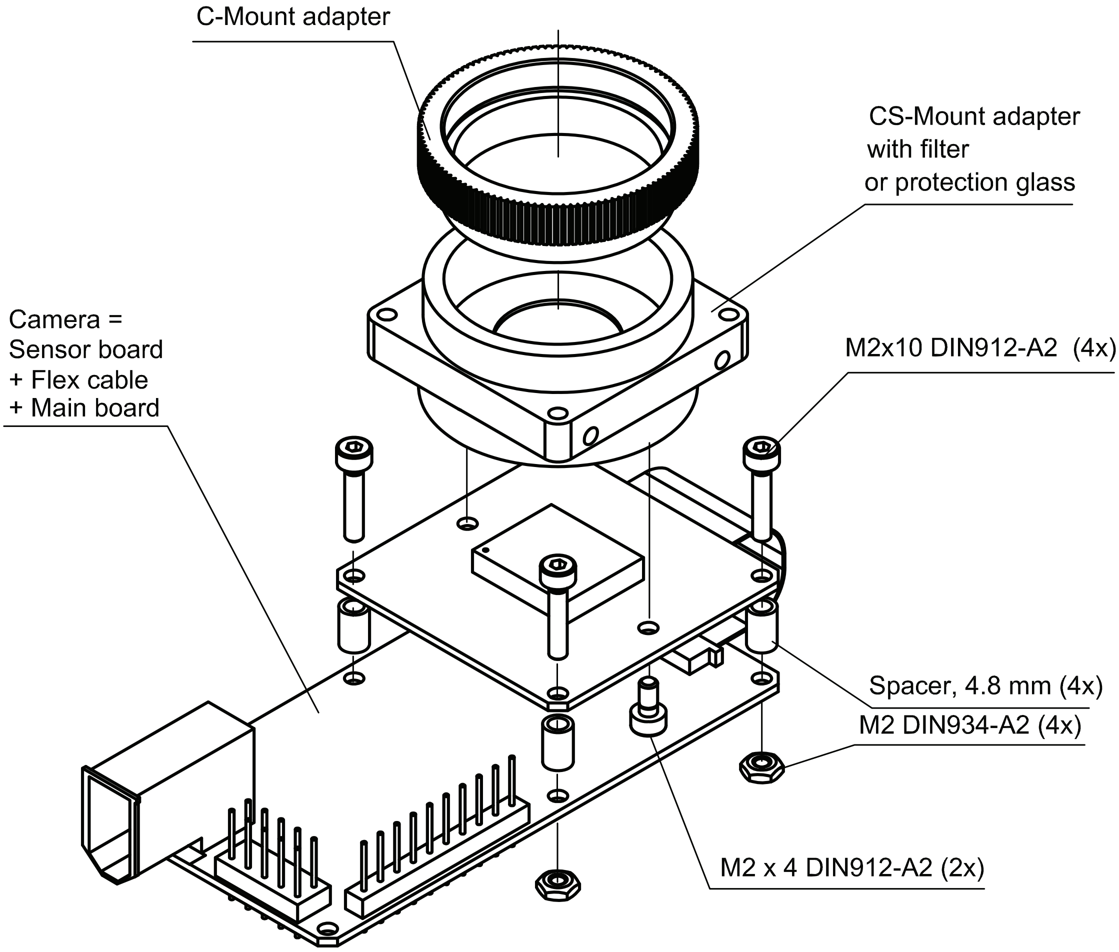


Figure 26: Guppy board level version: C-Mount

Guppy board level: M12-Mount

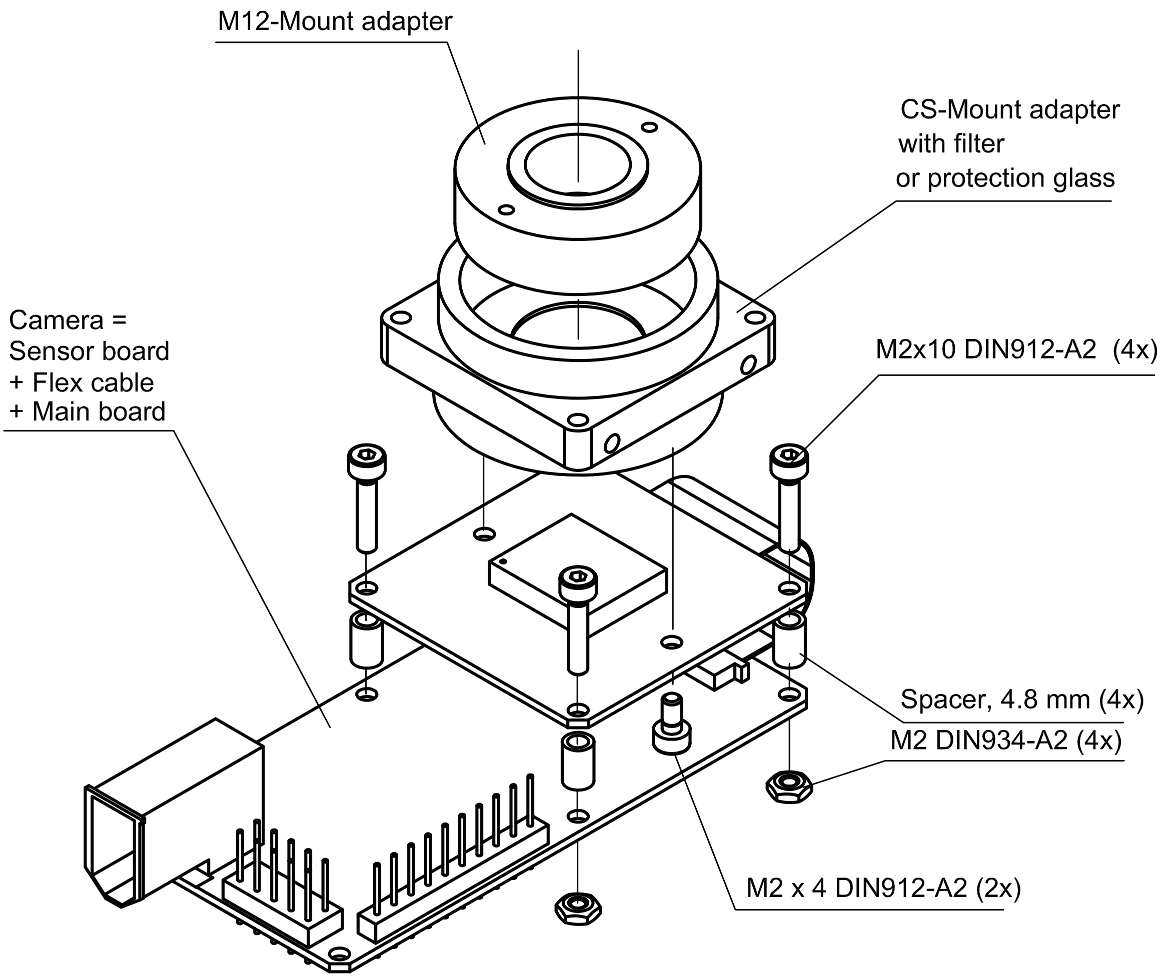


Figure 27: Guppy board level version: M12-Mount

Tripod adapter

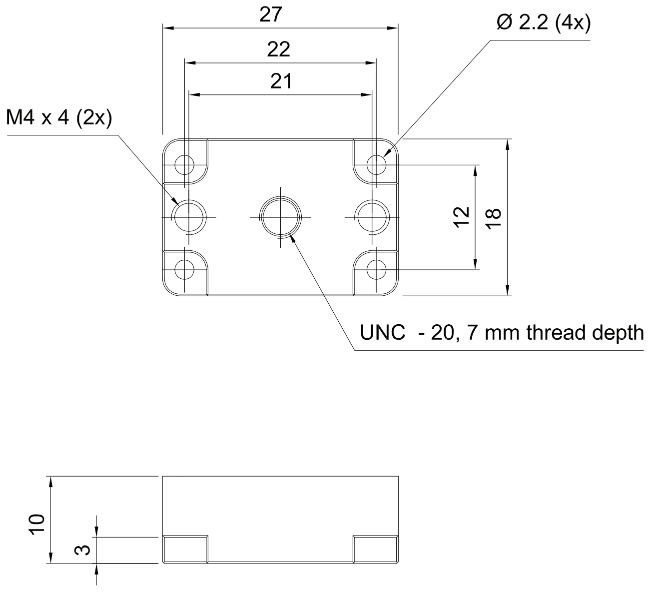


Figure 28: Tripod dimensions

Cross section: C-Mount

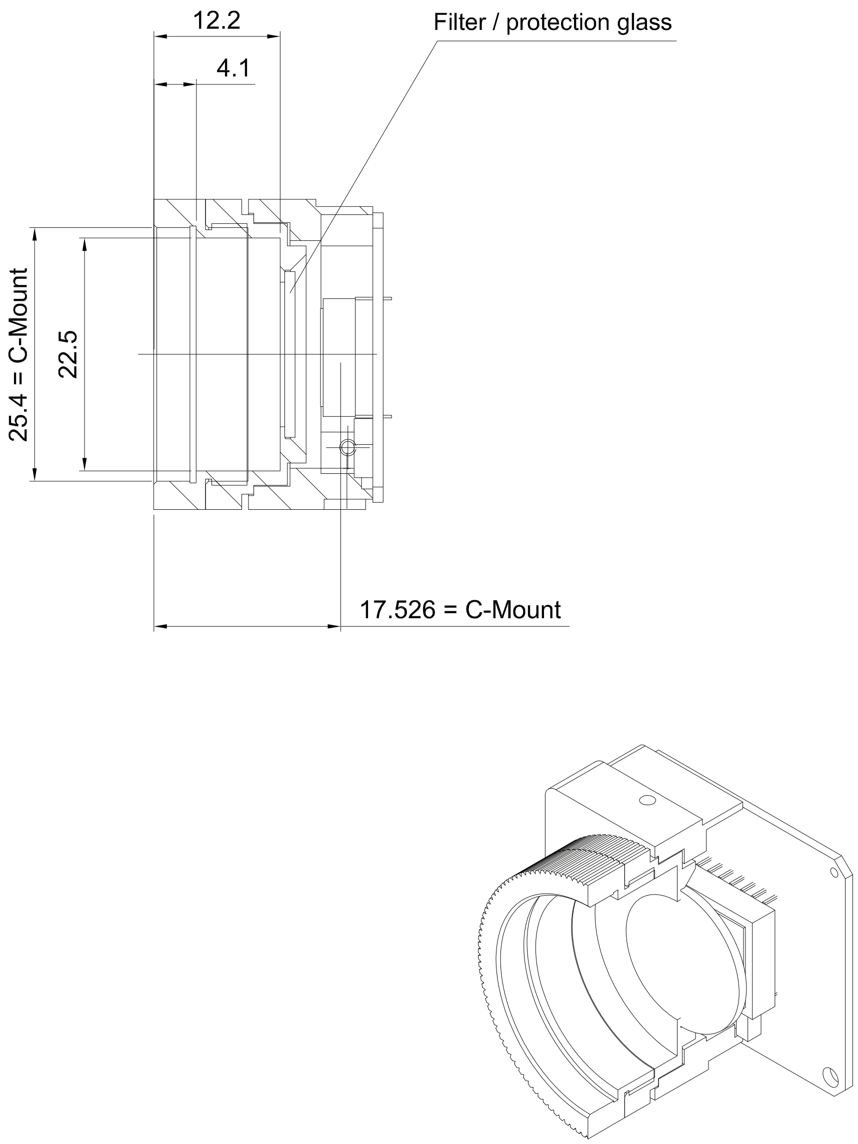


Figure 29: Guppy C-Mount dimensions

Cross section: CS-Mount

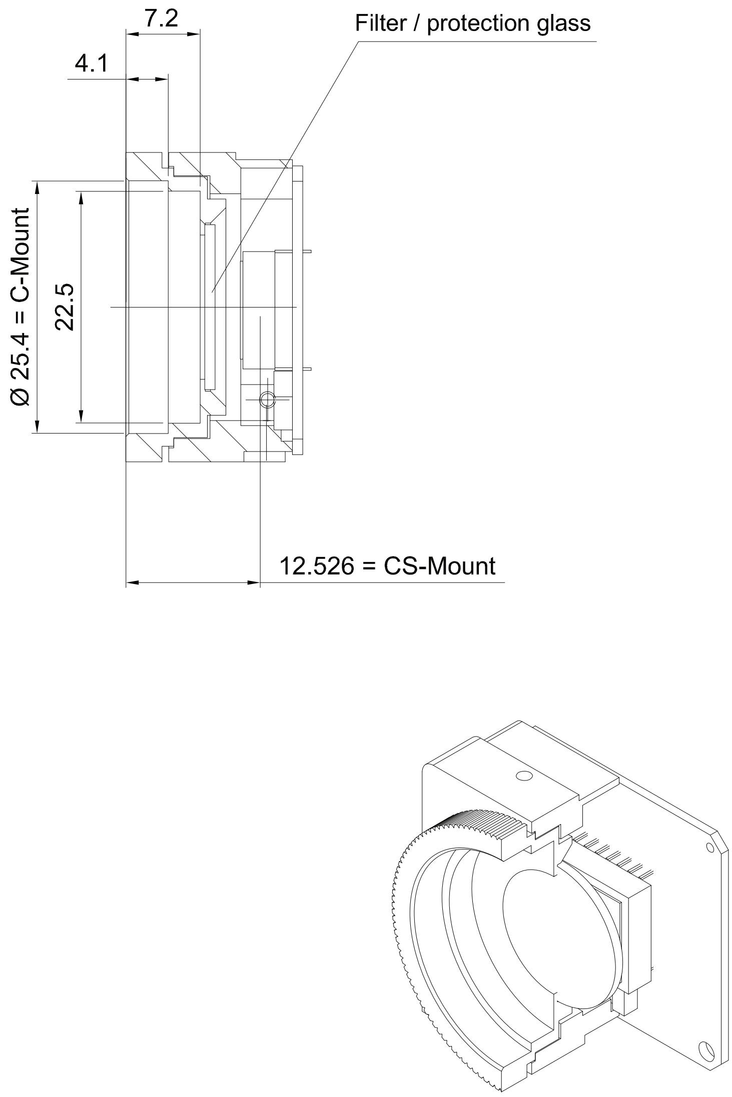


Figure 30: Guppy CS-Mount dimensions

Camera interfaces

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

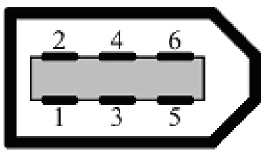
Note

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

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

IEEE 1394a port pin assignment

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



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

Figure 31: IEEE 1394 connector

Note

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

Board level camera: IEEE 1394a port pin assignment

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

The IEEE 1394 pin header (2.54 mm connector: FireWire connector 1) is designed for adding a 1394 adapter cable of:

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

It has the following pin assignment (see FireWire connector 1 in Figure 25: Guppy board level: CS-Mount on page 67):

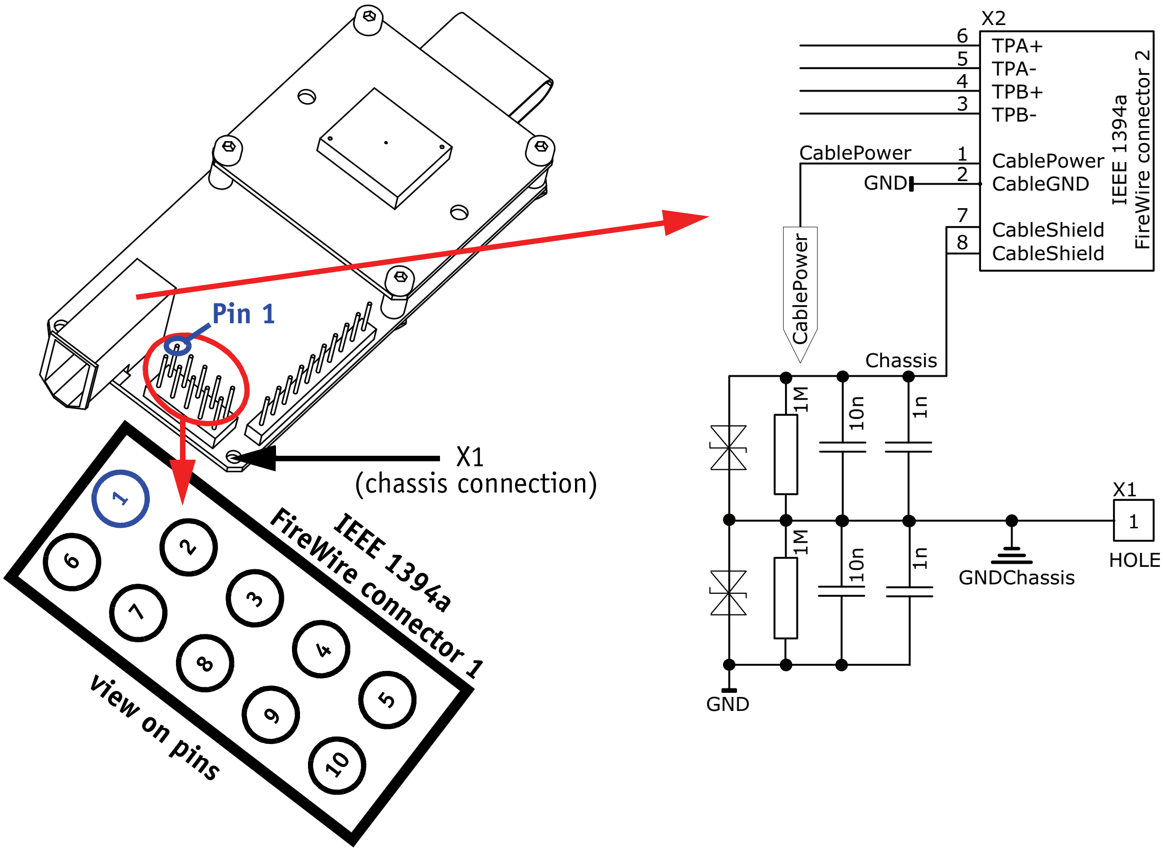


Figure 32: Board level camera: IEEE 1394 FireWire connector 1 (view on pins)

Signal	Pin	Pin	Signal
TPA+	**6**	**1**	TPA-
-	**7**	**2**	GND
TPB+	**8**	**3**	TPB-
-	**9**	**4**	Cable power
-	**10**	**5**	Cable shield

Table 19: Board level camera: IEEE 1394a pin assignment (FireWire connector 1)

Camera I/O connector pin assignment

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

It provides:

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

The following diagrams show the pinning as viewed in pin direction.

Note

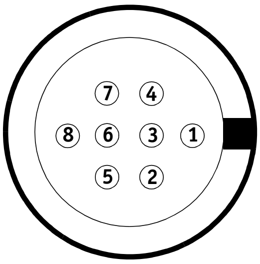
The part number of the appropriate straight I/O connector is:

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

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

I/O cable, open 8-pin HIROSE female to open end, 2.0 m	K1200196
I/O cable, open 8-pin HIROSE female to open end, 5 m	K1200197

GUPPY (housing)



Pin	Signal	Direction	Level	Description
1	Camera Out 1	Out	U_{out}(high) = 2.4 V...5 V U_{out}(low) = 0 V...0.4 V	Camera Output 1 (GPOut1) default: IntEna
2	Camera Out 2	Out	U_{out}(high) = 2.4 V...5 V U_{out}(low) = 0 V...0.4 V	Camera Output 2 (GPOut2) default: -
3	Camera Out 3	Out	U_{out}(high) = 2.4 V...5 V U_{out}(low) = 0 V...0.4 V	Camera Output 3 (GPOut3) default: Busy
4	Camera In 1	In	U_{in}(high) = 2.4 V...5 V U_{in}(low) = 0 V...0.8 V	Camera Input 1 (GPIn1) default: Trigger
5	RxD RS232	In	RS232	Terminal Receive Data
6	TxD RS232	Out	RS232	Terminal Transmit Data
7	External Power		+8 ... +36 V DC	Power supply
8	External GND		GND for RS232, GPIOs and ext. power	External Ground for RS232, GPIOs and external power

Figure 33: GUPPY (housing): Camera I/O connector pin assignment

Note

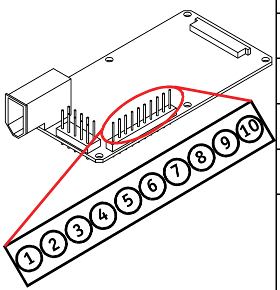
GP = General Purpose

For a detailed description of the **I/O connector and its operating instructions** see the **Hardware Installation Guide, Chapter *GUPPY input description***.

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

GUPPY (board level)

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



Pin	Signal	Direction	Level	Description
1	External GND		GND for RS232, GPIOs and ext. power	External Ground for RS232, GPIOs and external power
2	External Power		+8...+36 V DC	Power supply
3	GND			
4	TxD RS232	Out	RS232	Terminal Transmit Data
5	RxD RS232	In	RS232	Terminal Receive Data
6	GND			
7	Camera In/Out 4	In/Out	U_{in}(high) = 2 V...5 V U_{in}(low) = 0 V...0.8 V U_{out}(high) = 2.4 V...5 V U_{out}(low) = 0 V...0.4 V	Camera Input/Output 4 (GPInOut4) default: -
8	Camera In/Out 3	In/Out		Camera Input/Output 3 (GPInOut3) default: -
9	Camera In/Out 2	In/Out		Camera Input/Output 2 (GPInOut2) default: -
10	Camera In/Out 1	In/Out		Camera Input/Output 1 (GPInOut1) default: -

Figure 34: GUPPY (board level): 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 *GUPPY input description***.

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

Status LEDs

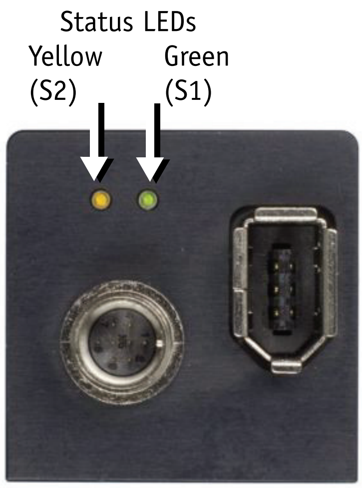


Figure 35: Status LEDs

On LED (green)

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

Status LED

The following states are displayed via the LED:

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

Table 20: LED indication

Blink codes are used to signal warnings or error states:

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

Table 21: Error codes

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

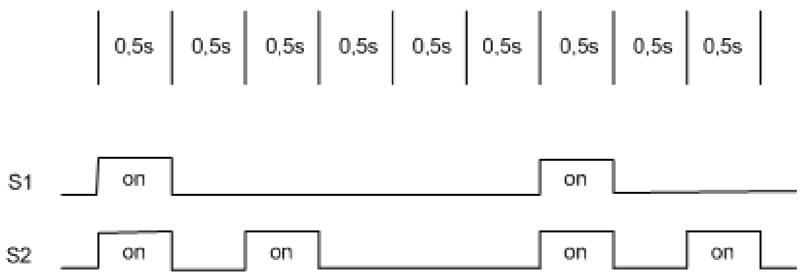


Figure 36: Warning and error states

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

Control and video data signals

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

Inputs

Note

For a general description of the **inputs** and **warnings** see the **Hardware Installation Guide**.

Triggers

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

Input/output pin control

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

Register	Name	Field	Bit	Description
0xF1000300	IO_INP_CTRL1	Presence_Inq	[0]	Indicates presence of this feature (read only)
		TiedToOutput	[1]	only board level Guppy: Tied to output pin x (read only)
		---	[2..6]	Reserved
		Polarity	[7]	0: Signal not inverted 1: Signal inverted
		---	[8..10]	Reserved
		InputMode	[11..15]	Mode see Table 23: Input routing on page 81
		---	[16..30]	Reserved
		PinState	[31]	RD: Current state of pin
0xF1000304	IO_INP_CTRL2	Same as IO_INP_CTRL1		Only Guppy board level cameras

Table 22: Input configuration register

Register	Name	Field	Bit	Description
0xF1000308	IO_INP_CTRL3	Same as IO_INP_CTRL1		Only Guppy board level cameras
0xF100030C	IO_INP_CTRL4	Same as IO_INP_CTRL1		Only Guppy board level cameras

Table 22: Input configuration register

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

Note

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

IO_INP_CTRL 1

The **Polarity** field determines whether the input is inverted (0) or not (1). See Table 22: Input configuration register on page 80.

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

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

Input modes

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

Table 23: Input routing

Trigger delay

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

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

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

Table 24: Trigger_Delay_Inquiry register

Register	Name	Field	Bit	Description
0xF0F00834	TRIGGER_DELAY	Presence_Inq	[0]	Presence of this feature: 0: Not available 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the value field 1: Control with value in the absolute value CSR. If this bit= 1 the value in the value field has to be ignored.
		---	[2..5]	Reserved
		ON_OFF	[6]	Write ON or OFF this feature ON=1 Read: Status of the feature OFF=0
		----	[7..19]	Reserved
		Value	[20..31]	Value

Table 25: Trigger Delay CSR

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

Trigger delay advanced register

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

Table 26: Trigger Delay Advanced CSR

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

Note

- This feature works with external Trigger_Mode_0 only.

Outputs

Note

For a general description of the **outputs** and **warnings** see the **Hardware Installation Guide**.

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

The main features of output signals are described below:

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

Table 27: Output signals

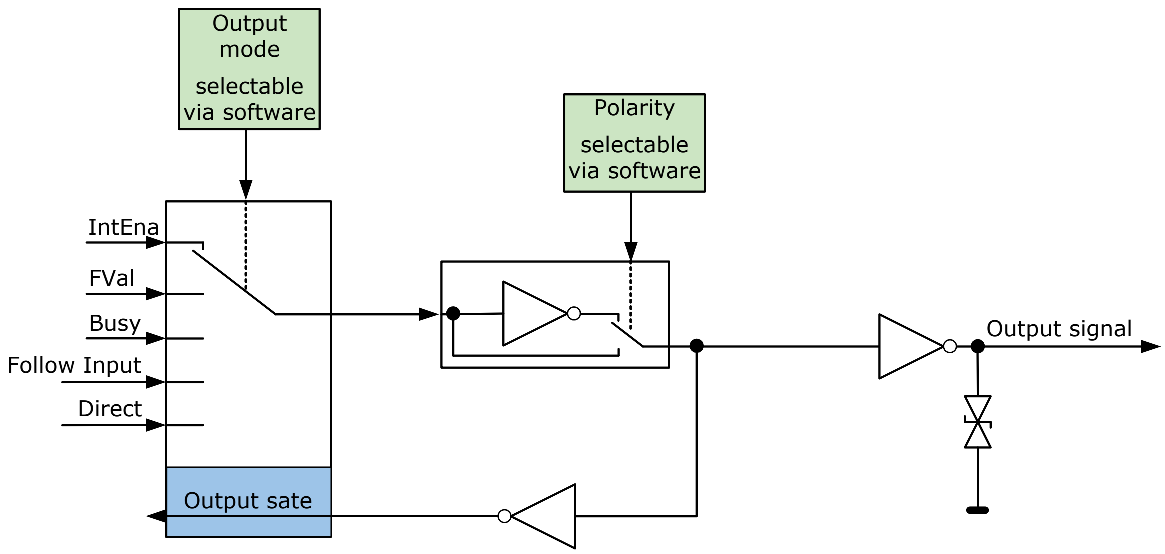


Figure 37: Output block diagram

Note

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

IO_OUTP_CTRL 1-3

The outputs are controlled via 3 advanced feature registers (see Table 28: Advanced register: Output control on page 86).

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

The **Polarity** field determines whether the output is inverted (1) or not (0). The **Output mode** can be viewed in the table below. The current status of the output can be queried and set via the **PinState**.

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

Register	Name	Field	Bit	Description
0xF1000320	IO_OUTP_CTRL1	Presence_Inq	[0]	Indicates presence of this feature (read only)
		PWMCapable	[1]	Only Guppy board level cameras: Indicates if an output pin supports the PWM feature. See Table 31: PWM configuration registers on page 90.
		---	[2..6]	Reserved
		Polarity	[7]	0: Signal not inverted 1: Signal inverted
		---	[8..10]	Reserved
		Output mode	[11..15]	Mode See Table 29: Output routing on page 87.
		---	[16..30]	Reserved
		PinState	[31]	RD: Current state of pin WR: New state of pin
0xF1000324	IO_OUTP_CTRL2	Same as IO_OUTP_CTRL1		
0xF1000328	IO_OUTP_CTRL3	Same as IO_OUTP_CTRL1		
0xF100032C	IO_OUTP_CTRL4	Same as IO_OUTP_CTRL1		Only Guppy board level cameras

Table 28: Advanced register: **Output control**

Output modes

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

Table 29: Output routing

Note

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

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

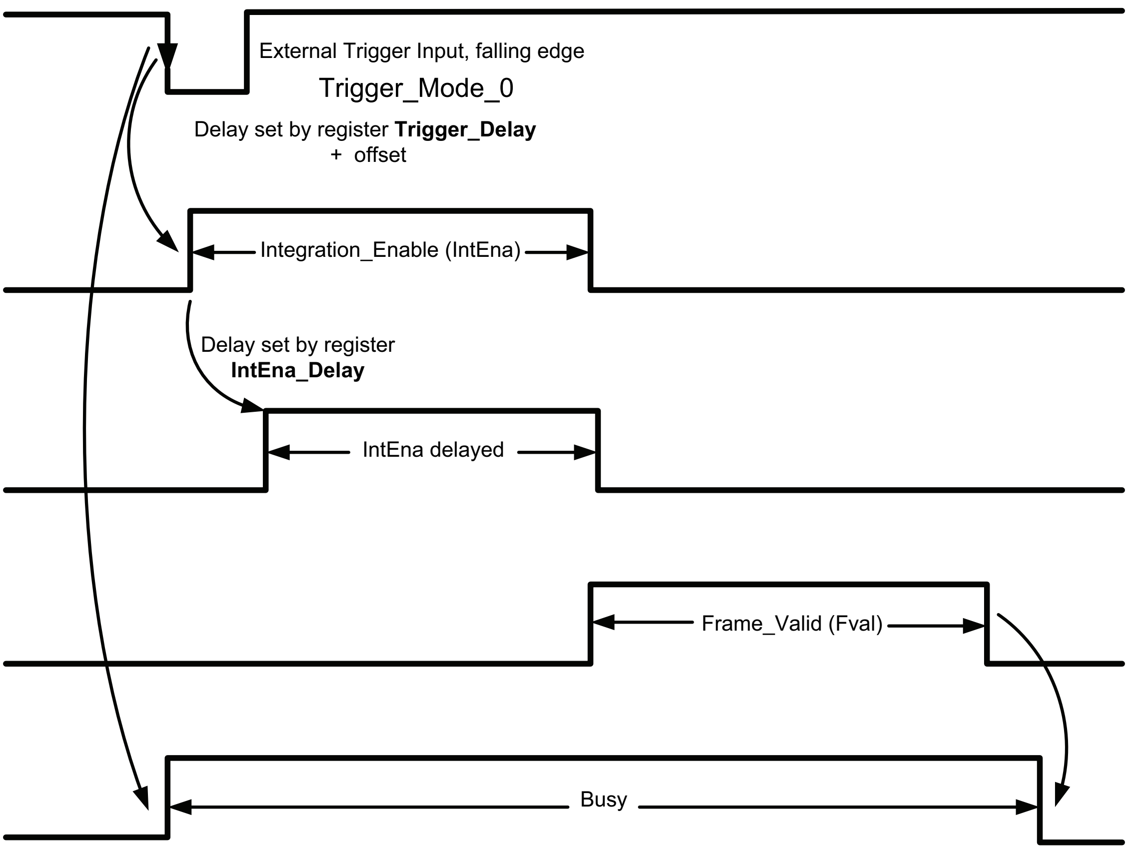


Figure 38: Output impulse diagram

See also Chapter Jitter at start of exposure on page 188.

