

**Digital Monochrome (b/w)  
Progressive Scan Camera**

 System: **Dual Gigabit Ethernet**
**Baumer HXG40 / HXG40-F**

Revision 2.0

**Art. No: 11080588 (C-Mount)  
11082535 (F-Mount)**

- Dual Gigabit Ethernet progressive scan CMOS camera
- 2048 x 2048 pixel with up to 56 full frames per second
- Burst mode with up to 180 full frames per second using integrated 256 MByte RAM for temporarily image buffering
- GigE Vision™ standard compliant
- Excellent image quality
- Global shutter architecture for minimized motion blur
- Low noise due to correlated double sampling (CDS)
- Binning, subsampling and true partial scan function (ROI) for increased frame rates
- High Dynamic Range (HDR) image acquisition
- External synchronization via industrial compliant process interface (trigger / flash)
- Integrated supplementary function for flexible integration
- Sequence function up to 2<sup>31</sup>-1 frames per sequence
- Jumbo frames supported
- Camera parameter programmable in real-time
- Static Link Aggregation for higher bandwidth and resilience
- Power over Ethernet support
- Compact and lightweight aluminum housing
- Standard RJ45 connector
- Screw-lock type industrial connector
- Baumer-GAPI: Flexible, generic software interface for Windows / Linux


**1. Overview**

Model Name	HXG40 / HXG40-F
Sensor	1" progressive scan CMOS
Vendor and Model	CMOSIS CMV-4000 (version 3)
Shutter / readout mode	global shutter / progressive scan readout
Number of pixel	2048 x 2048
Scan area	11.26 mm x 11.26 mm
Pixel size	5.5 µm x 5.5 µm
Color filter	-
<b>Operation modes</b>	
Trigger mode	yes, sequential or overlapped operation
Free running mode	yes, sequential or overlapped operation
Sensor readout channels	16 / 8 / 4 / 2 channel readout
<b>Signal processing</b>	real-time software programmable
Pixel clock	8/10 bit pixel format: 24/40/48 MHz 12 bit pixel format: 20/40 MHz
A/D converter	10 or 12 bit depending on pixel format
Internal exposure control (t <sub>exp</sub> )	total: 20 µsec .. 1 sec step 1 µsec
Trigger pulse width exposure control	Yes, via all trigger lines
Gain control	0 .. 12 dB
Offset (black level)	0 .. 255 LSB
Image data buffer	max. 60 full resolution images

Technical specifications subject to change

Image acquisition							
Camera image format modes	Format (pixel)	Gen<b>Cam standard	Pixel format	Pixel clock MHz	Frames per sec. (*2)		t <sub>treadout</sub>
					Burst mode	Dual GigE	
Full frame	2048 x 2048	yes	Mono8 (*4)	48	180	56	5550 μs
			Mono10	48	180	28	5550 μs
			Mono12	40	37	28	26500 μs
Binning 2x1	1024 x 2048	yes	Mono8 (*4)	48	180	112	5550 μs
			Mono10	48	180	56	5550 μs
			Mono12	40	37	37	26500 μs
Subsampling 2x2	1024 x 1024	Vendor specific	Mono8 (*4)	48	357	223	2800 μs
			Mono10	48	357	112	2800 μs
			Mono12	40	75	75	13300 μs
<b>Standard features</b>							
<b>Image size controls</b>							
Binning horizontal	yes, 2 pixel						
Binning vertical	-						
Pixel format	Mono8, Mono10, Mono12 (*1)						
Test image selector	yes, in all modes Off, GreyHorizontalRamp, GreyVerticalRamp						
Partial scan (ROI)	yes, format freely programmable in all modes, Step size horizontal: 32 pixels Step size vertical: 1 pixel						
Multi partial scan (Multi ROI)	yes, up to 8 horizontal and vertical regions						
<b>Analog controls</b>							
Gain	-						
Black Level (Off set)	yes						
Gamma	yes, via LUT						
Brightness correction (custom)	yes, in all binning modes						
<b>Digital controls</b>							
Digital gain	yes, factors 1.0 to 4.0 (*5)						
<b>Acquisition and Trigger</b>							
Acquisition mode	Continuous						
Acquisition frame rate	yes, ON / OFF (only in freerunning mode) 0 .. 21739 Hz, step: 0.01 Hz						
Trigger source	HardwareTrigger (Line0, Line1, Line2), Software, CommandTrigger (ActionCommand), Off						
Trigger delay	0 .. 2 sec, 512 trigger can be tracked, step: 1 μsec						
Sequencer	Up to 2 <sup>31</sup> -1 frames per sequence / one exposure time, one gain value and outputs for each parameter set max. set of sequences: Up to 2 <sup>31</sup> -1 frames x 128 parameter sets						
<b>Digital I/O</b>							
Lines	Input: Line0, Line1, Line2 Output: Line3, Line4, Line5						
Line source (outputs only)	Line3, Line4, Line5: Off, ExposureActive, ExposureEnlarged, ReadoutActive, FrameActive, TransferActive, TriggerReady, TriggerOverLapped, TriggerSkipped, Timer1Active, Timer2Active, Timer3Active, Line0, Line1, Line2, UserOutput0, UserOutput1, UserOutput2, SequencerOutput0, SequencerOutput1, SequencerOutput2, Counter1Active, Counter2Active						
Line debouncer	yes, low and high signal separately selectable 0 .. 5 msec step: 1μsec						
Line inverter	yes, Line0 .. Line5, on or off						
<b>Event Generation</b>							
Events	GigEVisionError, Heartbeattimeout, EventLost, Line[0,1,3]RisingEdge, Line[0,1,3]FallingEdge, Software, Action1, ExposureStart, ExposureEnd, FrameStart, FrameEnd, TriggerReady, TriggerOverlapped, TriggerSkipped						
Event Notification	yes, ON / OFF						