Offsets are camera specific. For more information read Chapter Exposure time offset on page 182.

Note

The signals can be inverted.

Caution

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

Note

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

Board level cameras: inputs and outputs

The following Guppy board level cameras are available:

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

Table 30: Guppy board level cameras

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

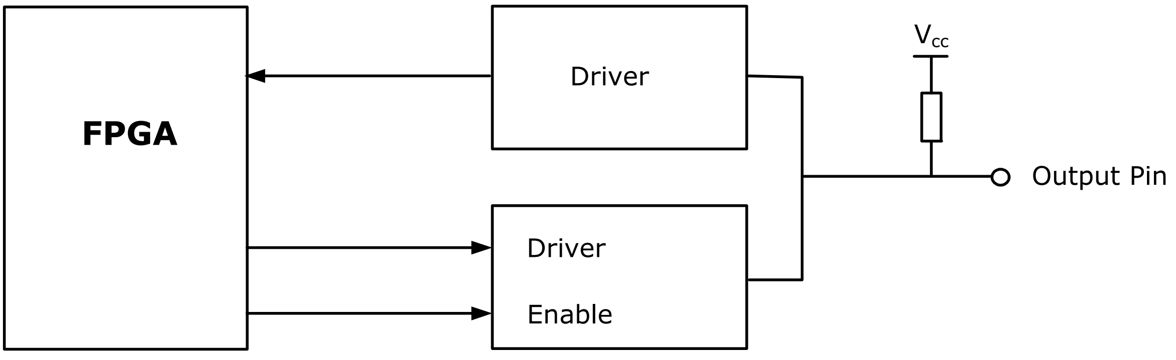


Figure 39: Input/output block diagram

Board level cameras: pulse-width modulation

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

Period (in µs) and pulse width (in µs) are adjustable via the following registers (see also examples in Chapter PWM: Examples in practice on page 91):

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

Table 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)).

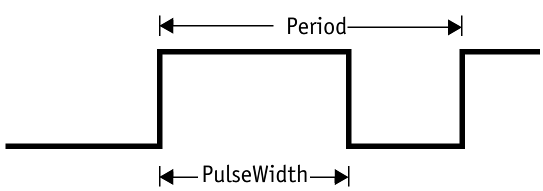


Figure 40: PulseWidth and Period definition

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).

$$
\begin{aligned}
& \text{period}_{\text{min}} = 3\mu\text{s} \\
\Rightarrow\ & \text{frequency}_{\text{max}} = \frac{1}{\text{period}_{\text{min}}} = \frac{1}{3\mu\text{s}} = 333.33\text{kHz} \\
& \text{frequency}_{\text{min}} = \frac{1}{2^{16} \times 10^{-6}\text{s}} = 15.26\text{Hz} \\
\Rightarrow\ & \text{period}_{\text{max}} = \frac{1}{\text{frequency}_{\text{min}}} = 2^{16}\mu\text{s}
\end{aligned}
$$

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.

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

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

Formula 2: PWM example 1

Example 2:

Set PWM with 250 Hz at 12% pulse width.

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

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

Formula 3: PWM example 2

Pixel data

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

sync bit

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

Table 32: Isochronous data block packet format. Source: IIDC V1.3

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

Table 33: Description of data block packet format

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

Video data formats (IIDC V1.3 and AVT)

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

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

Y (Mono12) format ➩ AVT own format (**Packed 12-Bit Mode**)

<Y (Mono) format>

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

Figure 41: **Y8 format** [Source: IIDC V1.3]

<Y (Mono16) format>

High byte	Low byte

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

Figure 42: **Y16 format** [Source: IIDC V1.3]

<Y (Mono12) format> (AVT)

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 34: **Packed 12-Bit Mode** (mono and raw) Y12 format from AVT

Data structure (IIDC V1.3 and AVT)

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

<Y, R, G, B>

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

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

Figure 43: Data structure of Y, R, G, B [Source: IIDC V1.3]

<U, V>

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

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

Figure 44: Data structure of U, V [Source: IIDC V1.3]

<Y (Mono16>

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

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

Figure 45: Data structure of Y (Mono16) [Source: IIDC V1.3]

<Y (Mono12)> (AVT)

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 35: Data structure of **Packed 12-Bit Mode** (mono and raw) from 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 sensor chip (CCD or CMOS) in the camera. The individual blocks are described in more detail in the following paragraphs. For sensor data see Chapter Specifications on page 29.

Note

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

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

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

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

Black and white cameras (CCD and CMOS)

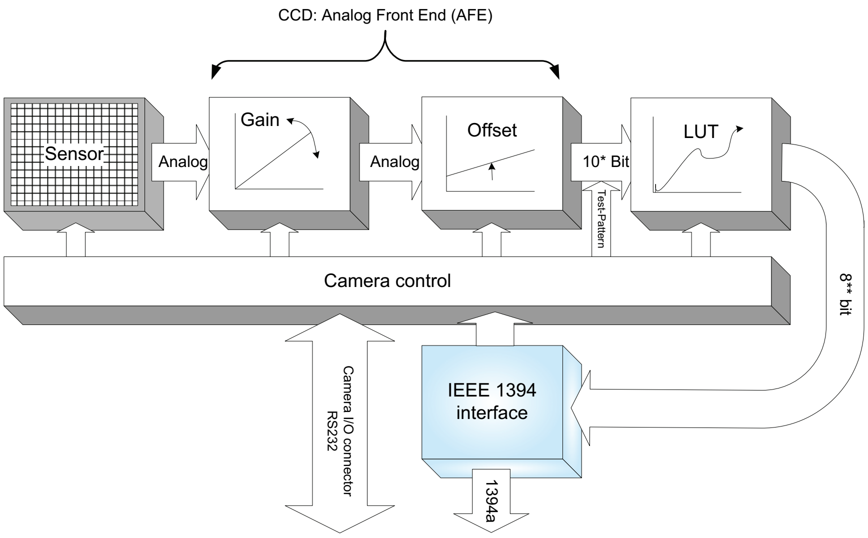


Figure 46: Block diagram b/w camera (CCD)

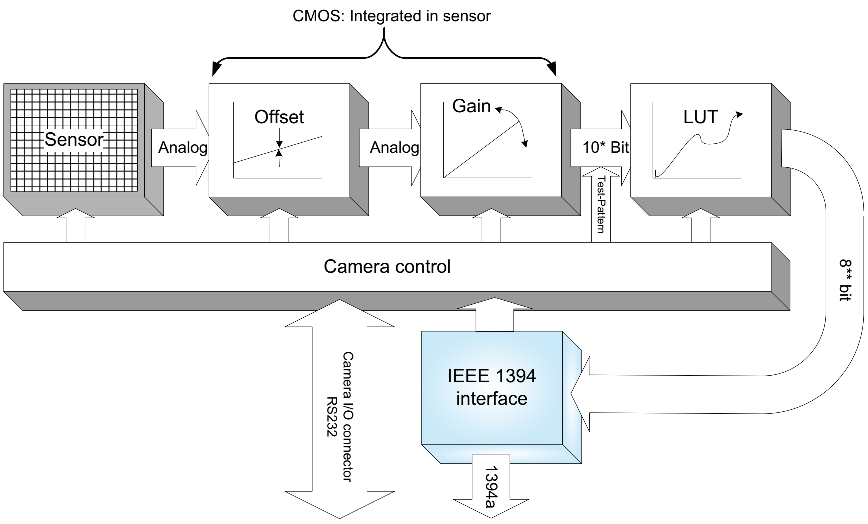


Figure 47: Block diagram b/w camera (CMOS)

Color cameras (CCD and CMOS)

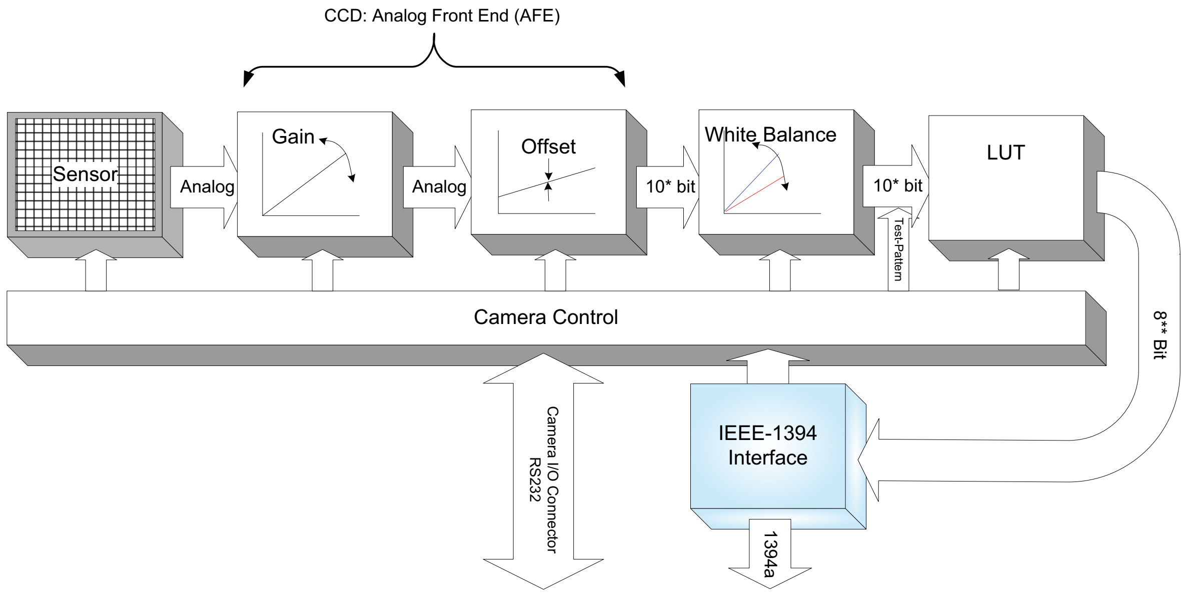


Figure 48: Block diagram color camera (CCD)

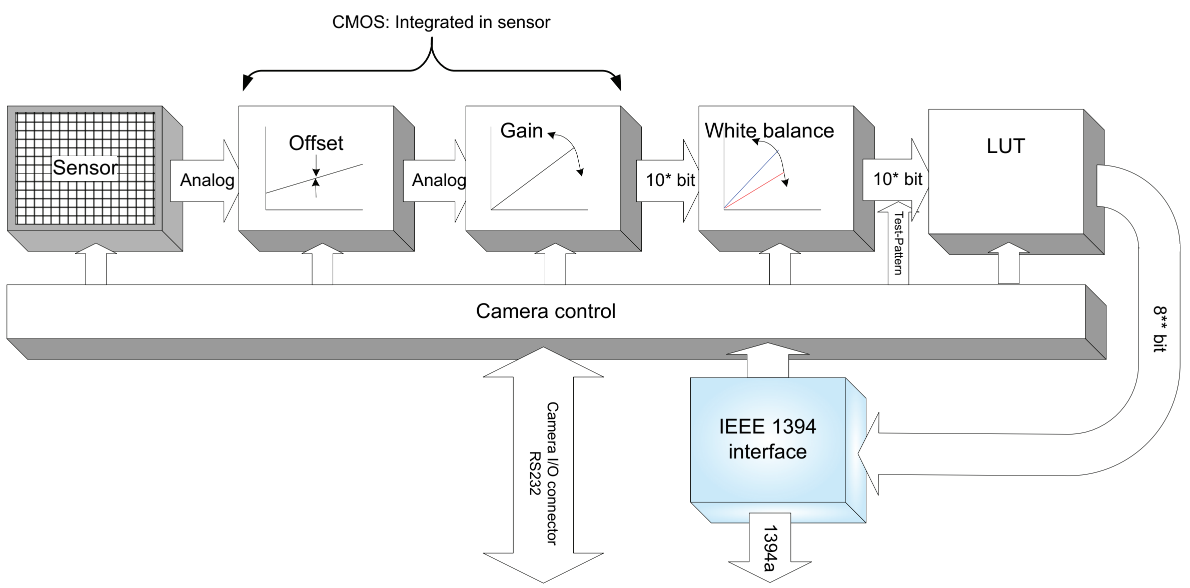


Figure 49: Block diagram color camera (CMOS)

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

The GUPPY F-038/038 NIR/044/044 NIR/025/029 cameras use so-called interline scan interlaced CCDs.

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

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

Advantages of interlaced CCDs compared to progressive CCDs:

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

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

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

Note

For demosaicing process outside of the camera, see Chapter BAYER pattern (raw data output) on page 159.

4-phase vertical shift register

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

- Field integration: the two gates are activated at the same time
  - see Figure 51: Format_7 Mode_0: 4-phase vertical shift register precharging (interlaced, field) on page 102 and
  - Figure 57: Format_7 Mode_2: 4-phase vertical shift register precharging (non-interlaced, field) on page 106
- Frame integration: the two gates are activated every other field
  - see Figure 54: Format_7 Mode_1: 4-phase vertical shift register precharging (interlaced, frame) on page 104
- Pre-charging of the phases defines interlaced or non-interlaced.

Interlaced and field integration (Format_7 Mode_0)

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

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

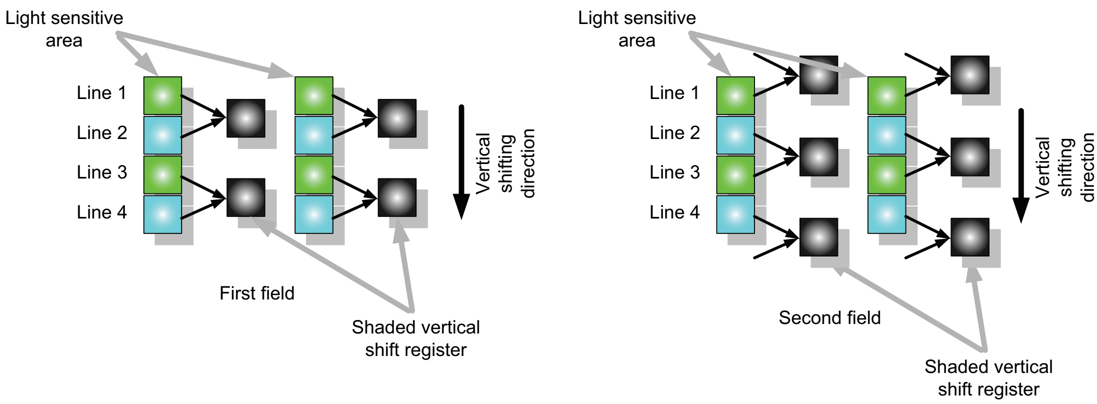


Figure 50: Format_7 Mode_0: field integration readout mode (interlaced)

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

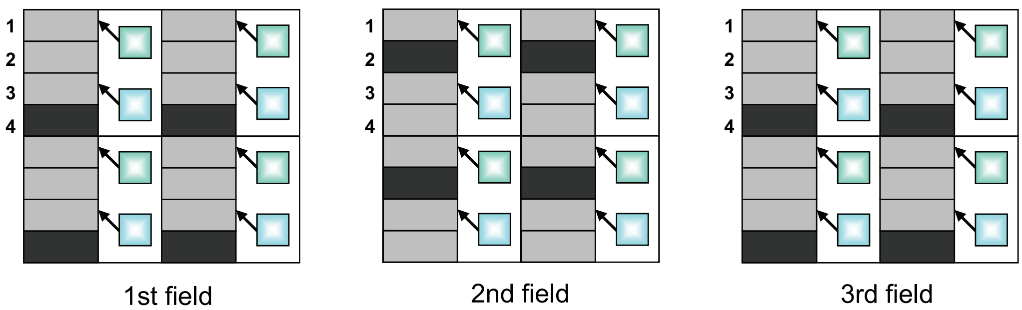


Figure 51: Format_7 Mode_0: 4-phase vertical shift register precharging (interlaced, field)

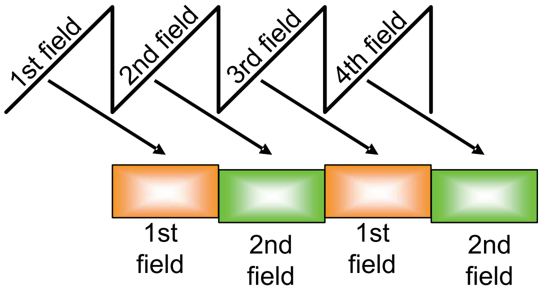


Figure 52: Format_7 Mode_0: output (interlaced, field)

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

Table 36: Format_7 Mode_0: output parameters (interlaced, field)

Interlaced and frame integration (Format_7 Mode_1)

Note

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

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

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

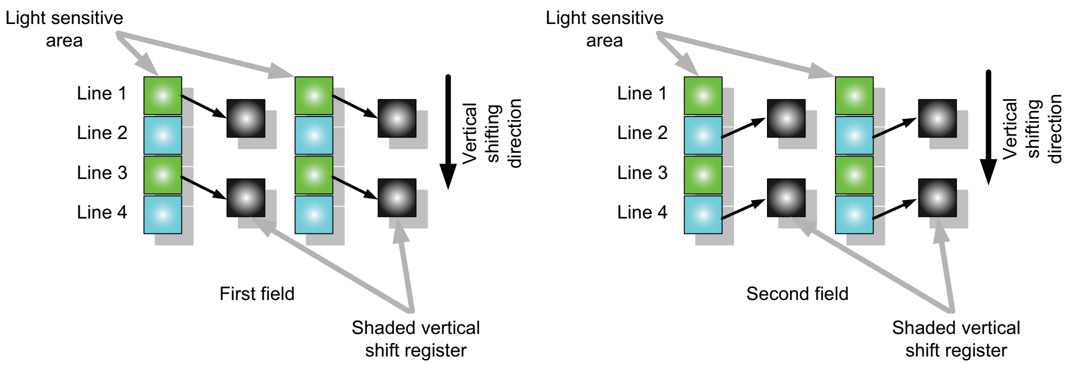


Figure 53: Format_7 Mode_1: frame integration readout mode (interlaced)

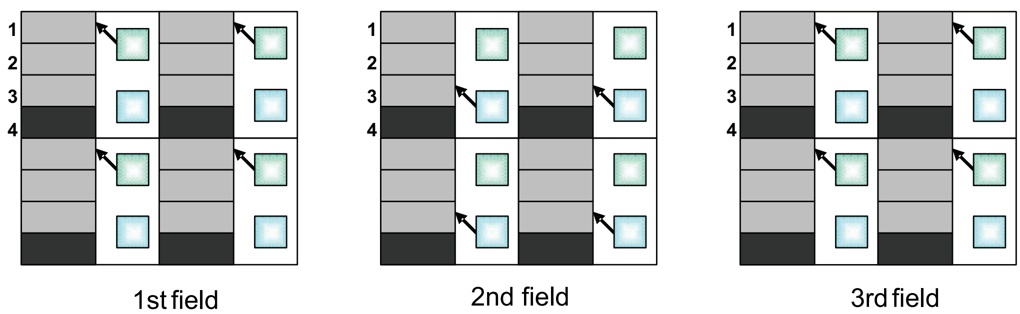


Figure 54: Format_7 Mode_1: 4-phase vertical shift register precharging (interlaced, frame)

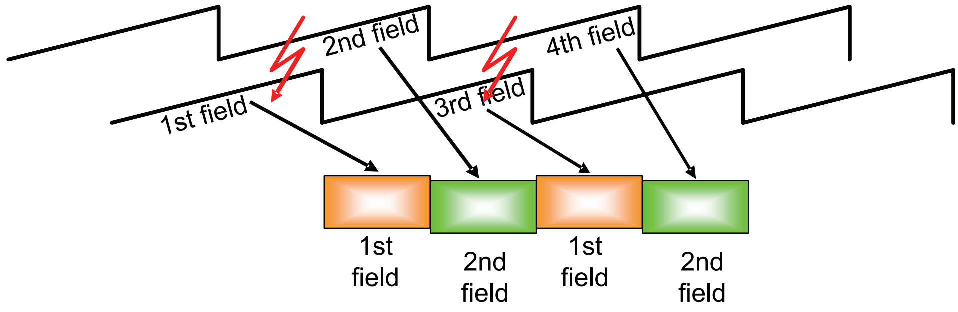


Figure 55: Format_7 Mode_1: output (interlaced, frame)

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

Table 37: Format_7 Mode_1: output parameters (interlaced, frame)

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

This mode emulates a progressive scan mode.

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

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

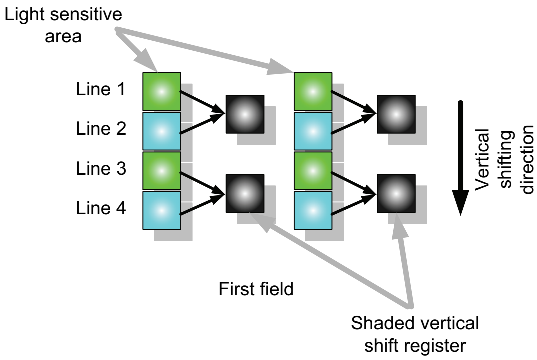


Figure 56: Format_7 Mode_2: field integration readout mode (non-interlaced)

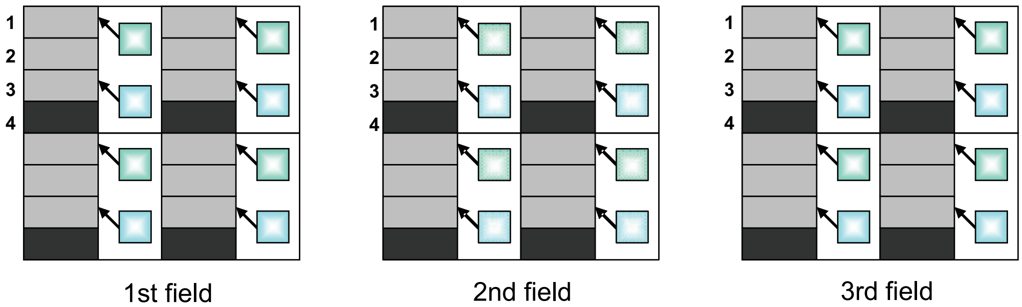


Figure 57: Format_7 Mode_2: 4-phase vertical shift register precharging (non-interlaced, field)

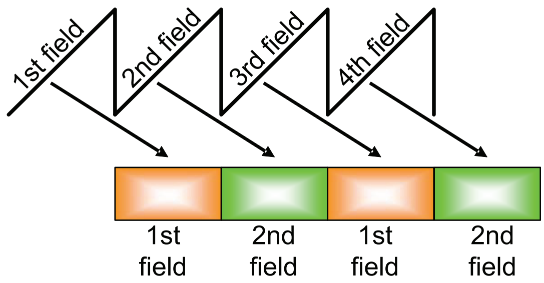


Figure 58: Format_7 Mode_2: output (non-interlaced, field integration, emulating progressive scan)

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

Table 38: Format_7 Mode_2: output parameters (non-interlaced, field)

Complementary colors and demosaicing

Note

Color correction: see Chapter Color correction (only interlaced GUPPYs) on page 113.

BAYER pattern: see Figure 96: BAYER pattern of SONY complementary sensors: 1st line: G - Mg, 2nd line: Cy - Ye on page 161

Debayering: see Chapter Format_7 Mode_0: sensor readout and color on page 110 and Chapter Format_7 Mode_1: sensor readout and color on page 112

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

Advantage of using complementary colors:

- Less energy needs to be filtered out. That means an increase of sensitivity (compare the spectral sensitivity diagrams in Chapter Spectral sensitivity on page 53)

Disadvantage of complementary colors:

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

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

Table 39: Comparison RGB and CMYG

How demosaicing works

The generation of the output signal luma (Y) and the two chrominance (C) signals (R-Y) and (B-Y) can be done relatively easy by vertically averaging the charges of two adjacent lines either in the analog domain (by field readout of the CCD in Format_7 Mode_0) or by a digital representation of this calculation process in Format_7 Mode_1 because of frame integration.

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

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

and the second two lines from the bottom give:

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

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

This is for the first line pair:

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

with the assumption:
$$(R + G) = Ye$$
$$(R + B) = Mg$$
$$(G + B) = Cy$$

Formula 4: Y signal expressed via RGB and CyMgYeG

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

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

Formula 5: First chroma signal V

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

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

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

Formula 6: Y signal for second line pair

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

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

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

Formula 7: Second chroma signal U

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

This is also true for the second field, which is generated by a vertical shift by one line. Complementary filtering is thus a way to achieve higher sensitivity at a slight expense of color resolution.

Format_7 Mode_0: sensor readout and color

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

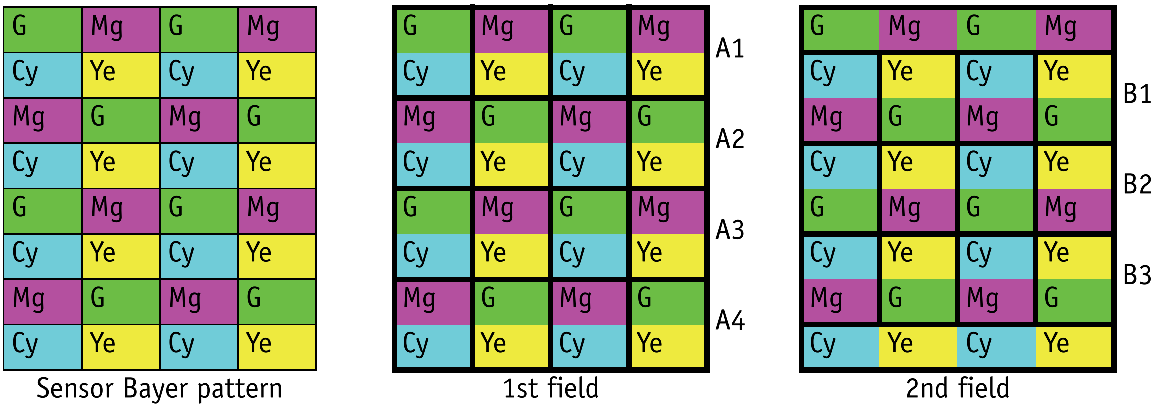


Figure 59: Format_7 Mode_0: Binning for 1st field and 2nd field

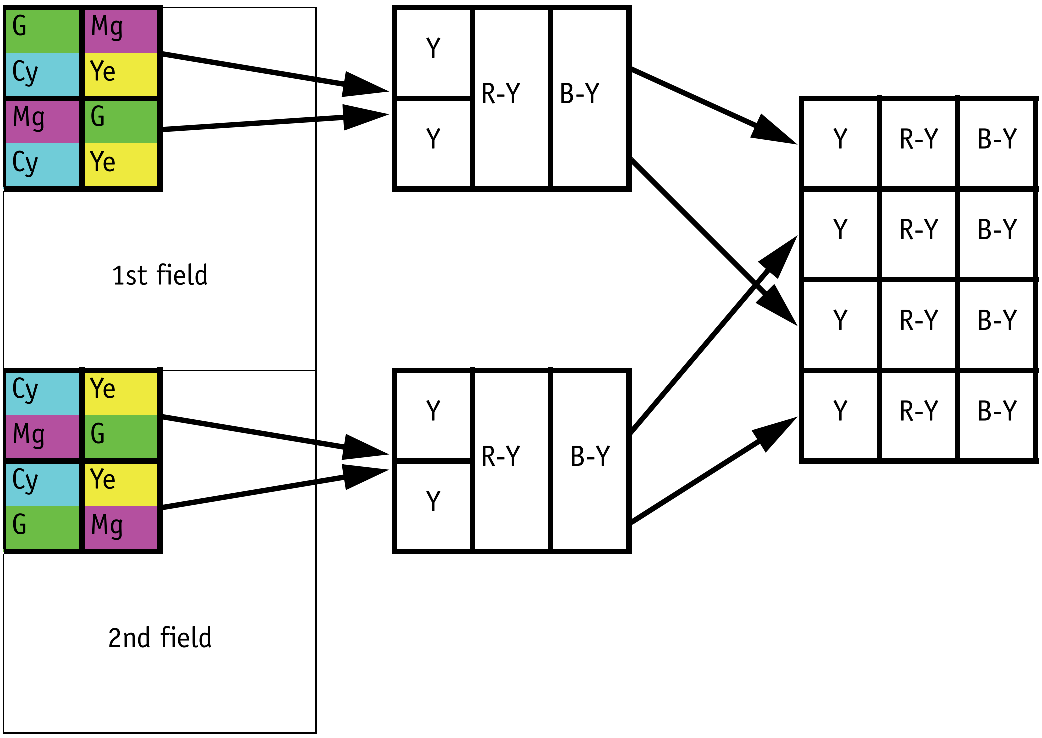


Figure 60: Format_7 Mode_0: Sensor readout

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

Format_7 Mode_1: sensor readout and color

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

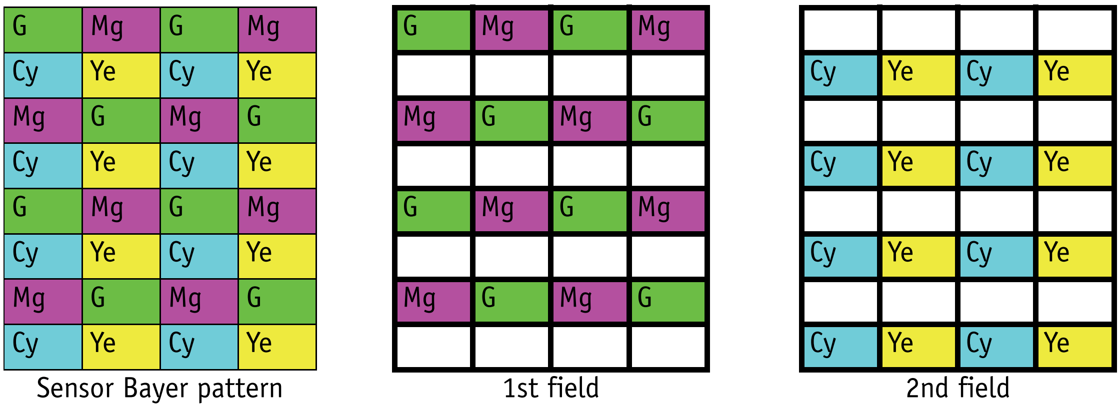


Figure 61: Format_7 Mode_1: 1st field and 2nd field

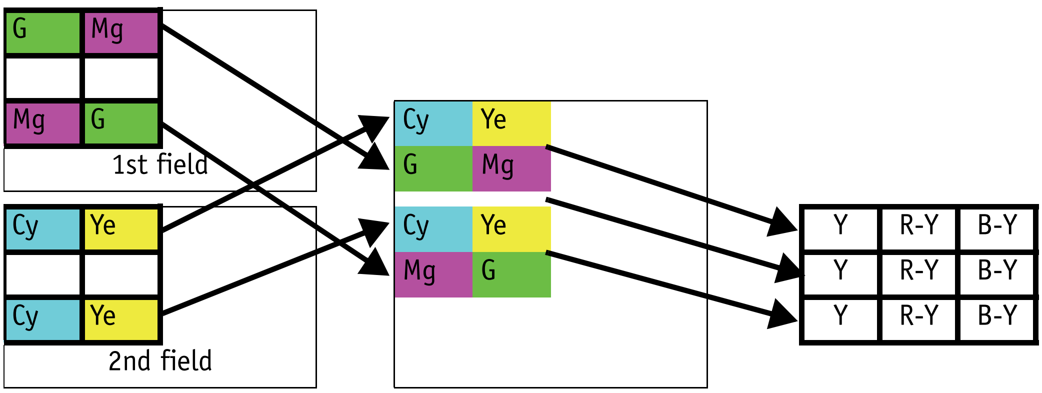


Figure 62: Format_7 Mode_1: Sensor readout

Because it is not possible to obtain full color or chroma information per field, the data has to be deinterlaced first. After that demosaicing is done (see Chapter How demosaicing works on page 108): luma (Y) and the two chroma values (R-Y and B-Y) are calculated from each 2x2 pixel array.

Color correction (only interlaced GUPPYs)

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

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

CyMgYeG is converted to YUV values according the given formulas from SONY (Chapter How demosaicing works on page 108).

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

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

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

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

Formula 8: Color correction formula for interlaced GUPPYs

Note

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

Horizontal and vertical mirror function (only Guppy F-036/F-503)

The Guppy F-036/F-503 CMOS cameras are equipped with a horizontal and vertical mirror function, which is built directly into the sensor. The mirror is centered to the actual **FOV** center and can be combined with all image manipulation functions, like **binning**.

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

Note

Configuration

To configure this feature in an advanced register: See Table 126: Advanced register: Mirror on page 275.

Note

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

White balance

There are two types of white balance:

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

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

White balance is applied so that non-colored image parts are displayed non-colored.

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

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

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

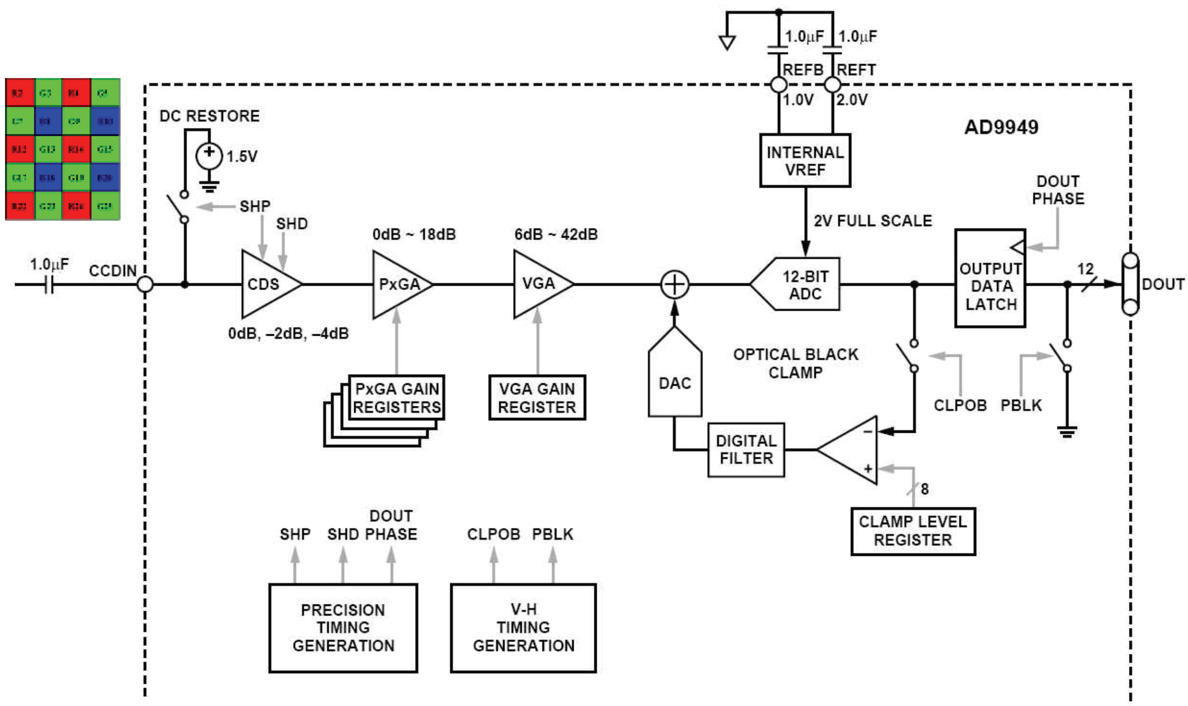


Figure 63: Block diagram of AFE (Source: Analog Devices)

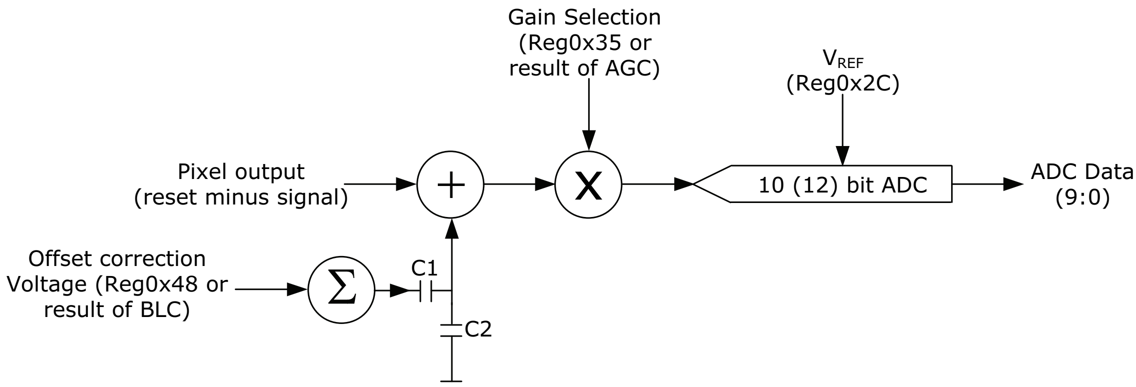


Figure 64: Signal path of MT9V022 (Guppy F-036 with CMOS sensor)

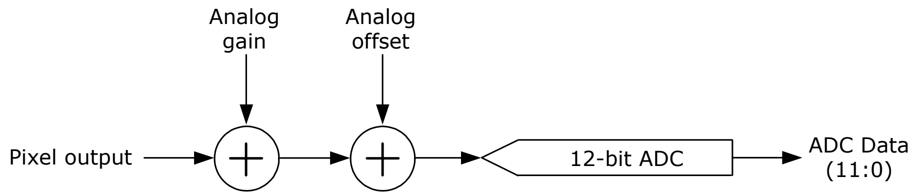


Figure 65: Signal path of MT9P031 (Guppy F-503 with CMOS sensor)

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

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

Register	Name	Field	Bit	Description
0xF0F0080C	WHITE_BALANCE	Presence_Inq	[0]	Presence of this feature: 0: N/A; 1: Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the **Value** field 1: Control with value in the **Absolute** value CSR If this bit= 1 the value in the **Value** field has to be ignored
		-	[2..4]	Reserved
		One_Push	[5]	Write: Set bit high to start Read: Status of the feature: Bit high: WIP Bit low: Ready
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF 1: ON
		A_M_MODE	[7]	Set bit high for Auto feature Read for Mode; 0= MANUAL; 1= AUTO
		U/B_Value	[8..19]	U/B value; Write if not Auto; Read
		V/R_Value	[20..31]	V/R Value

Table 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.

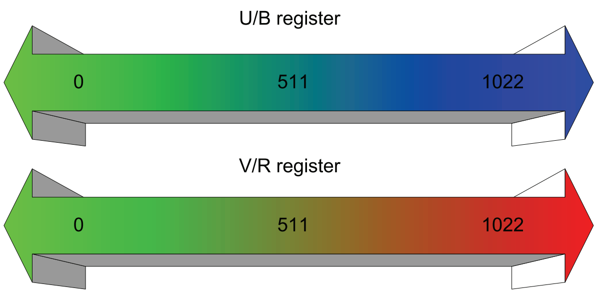


Figure 66: U/V slider range

White balance and interlaced GUPPYs

For the interlaced GUPPYs (GUPPY F-038/038 NIR/044/044 NIR) there is a non-standard (non-IIDC) register for white balance (0xF10080C4 and 0xF10080C8). This register is similar to the standard white balance CSR: here each of the four colors can be controlled independently. **One-push white balance** is not available.

Format_7 Mode_0: the binned 4 pixels have separate gains.

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

Register	Name	Field	Bit	Description
0xF10080C0	WHITE_BAL_INQ	Presence_Inq	[0]	Always 0
		-	[1..31]	Reserved
0xF10080C4	WHITE_BAL_12	Presence_Inq	[0]	Indicates presence of this feature (read only)
		-	[1..4]	Reserved
		OnePush	[5]	One-push white balance
		ON_OFF	[6]	Feature On/Off
		A_M_Mode	[7]	Auto white balance
		PXGA_2_Value	[8..19]	Green / red
		PXGA_1_Value	[20..31]	Magenta / green
0xF10080C8	WHITE_BAL_34	Presence_Inq	[0]	Indicates presence of this feature (read only)
		-	[1..7]	Reserved
		PXGA_4_Value	[8..19]	Cyan / green
		PXGA_3_Value	[20..31]	Yellow / blue

Table 41: White balance register for interlaced GUPPYs

One-push white balance

Note

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

Note

Configuration

To configure this feature in control and status register (CSR): See Table 106: Feature control register on page 248.

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

For white balance, in total **eight** frames are processed and a grid of at least **65536 samples** is equally spread over the whole image area. The R-G-B component values of the samples are added and are used as actual values for the **one-push white balance**.

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

Note

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

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

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

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

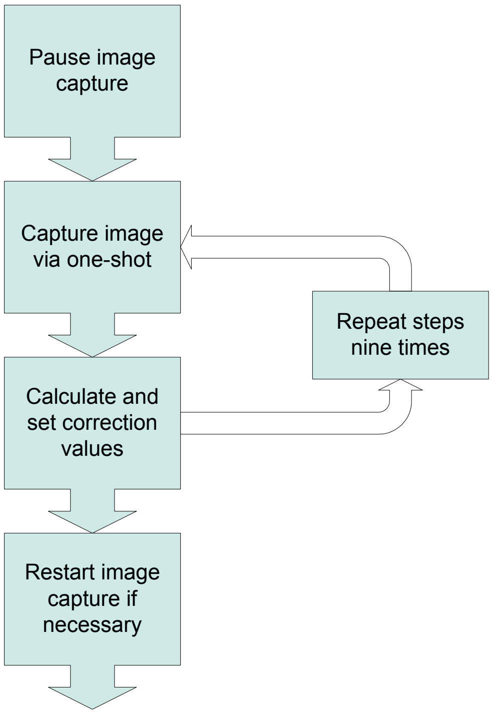


Figure 67: **One-push white balance** sequence

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

Auto white balance (AWB)

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

As a reference, it uses a grid of at least 65535 (2^{16}) samples equally spread over the area of interest or a fraction of it.

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

Note

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

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

Note

Configuration

To set position and size of the control area (Auto_Function_AOI) in an advanced register: see Table 124: Advanced register: Autofunction AOI on page 273.

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

The camera automatically adjusts the settings to the permitted values.

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

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

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

Note

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

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

The following drawing illustrates the AUTOFNC_AOI settings in greater detail.

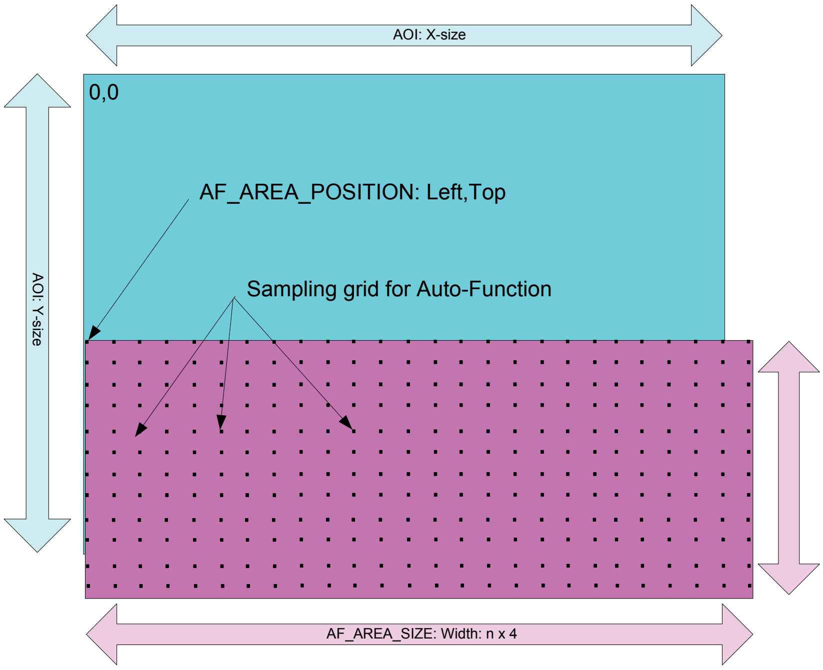


Figure 68: AUTOFNC_AOI positioning

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

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

Note

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

Manual gain

As shown in:

- Figure 63: Block diagram of AFE (Source: Analog Devices) on page 115
- Figure 64: Signal path of MT9V022 (Guppy F-036 with CMOS sensor) on page 116
- Figure 65: Signal path of MT9P031 (Guppy F-503 with CMOS sensor) on page 116

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

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

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

Table 42: Manual gain range of the various GUPPY types (CCD and CMOS)

Note

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

Auto gain

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

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

Increasing the auto exposure value (aka target grey value) increases the average brightness in the image and vice versa.

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

The following table shows the gain and auto exposure CSR.

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

Table 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: Auto_Exposure CSR

Note

Configuration

To configure this feature in an advanced register: See Table 123: Advanced register: Auto gain control on page 272.

Note

- Values can only be changed within the limits of gain CSR.
- Changes in auto exposure register only have an effect when auto gain is active.
- Auto exposure limits are 50..205. (**SmartView→Ctrl1 tab**: **Target grey level**)
- **Auto gain of Guppy F-036 (CMOS model)** is directly controlled by the CMOS sensor (the target grey level is fixed to 125). Changes to this register have no effect in conjunction with auto gain. Auto exposure is working in conjunction with auto shutter only.
- **Auto gain of Guppy F-503 (CMOS model)** behaves like Guppy CCD cameras.

Brightness (black level or offset)

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

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

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

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

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

Guppy F-036 (CMOS model): -127 .. 127 gray values

Increments are in 8/25 LSB

Note

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

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

The following table shows the BRIGHTNESS register.

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

Table 45: CSR: **Brightness**

Auto shutter

Note

Guppy interlaced cameras:

Due to the fact that electronic shutter is not possible in Format_7 Mode_1 consequently auto shutter is not useful in that mode.

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

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

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

Note

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

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

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

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

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

Table 46: CSR: **Shutter**

Note

Minimum shutter time for **interlaced models in Format_7 Mode_1** is limited to the duration time of one field (33/25 ms) see description of **Shutter (integration)** parameter in Table 37: Format_7 Mode_1: output parameters (interlaced, frame) on page 105.

Note

Configuration

To configure this feature in an advanced register: See Table 122: Advanced register: Auto shutter control on page 271.

Look-up table (LUT) and gamma function

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

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

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

One example of using a LUT is the gamma LUT:

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

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

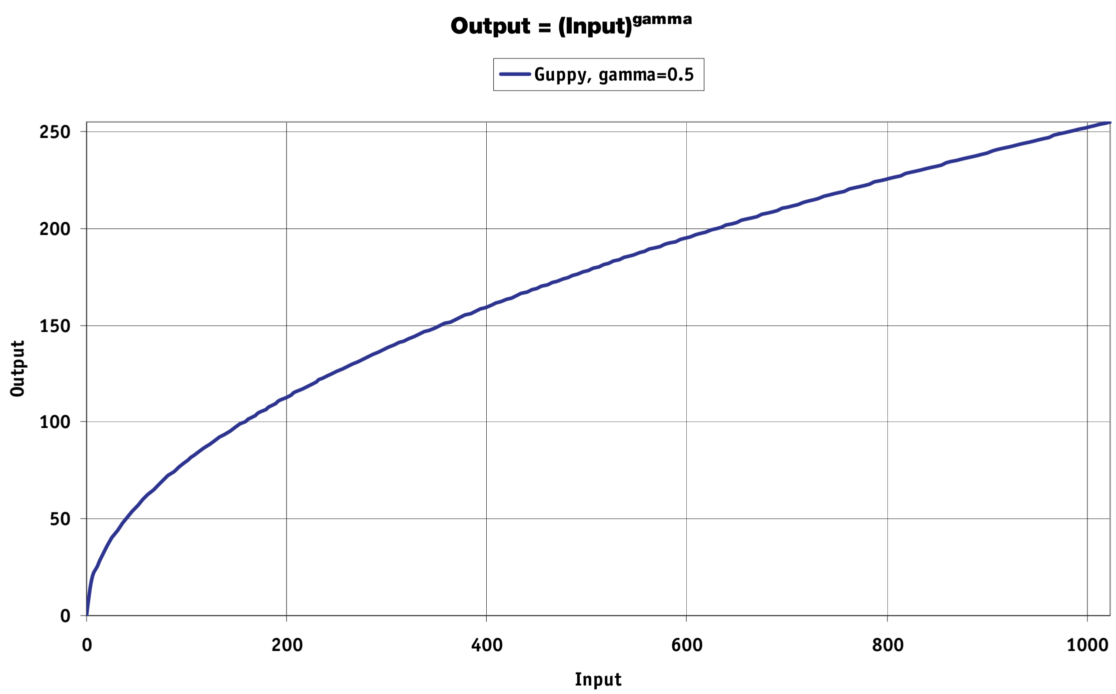


Figure 69: LUT with gamma=0.5

Note

- The input value is the 10-bit value from the digitizer. The gamma LUT of the CCD models outputs the most significant 8 bit as shown above.
- As gamma correction for the CCD models is also implemented via the look-up table, it is not possible to use a different LUT when gamma correction is enabled.
- With all CCD models, the user LUT will be overridden when gamma is enabled.
- **Guppy F-036 (CMOS model)** has the gamma function built in the sensor, so that it will not be overridden.
- **Guppy F-503 (CMOS model)** behaves like Guppy CCD cameras.
- LUT content is volatile.

Loading an LUT into the camera

Loading the LUT is carried out through the data exchange buffer called GPDATA_BUFFER. As this buffer can hold a maximum of 2 kB, and a complete LUT at 1024 x 8 bit is 1 kB, programming can take place in a one block write step. The flow diagram below shows the sequence required to load data into the camera.

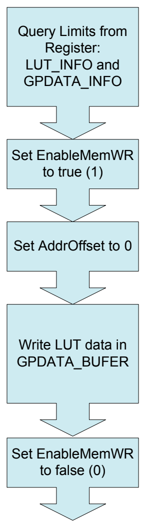


Figure 70: Loading an LUT

Note

Configuration

- To configure this feature in an advanced register: See Table 119: Advanced register: LUT on page 266.
- Information on GPDATA_BUFFER: See Chapter GPDATA_BUFFER on page 283.

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

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

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

The **X** marks a defect pixel.

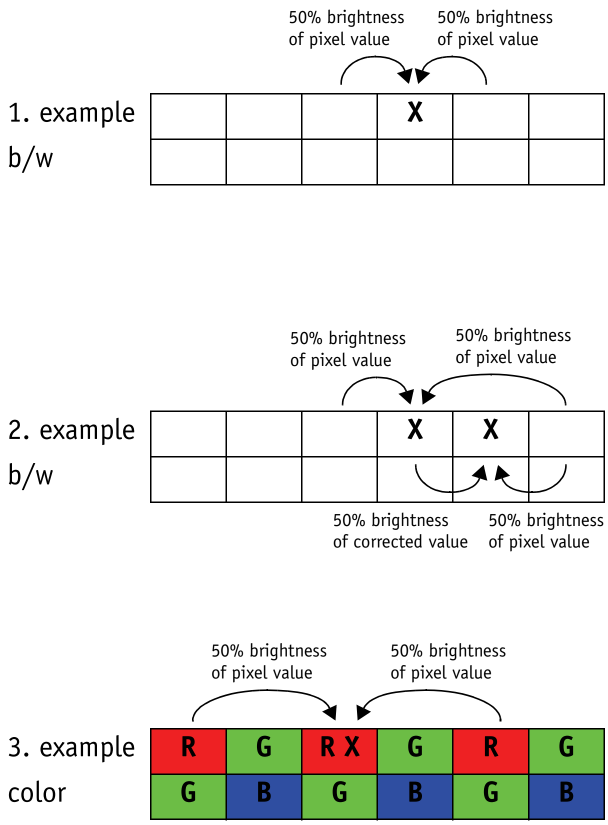


Figure 71: Mechanisms of defect pixel correction

The following flow diagram illustrates the defect pixel correction:

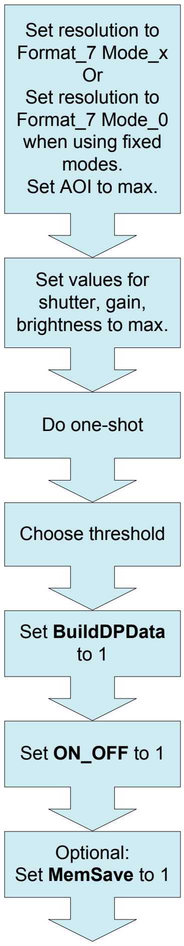


Figure 72: Defect pixel correction: build and store

Note

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

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

Note

Configuration

To configure this feature in an advanced register: See Table 120: Advanced register: Defect pixel correction on page 268.

Building defect pixel data

Note

- Defect pixel correction is **only possible in Mono8** modes. In all other modes you get an error message in advanced register 0xF1000298 bit [1] see Table 120: Advanced register: Defect pixel correction on page 268.
- Using Format_7 Mode_x: Defect pixel correction is done in **Format_7 Mode_x**.
- Using a fixed format (Format_0, Format_1 or Format_2): Defect pixel correction is done in **Format_7 Mode_0**.
- When using defect pixel correction with **binning** and **sub-sampling**: first switch to binning/sub-sampling mode and then apply defect pixel correction.

To build defect pixel data perform the following steps:

Grab an image with defect pixel data

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

Calculate defect pixel coordinates

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

Note

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

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

- greater than (mean value + threshold)

or

- less than (mean value - threshold)

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

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

   Defect pixel coordinates are:

   – 16-bit y-coordinate and
   – 16-bit x-coordinate

   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 120: Advanced register: Defect pixel correction on page 268.

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

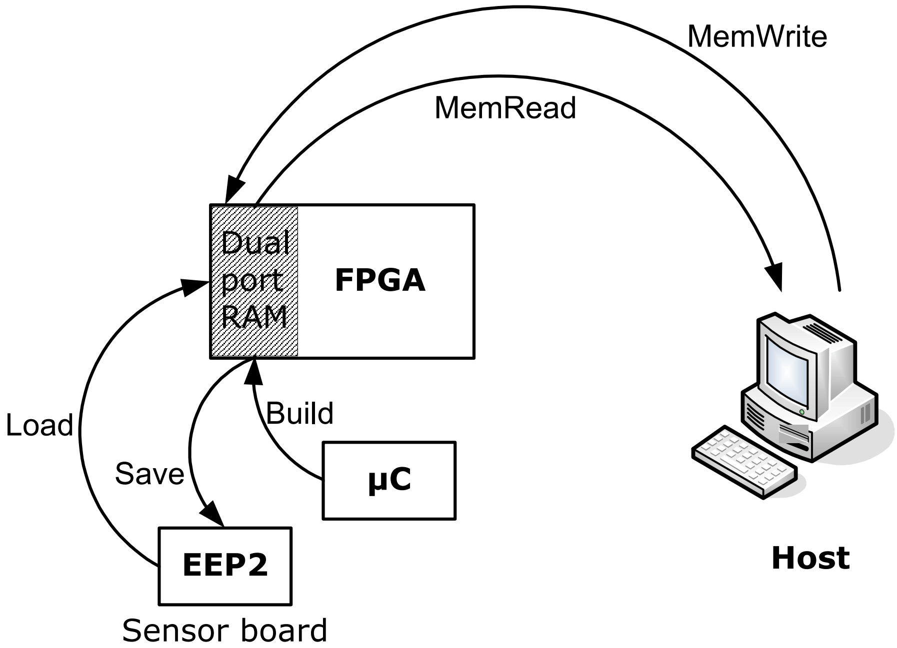


Figure 73: DPC data: storing mechanism

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

2 x and 4 x binning

Definition

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

Note

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

Guppy F-036: only b/w cameras

Guppy F-503: b/w and color cameras

Binning is used primarily for 3 reasons:

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

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

The higher this value, the better the signal quality. The unit of measurement used is generally known as the decibel (dB), a logarithmic power level. 6 dB is the signal level gain when binning two pixels, giving a theoretical SNR improvement of about 3 dB.

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

Only Format_7

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

Types

In general, we distinguish between four types of binning:

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

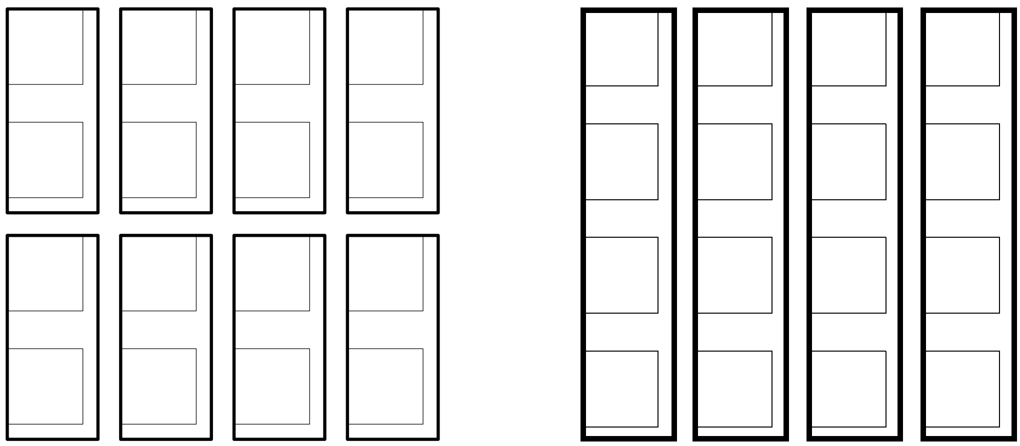
and the full binning modes:

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

2 x vertical binning and 4 x vertical binning

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

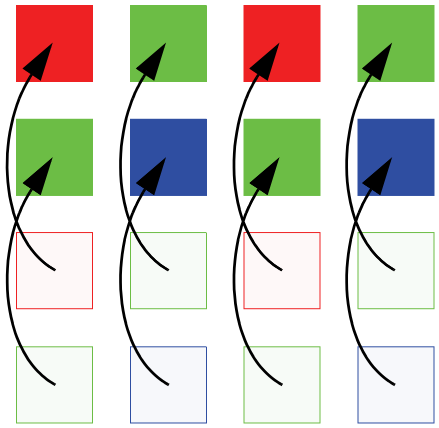
Table 47: Definition of 2 x and 4 x vertical binning



2 x vertical binning

4 x vertical binning

Figure 74: 2 x vertical binning and 4 x vertical binning (**Guppy F-036**)



2 x vertical binning (b/w and color)

Figure 75: 2 x vertical binning (**Guppy F-503**)

Note

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

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

Use **Format_7 Mode_5** to activate **4 x vertical binning**. (Guppy F-036B)

Note

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

Note

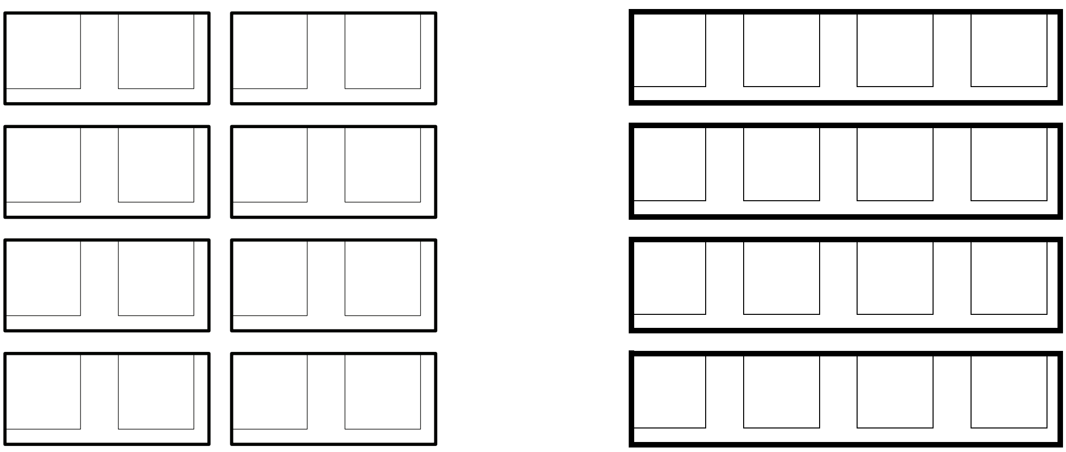
The frame rates in the vertical binning modes are lower than the frame rates in the corresponding AOI resolution.

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

2 x horizontal binning and 4 x horizontal binning

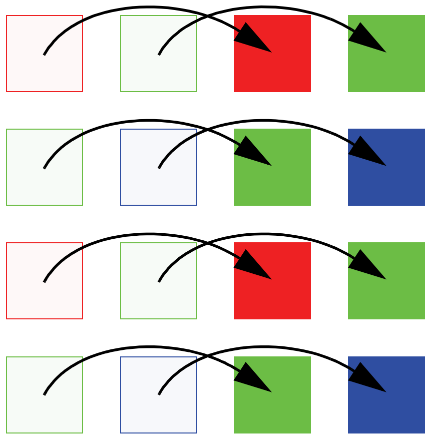
Binning mode	Guppy F-036B	Guppy F-503B/C
2 x horizontal binning	2 pixel signals from 2 vertical **neighboring pixels** are combined and their signals are **averaged**.	2 pixel signals from 2 vertical **adjacent same-color pixels** are combined and their signals are **added** or **averaged**.
4 x horizontal binning	4 pixel signals from 4 vertical **neighboring** pixels are combined and their signals are **averaged**.	4 pixel signals from 4 vertical **adjacent same-color pixels** are combined and their signals are **added** or **averaged**.
Averaged? or Additive?	Only averaged	Default: additive There is also an average binning mode implemented. To activate this mode see Chapter Low noise binning mode (2 x and 4 x binning) (only Guppy F-503) on page 281
When the signals are **averaged**, the image will **not be brighter** than without binning. When the signals are **added**, the image will be **brighter** than without binning.		