Technical specifications subject to change

<b>Counters and Timers</b>	
Counter	yes, CounterSelector: Counter1, Counter2 CounterEventSource: Off, Input: Line0/Line1/Line2, Software, Action1, ExposureStart, ExposureEnd, FrameStart, FrameEnd, TriggerSkipped CounterResetSource: Off, Input: Line0/Line1/Line2, Software, Action1, ExposureStart, ExposureEnd, FrameStart, FrameEnd, TriggerSkipped
Timer	yes, TimerSelector: Timer1, Timer2, Timer3 TimerTriggerSource: Off, Input: Line0/Line1/Line2, Software, Action1, ExposureStart, ExposureEnd, FrameStart, FrameEnd, TriggerSkipped TimerDelay: 0 µsec .. 2 sec, step: 1 µsec TimerDuration: 10 µsec .. 2 sec, step: 1 µsec
<b>LUT Controls</b>	
LUT selector	1 LUT: Luminance (12 bit) ON / OFF
<b>Image Correction</b>	
Defect pixel correction	yes, ON / OFF
Defect pixel list	yes, additional pixels can be added during the lifetime of the camera
DSNU / PRNU (FPN) correction	yes, ON / OFF, based on offset / factor per column, data set calculated with factory settings during production and stored in camera
<b>GigEVisionTransportLayer</b>	
PayLoadsize	576 Byte .. 8.388.880 Byte
<b>UserSets</b>	
User set selector	Default (factory settings / read only) UserSet1, UserSet2, UserSet3 (read and write)
UserSetDefaultSelector	yes, define the start up "UserSet"
<b>Advanced features</b>	
Image Flip	Horizontal, vertical or both
Time stamp function	yes, 64 bit tick = 1 nsec
Asynchronous message channel	Yes
Concatenation function	Yes
User defined identifier	yes, user programmable permanent identifier
ActionCommand	yes, ID 0 = Trigger, ID 1 = Timestamp set
High Dynamic Range (HDR)	Yes, piecewise linear response, up to 90 dB
<b>Data quality</b>	
Readout noise	at 20 °C, gain = 1, exposure time = 4 msec, full frame mode $\sigma < 0.3$ LSB (8 bit) typical
Dynamic range	typical 60 dB
<b>Optical interface</b>	
Optical filter	C-Mount on request: F-Mount dust protection on request: super polished, IR cut filter, daylight filter or no filter
<b>Process interface functions</b>	
Async. Trigger	yes, trigger mode operation, "Off", "software trigger", "hardware trigger", "command trigger" or "all" separately selectable (overtriggered signals and trigger signals during the readout time will be notified in the received image header)
Exposure Active (External flash sync)	yes, delay_value ( $t_{\text{delay flash}}$ ) $\leq 4$ µsec, duration_value ( $t_{\text{duration}}$ ): mode = $t_{\text{exp}} + 30$ µsec
User Output	yes, ON / OFF, UserOutput0, UserOutput1, UserOutput2
Timer	yes, Timer1
Software reset	Yes
Asynchronous reset	-
Image info header	yes
Temperature measurement	-

Technical specifications subject to change

<b>Electrical interface</b>	
Data / control	standard dual cable 1000 Base-T, Cat6 recommended / minimum Cat5e option: screw lock type connector
Power	Dedicated 3 pin power interface VCC: 20 VDC .. 30 VDC, I: 304 mA .. 397 mA
	Power over Ethernet (PoE) Class 0 device (via 1000 Base-T cable) VCC: 48VDC (38 VDC .. 30 VDC) I: 160 mA .. 259 mA, supported by port 1 (at the top)
Power consumption	approx. 8,4 Watt (with camera factory settings)
Digital input	1 / 2 / 3: Line 0 / Line 1 / Line 2: trigger signal, opto decoupled $U_{IN(low)} = 0 \dots 4.5 \text{ VDC}$ , $U_{IN(high)} = 11 \dots 30 \text{ VDC}$ $I_{IN} = \text{max. } 10 \text{ mA}$ rising edge (invert = false) (*6) min. impulse length ( $t_{min}$ ): 2 $\mu\text{sec}$ trigger delay out of $t_{readout}$ ( $t_{delay \text{ trigger}}$ ): 4 $\mu\text{sec}$ max. trigger delay during $t_{readout}$ ( $t_{delay \text{ trigger}}$ ): 30 $\mu\text{sec}$
Digital output	1 / 2 / 3: Line 3 / Line 4 / Line 5: opto decoupled $U_{EXT} = 5 \dots 30 \text{ VDC}$ / 24 VDC typical, $I_{OUT} = \text{max. } 100 \text{ mA}$ high active (invert = false) (***)
LED	1(Camera): green: Power on yellow: Readout active 2 (GigE Port 1): green: Link active green flash: Receiving 3 (GigE Port 1): yellow: Transmitting 4 (GigE Port 2): green: Link active green flash: Receiving 5 (GigE Port 2): yellow: Transmitting
<b>Environmental</b>	
Storage temperature	-10 °C .. +70 °C
Operating temperature	+5 °C .. +50 °C
Housing operating temperature	between +15 °C .. +50 °C, note the max. housing and internal temperature max. +50 °C (*7) (measurement point, see item 4)
Humidity	10 % .. 90 % non condensing
Conformity	CE, FCC Part 15 class B, RoHS compliant
<b>Housing</b>	
Aluminum	
Dimensions	52 x 52 x 55 mm <sup>3</sup> (C-Mount) 52 x 52 x 55 mm <sup>3</sup> (F-Mount)
Weight	232 g (C-Mount) 323 g (F-Mount)
<b>1000 Base-T interface</b>	
Ports	2
Ethernet IP configuration	persistent IP / DHCP / LLA
Stream channel packet size	576 Byte (default) .. 65535 Byte jumbo frames supported
Interpacketgap	0 .. 2 <sup>32</sup> -1 ticks
Multicast function	yes
Resend function	Yes
Link aggregation	Yes, according to 802.3ad, static configuration
<b>Software</b>	Baumer-GAPI SDK with supported OS socket driver and Baumer filter driver / SDK for Windows XP (32 bit) / Windows Vista (32 bit / 64 bit) / Windows 7 (32 bit / 64 bit) / Linux Kernel 2.6.xx (64 bit / 32 bit)
	GigE Vision <sup>®</sup> compatible programs and image processing libraries supported Windows / Linux depending on the actually driver software is used

- (\*1) For changing the pixel frequency or the pixel format, the camera has to be stopped.  
(\*2) Maximum frame rate in free running mode, effective frame rate depending on camera image format mode settings and set exposure time ( $t_{exp} < t_{readout}$ ). This assumes 16 tap readout at maximum pixel frequency.  
(\*3) -  
(\*4) Default pixel format  
(\*5) Digital gain is applied on the raw data obtained from the sensor. In 10 and 12 bit modes, this is just a bit shift cutting away the MSBs!  
(\*6) can be inverted via software  
(\*7) housing temperature is limited by CMOS sensor specification  
In warm environments take care of adequate dissipation of heat. It is recommended to operate the cameras in mounted condition with a good heat conductor (e.g. aluminum) or with sufficient air flow.