Table 48: Definition of 2 x and 4 x horizontal binning



2 x horizontal binning 4 x horizontal binning

Figure 76: 2 x horizontal binning and 4 x horizontal binning (**Guppy F-036**)



2 x horizontal binning (b/w and color)

Figure 77: 2 x horizontal binning (**Guppy F-503**)

Note

Horizontal resolution is reduced, but **signal-to noise ratio** (SNR) is increased by about 3 or 6 dB (2 x or 4 x binning), (**Guppy F-503**: if low noise binning mode is activated).

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

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

Guppy F-036B:

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

Note

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

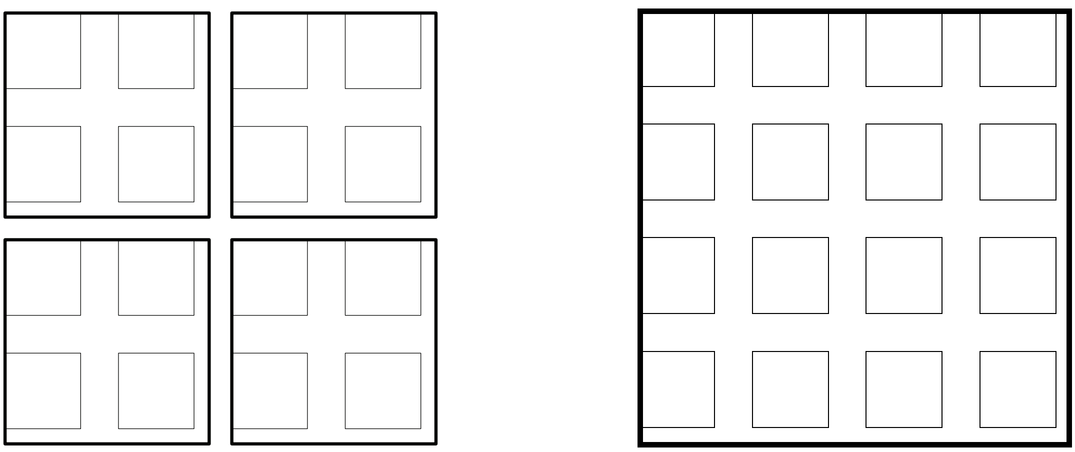
2 x full binning and 4 x full binning

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

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

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

Table 49: Definition of 2 x and 4 x full binning



2 x full binning

4 x full binning

Figure 78: Full binning (**Guppy F-036**)

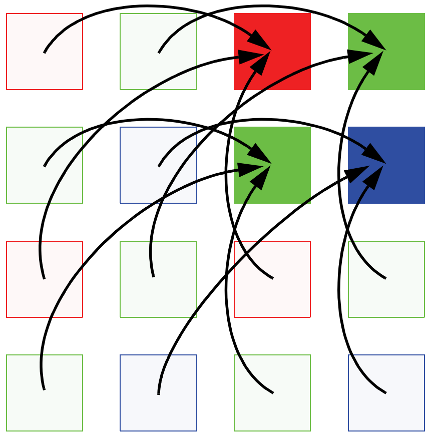


Figure 79: Full binning (**Guppy F-503**)

Note

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

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

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

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

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

Guppy F-036B:

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

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

What is sub-sampling?

Definition

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

Which Guppy models have sub-sampling?

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

Description of sub-sampling

Sub-sampling is used primarily for the following reason:

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

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

Format_7 Mode_4

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

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

The different sub-sampling patterns are shown below.

2 out of 4

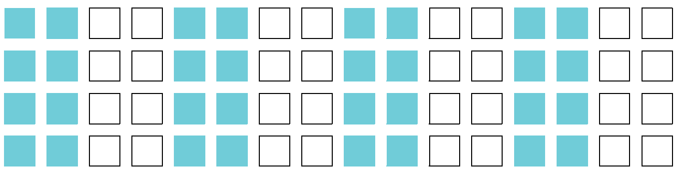


Figure 80: Horizontal sub-sampling 2 out of 4 (**b/w**)

2 out of 8

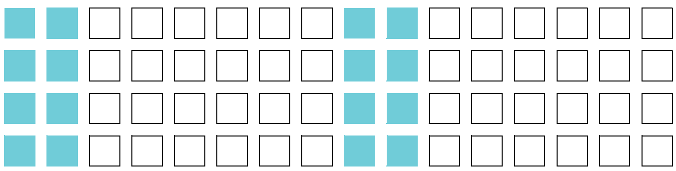


Figure 81: Horizontal sub-sampling 2 out of 8 (**b/w**)

2 out of 4

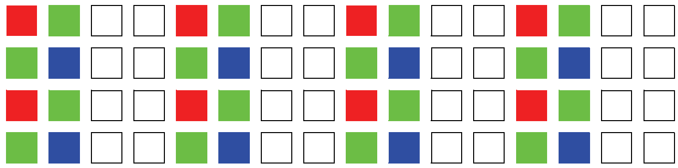


Figure 82: Horizontal sub-sampling 2 out of 4 (**color**)

2 out of 8

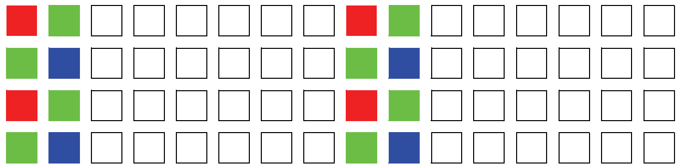


Figure 83: Horizontal sub-sampling 2 out of 8 (**color**)

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.

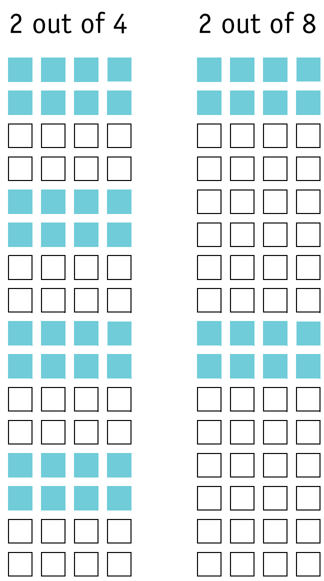


Figure 84: Vertical sub-sampling (**b/w**)

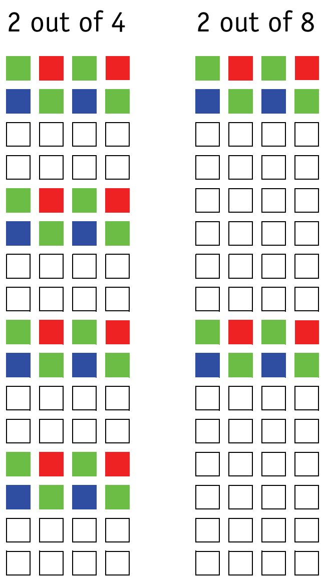


Figure 85: Vertical sub-sampling (**color**)

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.

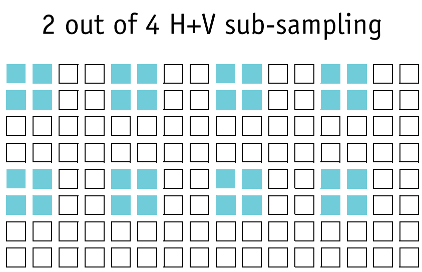


Figure 86: 2 out of 4 H+V sub-sampling (**b/w**)

2 out of 8 H+V sub-sampling

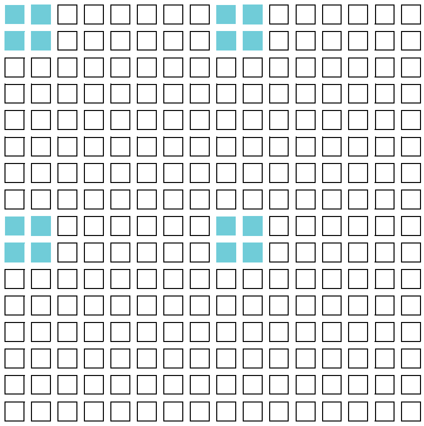


Figure 87: 2 out of 8 H+V sub-sampling (**b/w**)

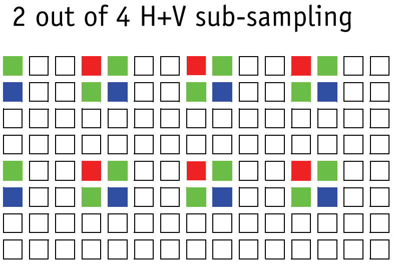


Figure 88: 2 out of 4 H+V sub-sampling (**color**)

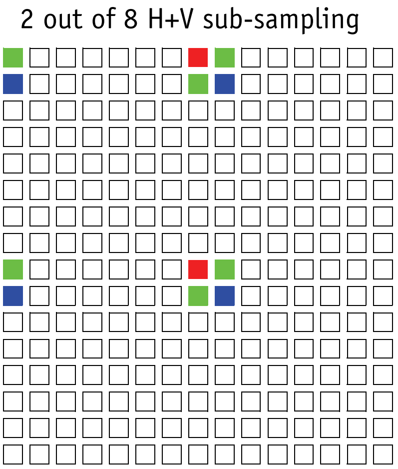


Figure 89: 2 out of 8 H+V sub-sampling (**color**)

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 (only Guppy F-503)

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

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

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

- **Format_7 Mode_0** is fixed and cannot be changed
- A maximum of 7 individual 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 152*)
- Mappings can be stored via register (see Chapter Format_7 mode mapping (only Guppy F-503) on page 280) and are uploaded automatically into the camera on camera reset.
- The **default settings** (per factory) in the Format_7 modes are listed in the following table:

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

Table 50: Default Format_7 binning and sub-sampling modes (per factory)

Note

- A **combination** of binning and sub-sampling modes is **not possible**.
  Use either pure binning or pure sub-sampling modes.
- The Format_ID numbers 0...26 in the binning / sub-sampling list on page 152 do **not** correspond to any of the Format_7 modes.

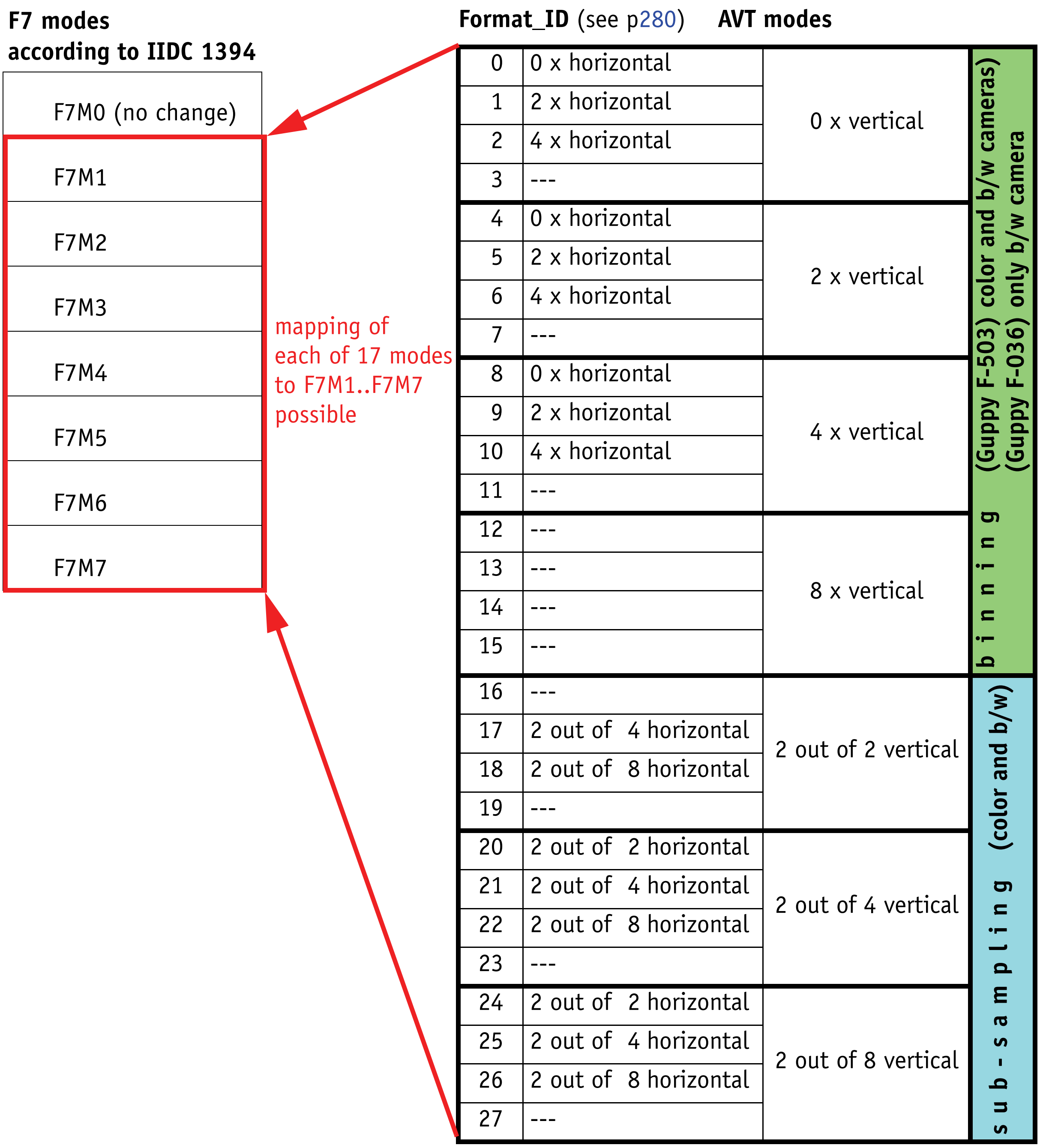


Figure 90: Mapping of possible Format_7 modes to F7M1...F7M7

Note

Configuration

To configure this feature in an advanced register: See Table 131: Advanced register: Format_7 mode mapping on page 280.

Packed 12-Bit Mode

Definition All Guppy 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 51: **Packed 12-Bit Mode**

Note

For data block packet format see Table 34: Packed 12-Bit Mode (mono and raw) Y12 format from AVT on page 95.

For data structure see Table 35: Data structure of Packed 12-Bit Mode (mono and raw) from AVT on page 97.

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 108: Format_7 control and status register on page 252.

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

Table 52: **Packed 12-Bit Mode**: color coding

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

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

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

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

HDR overview (HiDy sensor)

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

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

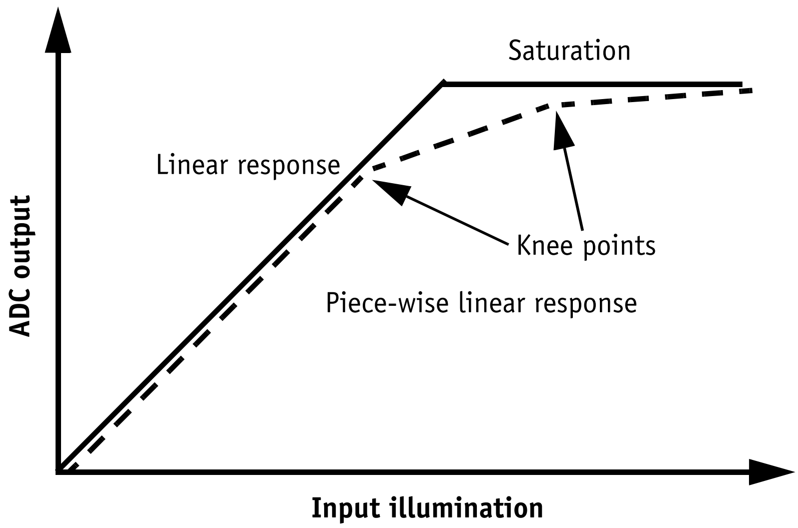


Figure 91: HDR response curves

Note

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

Pixel operations in detail

The following diagrams show the principle of the pixel operations:

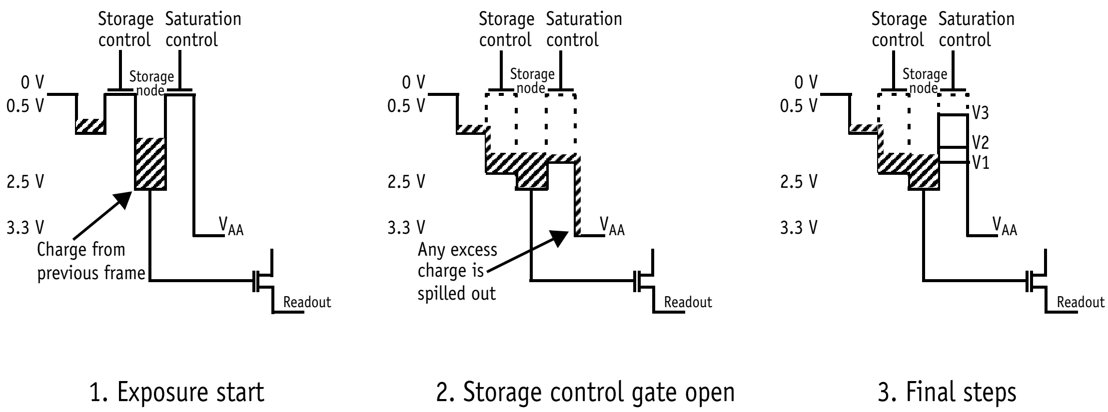


Figure 92: Details of pixel operations

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

Note

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

Single knee point vs. two knee points

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

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

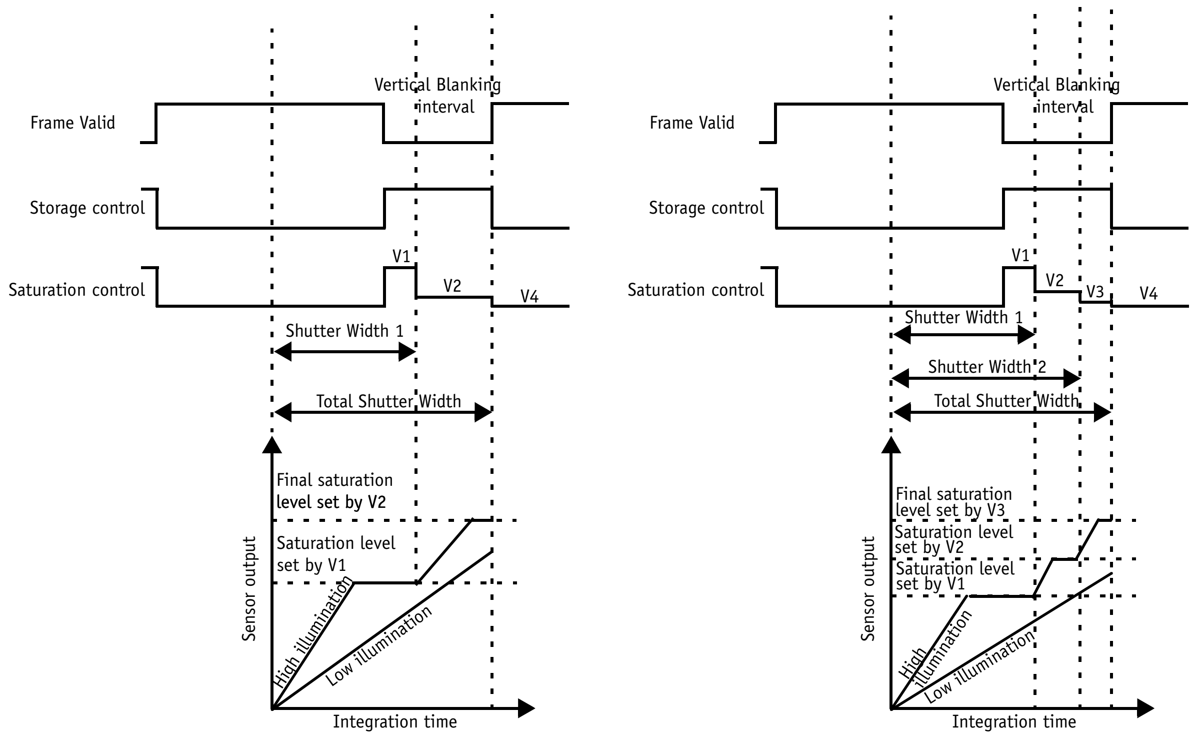
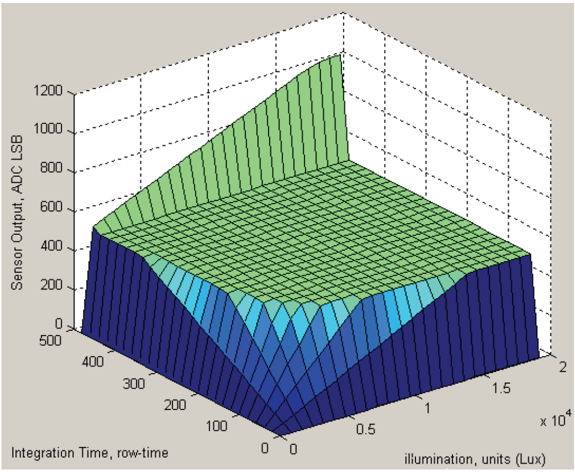
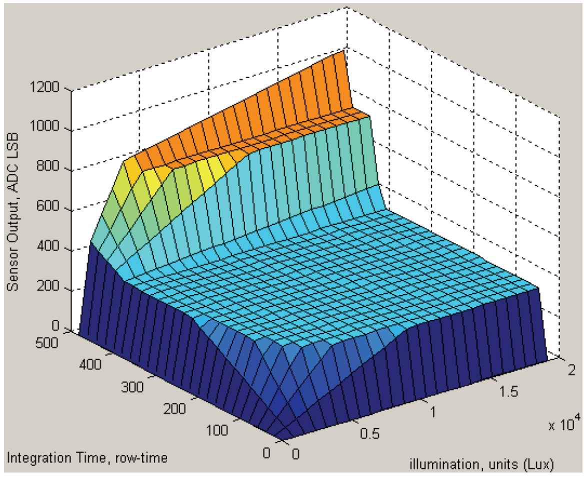


Figure 93: Single knee situation (left) and two knee point situation (right)

Note

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

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

Pixel output response for one knee operation</td><td>

Pixel output response for two knee operation</td></tr>
</table>

Table 53: Setting knee points and pixel output response

Effects of a HiDy sensor

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

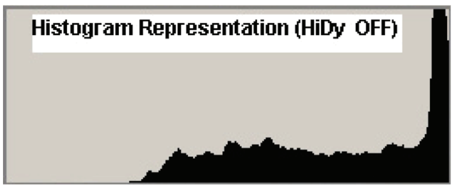
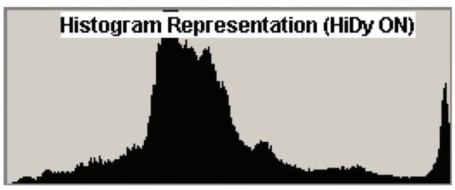
<table>
<tr><th>Histogram (HiDy off)</th><th>Histogram (HiDy on)</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td colspan="2">This is a histogram example from an outdoor scene taken with HiDy off (left) and HiDy on (right). The HiDy mode is able to show details in both the bright and dark areas to be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

Table 54: Histogram with HiDy off (left) and HiDy on (right)

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

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

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

Table 55: High dynamic range (HDR) configuration register

Note

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

BAYER pattern (raw data output)

Definition

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

No color interpolation

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

- For GUPPY cameras with SONY progressive scan sensors the first pixel of the sensor is **RED.** (GUPPY F-033C, GUPPY F-046C, GUPPY F-080C)
- For GUPPY F-036C the first pixel of the sensor is **BLUE**.
- For GUPPY F-503C the first pixel of the sensor is **GREEN**.
- For interlaced GUPPY cameras the first pixel of the first line is **GREEN** followed by **MAGENTA** and the first pixel of the second line is **CYAN** followed by **YELLOW**.
  GREEN and **MAGENTA** change every second line.
  (GUPPY F-038C, GUPPY F-038C NIR, GUPPY F-044C, GUPPY F-044C NIR)

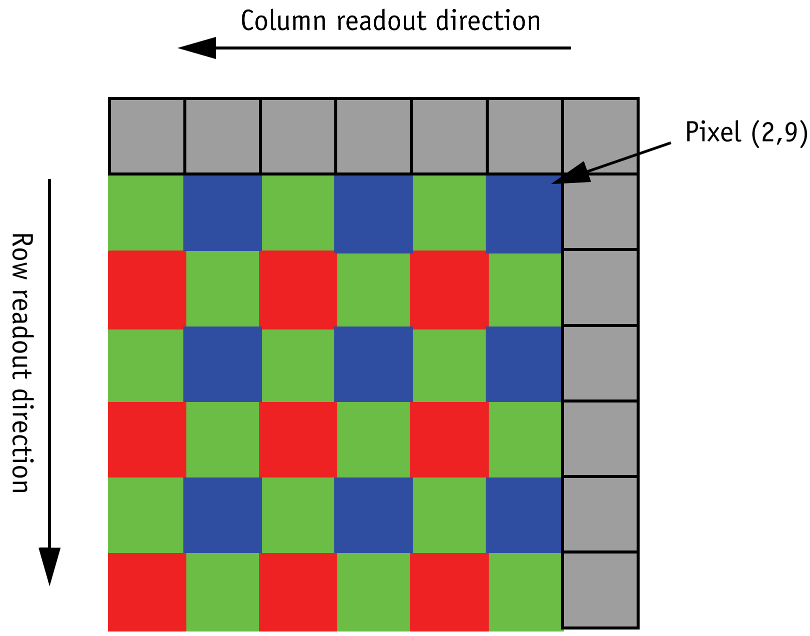


Figure 94: Bayer pattern of Guppy F-036C

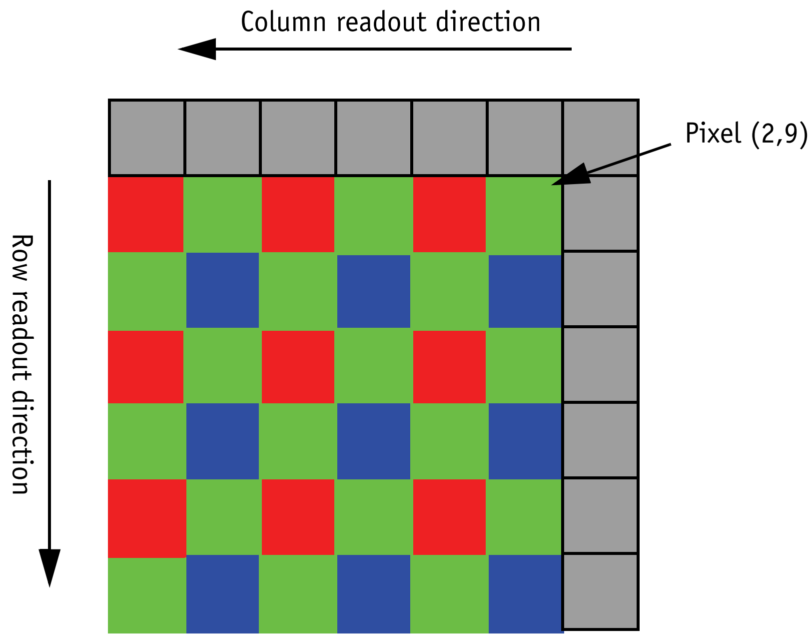


Figure 95: Bayer pattern of Guppy F-503C

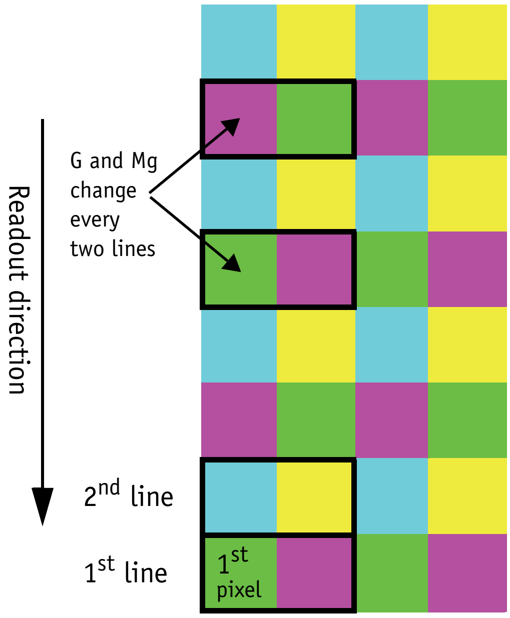


Figure 96: BAYER pattern of SONY complementary sensors: 1st line: G - Mg, 2nd line: Cy - Ye

Serial interface

All Guppy cameras are equipped with the SIO (serial input/output) feature as described in IIDC V1.31. This means that the GUPPYs serial interface which is used for firmware upgrades can also be used as a general RS232 interface.

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

Note

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

Base address for the function is: F0F02100h.

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

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

Table 56: Serial input/output control and status register (SIO CSR)

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

Table 56: 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 WR: Number of bytes to be read from the receive FIFO RD: Number of bytes left for readout from the receive FIFO
		-	[16..31]	Reserved
00Ch	TRANSMIT_BUFFER_STATUS_CONTRL	TBUF_ST	[0..7]	SIO output buffer status RD: Space left in TX buffer WR: Ignored
		TBUF_CNT	[8..15]	SIO output buffer control RD: Number of bytes written to transmit FIFO WR: Number of bytes to transmit
		-	[16..31]	Reserved
010h .. 0FFh		-		Reserved
100h	SIO_DATA_REGISTER	CHAR_0	[0..7]	Character_0 RD: Read char. from receive buffer WR: Write char. to transmit buffer
	SIO_DATA_REGISTER	CHAR_1	[8..15]	Character_1 RD/WR
	SIO_DATA_REGISTER	CHAR_2	[16..23]	Character_2 RD/WR
	SIO_DATA_REGISTER	CHAR_3	[24..31]	Character_3 RD/WR

Table 56: Serial input/output control and status register (SIO CSR)

To read data:

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

To write data:

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

Note

- Contact your local dealer if you require further information or additional test programs or software.
- 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

Global shutter (CCD cameras only)

Shutter modes The cameras support the SHUTTER_MODES specified in IIDC V1.3. For all Guppy models (except Guppy F-036/503) this shutter is a **global shutter**; meaning that all pixels are exposed to the light at the same moment and for the same time span.