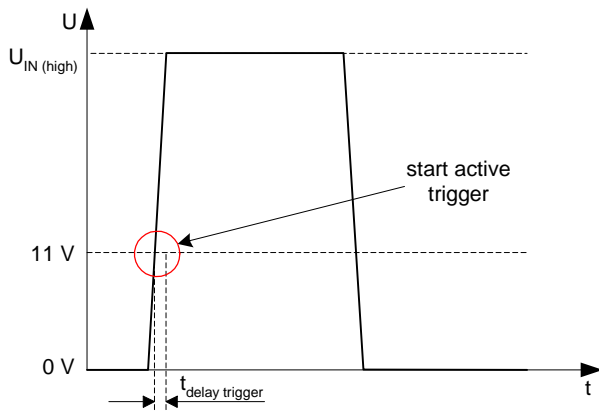
Technical specifications subject to change

## 2. Camera Factory Settings after Camera Start-up

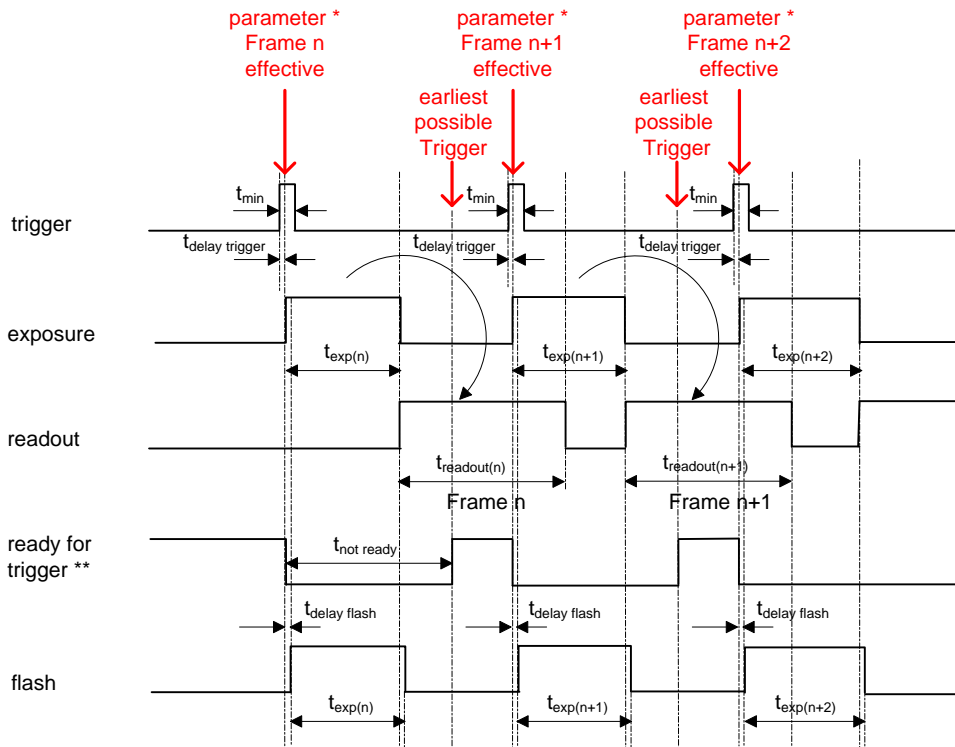
Camera factory settings after camera start-up or reboot	
<b>Operation modes</b>	free running mode, overlapped readout
<b>Signal processing</b>	
Exposure control	Internal, 4 msec
Gain control	factor 1 = 0 dB
Offset (black level)	0
<b>Image acquisition</b>	
Camera image format mode	Full frame Mono8, 16 tap readout
Pixel frequency	48 MHz
Partial scan function	not active
Acquisition frame rate	Off
Timer	Off
Transmission delay	0 ticks
Test image selector	Off
Defect pixel correction	On
FPN correction	Off
<b>Electrical interface</b>	
Digital input	1 / 2 / 3: Line 0 / Line 1 / Line 2: invert = false
Digital output	1 / 2 / 3: Line 3 / Line 4 / Line 5: Line source=Off, invert = false, digital output set to low status (high impedance)