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

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

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

Pipelined global shutter (only Guppy F-036)

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

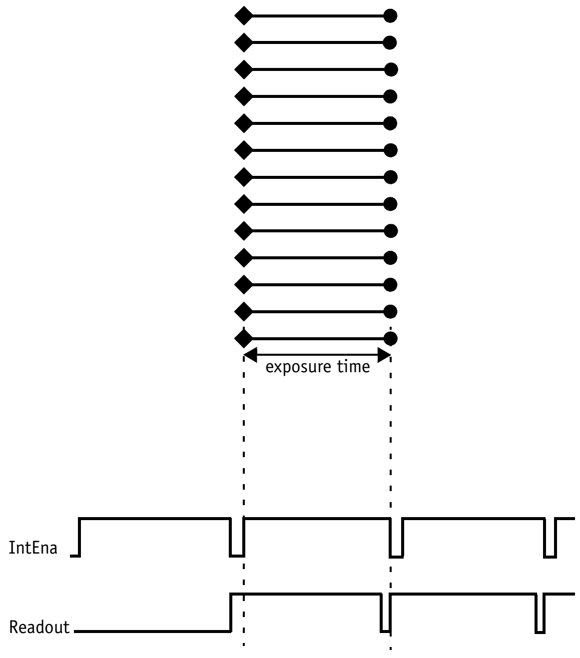
Shutter mode Guppy F-036	Description
Pipelined global shutter  	**Advantage:** designed for high frame rate and high sensitivity; behaves like CCD sensor **How it works:** • exposure time is the same for all rows • start of exposure is the same for each row ⇨ same behavior as Guppy CCD models

Table 57: GUPPY F-036 shutter mode

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

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

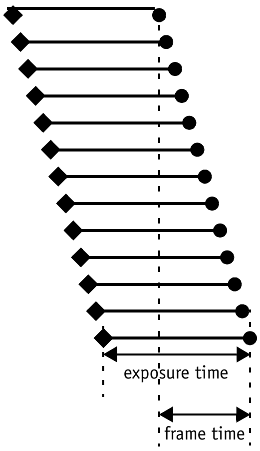
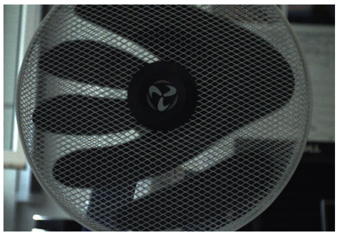
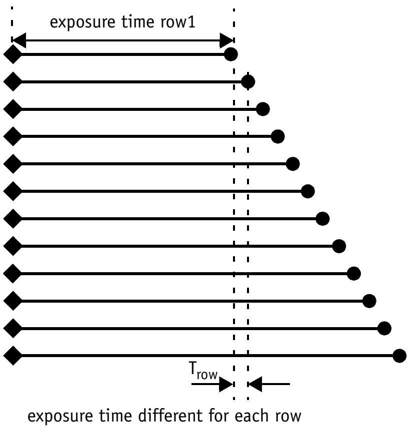
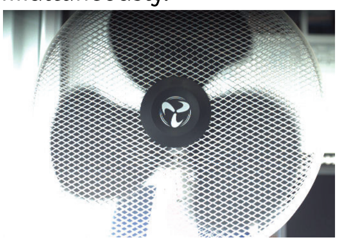
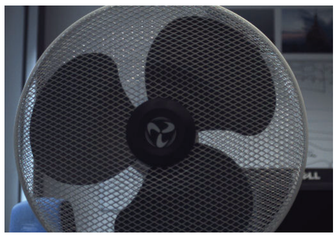
<table>
<tr><th>Shutter mode Guppy F-503</th><th>Description</th></tr>
<tr><td>Electronic rolling shutter (ERS)

</td><td>Advantage: designed for maximum frame rates
How it works:
exposure time is the same for all rows
start of exposure is different for each row
⇨ This can cause a shear in moving objects, see photo below.
Customer action: Use this mode only in situations with non-moving objects.
</td></tr>
<tr><td>Global reset release shutter (GRR)

</td><td>Advantage: designed for situations with moving objects; use this mode to avoid the problems with ERS described above
How it works: Image acquisition is done by starting all rows exposures at the same time.
⇨ So there is no shear in moving objects.
exposure time is different for each row
start of exposure is the same for each row
Customer action: Different exposure time for each row will result in images which get brighter with each row (see photo below left). In order to get an image with uniform illumination, use special lighting (flash) or mechanical/LCD extra shutter (see photo below right) which will stop the exposure of all rows simultaneously.
 </td></tr>
</table>

Table 58: GUPPY F-503 shutter modes

Trigger modes

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

Note

- **CMOS cameras Guppy F-036 / Guppy F-503** support only Trigger_Mode_0.
- **Interlaced cameras** (GUPPY F-038 / F-038 NIR / F-044 / F-044 NIR) support only Trigger_Mode_0 and Trigger_Mode_15.
  These models can only be triggered in Format_7 Mode_0 and Mode_2.

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

Table 59: Trigger modes

Trigger_Mode_0 (edge mode) and Trigger_Mode_1 (level mode)

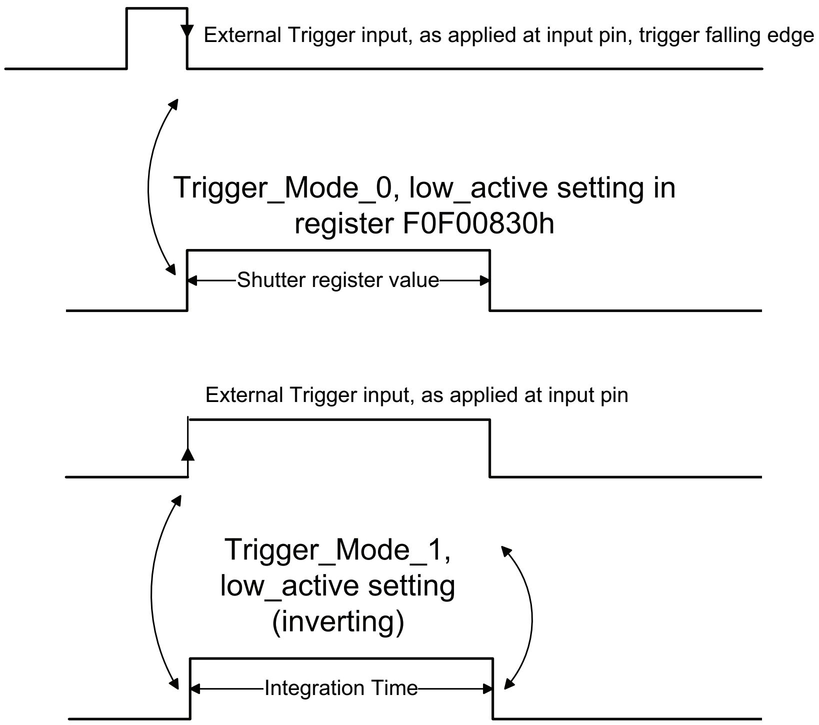


Figure 97: Trigger_Mode_0 and 1: global shutter (CCD only)

The Guppy F-503 has two shutter modes:

- electronic rolling shutter (ERS) and
- global reset release shutter (GRR)

Note

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

Guppy F-503, Trigger_Mode_0, electronic rolling shutter

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

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

Long exposure time:

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

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

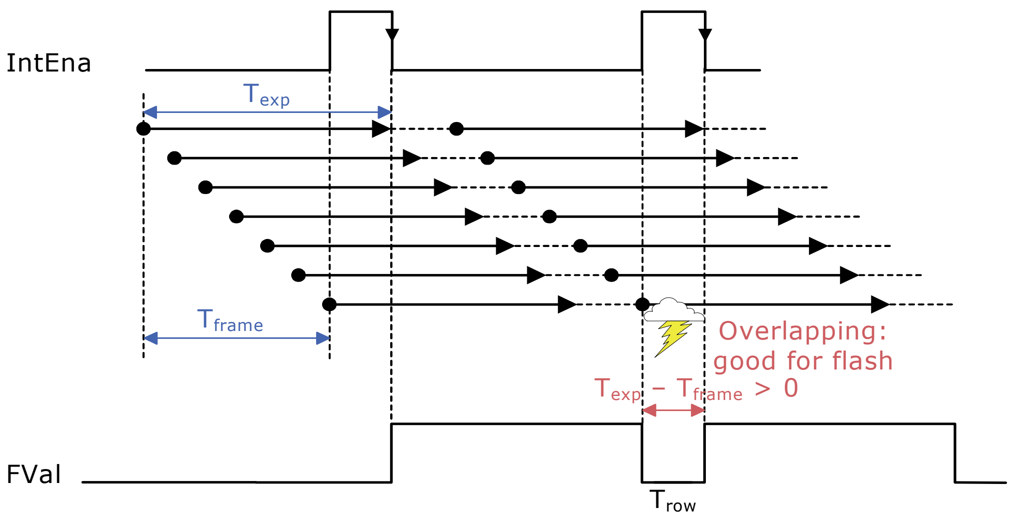


Figure 98: Trigger_Mode_0: Guppy F-503 electronic rolling shutter (**long** exposure time)

Short exposure time:

If the following condition is true:

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

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

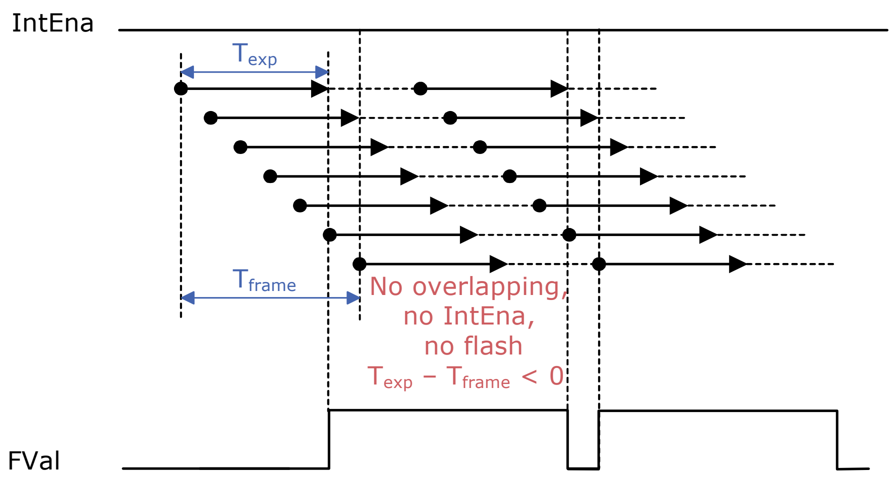


Figure 99: Trigger_Mode_0: Guppy F-503 electronic rolling shutter (**short** exposure time)

Guppy F-503, Trigger_Mode_0, global reset release shutter

Note

For activating **global reset release shutter** in an advanced register see Table 133: Advanced register: Global reset release shutter on page 282.

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

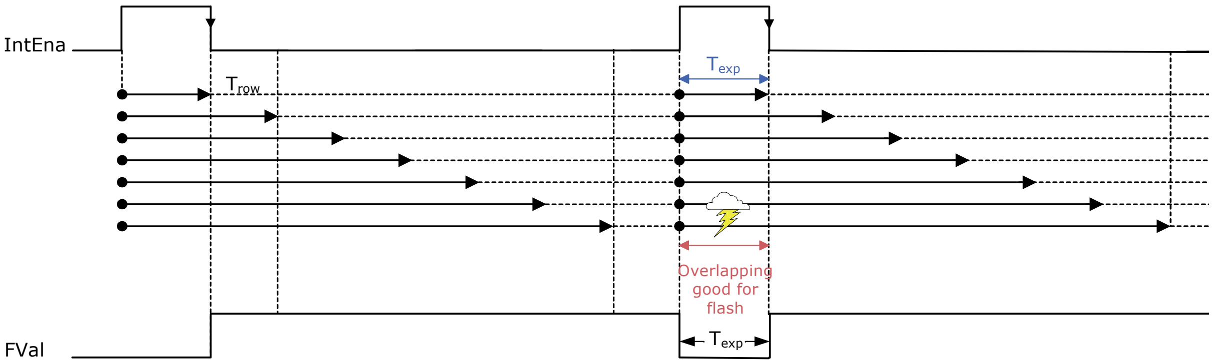


Figure 100: Trigger_Mode_0: Guppy F-503: global reset release shutter

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

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

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

Trigger_Mode_15 (bulk trigger)

Note

Trigger_Mode_15 is only available for Guppy CCD cameras.

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

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

This is especially useful for:

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

The next diagram shows this mode in detail.

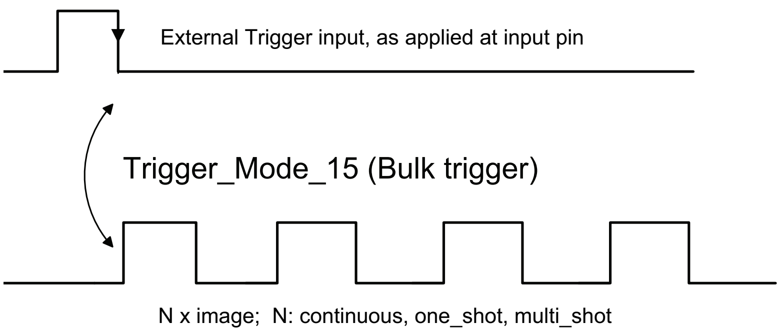


Figure 101: Trigger_Mode_15

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

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

Table 60: Trigger_Mode_15

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

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

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

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

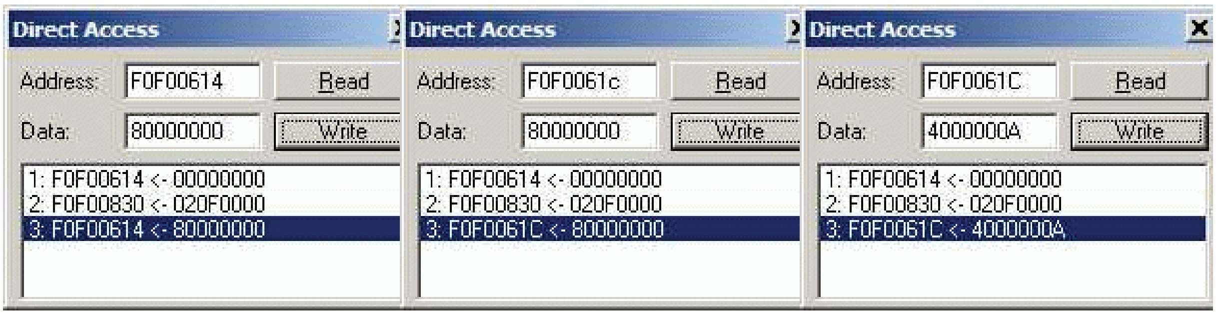


Figure 102: Using Trigger_Mode_15: continuous, one-shot, multi-shot

Note

Shutter for the images is controlled by shutter register.

Trigger delay

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

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

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

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

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

Table 63: CSR: **trigger delay**

Trigger delay advanced register

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

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

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

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

Note

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

Exposure time (shutter) and offset

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

Shutter register value x timebase + offset

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

The shutter register value is multiplied by the time base register value (see Table 116: Time base ID on page 263). The default value here is set to 20 µs.

Exposure time of GUPPY F-036 (CMOS)

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

Note

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

Exposure time of GUPPY F-503 (CMOS)

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

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

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

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

Formula 9: Row time for GUPPY F-503 (CMOS): GRR

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

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

Formula 10: Min. row time and row time by max. resolution for GUPPY F-503 (CMOS): GRR

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

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

For more information see Chapter Extended shutter on page 264 and Table 117: Advanced register: Extended shutter on page 264.

Minimum shutter time of GUPPY F-036

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

Example GUPPY F-036

Set Shutter register: 100

100 x 20 µs = 2000 µs

2000 µs/29.89 µs = 66.91

Effective shutter:

66 x 29.89 µs = 1972.74 µs (without offset)

Example GUPPY F-503

Set Shutter register: 100

100 x 20 µs = 2000 µs

2000 µs/41.8 µs = 47.85

Effective shutter:

47 x 41.8 µs = 1964.6 µs (without offset)

Exposure time offset

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

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

Table 65: Camera-specific exposure time offset

Example GUPPY F-033

Camera	Register value	Timebase
GUPPY F-033	100	20 µs

Table 66: Register value and Timebase for GUPPY F-033

100 x 20 µs + 109 µs = 2109 µs exposure time

The minimum adjustable exposure time set by register is 20 µs. → The real minimum exposure time of GUPPY F-033 is then 20 µs + 109 µs = 129 µs.

Extended shutter

The exposure time for long-term integration of:

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

can be extended via the EXTENDED_SHUTTER register.

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

Table 67: Extended shutter configuration

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

Note

Minimum shutter time for **interlaced models in Format_7 Mode_1** is limited to the duration time of one field (33/25 ms) see description of **Shutter (integration)** parameter in Table 37: Format_7 Mode_1: output parameters (interlaced, frame) on page 105.

Note

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

One-Shot

The camera can record an image by setting the **one-shot bit** in the 61Ch register. This bit is automatically cleared after the image is captured. If the camera is placed in Iso_Enable mode (see Chapter ISO_Enable / free-run on page 187), this flag is ignored.

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

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

Note

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

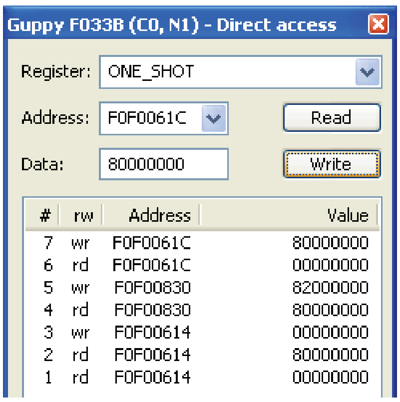


Figure 103: One-shot control (SmartView)

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

Table 68: One-shot control: descriptions

One-shot command on the bus to start of exposure

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

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

Feature	Value
One-shot → Microcontroller-Sync	≤ 250 µs (processing time in the microcontroller)
µC-Sync/ExSync → Integration-Start	8 µs

Table 69: Values for one-shot

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

End of exposure to first packet on the bus

After the exposure, the CCD or CMOS sensor is read out; some data is written into a small FIFO buffer before being transmitted to the bus.

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

500 µs ± 62.5 µs

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

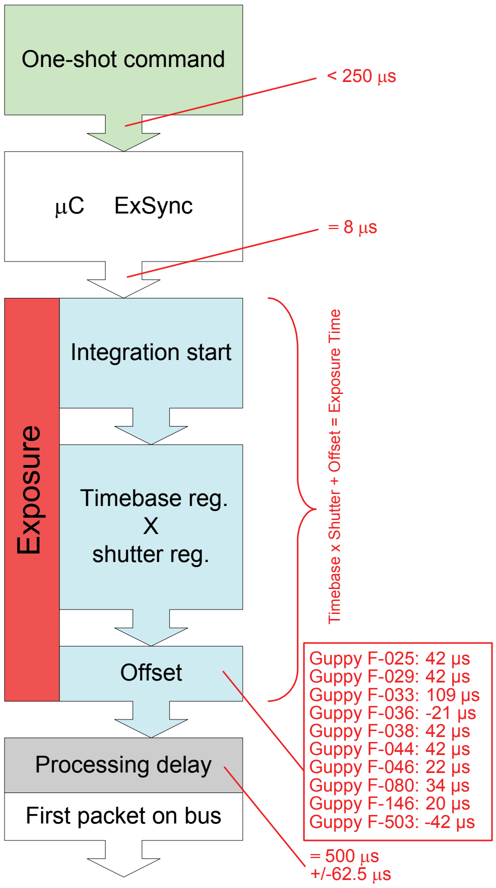


Figure 104: Data flow and timing after end of exposure (Guppy F-038/044 also NIR)

Multi-shot

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

The number is indicated in bits 16 to 31. If the camera is put into **Iso_Enable** mode (see Chapter ISO_Enable / free-run on page 187), this flag is ignored and deleted automatically once all the images have been recorded.

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

Multi-shot can also be combined with the external trigger in order to grab a certain number of images based on an external trigger.

ISO_Enable / free-run

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

Asynchronous broadcast

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

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

Inter-camera latency is described in Chapter Jitter at start of exposure on page 188.

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

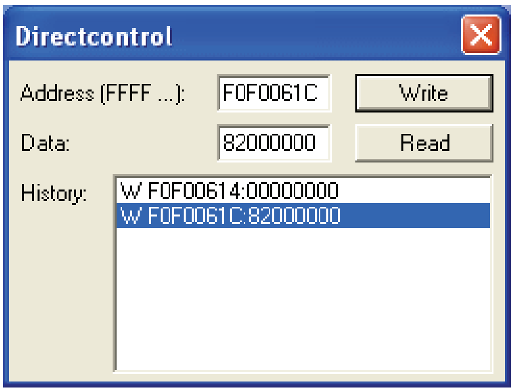


Figure 105: Broadcast one-shot

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

Jitter at start of exposure

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

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

- The **Micron/Aptina CMOS sensor** of the **GUPPY F-036** uses a **pipelined global shutter**, thus imitating the separate light sensitive and storage area of a CCD. For more information see Chapter Pipelined global shutter (only Guppy F-036) on page 168.
- The **Micron/Aptina CMOS sensor** of the **GUPPY F-503** uses an **electronic rolling shutter** and a **global reset release shutter**. For more information see Chapter Electronic rolling shutter (ERS) and global reset release shutter (GRR) (only Guppy F-503) on page 169.

For the CCDs the uncertainty time delay before the start of exposure depends on the state of the sensor. A distinction is made as follows:

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

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

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

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

Model	Camera idle	Camera busy
Guppy F-033	40.69 ns	32.29 µs
Guppy F-036	29.89 µs	29.89 µs
Guppy F-038	8.77 µs	68.06 µs
Guppy F-038 NIR	8.77 µs	68.06 µs

Table 70: Jitter at exposure start

Model	Camera idle	Camera busy
Guppy F-044	8.77 µs	66.94 µs
Guppy F-044 NIR	8.77 µs	66.94 µs
Guppy F-046	33.34 ns	31.73 µs
Guppy F-080	30.30 ns	40.45 µs
Guppy F-146	30.30 ns	42.18 µs
Guppy F-503	11.97 ns	t_{row}

Table 70: Jitter at exposure start

Note

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

User profiles

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

The feature is described in Chapter User profiles on page 277.

Video formats, modes and bandwidth

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

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

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

Note

- The maximum frame rates can only be achieved with shutter settings lower than 1/framerate. This means that with default shutter time of 40 ms, a camera will not achieve frame rates higher than 25 frames/s. In order to achieve higher frame rates, please reduce the shutter time proportionally.
- **The following tables assume that bus speed is 400 Mbit/s.** With lower bus speeds (e.g. 200 or 100 Mbit/s) not all frame rates may be achieved.
- For information on bit/pixel and byte/pixel for each color mode see Table 90: ByteDepth on page 219.

Note

H-binning means horizontal binning.

V-binning means vertical binning.

Full binning means horizontal + vertical binning

2 x binning means: 2 neighboring pixels are combined.

4 x binning means: 4 neighboring pixels are combined.

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

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

Format	Mode	Resolution	Color mode	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120	YUV444						
	1	320 x 240	YUV422						
	2	640 x 480	YUV411						
	3	640 x 480	YUV422						
	4	640 x 480	RGB8						
	5	640 x 480	MONO8	x x*	x x*	x x*	x x*	x x*	
	6	640 x 480	MONO16						
7	0	656 x 494 656 x 494	MONO8 Raw8	@58 fps @58 fps					
	1								
	2								
	3								

Table 71: Video formats Guppy F-033B / Guppy F-033C and board level versions

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

Guppy F-036B / Guppy F-036C

Format	Mode	Resolution	Color mode	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120	YUV444						
	1	320 x 240	YUV422						
	2	640 x 480	YUV411						
	3	640 x 480	YUV422						
	4	640 x 480	RGB8						
	5	640 x 480	MONO8	x x*	x x*	x x*			
	6	640 x 480	MONO16						
7	0	752 x 480 752 x 480	MONO8 Raw8	@64 fps @64 fps					
	1	376 x 480	MONO8	@43 fps, 2 x H-binning average					
	2	752 x 240	MONO8	@119 fps, 2 x V-binning average					
	3	376 x 240	MONO8	@81 fps, 2 x full binning average					
	4	188 x 480	MONO8	@37 fps, 4 x H-binning average					
	5	752 x 120	MONO8	@209 fps, 4 x V-binning average					
	6	188 x 120	MONO8	@122 fps, 4 x full binning average					

Table 72: Video formats Guppy F-036B / Guppy F-036C

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

Note

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

Guppy F-038B / Guppy F-038C

Format	Mode	Resolution	Color mode	Max. frame rates in Format_7
7	0	768 x 492	MONO8	@30 fps, 2 x V-binning, interlaced, field integration mode
		768 x 492	Raw8	@30 fps, 2 x V-binning, interlaced, field integration mode (binned colors)
	1	768 x 492	MONO8	@30 fps, no binning, interlaced, frame integration mode
		768 x 492	Raw8	@30 fps, no binning, interlaced, frame integration mode
	2	384x244	MONO8	@59 fps, 2 x full binning for aspect ratio, non-interlaced, progressive readout mode
	3	768x244	MONO8	@59 fps, 2 x V-binning, non-interlaced, progressive readout mode

Table 73: Video formats Guppy F-038B / Guppy F-038C

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

Guppy F-038B NIR / Guppy F-038C NIR

Format	Mode	Resolution	Color mode	Max. frame rates in Format_7
7	0	768 x 492	MONO8	@30 fps, 2 x V-binning, interlaced, field integration mode
		768 x 492	Raw8	@30 fps, 2 x V-binning, field integration mode (binned colors)
	1	768 x 492	MONO8	@30 fps, no binning, interlaced, frame integration mode
		768 x 492	Raw8	@30 fps, no binning, interlaced, frame integration mode
	2	384x244	MONO8	@59 fps, 2 x full binning for aspect ratio, non-interlaced, progressive readout mode
	3	768x244	MONO8	@59 fps, 2 x V-binning, non-interlaced, progressive readout mode

Table 74: Video formats Guppy F-038B NIR / Guppy F-038C NIR

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

Guppy F-044B / Guppy F-044C

Format	Mode	Resolution	Color mode	Max. frame rate in Format_7
7	0	752 x 580	MONO8	@25 fps, 2 x V-binning, field readout mode
		752 x 580	Raw8	@25 fps, 2 x V-binning, field readout mode
	1	752 x 580	MONO8	@25 fps, no binning, frame integration mode
		752 x 580	Raw8	@ 25 fps, no binning, frame integration mode
	2	376 x 288	MONO8	@52 fps, 2 x full binning for aspect ratio, progressive readout mode, only first field is read out
	3	752 x 288	MONO8	@52 fps, 2 x V-binning, non-interlaced, progressive readout mode

Table 75: Video formats Guppy F-044B / Guppy F-044C

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

Guppy F-044B NIR / Guppy F-044C NIR

Format	Mode	Resolution	Color mode	Max. frame rate in Format_7
7	0	752 x 580	MONO8	@25 fps, 2 x V-binning, interlaced, field readout mode
		752 x 580	Raw8	@25 fps, 2 x V-binning, interlaced, field readout mode
	1	752 x 580	MONO8	@25 fps, no binning, interlaced, frame integration mode
		752 x 580	Raw8	@ 25 fps, no binning, interlaced, frame integration mode
	2	376 x 288	MONO8	@52 fps, 2 x full binning for aspect ratio, progressive readout mode, only first field is read out
	3	752 x 288	MONO8	@52 fps, 2 x V-binning, non-interlaced, progressive readout mode

Table 76: Video formats Guppy F-044B NIR / Guppy F-044C NIR

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

Guppy F-046B / Guppy F-046C

Format	Mode	Resolution	Color mode	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120	YUV444						
	1	320 x 240	YUV422						
	2	640 x 480	YUV411						
	3	640 x 480	YUV422						
	4	640 x 480	RGB8						
	5	640 x 480	MONO8	x x*	x x*	x x*	x x*	x x*	
	6	640 x 480	MONO16						
7	0	780 x 582 780 x 582	MONO8 Raw8	@49.4 fps @49.4 fps					
	1								
	2								
	3								

Table 77: Video formats Guppy F-046B / Guppy F-046C

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

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

Format	Mode	Resolution	Color mode	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120	YUV444						
	1	320 x 240	YUV422						
	2	640 x 480	YUV411						
	3	640 x 480	YUV422						
	4	640 x 480	RGB8						
	5	640 x 480	MONO8		x x*	x x*	x x*	x x*	
	6	640 x 480	MONO16						
1	0	800 x 600	YUV422						
	1	800 x 600	RGB8						
	2	800 x 600	MONO8		x x*	x x*	x x*		
	3	1024 x 768	YUV422						
	4	1024 x 768	RGB8						
	5	1024 x 768	MONO8		x x*	x x*	x x*	x x*	
	6	800 x 600	MONO16						
	7	1024 x 768	MONO16						
7	0	1032 x 778 1032 x 778	MONO8 Raw8	@30 fps @30 fps					
	1								
	2								
	3								

Table 78: Video formats Guppy F-080B / Guppy F-080C

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

Guppy F-146B / Guppy F-146C

Format	Mode	Resolution	Color mode	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120	YUV444						
	1	320 x 240	YUV422						
	2	640 x 480	YUV411						
	3	640 x 480	YUV422						
	4	640 x 480	RGB8						
	5	640 x 480	MONO8		x x*	x x*	x x*	x x*	
	6	640 x 480	MONO16		x	x	x	x	
1	0	800 x 600	YUV422						
	1	800 x 600	RGB8						
	2	800 x 600	MONO8			x x*	x x*		
	3	1024 x 768	YUV422						
	4	1024 x 768	RGB8						
	5	1024 x 768	MONO8			x x*	x x*	x x*	x x*
	6	800 x 600	MONO16			x	x		
	7	1024 x 768	MONO16			x	x	x	x
2	0	1280 x 960	YUV422						
	1	1280 x 960	RGB8						
	2	1280 x 960	Mono8			x x*	x x*	x x*	x x*
	3	1600 x1200	YUV422						
	4	1600 x1200	RGB8						
	5	1600 x1200	Mono8						
	6	1280 x 960	Mono16				x	x	x
	7	1600 x1200	Mono16						
7	0	1392 x 1040 1392 x 1040	Mono8 Mono12 Mono16 Raw8,Mono8 Raw12 Raw16	@17.7 fps @15.0 fps @11.3 fps @17.7 fps @15.0 fps @11.3 fps					
	1								
	2								
	3								

Table 79: Video formats Guppy F-146B / Guppy F-146C

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

Guppy F-503B / Guppy F-503C

Format	Mode	Resolution	Color mode	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120	YUV444						
	1	320 x 240	YUV422						
	2	640 x 480	YUV411						
	3	640 x 480	YUV422						
	4	640 x 480	RGB8						
	5	640 x 480	MONO8	x x*	x x*	x x*	x x*	x x*	x x*
	6	640 x 480	MONO16		x x*	x x*	x x*	x x*	x x*

Table 80: Video formats Guppy F-503B / Guppy F-503C

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

Table 80: Video formats Guppy F-503B / Guppy F-503C

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

Area of interest (AOI)

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

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

Note

The setting of AOIs is supported only in video Format_7.

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

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

Note

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

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

Note

For more information see Table 108: Format_7 control and status register on page 252.