## 3. Timing Operation Modes

Trigger Mode: start up time



Trigger Mode: trigger mode 0, overlapped trigger



$$t_{exp} < t_{readout}: t_{earliest\ possible\ trigger\ (n+1)} = t_{readout(n)} - t_{exp(n+1)}$$

$$t_{exp} > t_{readout}: t_{earliest\ possible\ trigger\ (n+1)} = t_{exp(n)}$$

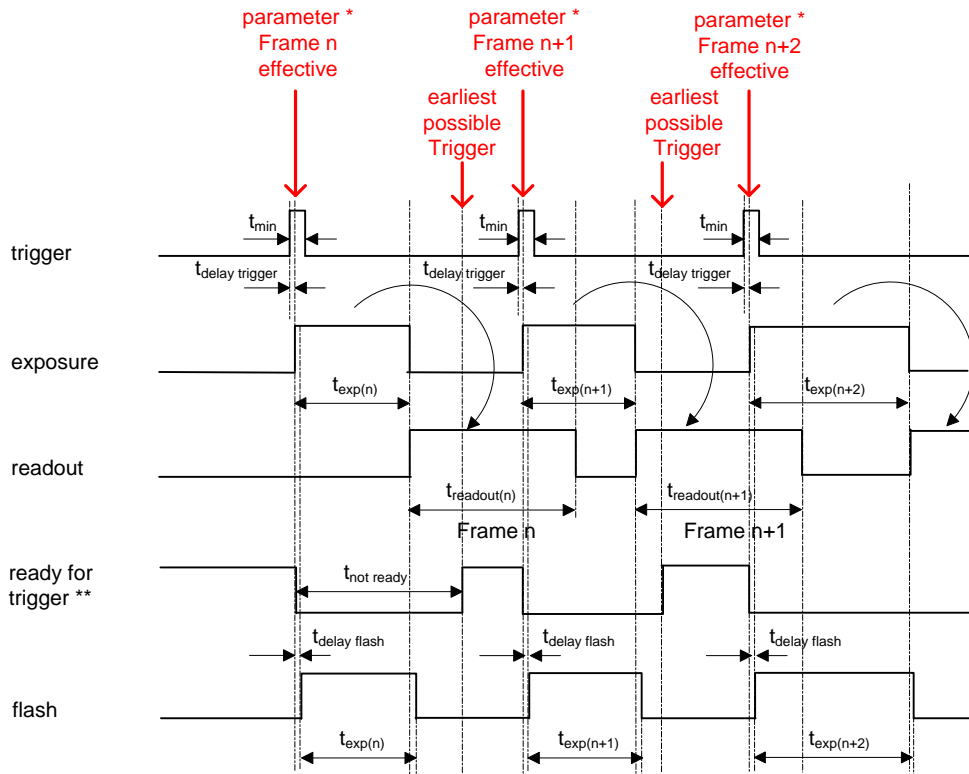
$$t_{exp} < t_{readout}: t_{not\ ready\ (n+1)} = t_{exp(n)} + t_{readout(n)} - t_{exp(n+1)}$$

$$t_{exp} > t_{readout}: t_{not\ ready\ (n+1)} = t_{exp(n)}$$

\* image parameter: exposure  
offset  
gain  
readout mode  
LUT  
flip image

\*\* signal will be notified as event "TriggerReady"

Trigger Mode: trigger mode 0, overlapped trigger , when  $t_{exp(n+2)} > t_{exp(n+1)}$



$$t_{exp} < t_{readout}: t_{earliest\ possible\ trigger(n+1)} = t_{readout(n)} - t_{exp(n+1)}$$

$$t_{exp} > t_{readout}: t_{earliest\ possible\ trigger(n+1)} = t_{exp(n)}$$

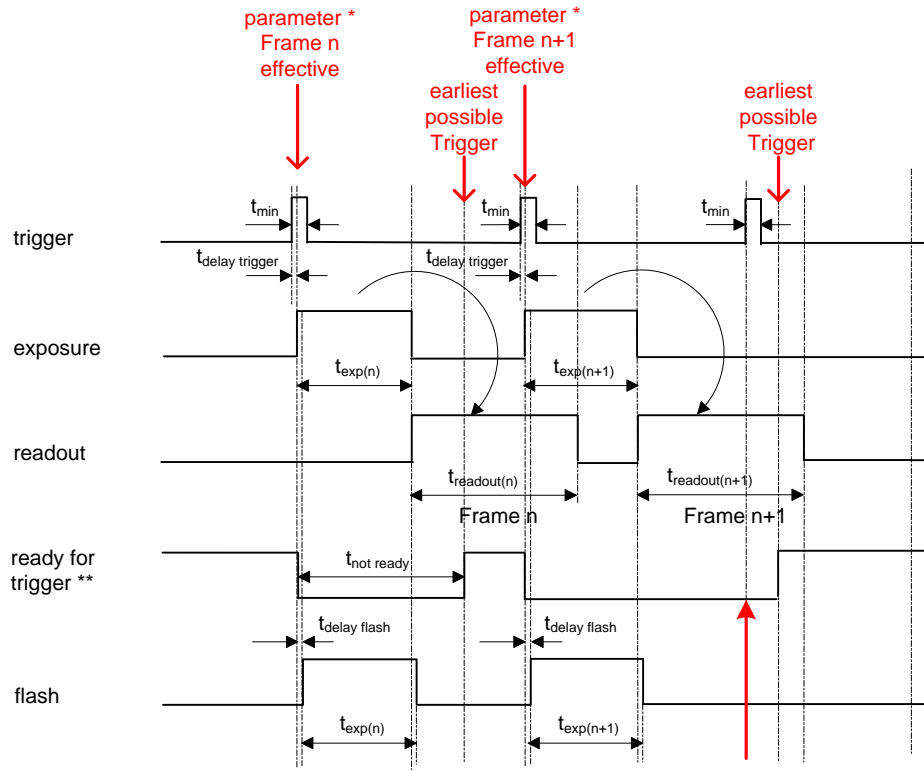
$$t_{exp} < t_{readout}: t_{not\ ready(n+1)} = t_{exp(n)} + t_{readout(n)} - t_{exp(n+1)}$$

$$t_{exp} > t_{readout}: t_{not\ ready(n+1)} = t_{exp(n)}$$

- \* image parameter:
- exposure
  - offset
  - gain
  - readout mode
  - LUT
  - flip image

\*\* signal will be notified as event "TriggerReady"

Trigger Mode: trigger mode 0, overlapped trigger , when  $t_{exp(n+2)} < t_{exp(n+1)}$



Frame n+2  
not started / overtriggered

$$t_{exp} < t_{readout}: \quad t_{earliest\ possible\ trigger\ (n+1)} = t_{readout(n)} - t_{exp(n+1)}$$

$$t_{exp} > t_{readout}: \quad t_{earliest\ possible\ trigger\ (n+1)} = t_{exp(n)}$$

$$t_{exp} < t_{readout}: \quad t_{not\ ready\ (n+1)} = t_{exp(n)} + t_{readout(n)} - t_{exp(n+1)}$$

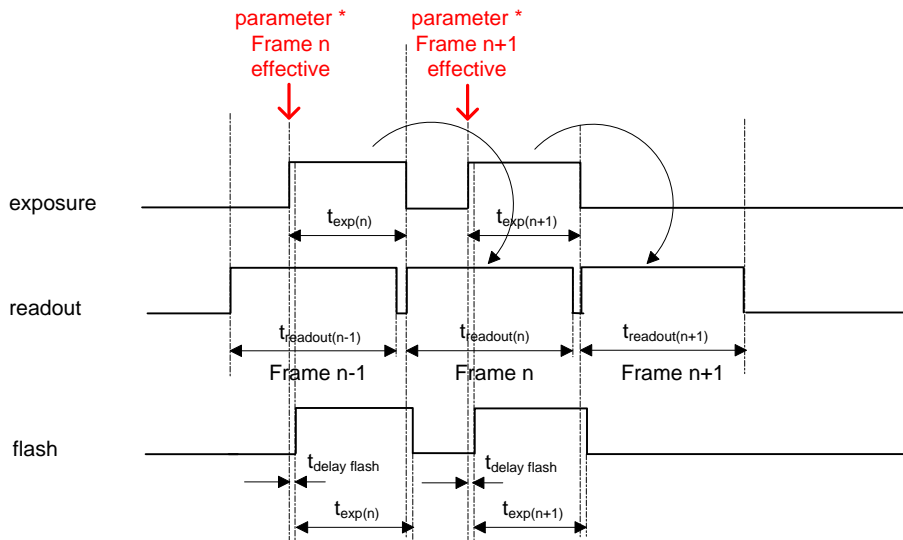
$$t_{exp} > t_{readout}: \quad t_{not\ ready\ (n+1)} = t_{exp(n)}$$