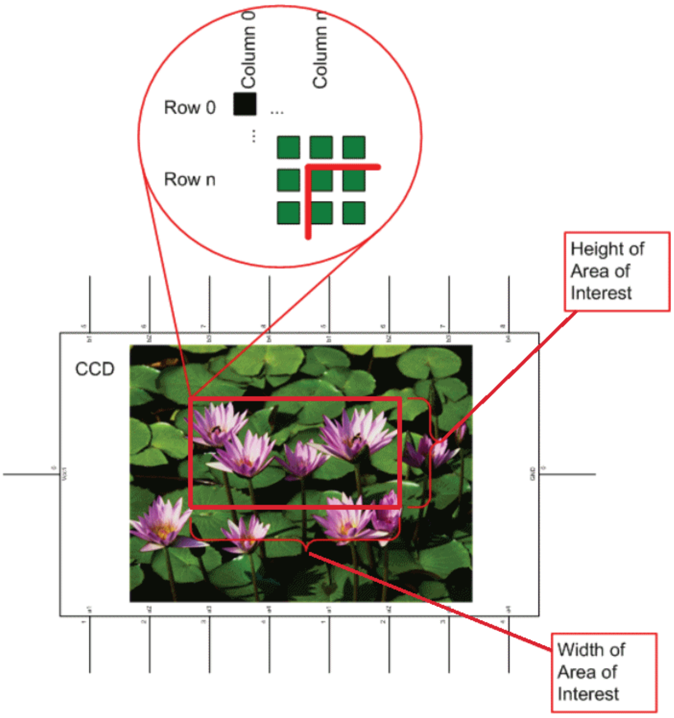


Figure 106: Area of interest (AOI)

Note

- The left position + width and the upper position + height may not exceed the maximum resolution of the sensor.
- The coordinates for width and height must be divisible by 4. The minimum AOI of the Guppy F036 is limited to 92 x 60 pixels.

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

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

Autofunction AOI (not interlaced GUPPYs)

Note

Interlaced GUPPY cameras do not have autofunction AOI feature.

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

- Auto shutter
- Auto gain
- Auto white balance

Note

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

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

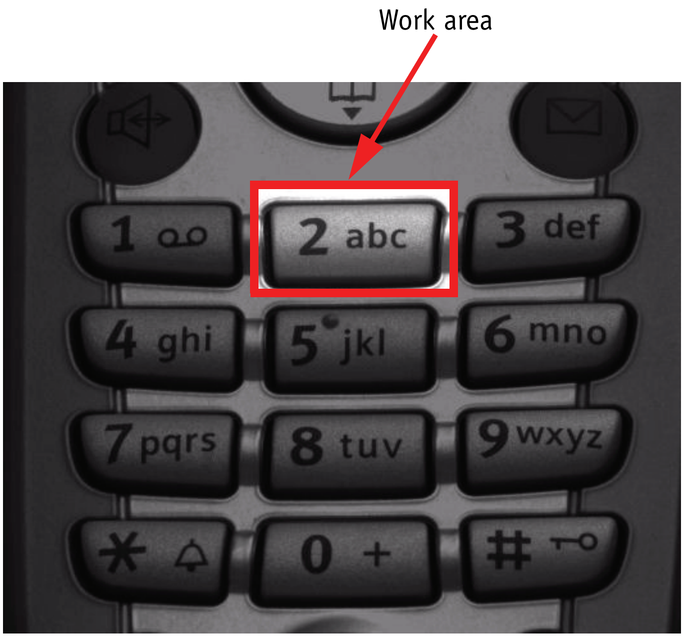


Figure 107: Example of autofunction AOI (Show work area is on)

Note

For more information see Chapter Autofunction AOI on page 273.

Note

Autofunction AOI is independent from Format_7 AOI settings.

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

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

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

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

Frame rates

An IEEE 1394 camera requires bandwidth to transport images.

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

Note

All bandwidth data is calculated with:

1 MByte = 1024 kByte

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

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

The tables are divided into three formats:

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

Table 81: Overview fixed formats

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

Note

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

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

Frame rates Format_7

In video Format_7 frame rates are no longer fixed.

Note

- Different values apply for the different sensors.
- Frame rates may be further limited by longer shutter times and/or bandwidth limitation from the IEEE 1394 bus.

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

Details are described in the next chapters:

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

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

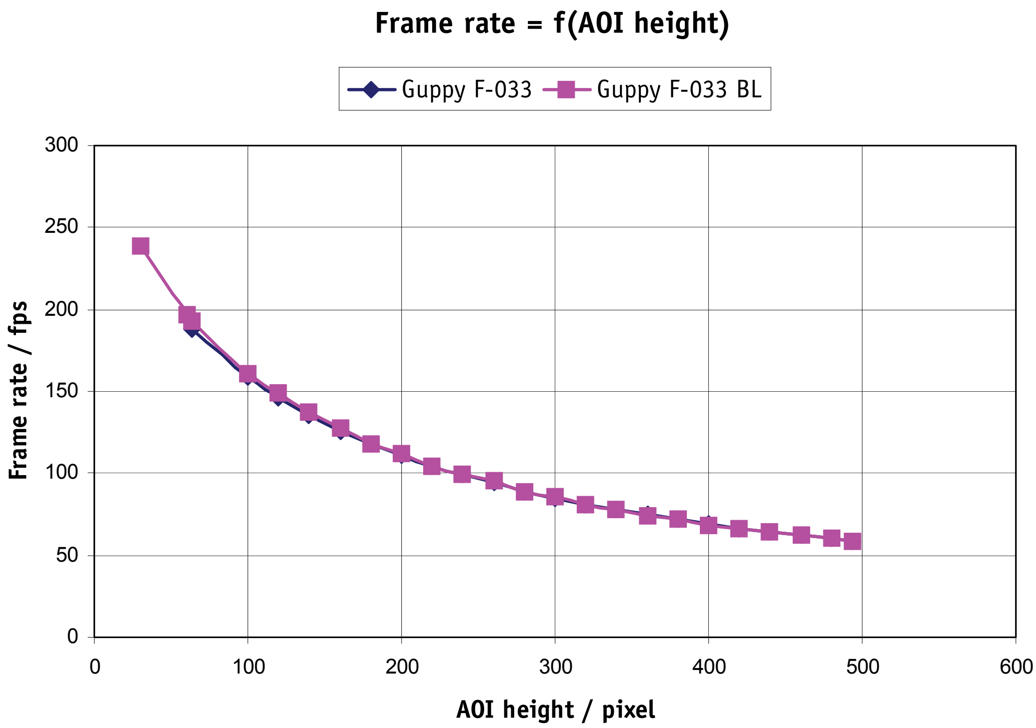


Figure 108: Frame rates GUPPY F-033 and board level versions

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

Table 82: Frame rates GUPPY F-033 and board level versions

AOI height / pixel	Frame rate / fps Guppy F-033	Frame rate / fps Guppy F-033 BL
300	85	86
280	89	89
260	94	95
240	99	99
220	104	104
200	111	112
180	118	118
160	126	128
140	135	137
120	146	149
100	159	161
64	188	193
60	not available	197
30	not available	239

Table 82: Frame rates GUPPY F-033 and board level versions

GUPPY F-036: AOI frame rates

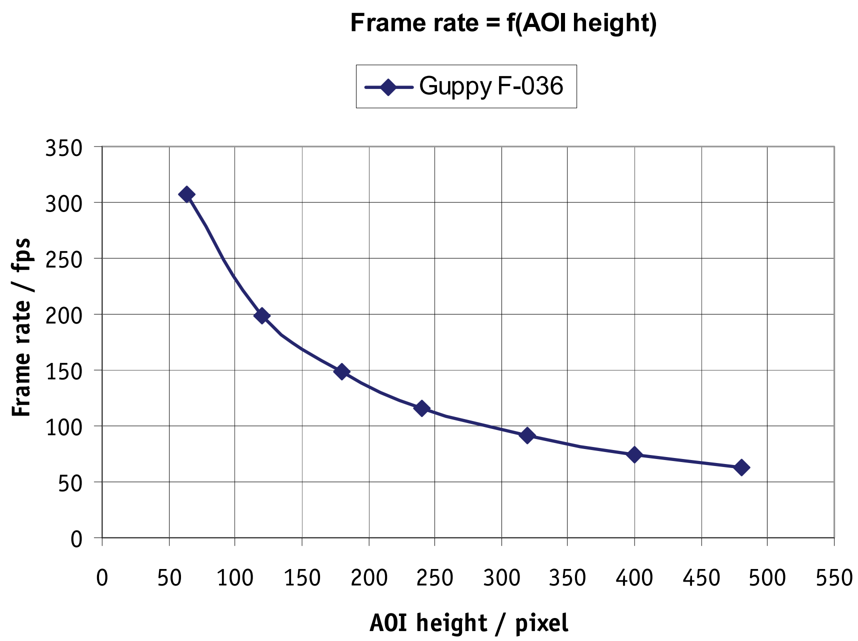


Figure 109: Frame rates GUPPY F-036 as function of AOI height

The frame rates in the following table are measured directly at the output of the camera. Compare with Chapter How does bandwidth affect the frame rate? on page 219.

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

Table 83: Frame rates GUPPY F-036 as function of AOI height

Note

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

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

GUPPY F-038 / GUPPY F-038 NIR (only F7M0 and F7M1): AOI frame rates

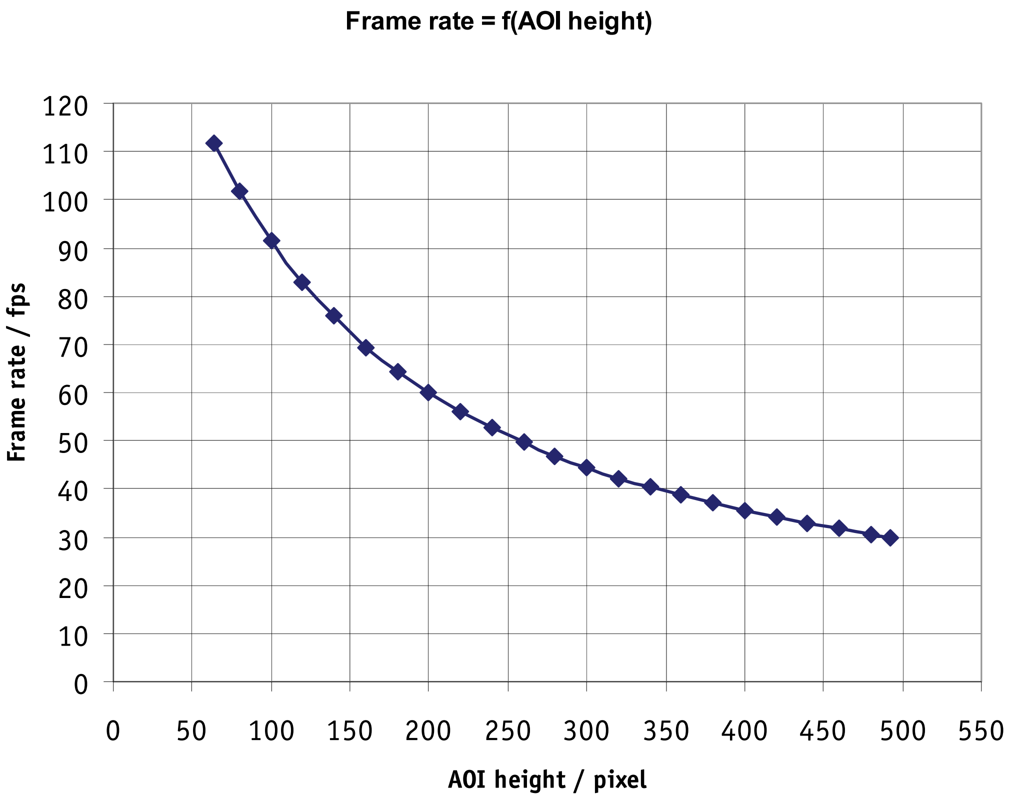


Figure 110: Frame rates GUPPY F-038 / GUPPY F-038 NIR as function of AOI height

The frame rates in the following table are measured directly at the output of the camera. Compare with Chapter How does bandwidth affect the frame rate? on page 219.

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

Table 84: Frame rates GUPPY F-038 / F-038 NIR as function of AOI height

AOI height / pixel	Frame rate / fps
360	38.7
340	40.5
320	42.2
300	44.4
280	46.9
260	49.8
240	52.7
220	56.0
200	59.9
180	64.2
160	69.2
140	75.8
120	82.9
100	91.4
80	101.9
64	111.7

Table 84: Frame rates GUPPY F-038 / F-038 NIR as function of AOI height

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

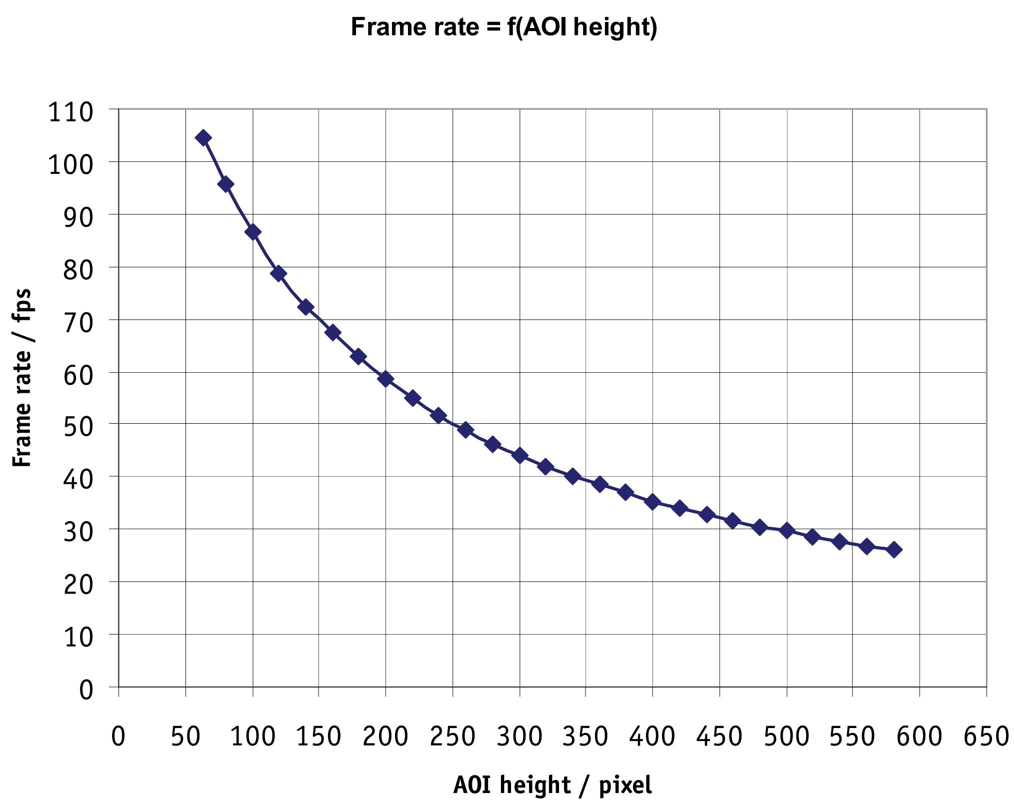


Figure 111: Frame rates GUPPY F-044 / GUPPY F-044 NIR as function of AOI height

The frame rates in the following table are measured directly at the output of the camera. Compare with Chapter How does bandwidth affect the frame rate? on page 219.

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

Table 85: Frame rates GUPPY F-044 / F-044 NIR as function of AOI height

AOI height / pixel	Frame rate / fps
440	32.7
420	33.9
400	35.3
380	37.1
360	38.5
340	40.1
320	41.9
300	44.0
280	46.3
260	48.8
240	51.8
220	55.0
200	58.6
180	62.8
160	67.5
140	72.4
120	78.8
100	86.5
80	95.7
64	104.4

Table 85: Frame rates GUPPY F-044 / F-044 NIR as function of AOI height

GUPPY F-046: AOI frame rates

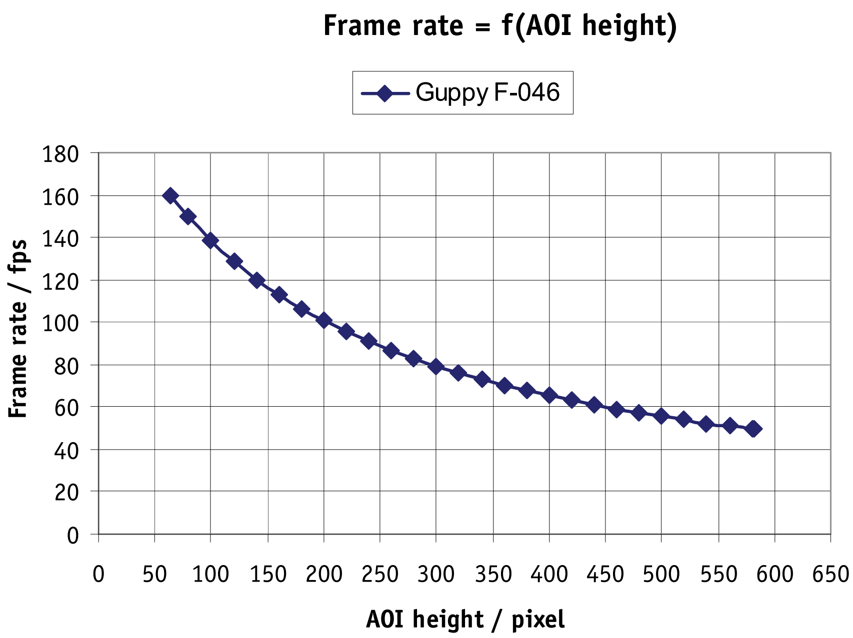


Figure 112: Frame rates GUPPY F-046 as function of AOI height

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

Table 86: Frame rates GUPPY F-046

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

Table 86: Frame rates GUPPY F-046

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

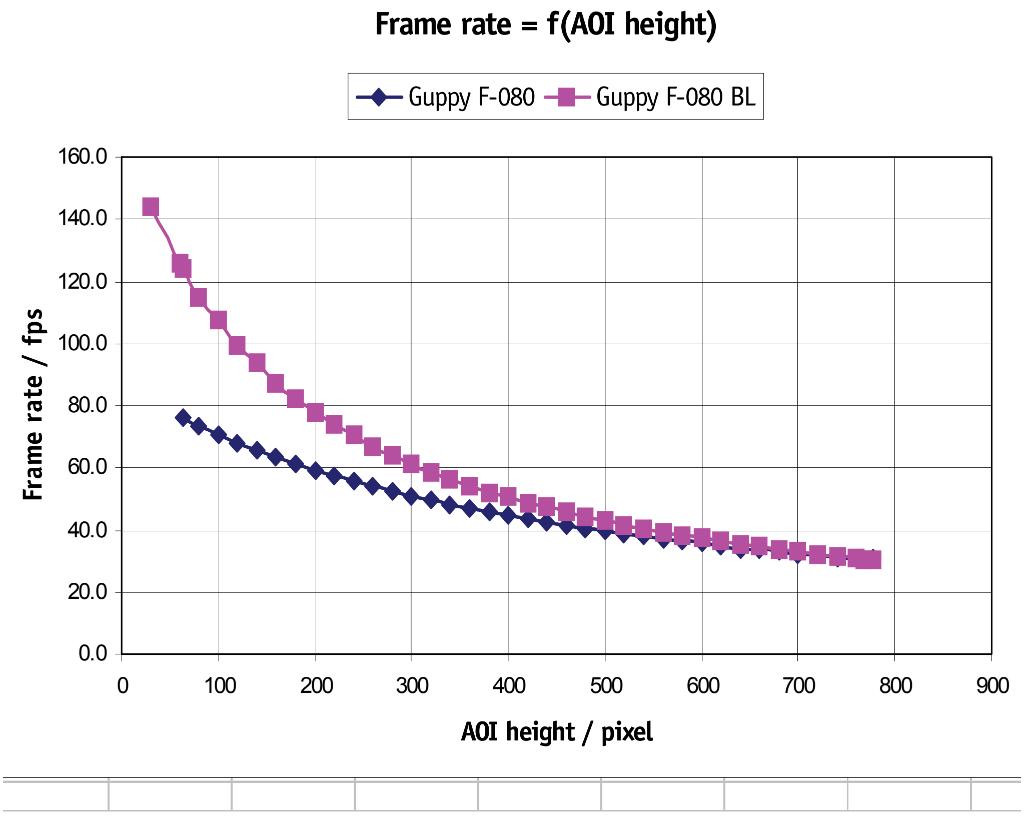


Figure 113: Frame rates GUPPY F-080 and board level versions

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

Table 87: Frame rates GUPPY F-080 and board level versions

AOI height / pixel	Frame rate / fps Guppy F-080	Frame rate / fps Guppy F-080 BL
640	33.4	35.5
620	34.7	36.3
600	35.6	37.3
580	36.4	38.2
560	37.2	39.3
540	38.0	40.3
520	38.8	41.6
500	39.7	43.0
480	40.5	44.1
460	41.4	45.6
440	42.5	47.2
420	43.5	48.6
400	44.5	50.5
380	45.7	52.1
360	46.8	54.2
340	48.1	56.1
320	49.4	58.6
300	50.8	61.3
280	52.3	63.8
260	53.9	67.0
240	55.5	70.5
220	57.3	73.7
200	59.1	78.0
180	61.2	82.0
160	63.2	87.4
140	65.5	93.6
120	68.0	99.4
100	70.8	107.4
80	73.6	115.0
64	76.2	124.0
60	not available	126.0
30	not available	144.0

Table 87: Frame rates GUPPY F-080 and board level versions

GUPPY F-146: AOI frame rates

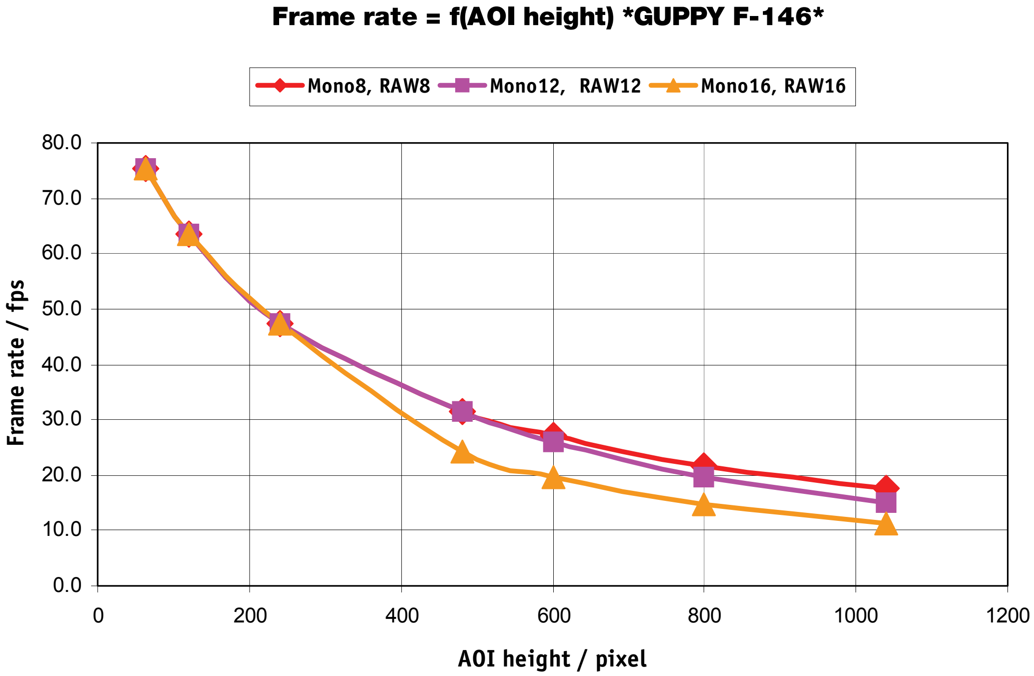


Figure 114: Frame rates GUPPY F-146

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

Table 88: Frame rates (fps) of **GUPPY F-146** as a function of AOI height

GUPPY F-503: AOI frame rates

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

Formula 11: **Guppy F-503**: theoretical max. frame rate of CMOS

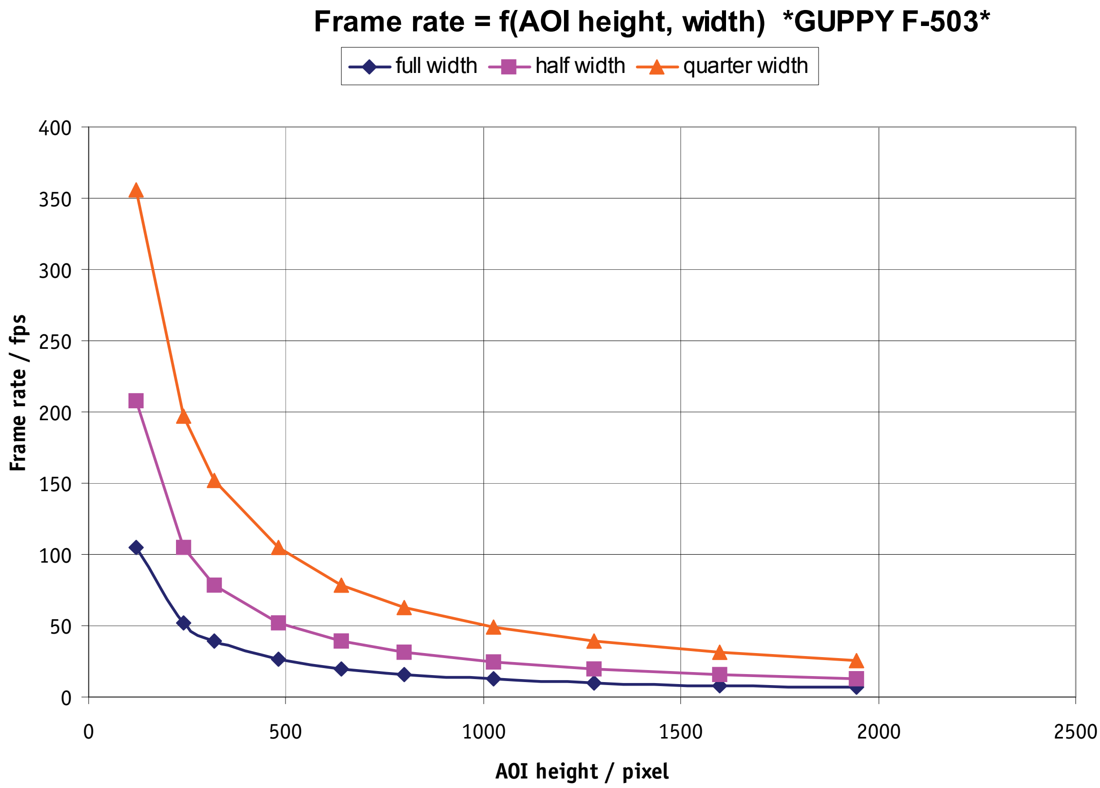


Figure 115: Frame rates GUPPY F-503 as function of AOI height and AOI width (full/half/quarter)

The frame rates in the following table are measured directly at the output of the camera. Compare with Chapter How does bandwidth affect the frame rate? on page 219.

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

Table 89: Frame rates GUPPY F-503 as function of AOI height and AOI width (full/half/quarter)

Note

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

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

How does bandwidth affect the frame rate?

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

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

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

Formula 12: Byte_per_Packet calculation (only Format_7)

If the value for **BYTE_PER_PACKET** is greater than 4096 (the maximum data payload), the sought-after frame rate cannot be attained. The attainable frame rate can be calculated using this formula:

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

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

Formula 13: Maximum frame rate calculation

ByteDepth based on the following values:

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

Table 90: ByteDepth

Example formula for the b/w camera

Mono8, 1024 x 768, 15 fps desired

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

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

Formula 14: Example max. fps calculation

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

Test images

Loading test images

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

Table 91: Loading test images in different viewers

Test images b/w cameras (progressive and interlaced)

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

Figure 116: Gray bar test image (progressive and interlaced)

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

Formula 15: Calculating the gray value

Test images for color cameras

The color cameras have 2 test images.

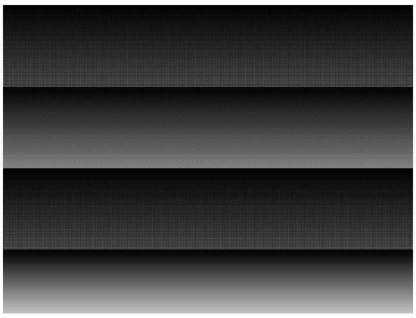
Test image	Description
Test image 1	Mono8 (raw data) static see screenshot below
Test image 2	Available with FPGA 1.05 and higher Mono8 (raw data) moving see screenshot below

Table 92: Test images color cameras

Note

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

Test image 1 (Mono8 mode) progressive



without Debayering

with Debayering

Figure 117: Test image 1 progressive

Test image 2 (Mono8 mode) progressive

without Debayering | with Debayering

Figure 118: Test image 2 progressive

Test image 1 and 2 (Mono8 mode) interlaced

without Debayering | with Debayering

Figure 119: Test image 1 (static) interlaced (Format_7 Mode_1)

Note

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

Configuration of the camera

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

This applies to:

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

Camera_Status_Register

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

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

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

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

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

If a CSR F0F00600h is mentioned below this means in full:

Bus_Id, Node_Id, FFFF F0F00600h

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

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

Far left

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

Table 93: 32-bit register

Example

This requires, for example, that to enable **ISO_Enabled mode** (see Chapter ISO_Enable / free-run on page 187), (bit 0 in register 614h), the value 80000000 h must be written in the corresponding register.

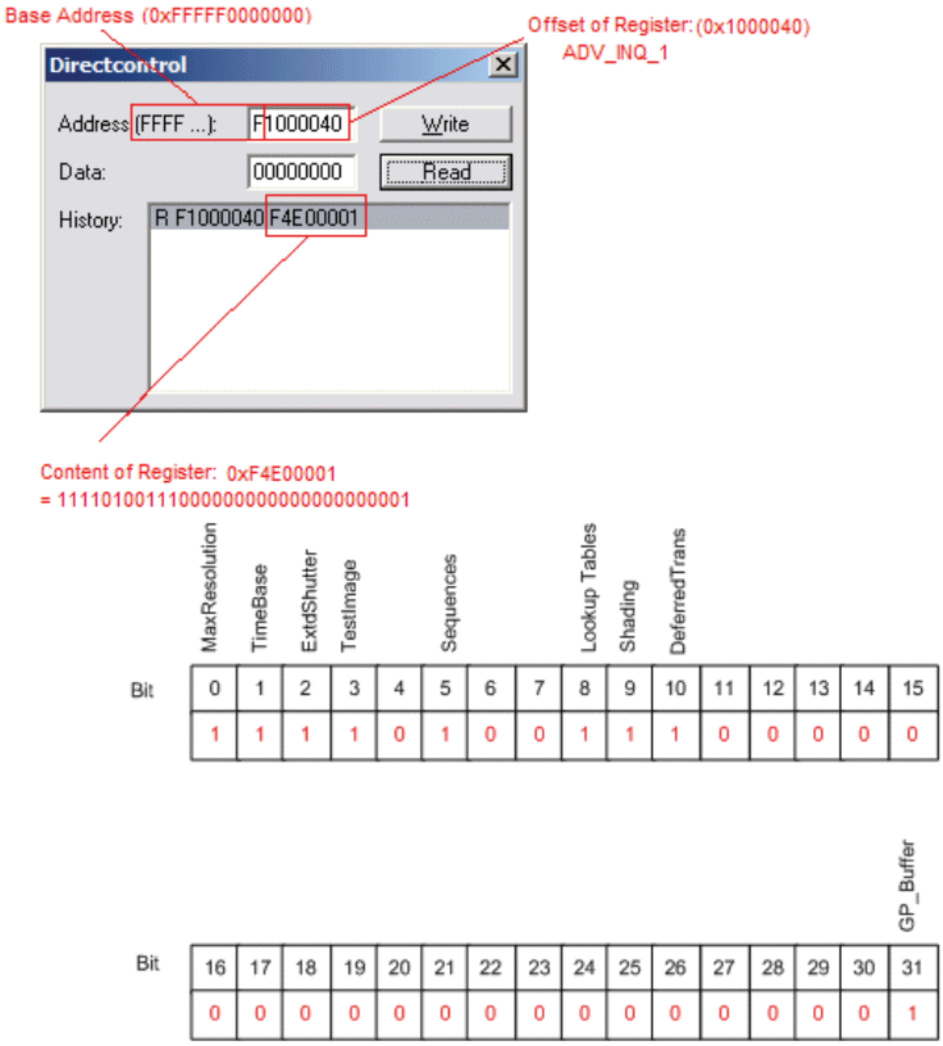


Figure 120: Configuration of the camera

Sample program

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

```
…
WriteQuad(m_cmdRegBase + CCR_FRAME-RATE, Frame-Rate << 29);
WriteQuad(m_cmdRegBase + CCR_VMODE, mode << 29);
WriteQuad(m_cmdRegBase + CCR_VFORMAT, format << 29);
WriteQuad(m_cmdRegBase + CCR_TRGMODE, extTrigger ? 0x82000000 : 0);
Sleep(100);
WriteQuad(m_cmdRegBase + CCR_ISOENABLE, 0x80000000);
…
```

Configuration ROM

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

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

Note

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

F0F00000h + Offset

The ConfigRom is divided into the

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

Note

The following assignments are only an example.

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

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

	Offset	0-7	8-15	16-23	24-31	
Bus info block	400h	04	29	C3	17	
	404h	31	33	39	34	.... ASCII for 1394
	408h	20	00	A2	02	.... Bus capabilities
	40Ch	00	0A	47	01	.... Node_Vendor_Id, Chip_id_hi
	410h	Serial number				.... Chip_id_lo
Root directory	414h	00	04	CRC		According to IEEE 1212, the root directory length may vary. The keys (e.g. 8D) point to the offset factors rather than the offset (e.g.420h) itself.
	418h	03	00	0A	47	
	41Ch	0C	00	83	C0	
	420h	8D	00	00	02	
	424h	D1	00	00	04	

Table 94: Config ROM

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

420h + 000002 * 4 = 428h

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

Table 95: Config ROM

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

424h + 000004 * 4 = 434h

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

Table 96: Config ROM

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

440h + 000001 * 4 = 444h

	Offset	0-7	8-15	16-23	24-31
	444h	00	0B	CRC	
Unit dependent info	448h	40	3C	00	00
	44Ch	81	00	00	0A
	450h	82	00	00	0E
	454h	38	00	00	00
	458h	39	00	00	00
	45Ch	3A	00	00	00
	460h	3B	00	00	00
	464h	3C	00	00	00
	468h	3D	00	00	00
	46Ch	3E	00	00	00
	470h	3F	00	00	00

Table 97: Config ROM

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

FFFF F0000000h + 3C0000h * 4 = FFFF F0F00000h

The base address of the camera control register is thus:

FFFF F0F00000h

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

Note

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

F0F00000h + Offset

Implemented registers (IIDC V1.3)

The following tables show how standard registers from IIDC V1.3 are implemented in the camera. Base address is F0F00000h. Differences and explanations can be found in the third column.

Camera initialize register

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

Table 98: 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 99: **Format** inquiry register

Inquiry register for video mode

Offset	Name	Field	Bit	Description	Supported
180h	V_MODE_INQ (Format_0)	Mode_0	[0]	160 x 120 YUV 4:4:4	
		Mode _1	[1]	320 x 240 YUV 4:2:2	
		Mode _2	[2]	640 x 480 YUV 4:1:1	
		Mode _3	[3]	640 x 480 YUV 4:2:2	
		Mode _4	[4]	640 x 480 RGB	
		Mode _5	[5]	640 x 480 MONO8	x
		Mode _6	[6]	640 x 480 MONO16	
		Mode _X	[7]	Reserved	
		-	[8..31]	Reserved (zero)	
184h	V_MODE_INQ (Format_1)	Mode_0	[0]	800 x 600 YUV 4:2:2	
		Mode _1	[1]	800 x 600 RGB	
		Mode _2	[2]	800 x 600 MONO8	x
		Mode _3	[3]	1024 x 768 YUV 4:2:2	
		Mode _4	[4]	1024 x 768 RGB	
		Mode _5	[5]	1024 x 768 MONO8	x
		Mode _6	[6]	800 x 600 MONO16	
		Mode _7	[7]	1024 x 768 MONO16	
		-	[8..31]	Reserved (zero)	
188h	V_MODE_INQ (Format_2)	Mode_0	[0]	1280 x 960 YUV 4:2:2	
		Mode _1	[1]	1280 x 960 RGB	
		Mode _2	[2]	1280 x 960 MONO8	x
		Mode _3	[3]	1600 x 1200 YUV 4:2:2	
		Mode _4	[4]	1600 x 1200 RGB	
		Mode _5	[5]	1600 x 1200 MONO8	x
		Mode _6	[6]	1280 x 960 MONO16	
		Mode _7	[7]	1600 x 1200 MONO16	
		-	[8..31]	Reserved (zero)	
18Ch … 197h	Reserved for other V_MODE_INQ_x for Format_x.			Always 0	
198h	V_MODE_INQ_6 (Format_6)			Always 0	

Table 100: **Video mode** inquiry register

Offset	Name	Field	Bit	Description	Supported
19Ch	V_MODE_INQ (Format_7)	Mode_0	[0]	Format_7 Mode_0	Mono8 RAW8
		Mode _1	[1]	Format_7 Mode_1	
		Mode _2	[2]	Format_7 Mode_2	
		Mode _3	[3]	Format_7 Mode_3	
		Mode _4	[4]	Format_7 Mode_4	
		Mode _5	[5]	Format_7 Mode_5	
		Mode _6	[6]	Format_7 Mode_6	
		Mode _7	[7]	Format_7 Mode_7	
		-	[8..31]	Reserved (zero)	

Table 100: **Video mode** inquiry register

Note

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

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

Inquiry register for video frame rate and base address

Offset	Name	Field	Bit	Description
200h	V_RATE_INQ (Format_0, Mode_0)	FrameRate_0	[0]	Reserved
		FrameRate _1	[1]	Reserved
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	120 fps (v1.31)
		FrameRate _7	[7]	240 fps (v1.31)
		-	[8..31]	Reserved (zero)

Table 101: **Frame rate** inquiry register

Offset	Name	Field	Bit	Description
204h	V_RATE_INQ (Format_0, Mode_1)	FrameRate_0	[0]	1.875 fps
		FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	120 fps (v1.31)
		FrameRate _7	[7]	240 fps (v1.31)
		-	[8..31]	Reserved (zero)
208h	V_RATE_INQ (Format_0, Mode_2)	FrameRate_0	[0]	1.875 fps
		FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	120 fps (v1.31)
		FrameRate _7	[7]	240 fps (v1.31)
		-	[8..31]	Reserved (zero)
20Ch	V_RATE_INQ (Format_0, Mode_3)	FrameRate_0	[0]	1.875 fps
		FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	120 fps (v1.31)
		FrameRate _7	[7]	240 fps (v1.31)
		-	[8..31]	Reserved (zero)

Table 101: **Frame rate** inquiry register

Offset	Name	Field	Bit	Description
210h	V_RATE_INQ (Format_0, Mode_4)	FrameRate_0	[0]	1.875 fps
		FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	120 fps (v1.31)
		FrameRate _7	[7]	240 fps (v1.31)
		-	[8..31]	Reserved (zero)
214h	V_RATE_INQ (Format_0, Mode_5)	FrameRate_0	[0]	1.875 fps
		FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	120 fps (v1.31)
		FrameRate _7	[7]	240 fps (v1.31)
		-	[8..31]	Reserved (zero)
218h	V_RATE_INQ	(Format_0, Mode_6) FrameRate_0	[0]	1.875 fps
		FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	120 fps (v1.31)
		FrameRate _7	[7]	240 fps (v1.31)
		-	[8..31]	Reserved (zero)
21Ch … 21Fh	Reserved V_RATE_INQ_0_x (for other Mode_x of Format_0)			Always 0

Table 101: **Frame rate** inquiry register

Offset	Name	Field	Bit	Description
220h	V_RATE_INQ (Format_1, Mode_0)	FrameRate_0	[0]	Reserved
		FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	120 fps (v1.31)
		FrameRate _7	[7]	240 fps (v1.31)
		-	[8..31]	Reserved (zero)
224h	V_RATE_INQ (Format_1, Mode_1)	FrameRate_0	[0]	Reserved
		FrameRate _1	[1]	Reserved
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	120 fps (v1.31)
		FrameRate _7	[7]	240 fps (v1.31)
		-	[8..31]	Reserved (zero)
228h	V_RATE_INQ (Format_1, Mode_2)	FrameRate_0	[0]	Reserved
		FrameRate _1	[1]	Reserved
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	120 fps (v1.31)
		FrameRate _7	[7]	240 fps (v1.31)
		-	[8..31]	Reserved (zero)

Table 101: **Frame rate** inquiry register

Offset	Name	Field	Bit	Description
22Ch	V_RATE_INQ (Format_1, Mode_3)	FrameRate_0	[0]	1.875 fps
		FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	120 fps (v1.31)
		FrameRate _7	[7]	240 fps (v1.31)
		-	[8..31]	Reserved (zero)
230h	V_RATE_INQ (Format_1, Mode_4)	FrameRate_0	[0]	1.875 fps
		FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	120 fps (v1.31)
		FrameRate _7	[7]	240 fps (v1.31)
		-	[8..31]	Reserved (zero)
234h	V_RATE_INQ (Format_1, Mode_5)	FrameRate_0	[0]	1.875 fps
		FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	120 fps (v1.31)
		FrameRate _7	[7]	240 fps (v1.31)
		-	[8..31]	Reserved (zero)

Table 101: **Frame rate** inquiry register

Offset	Name	Field	Bit	Description
238h	V_RATE_INQ (Format_1, Mode_6)	FrameRate_0	[0]	1.875 fps
		FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	120 fps (v1.31)
		FrameRate _7	[7]	240 fps (v1.31)
		-	[8..31]	Reserved (zero)
23Ch	V_RATE_INQ (Format_1, Mode_7)	FrameRate_0	[0]	1.875 fps
		FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	120 fps (v1.31)
		FrameRate _7	[7]	Reserved
		-	[8..31]	Reserved (zero)
240h	V_RATE_INQ (Format_2, Mode_0)	FrameRate_0	[0]	1.875 fps
		FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	Reserved
		FrameRate _7	[7]	Reserved
		-	[8..31]	Reserved (zero)

Table 101: **Frame rate** inquiry register

Offset	Name	Field	Bit	Description
244h	V_RATE_INQ (Format_2, Mode_1)	FrameRate_0	[0]	1.875 fps
		FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	Reserved
		FrameRate _7	[7]	Reserved
		-	[8..31]	Reserved (zero)
248h	V_RATE_INQ (Format_2, Mode_2)	FrameRate_0	[0]	1.875 fps
		FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	120 fps (v1.31)
		FrameRate _7	[7]	Reserved
		-	[8..31]	Reserved (zero)
24Ch	V_RATE_INQ (Format_2, Mode_3)	FrameRate_0	[0]	1.875 fps
		FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	Reserved
		FrameRate _7	[7]	Reserved
		-	[8..31]	Reserved (zero)

Table 101: **Frame rate** inquiry register

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

Table 101: **Frame rate** inquiry register

Offset	Name	Field	Bit	Description
25Ch	V_RATE_INQ	FrameRate_0	[0]	1.875 fps
	(Format_2, Mode_7)	FrameRate _1	[1]	3.75 fps
		FrameRate _2	[2]	7.5 fps
		FrameRate _3	[3]	15 fps
		FrameRate _4	[4]	30 fps
		FrameRate _5	[5]	60 fps
		FrameRate _6	[6]	Reserved
		FrameRate _7	[7]	Reserved
		-	[8..31]	Reserved
260h … 2BFh	Reserved V_RATE_INQ_y_x (for other Format_y, Mode_x)			
2C0h	V_REV_INQ_6_0 (Format_6, Mode0)			Always 0
2C4h .. 2DFh	Reserved V_REV_INQ_6_x (for other Mode_x of Format_6)			Always 0
2E0h	V-CSR_INQ_7_0		[0..31]	CSR_quadlet offset for Format_7 Mode_0
2E4h	V-CSR_INQ_7_1		[0..31]	CSR_quadlet offset for Format_7 Mode_1
2E8h	V-CSR_INQ_7_2		[0..31]	CSR_quadlet offset for Format_7 Mode_2
2ECh	V-CSR_INQ_7_3		[0..31]	CSR_quadlet offset for Format_7 Mode_3
2F0h	V-CSR_INQ_7_4		[0..31]	CSR_quadlet offset for Format_7 Mode_4
2F4h	V-CSR_INQ_7_5		[0..31]	CSR_quadlet offset for Format_7 Mode_5
2F8h	V-CSR_INQ_7_6		[0..31]	CSR_quadlet offset for Format_7 Mode_6
2FCh	V-CSR_INQ_7_7		[0..31]	CSR_quadlet offset for Format_7 Mode_7

Table 101: **Frame rate** inquiry register

Inquiry register for basic function

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

Table 102: **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 103: **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 103: **Feature presence** inquiry register

Inquiry register for feature elements

Register	Name	Field	Bit	Description
0xF0F00500	BRIGHTNESS_INQUIRY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One-push auto mode (Controlled automatically by the camera once)
		Readout_Inq	[4]	Capability of reading out the value of this feature
		ON_OFF	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto Mode (Controlled automatically by the camera)
		Manual_Inq	[7]	Manual Mode (Controlled by user)
		Min_Value	[8..19]	Min. value for this feature
		Max_Value	[20..31]	Max. value for this feature
504h	AUTO_EXPOSURE_INQ	Same definition as Brightness_inq.		
508h	SHARPNESS_INQ	Same definition as Brightness_inq.		
50Ch	WHITE_BAL_INQ	Same definition as Brightness_inq. For interlaced GUPPYs: always 0. Use advanced registers 80C4 and 80C8 instead.		
510h	HUE_INQ	Same definition as Brightness_inq.		
514h	SATURATION_INQ	Same definition as Brightness_inq.		
518h	GAMMA_INQ	Same definition as Brightness_inq.		
51Ch	SHUTTER_INQ	Same definition as Brightness_inq.		
520h	GAIN_INQ	Same definition as Brightness_inq.		
524h	IRIS_INQ	Always 0		
528h	FOCUS_INQ	Always 0		
52Ch	TEMPERATURE_INQ	Same definition as Brightness_inq.		

Table 104: **Feature elements** inquiry register

Register	Name	Field	Bit	Description
530h	TRIGGER_INQ	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2..3	Reserved
		Readout_Inq	[4]	Capability of reading out the value of this feature
		ON_OFF	[5]	Capability of switching this feature ON and OFF
		Polarity_Inq	[6]	Capability of changing the polarity of the rigger input
		-	[7..15]	Reserved
		Trigger_Mode0_Inq	[16]	Presence of Trigger_Mode 0
		Trigger_Mode1_Inq	[17]	Presence of Trigger_Mode 1
		Trigger_Mode2_Inq	[18]	Presence of Trigger_Mode 2
		Trigger_Mode3_Inq	[19]	Presence of Trigger_Mode 3
		-	[20..30]	Reserved
		Trigger_Mode15_Inq	[31]	Presence of Trigger_Mode 15
534h	TRIGGER_DELAY_INQUIRY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One-push auto mode Con-trolled automatically by the camera once)
		Readout_Inq	[4]	Capability of reading out the value of this feature
		ON_OFF	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto Mode (Controlled auto-matically by the camera)
		Manual_Inq	[7]	Manual Mode (Controlled by user)
		Min_Value	[8..19]	Min. value for this feature
		Max_Value	[20..31]	Max. value for this feature
538 .. 57Ch	Reserved for other FEATURE_HI_INQ			
580h	ZOOM_INQ	Always 0		

Table 104: **Feature elements** inquiry register

Register	Name	Field	Bit	Description
584h	PAN_INQ	Always 0		
588h	TILT_INQ	Always 0		
58Ch	OPTICAL_FILTER_INQ	Always 0		
590 .. 5BCh	Reserved for other FEATURE_LO_INQ	Always 0		
5C0h	CAPTURE_SIZE_INQ	Always 0		
5C4h	CAPTURE_QUALITY_INQ	Always 0		
5C8h .. 5FCh	Reserved for other FEATURE_LO_INQ	Always 0		
600h	CUR-V-Frm_RATE/Revision	Bits [0..2] for the frame rate		
604h	CUR-V-MODE	Bits [0..2] for the current video mode		
608h	CUR-V-FORMAT	Bits [0..2] for the current video format		
60Ch	ISO-Channel	Bits [0..3] for channel, [6..7] for ISO speed		
610h	Camera_Power	Always 0		
614h	ISO_EN/Continuous_Shot	Bit 0: 1 for continuous shot; 0 for stop		
618h	Memory_Save	Always 0		
61Ch	One_Shot, Multi_Shot, Count Number	See text		
620h	Mem_Save_Ch	Always 0		
624	Cur_Mem_Ch	Always 0		
628h	Vmode_Error_Status	Error in combination of Format/Mode/ISO Speed: Bit(0): No error; Bit(0)=1: error		

Table 104: **Feature elements** inquiry register

Inquiry register for absolute value CSR offset address

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

Table 105: **Absolute value** inquiry register

Status and control register for feature

The **OnePush** feature, WHITE_BALANCE, is currently implemented. If this flag is set, the feature becomes immediately active, even if no images are being input.

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

Table 106: **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 106: **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 106: **Feature** control register

Offset	Name	Field	Bit	Description
810h	HUE			Always 0
814h	SATURATION			Always 0
818h	GAMMA			See above
81Ch	SHUTTER			see Advanced Feature Timebase Chapter CSR: Shutter on page 129
820h	GAIN			See above
824h	IRIS			Always 0
828h	FOCUS			Always 0
82Ch	TEMPERATURE			Always 0
830h	TRIGGER-MODE			Can be effected via advanced feature IO_INP_CTRLx.
834h .. 87C	Reserved for other FEATURE_HI			Always 0
880h	Zoom			Always 0
884h	PAN			Always 0
888h	TILT			Always 0
88Ch	OPTICAL_FILTER			Always 0
890 .. 8BCh	Reserved for other FEATURE_LO			Always 0
8C0h	CAPTURE-SIZE			Always 0
8C4h	CAPTURE-QUALITY			Always 0
8C8h .. 8FCh	Reserved for other FEATURE_LO			Always 0

Table 106: **Feature** control register

Feature control error status register

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

Table 107: **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 101: Frame rate inquiry register on page 232) gives 003C2000h.

4 x 3C2000h = F08000h so that the base address for the latter (Table 108: Format_7 control and status register on page 252) equals to F0000000h + F08000h = F0F08000h.

Quadlet offset Format_7 Mode_1

The quadlet offset to the base address for **Format_7 Mode_1**, which can be read out at F0F002E4h (according to Table 101: Frame rate inquiry register on page 232) gives 003C2400h.

4 x 003C2400h = F09000h so that the base address for the latter (Table 108: Format_7 control and status register on page 252) equals to F0000000h + F09000h = F0F09000h.

Format_7 control and status register (CSR)

Offset	Name	Notes
000h	MAX_IMAGE_SIZE_INQ	Acc. to IIDC V1.3
004h	UNIT_SIZE_INQ	Acc. to IIDC V1.3
008h	IMAGE_POSITION	Acc. to IIDC V1.3
00Ch	IMAGE_SIZE	Acc. to IIDC V1.3
010h	COLOR_CODING_ID	See note
014h	COLOR_CODING_INQ	Acc. to IIDC V1.3
024h . . 033h	COLOR_CODING_INQ	Vendor Unique Color_Coding 0-127 (ID=128-255) **ID=132 ECCID_MONO12** **ID=136 ECCID_RAW12** ID=133 Reserved ID=134 Reserved ID=135 Reserved See Chapter Packed 12-Bit Mode on page 153.
034h	PIXEL_NUMBER_INQ	Acc. to IIDC V1.3
038h	TOTAL_BYTES_HI_INQ	Acc. to IIDC V1.3
03Ch	TOTAL_BYTES_LO_INQ	Acc. to IIDC V1.3

Table 108: **Format_7** control and status register

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

Table 108: **Format_7** control and status register

Note

- For all modes in Format_7, **ErrorFlag_1** and **ErrorFlag_2** are refreshed on each access to the Format_7 Register.
- Contrary to IIDC V1.3, registers relevant to Format_7 are refreshed on each access. The **Setting_1** bit is automatically cleared after each access.
- When **ErrorFlag_1** or **ErrorFlag_2** are set and Format_7 is configured, no image capture is started.
- Contrary to IIDC V1.3, COLOR_CODING_ID is set to a default value after an INITIALIZE or **reset**.
- Contrary to IIDC V1.3, the **UnitBytePerPacket** field is already filled in with a fixed value in the PACKET_PARA_INQ register.

Advanced features (AVT-specific)

The camera has a variety of extended features going beyond the possibilities described in IIDC V1.3. 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 98
- Links given in the table below

Advanced registers summary

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

Register	Register name	Remarks
0xF1000010	VERSION_INFO	see Table 110: Advanced register: Extended version information on page 257
0xF1000014	VERSION_INFO1_EX	
0xF1000018	VERSION_INFO3	
0xF100001C	VERSION_INFO3_EX	
0xF1000040	ADV_INQ_1	Table 112: Advanced register: Advanced feature inquiry on page 259
0xF1000044	ADV_INQ_2	
0xF1000048	ADV_INQ_3	
0xF100004C	ADV_INQ_4	
0xF1000100	CAMERA_STATUS	see Table 113: Advanced register: Camera status on page 261
0xF1000200	MAX_RESOLUTION	see Table 114: Advanced register: Max. resolution inquiry on page 262
0xF1000208	TIMEBASE	see Table 115: Advanced register: Timebase on page 262
0xF100020C	EXTD_SHUTTER	see Table 117: Advanced register: Extended shutter on page 264
0xF1000210	TEST_IMAGE	see Table 118: Advanced register: Test image on page 265
0xF1000240	LUT_CTRL	see Table 119: Advanced register: LUT on page 266
0xF1000244	LUT_MEM_CTRL	
0xF1000248	LUT_INFO	

Table 109: **Advanced registers** summary

Register	Register name	Remarks
0xF1000270	FRAMEINFO	Not supported
0xF1000274	FRAMECOUNTER	Not supported
0xF1000280	HDR_CONTROL	High dynamic range mode (only Guppy F-036)
0xF1000284	KNEEPOINT_1	see Chapter HDR (high dynamic range) (GUPPY F-036 only) on page 154
0xF1000288	KNEEPOINT_2	
0xF100028C	KNEEPOINT_3	
0xF1000298	DEFECT_PIXEL_CORRECTION	Defect pixel correction (only Guppy F-503)
0xF100029C		see Table 120: Advanced register: Defect pixel correction on page 268
0xF10002A0		
0xF1000300	IO_INP_CTRL1	see Table 22: Input configuration register on page 80
0xF1000304	IO_INP_CTRL2	only Guppy board level cameras
0xF1000308	IO_INP_CTRL3	see Table 22: Input configuration register on page 80
0xF100030C	IO_INP_CTRL4	
0xF1000320	IO_OUTP_CTRL1	see Table 28: Advanced register: Output control on page 86
0xF1000324	IO_OUTP_CTRL2	
0xF1000328	IO_OUTP_CTRL3	
0xF100032C	IO_OUTP_CTRL4	only Guppy board level cameras see Table 28: Advanced register: Output control on page 86
0xF1000340	IO_INTENA_DELAY	see Table 121: Advanced register: Delayed Integration Enable (IntEna) on page 271
0xF1000360	AUTOSHUTTER_CTRL	see Table 122: Advanced register: Auto shutter control on page 271
0xF1000364	AUTOSHUTTER_LO	
0xF1000368	AUTOSHUTTER_HI	
0xF1000370	AUTOGAIN_CTRL	see Table 123: Advanced register: Auto gain control on page 272
0xF1000390	AUTOFNC_AOI	see Table 124: Advanced register: Autofunction AOI on page 273
0xF1000394	AF_AREA_POSITION	
0xF1000398	AF_AREA_SIZE	
0xF1000400	TRIGGER_DELAY	see Table 125: Advanced register: Trigger Delay Advanced CSR on page 274
0xF1000410	MIRROR_IMAGE	See Table 126: Advanced register: Mirror on page 275
0xF1000510	SOFT_RESET	see Table 127: Advanced register: Soft reset on page 276
0xF1000550	USER PROFILES	see Table 128: Advanced register: user profiles on page 277

Table 109: **Advanced registers** summary

Register	Register name	Remarks
0xF1000580	LOW_NOISE_BINNING	see Chapter Low noise binning mode (2 x and 4 x binning) (only Guppy F-503) on page 281
0xF1000800	IO_OUTP_PWM1	Guppy board level cameras only see Table 31: PWM configuration registers on page 90
0xF1000804	IO_OUTP_PWM2	
0xF1000808	IO_OUTP_PWM3	
0xF100080C	IO_OUTP_PWM4	
0xF1000FFC	GPDATA_INFO	see Table 134: Advanced register: GPData buffer register on page 283
0xF1001000 … 0xF10017FC	GPDATA_BUFFER	

Table 109: **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 111: Camera type ID list on page 258
		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 110: Advanced register: **Extended version** information

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

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

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

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

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

Note

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

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

ID (decimal)	Camera type
201	Guppy F-033B
202	Guppy F-033C
203	Guppy F-036B
204	Guppy F-036C
205	Guppy F-046B
206	Guppy F-046C
207	Guppy F-080B
208	Guppy F-080C
209	Guppy F-146B
210	Guppy F-146C
213	Guppy F-033B BL (board level)
214	Guppy F-033C BL (board level)
215	
216	
217	
218	
219	Guppy F-038B
220	Guppy F-038C
221	Guppy F-038B NIR
222	Guppy F-038C NIR
223	Guppy F-044B NIR
224	Guppy F-044C NIR
225	Guppy F-080B BL (board level)
226	Guppy F-080C BL (board level)
227	Guppy F-044B
228	Guppy F-044C
233	Guppy F-503B
234	Guppy F-503C

Table 111: Camera type ID list

Advanced feature inquiry

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

Note

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

Register	Name	Field	Bit	Description
0xF1000040	ADV_INQ_1	MaxResolution	[0]	
		TimeBase	[1]	
		ExtdShutter	[2]	
		TestImage	[3]	
		FrameInfo	[4]	
		---	[5]	Reserved
		VersionInfo	[6]	
		---	[7]	Reserved
		Look-up tables	[8]	
		---	[9]	Reserved
		---	[10]	Reserved
		HDR control	[11]	Guppy F-036 only
		---	[12]	Reserved
		---	[13]	Reserved
		TriggerDelay	[14]	
		Mirror image	[15]	Guppy F-036 only
		Soft Reset	[16]	
		---	[17]	Reserved
		Color Correction	[18]	Reserved
		---	[19..20]	Reserved
		User Sets	[21]	
		---	[22..30]	Reserved
		GP_Buffer	[31]	

Table 112: Advanced register: **Advanced feature** inquiry

Register	Name	Field	Bit	Description
0xF1000044	ADV_INQ_2	Input_1	[0]	
		---	[1]	Reserved
		---	[2]	Reserved
		---	[3..7]	Reserved
		Output_1	[8]	
		Output_2	[9]	
		Output_3	[10]	
		---	[11..15]	Reserved
		IntEnaDelay	[16]	
		---	[17..23]	Reserved
		Output 1 PWM	[24]	Board level only
		Output 2 PWM	[25]	Board level only
		Output 3 PWM	[26]	Board level only
		Output 4 PWM	[27]	Board level only
		---	[28..31]	Reserved
0xF1000048	ADV_INQ_3	Camera Status	[0]	
		Max Isosize	[1]	
		---	[2]	Reserved
		Format_7 Mode Mapping	[3]	
		Auto Shutter	[4]	
		Auto Gain	[5]	
		Auto FNC AOI	[6]	
		---	[7..8]	Reserved
		Low Noise Binning	[9]	
		AFE References	[10]	
		Global Reset Release Shutter	[11]	
		Defect Pixel Correction	[12]	
		---	[13..31]	Reserved
0xF100004C	ADV_INQ_4	---	[0..3]	Reserved
		White Balance	[4..31]	Guppy interlaced only

Table 112: Advanced register: **Advanced feature** inquiry

Camera status

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

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

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

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

Note

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

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

Table 113: 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 29.

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

Table 114: Advanced register: **Max. resolution** inquiry

Time base

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

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

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

Register	Name	Field	Bit	Description
0xF1000208	TIMEBASE	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..7]	Reserved
		ExpOffset	[8..19]	Exposure offset in µs
		---	[20..27]	Reserved
		Timebase_ID	[28..31]	See Table 116: Time base ID on page 263.

Table 115: Advanced register: **Timebase**

The time base IDs 0-9 are in bits 28 to 31. See Table 116: Time base ID on page 263. 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 65: Camera-specific exposure time offset on page 182) 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 116: Time base ID

Note

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

Extended shutter

- For **CCD** models and **Guppy F-503 with electronic rolling shutter**:
  The exposure time for long-term integration can be entered with µs precision via the EXTENDED_SHUTTER register.
  - **CCD models:** max. exposure time up to 67 seconds (3FFFFFFh)
  - **CMOS Guppy F-503 with electronic rolling shutter:** max. exposure time up to ~2.3 s
- For **CMOS** models: The maximum exposure time is
  (Guppy F-036) 32767 x 29.89 µs = 979.4 ms
  (Guppy F-503 with global reset release shutter) ~2.3 s
  Although you may enter values with µs precision, the camera will round down or up to integer multiples of the row time, leaving an uncertainty of only half of the row time.

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

Table 117: Advanced register: **Extended shutter**

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

Note

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

Test images

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

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

- auto gain
- auto shutter
- auto white balance

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

Table 118: Advanced register: **Test image**

Look-up tables (LUT)

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

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

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

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

Table 119: Advanced register: **LUT**

Note

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

Examples:

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

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

Note

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

Note

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

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

Defect pixel correction (only Guppy F-503)

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

DPC = defect pixel correction

WR = write

RD = read

MEM, Mem = memory

Note

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

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

Table 120: Advanced register: **Defect pixel correction**

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

Table 120: Advanced register: **Defect pixel correction**

Input/output pin control

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

Note

- See Chapter Inputs on page 80.
- See Table 22: Input configuration register on page 80.
- See Table 23: Input routing on page 81.
- See Chapter Chapter IO_OUTP_CTRL 1-3 on page 86.

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.

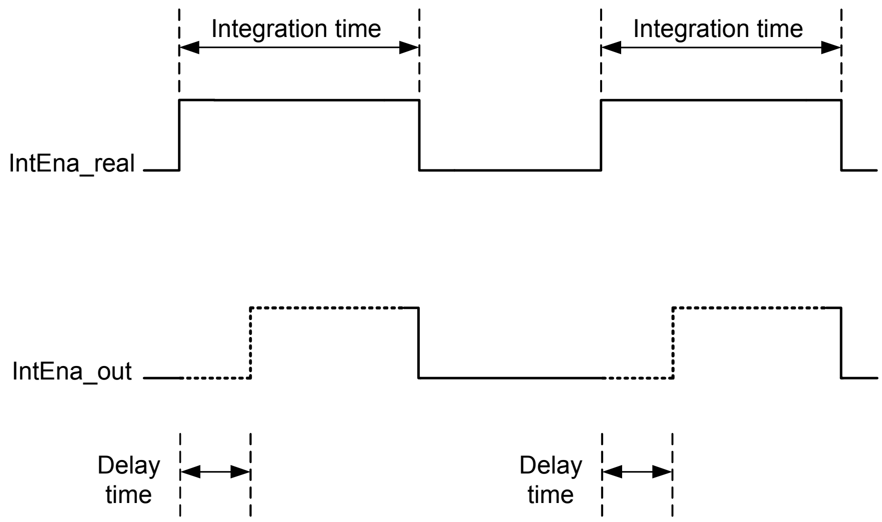


Figure 121: Delayed integration timing

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

Auto shutter control

The table below illustrates the advanced register for **auto shutter control**. The purpose of this register is to limit the range within which auto shutter operates.

Register	Name	Field	Bit	Description
0xF1000360	AUTOSHUTTER_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..31]	Reserved
0xF1000364	AUTOSHUTTER_LO	---	[0..5]	Reserved
		MinValue	[6..31]	Minimum auto shutter value
0xF1000368	AUTOSHUTTER_HI	---	[0..5]	Reserved
		MaxValue	[6..31]	Maximum auto shutter value

Table 122: 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 123: Advanced register: **Auto gain control**

Note

- Values can only be changed within the limits of gain CSR.
- Changes in auto exposure register only have an effect when auto gain is active.
- Auto exposure limits are 50..205.

MinValue and **MaxValue** limits the range the auto gain feature is allowed to use for the regulation process. Both values are initialized with the minimum and maximum value defined in the standard GAIN_INQ register.

Changing the **auto gain range** might not affect the regulation, if the regulation is in a stable condition and no other condition affecting the image brightness is changed.

If both auto gain and auto shutter are enabled and if the gain is at its lower boundary and shutter regulation is in progress, decreasing the lower auto gain boundary has no effect on auto gain/shutter regulation as long as auto shutter regulation is active.

Both values can only be changed within the range defined by the standard GAIN_INQ register.

Autofunction AOI

The table below illustrates the advanced register for **autofunction AOI**.

Register	Name	Field	Bit	Description
0xF1000390	AUTOFNC_AOI	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..3]	Reserved
		ShowWorkArea	[4]	Show work area
		---	[5]	Reserved
		ON_OFF	[6]	Enable/disable AOI (see note above)
		---	[7]	Reserved
		YUNITS	[8..19]	Y units of work area/pos. beginning with 0 (read only)
		XUNITS	[20..31]	X units of work area/pos. beginning with 0 (read only)
0xF1000394	AF_AREA_POSITION	Left	[0..15]	Work area position (left coordinate)
		Top	[16..31]	Work area position (top coordinate)
0xF1000398	AF_AREA_SIZE	Width	[0..15]	Width of work area size
		Height	[16..31]	Height of work area size

Table 124: Advanced register: **Autofunction AOI**

The possible increment of the work area position and size is defined by the YUNITS and XUNITS fields. The camera automatically adjusts your settings to permitted values.

Note

If the adjustment fails and the work area size and/or work area position becomes invalid, then this feature is automatically switched off.

Read back the ON_OFF flag, if this feature does not work as expected.

Trigger delay

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

Table 125: Advanced register: Trigger Delay Advanced CSR

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

Note

Trigger delay woks with external trigger modes only.

Mirror image (only Guppy F-036)

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

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

Table 126: Advanced register: **Mirror**

Pulse-width modulation (board level cameras only)

Note

See Table 31: PWM configuration registers on page 90.

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 127: Advanced register: **Soft reset**

The SOFT_RESET feature is similar to the INITIALIZE register, with the following differences:

- 1 or more bus resets will occur
- the FPGA will be rebooted

The reset can be delayed by setting the **Delay** to a value unequal to 0 - the delay is defined in 10 ms steps.

Note

When SOFT_RESET has been defined, the camera will respond to further read or write requests but will not process them.

User profiles

Within the IIDC specification user profiles are called memory channels. Often they are called user sets. In fact these are different expressions for the following: storing camera settings into a non-volatile memory inside the camera.

Register	Name	Field	Bit	Description
0xF1000550	USER_PROFILE	Presence_Inq	[0]	Indicates presence of this feature (read only)
		Error	[1]	An error occurred
		---	[2..7]	Reserved
		SaveProfile	[8]	Save settings to profile
		RestoreProfile	[9]	Load settings from profile
		SetDefault	[10]	Set default user profile
		---	[11..19]	Reserved
		ErrorCode	[20..23]	Error code See Table 129: User profile: Error codes on page 278.
		---	[24..27]	Reserved
		ProfileID	[28..31]	User profile ID (memory channel)

Table 128: Advanced register: user profiles

In general this advanced register is a wrapper around the standard memory channel registers with some extensions. In order to query the number of available user profiles please check the **Memory_Channel** field of the **BASIC_FUNC_INQ** register at offset **0x400** (see IIDC V1.3x for details).

The **ProfileID** is equivalent to the memory channel number and specifies the profile number to store settings to or to restore settings from. In any case profile #0 is the hard-coded factory profile and cannot be overwritten.

After an initialization command, startup or reset of the camera, the **ProfileID** also indicates which profile was loaded on startup, reset or initialization.

Note

- The default profile is the profile that is loaded on power-up or an INITIALIZE command.
- A save or load operation delays the response of the camera until the operation is completed. At a time only one operation can be performed.

Store To store the current camera settings into a profile:

1. Write the desired **ProfileID** with the **SaveProfile** flag set
2. Read back the register and check the **ErrorCode** field

Restore To restore the settings from a previous stored profile:

1. Write the desired **ProfileID** with the **RestoreProfile** flag set
2. Read back the register and check the **ErrorCode** field

Set default To set the default profile to be loaded on startup, reset or initialization:

1. Write the desired **ProfileID** with the **SetDefaultID** flag set
2. Read back the register and check the **ErrorCode** field

To go back to the factory default profile:

1. Select ProfileID= 0 and toggle the **SetDefaultID** flag set
2. Read back the register and check the **ErrorCode** field

Error codes

ErrorCode #	Description
0x00	No error
0x01	Profile data corrupted
0x02	Camera not idle during restore operation
0x03	Feature not available (feature not present)
0x04	Profile does not exist
0x05	ProfileID out of range
0x06	Restoring the default profile failed
0x07	Loading LUT data failed
0x08	Storing LUT data failed

Table 129: User profile: Error codes

Reset of error codes

The **ErrorCode** field is set to zero on the next write access.

You may also reset the **ErrorCode**

- by writing to the **USER_PROFILE** register with the **SaveProfile**, **RestoreProfile** and **SetDefaultID** flag not set.
- by writing 00000000h to the **USER_PROFILE** register.

Stored settings

The following table shows the settings stored inside a profile:

Standard registers	Standard registers (Format_7)	Advanced registers
Cur_V_Frm_Rate Cur_V_Mode Cur_V_Format ISO_Channel ISO_Speed BRIGHTNESS AUTO_EXPOSURE (Target grey level) SHARPNESS WHITE_BALANCE (+ auto on/off) GAMMA (+ gamma on) SHUTTER (+ auto on/off) GAIN TRIGGER_MODE TRIGGER_POLARITY TRIGGER_DELAY ABS_GAIN	IMAGE_POSITION (AOI) IMAGE_SIZE (AOI) COLOR_CODING_ID BYTES_PER_PACKET	TIMEBASE EXTD_SHUTTER IO_INP_CTRL IO_OUTP_CTRL IO_INTENA_DELAY AUTOSHUTTER_CTRL AUTOSHUTTER_LO AUTOSHUTTER_HI AUTOGAIN_CTRL AUTOFNC_AOI (+ on/off) TRIGGER_DELAY MIRROR_IMAGE LUT_CTRL (LutNo; ON_OFF is not saved)

Table 130: User profile: stored settings

The user can specify which user profile will be loaded upon startup of the camera.

This frees the user software from having to restore camera settings, that differ from default, after every cold start. This can be especially helpful if third party software is used which may not give easy access to certain advanced features or may not provide efficient commands for quick writing of data blocks into the camera.

Note

- A profile save operation automatically disables capturing of images.
- A profile save or restore operation is an uninterruptable (atomic) operation. The write response (of the asynchronous write cycle) will be sent after completion of the operation.
- Restoring a profile will not overwrite other settings than listed above.
- If a restore operation fails or the specified profile does not exist, all registers will be overwritten with the hard-coded factory defaults (profile #0).
- Data written to this register is not reflected in the standard memory channel registers.

Format_7 mode mapping (only Guppy F-503)

With Format_7 mode mapping it is possible to map special binning and sub-sampling modes to F7M1..F7M7 (see Figure 90: Mapping of possible Format_7 modes to F7M1...F7M7 *on page 152*).

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

Table 131: Advanced register: **Format_7 mode mapping**

Additional Format_7 modes

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

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

There are visible Format_7 modes and internal Format_7 modes:

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

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

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

Example

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

Note

For available Format_7 modes see Figure 90: Mapping of possible Format_7 modes to F7M1...F7M7 *on page 152*.

Setting the F7MODE_x register to:

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

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

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

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

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

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

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

Table 132: Advanced register: **Low noise binning mode**

Global reset release shutter (only Guppy F-503)

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

Table 133: Advanced register: **Global reset release shutter**

GPDATA_BUFFER

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

GPDATA_INFO Buffer size query

GPDATA_BUFFER Indicates the actual storage range.

Register	Name	Field	Bit	Description
0xF1000FFC	GPDATA_INFO	---	[0..15]	Reserved
		BufferSize	[16..31]	Size of GPDATA_BUFFER (byte)
0xF1001000 … 0xF10017FC	GPDATA_BUFFER			

Table 134: Advanced register: GPData buffer register

Note

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

Little endian vs. big endian byte order

- Read/WriteBlock accesses to GPDATA_BUFFER are recommended, to read or write more than 4 byte data. This increases the transfer speed compared to accessing every single quadlet.
- The big endian byte order of the 1394 bus is unlike the little endian byte order of common operating systems (Intel PC). Each quadlet of the local buffer, containing the LUT data or shading image for instance, has to be swapped bytewise from little endian byte order to big endian byte order before writing on the bus.

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

Table 135: Swapped first quadlet at address offset 0

Firmware update

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

Note

For further information:

- Read the application note:
  How to update Guppy/Pike/Stingray firmware
  at 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

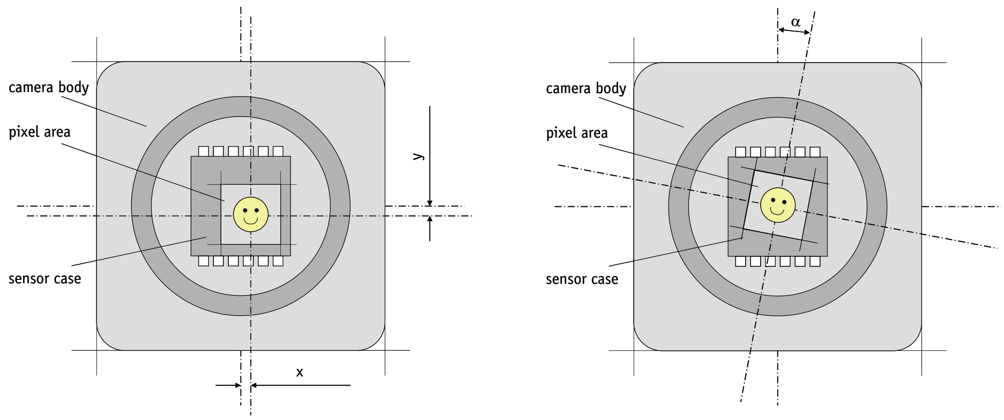
xx.xx.xx.xx

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 136: New version number (microcontroller and FPGA)

Appendix

Sensor position accuracy of AVT 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 122: AVT sensor position accuracy

Index

Numbers

0xF1000010 (version info) 257
0xF1000040 (advanced feature inquiry)......259
0xF1000100 (camera status).....................261
0xF1000200 (max. resolution) 262
0xF1000208 (time base) 262
0xF100020C (extended shutter).................264
0xF1000210 (test images) 265
0xF1000240 (LUT).................................266
0xF1000298 (DPC_CTRL)..........................268
0xF1000340 (Delayed IntEna) 271
0xF1000360 (auto shutter control) 271
0xF1000370 (auto gain control) 272
0xF1000390 (autofunction AOI) 273
0xF1000400 (trigger delay) 274
0xF1000410 (image)...............................275
0xF1000510 (soft reset)..........................276
0xF1000550 (user profiles).......................277
0xF1000580 (F7 mode mapping) 280
0xF10005B0 (low noise binning mode).......281
0xF10005C0 (global reset release shutter)...282
0xF1000FFC (GPData buffer)......................283
2 out of 4 H+V sub-sampling (b/w)
drawing 148
2 out of 4 H+V sub-sampling (color)
drawing 150
2 out of 8 H+V sub-sampling (b/w)
drawing 149
2 out of 8 H+V sub-sampling (color)
drawing 150

A

Abs_Control (Field) 117, 124, 125, 127, 129
Abs_Control_Inq (Field) 82
access
binning and sub-sampling...................151
AccessLutNo (Field)................................266
Access_Control_Register 243
accuracy
sensor position 285
AddrOffset (Field) 266
Advanced feature inquiry (advanced register)....
259
Advanced features..................................254
activate 256
base address....................................243
inquiry...241
advanced register
Advanced feature inquiry....................259
Auto gain control 272
Auto shutter control 271
Autofunction AOI 273
Camera status 261
Delayed Integration Enable (IntEna) 271
Extended shutter..............................264
Extended version..............................257
Format_7 mode mapping 280
global reset release shutter.................282
GPData buffer 283
Low noise binning mode.....................281
LUT 266, 268
Max. resolution 262
Mirror 275
Output control 86
Soft reset 276
Test images 265
Time base..262
trigger counter 277
Trigger delay 274
amplification..115
analog color signal.................................115
Analog Devices 115
area of interest (AOI) 203
Asynchronous broadcast...........................187
auto exposure
limits 271
target grey level........................126, 271
auto gain..................................... 124, 271
Auto gain control (advanced register)........272
auto shutter........................... 121, 128, 271
Auto shutter control (advanced register) 271
auto white balance (AWB)........................120
external trigger................................120
AUTOFNC_AOI................................121, 273
Autofunction AOI (advanced register) 273
AUTO_EXPOSURE 125
Auto_Exposure CSR.................................125

Auto_Inq 82
AVT sensor position accuracy 285
AWB...120
A_M_MODE (Field)....... 117, 124, 125, 127, 129

B

bandwidth 190
    affect frame rate 219
    frame rates...................................203
    limitation of IEEE 1394 bus.................204
BAYER mosaic.......................................159
binning 138
    access..151
    full..143
    horizontal 141
    vertical 139
BitsPerValue..266
black level 126
black value 123, 126
black/white camera (CCD)
    block diagram 99
black/white camera (CMOS)
    block diagram 99
blink codes 79
block diagram
    AFE 115
    b/w camera (CCD).............................. 99
    b/w camera (CMOS) 99
    color camera (CCD) 100
    color camera (CMOS) 100
block diagrams
    cameras 98
BRIGHTNESS..................................127, 248
Brightness
    inquiry register 242
brightness
    auto shutter 128
    average...124
    decrease 271
    IIDC register...................................127
    increase 123, 271
    LUT 131
    nonlinear 131
    reference................................124, 128
    setting..126
    sub-sampling 145
    variation 270
Brightness Control 242
Brightness (CSR register) 127
BRIGHTNESS (Name)...............................127
BRIGHTNESS_INQUIRY 244
Brightness_inq. 244
buffer
    LUT 132
BuildDPData flag...................................135
    advanced register 268
bulk trigger..................................170, 175
Busy signal 84
Bus_Id 224

C

Cable GND.. 73
camera dimensions................................. 63
camera interfaces.................................. 73
Camera lenses 27
Camera status (advanced register) 261
Camera status (register)..........................261
cameras
    block diagram 98
CAMERA_STATUS 261
Camera_Status_Register..........................224
CDS..115
CE 24
channel 93
color camera (CCD)
    block diagram 100
color camera (CMOS)
    block diagram 100
color coding..153
color codings 153
Color Correction (Field)...........................259
color information..................................159
Color_Coding..153
COLOR_CODING_INQ 153
controlling
    image capture..................................167
correlated double sampler 115
CSR..224
CSR register
    Brightness......................................127
    GAIN 124

D

data block packet format 93
    description 93

data exchange buffer
LUT 132
data packets 93
data path.......... 98
data payload size..........219
data_length 93
DCAM 22, 190, 224
declaration of conformity.......... 24
defect pixel correction (DPC) 268
defect pixel correction (only Guppy F-503)
advanced register 268
building defect pixel data..........135
calculated mean value..........268
max. 2000 defect pixels..........269
mechanisms..........133
Delayed Integration Enable (IntEna) (advanced register) 271
DelayTime..........270
Digital Camera Specification 224
digital video information 93
digitization..........115
digitizer 132
document history.......... 10
DPC (defect pixel correction) 268
DPC_CTRL..........268
DPC_INFO 269
DPC_MEM..........269
DPDataSize
defect pixel data size (max. 2000) 269

E

edge mode (Trigger_Mode_0)..........170
electronic rolling shutter (ERS) 169, 188
EnableMemWR (Field) 266
End of exposure..........185
error code
user profiles 278
error codes
LED 79
error states 79
ERS (=electronic rolling shutter) 169, 188
Exposure time
(Field) 183
exposure time..........181
81 Ch register 184
example..........183
extended shutter..........264
formula..........181
longest..........183
long-term integration 183
minimum 183
ExpTime (Field) 183
EXTD_SHUTTER 264
extended shutter 183
configuration..........183
FireDemo..........264
FireView..........264
inactive 184, 264
register..........264
trigger mode 170
Extended shutter (advanced register)..........264
Extended version (advanced register)..........257
EXTENDED_SHUTTER 183
External GND 76, 77
external trigger 80

F

F-033B/C BL (Specification) 31
F-033B/C (Specification).......... 29
F-036B/C (Specification).......... 33
F-038B/C NIR (Specification).......... 37
F-038B/C (Specification).......... 35
F-044B/C NIR (Specification).......... 41
F-044B/C (Specification).......... 39
F-046B/C (Specification).......... 43
F-080B/C BL (Specification) 47
F-080B/C (Specification).......... 45
F-146B/C (Specification).......... 49
F-503B/C (Specification).......... 51
FCC Class B.......... 24
FireDemo
Extended shutter..........264
FirePackage
OHCI API software 22
FireView
Extended shutter..........264
firmware update 284, 285
flash 169
focal width 27
MF-033/046/145/146 27
MF-080 28
Format_7 modes
default 151
mapping 152
mapping (advanced register)..........280
FORMAT_7_ERROR_1.......... 79

FORMAT_7_ERROR_2 79
FOV 114
FPGA 115
FPGA Boot error 79
frame rates
 bandwidth 203
 bandwidth limitation 204
 bus speed...190
 Format_7 204
 GUPPY models...................................190
 maximum 190
 tables 203
 video mode 0....................................204
 video mode 2....................................204
Frame valid 84
Free-Run 187
Full binning 143
Fval 84
Fval signal 84

G

Gain
 Pixel Gain Amplifier 115
gain
 auto 124
 auto exposure CSR 124
 AUTOFNC_AOI 121
 formula 126
 manual 122
 manual gain range..............................123
 ranges 123
 white balance 115
gain CSR 126, 272
GAIN (CSR register) 124
GAIN (Name) 124
GAIN (register) 119
gamma function 131
 CMOS models 132
gamma LUT 131
global reset release shutter (GRR)
 advanced register 282
 description 169
 jitter 188
global shutter (CCD only) 167, 171
GND for RS232 .... 76, 77
GPData buffer (advanced register) 283
GPDATA_BUFFER 132
GRR (global reset release shutter)
 description 169
Guppy F-033B/C BL (Specification) 31
Guppy F-033B/C (Specification) 29
Guppy F-036B/C (Specification) 33
Guppy F-038B/C NIR (Specification) 37
Guppy F-038B/C (Specification) 35
Guppy F-044B/C NIR (Specification) 41
Guppy F-044B/C (Specification) 39
Guppy F-046B/C (Specification) 43
Guppy F-080B/C BL (Specification) 47
Guppy F-080B/C (Specification) 45
Guppy F-146B/C (Specification) 49
Guppy F-503B/C (Specification) 51
Guppy types 23

H

hardware trigger 83, 179
HDR
 configuration register 158
high dynamic range
 configuration register 158
HIROSE... 75
Horizontal binning 141
horizontal mirror (Guppy F-036)................114
horizontal sub-sampling (b/w)
 drawing 145
horizontal sub-sampling (color)
 drawing 146

I

ID
 color coding 153
IEEE 1394 22
 declaration of conformity 24
IEEE 1394 connector 73
IEEE 1394a port
 pin assignment 73
IEEE-1394 Trade Association.....................224
IIDC 22, 190, 224
 isochronous data block packet format.... 93
 trigger delay...................................... 82
 video data format......................... 94, 95
 Y16 94
IIDC V1.3...167
 data structure 95, 96
 pixel data.. 93
 Y8.. 94

image capture
controlling 167
input
configuration register 80
current status 81
high active....................................... 81
in detail.. 80
low active 81
polarity setting 87
Trigger (Mode) 81
input mode 81
input pin control 81
InputMode (Field) 80
inputs 75
general 80
input/output pin control........................270
Inquiry register
basic function.................................241
Integration Enable signal......................... 84
IntEna.. 76, 88
IntEna active
missing image.................................. 88
IntEna signal 84, 270
IntEna_Out 270
internal trigger.............................. 170, 175
IO_INP_CTRL1 80
IO_INP_CTRL2 80
IO_INP_CTRL3 81
IO_INP_CTRL4 81
IO_OUTP_CTRL1 86
IO_OUTP_CTRL2 86
IO_OUTP_CTRL3 86
IO_OUTP_CTRL4 86
isochronous blocks 93
isochronous channel number 93
isochronous data block packet format 93
IsoEnable
white balance 119
ISO_Enable 187
ISO_Enable mode..................................187
Iso_Enable mode
multi-shot......................................186
one-shot 184

J

jitter... 185, 188
at exposure start..............................188

L

latching connectors................................ 73
LCD shutter 174
LED
error codes 79
indication 78
on (green)....................................... 78
status 78
yellow 78
Legal notice 2
level mode (Trigger_Mode_1)...................170
look-up table
user-defined 131
look-up table (LUT) 131, 266
Low noise binning mode (advanced register)....
281
LUT...266
data exchange buffer 132
example 131
gamma 131
general 131
loading into camera..........................132
volatile 132
LUT (advanced register) 266, 268
LutNo (Field)..266
LUT_CTRL..266
LUT_INFO 266
LUT_MEM_CTRL....................................266

M

manual gain range
CCD cameras 123
Guppy F-036 123
Guppy F-503 123
Manual_Inq... 82
mapping
Format_7 modes..............................152
Format_7 modes (advanced register) 280
MaxLutSize (Field) 266
MaxResolution (Field).............................259
MaxResolution (Register) 262
MaxSize (Field)......................................269
Max. resolution (advanced register)...........262
MAX_RESOLUTION 262
Max_Value 82
Mean
defect pixel mean value 268

mechanical shutter 174
memory channels (user profiles) 277
Micron/Aptina CMOS sensor 169
Min_Value 82
mirror
  horizontal (Guppy F-036) 114
  vertical (Guppy F-036) 114
Mirror (advanced register) 275
missing image
  while IntEna active 88
MSB aligned 15, 94
Multi-Shot 186
multi-shot 186
  external trigger 186

N

No DCAM object 79
No FLASH object 79
Node_Id 224
NumOfLuts (Field) 266

O

OFFSET
  automatic white balance 119
offset 181
  800h 127
  CCD 126
  configuration ROM 227
  factors 227
  for GUPPY models 182
  formula 126
  initialize register 230
  inquiry register video format 230
  inquiry register video mode 231
  setting brightness 126
  setting gain 123
offsets
  camera specific 182
OHCI API
  FirePackage 22
one-push white balance 119, 120
One-Shot 184
one-shot
  Trigger_Mode_15 .... 170, 175, 177
  using Trigger_Mode_15 177
  values 185
one-shot bit 184
one-shot mode 184
One_Push (Field) 117, 124, 125, 127, 129
One_Push_Inq 82
ON_OFF 82
ON_OFF (Field) 117
output
  block diagram 85
  signals 84
Output control (advanced register) 86
Output mode 86
output mode 86, 87
Output mode (Field) 86
output pin control 87
outputs 75, 84
  general 80
  registers 86
  set by software 89

P

Packed 12-Bit Mode 153
Packed 12-Bit MONO 153
Packed 12-Bit RAW 153
packet format 93
PI controller 124
pin control 270
PinState 86
PinState flag 86
PinState (Field) 80
pipelined global shutter
  Guppy F-036 .... 168, 188
plus integral controller 124
Polarity 80, 86
power
  GND 76, 77
  IEEE-1394 pin assignment 73, 75
  LED 78
Presence_Inq 80
Presence_Inq (Field) 82, 117
programmable mode (Trigger_Mode_15) 170
PxGA 115
PxGA® 115

R

Readout_Inq 82
register 117, 118
Register mapping 79
RoHS (2002/95/EC) 25

rolling shutter 188
row time
GUPPY F-503.....................................181
RS232 .... 76, 77
RxD_RS232.. 76, 77

S

sensor position accuracy 285
sequence
BAYER color pattern...........................115
loading a LUT 132
one-push white balance......................120
one-shot 184
SHUTTER..129
Shutter CSR 129
shutter time
formula 181
SHUTTER_MODES 167
signal-to-noise ratio (SNR) 138
signal-to-noise separation 138
SmartView... 22
SNR 138
Soft reset (advanced register) 276
specifications 29
spectral sensitivity 53
spectral transmission
IR cut filter 26
Jenofilt 217..................................... 26
Stack setup 79
Stack start 79
standard housing 64, 65
status LED... 78
stored settings
user profile......................................279
styles 20
sub-sampling
access..151
brightness 145
definition..145
sy (sync bit).. 93
symbols 20
sync bit (sy).. 93
synchronization value (sync bit) 93

T

tag field 93
target grey level
corresponds to Auto_exposure.............249
Target grey level (auto exposure) 126, 271
Target grey level (SmartView)
corresponds to auto exposure..............128
tCode 93
test image 221
b/w cameras....................................221
color cameras 222
configuration register 265
gray bar..221
save 265
Test images (advanced register) 265
TEST_IMAGE 265
tg 93
threshold
defect pixel correction 135, 268
time base
setting 264
time base ID 263
Time base (advanced register) 262
time response..185
TIMEBASE 254, 262
timebase
exposure time..................................181
MF-033 183
trigger delay...............................82, 178
TimeBase (Field) 259
timebase (Register)................................262
TPA- 73, 75
TPA+... 73, 75
TPB- 73, 75
TPB+... 73, 75
transaction code (tCode)........................... 93
trigger 80
bulk 170, 175
control image capture 167
delay... 81, 89
edge... 83
external 167
hardware..................................83, 179
impulse..184
IntEna 88
internal 170, 175
latency time 188
microcontroller 185
one-shot 184
signal 80
software..187
synchronize 188

trigger counter (advanced register) 277
trigger delay 178
advanced CSR..............................83, 179
advanced register 83, 179
off 83
on... 83
Trigger Delay CSR 83, 179
Trigger delay (advanced register) 274
trigger function 176
trigger modes.......................................170
TRIGGER_DELAY 83, 179
TRIGGER_DELAY_INQUIRY....................82, 178
Trigger_Delay_Inquiry register 82, 178
TRIGGER_MODE 176
Trigger_Mode 176
Trigger_Mode_0 ....84, 170
Trigger_Mode_0 Guppy F-503
electronic rolling shutter 172, 173
global reset release shutter................174
Trigger_Mode_0 (edge mode)...................170
Trigger_Mode_1 170
Trigger_Mode_1 (level mode)...................170
Trigger_Mode_15 ....170, 175
Trigger_Mode_15 (programmable mode) 170
Trigger_Polarity 176
Trigger_Source 176
Trigger_Value 176
Tripod adapter.. 70
Tripod dimensions.................................... 70
types
Guppy cameras.................................. 23

U

user profile
stored settings.................................279
user profiles...277
error code 278
U/B_Value (Field) 117
U/V slider range 117

V

Vendor Unique Color_Coding.....................153
Vendor unique Features...........................241
Vertical binning 139
vertical mirror (Guppy F-036)....................114
vertical sub-sampling (b/w)
drawing 147
vertical sub-sampling (color)
drawing 148
video data format
IIDC 1.3.. 94
Video data payload 93
video format
available bandwidth...........................203
frame rate 203
video formats 190
GUPPY F-033...................................191
GUPPY F-036...................................192
GUPPY F-038...................................193
GUPPY F-038 NIR.............................193
GUPPY F-044...................................194
GUPPY F-044 NIR.............................194
GUPPY F-046...................................195
GUPPY F-080 (BL)............................196
GUPPY F-146...................................197
GUPPY F-503...................................198
video Format_7
AOI 200
video information 93
video mode
CUR-V-MODE 246
Format_7 252
inquiry register 231
sample C code..................................226
video mode 0 204
video mode 2 204
VMode_ERROR_STATUS............................. 79
V/R_Value (Field)...................................117

W

white balance................................117, 118
auto 120
auto gain feature 124
auto shutter 128
AUTOFNC_AOI 121
conditions..............................119, 121
FPGA 115
general 114
one-push 119, 120
register..................................117, 118
register 80Ch 116
WHITE_BALANCE 117, 120
WHITE_BAL_INQ 118
www.alliedvisiontec.com 22, 23