- \* image parameter:
- exposure
  - offset
  - gain
  - readout mode
  - LUT
  - flip image

\*\* signal will be notified as event "TriggerReady"



Free Running Mode: overlapped operation



\* image parameter:  
 exposure  
 offset  
 gain  
 readout mode  
 LUT  
 flip image

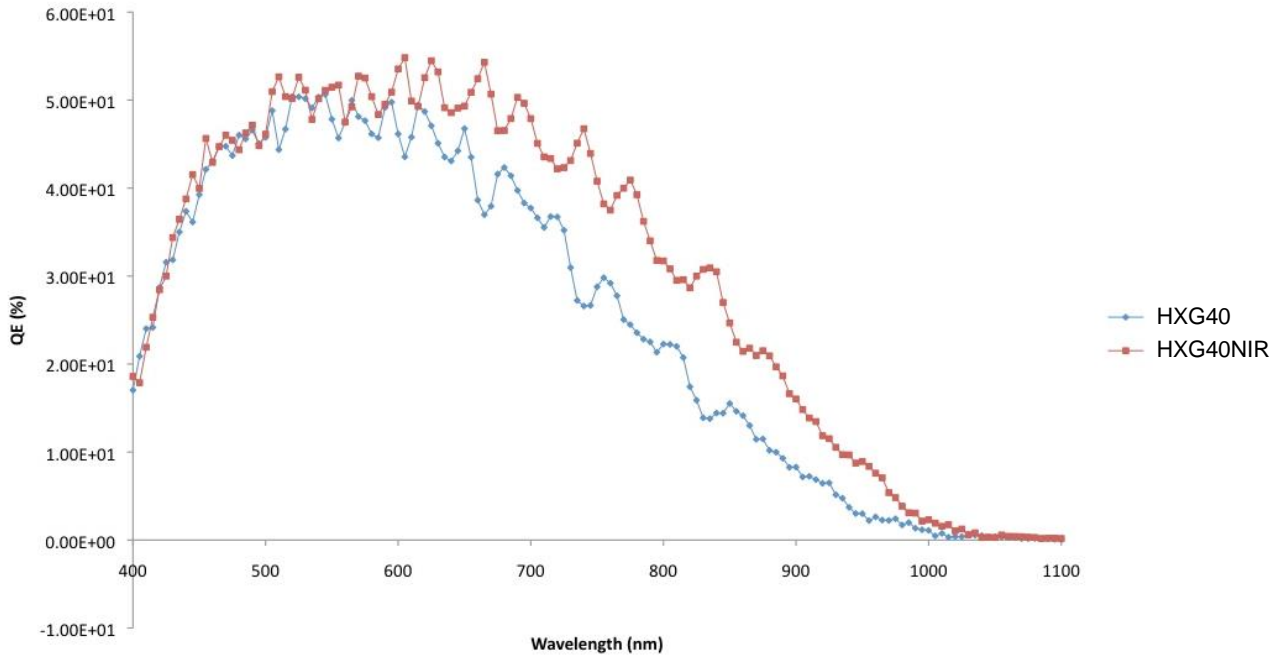
#### 4. Region of Interest (ROI) Examples

The following table lists achievable frame rates in burst mode for a short time using the integrated image buffer of 256 MB and continuously over the Dual GigE interface.

Format	Resolution	max. fps burst mode (buffered)	max. fps continuously (Single GigE) (*1)	max. fps continuously (Dual GigE) (*1)
2kx2k	2048 x 2048	180	28	56
	2048 x 1080	338	53	106
HDTV	1920 x 1080	338	56	113
	1280 x 720	504	127	253
XGA	1024 x 768	473	149	298
DVD	736 x 576	627	277	536
VGA	640 x 480	748	382	640
CIF	352 x 288	1.221	1044	1044
QCIF	176 x 144	2.319	1983	1983
Line Scan	2048 x 1024	357	56	112
	2048 x 512	703	112	223
	2048 x 256	1.363	224	443
	2048 x 128	2.576	447	877
	2048 x 64	4.637	888	1736
	2048 x 32	7.712	1753	3231
	2048 x 16	11.560	3437	6021
	2048 x 8	15.407	6531	-
	2048 x 4	18.436	-	-
	2048 x 2	20.349	-	-
	2048 x 1	21.653	-	-

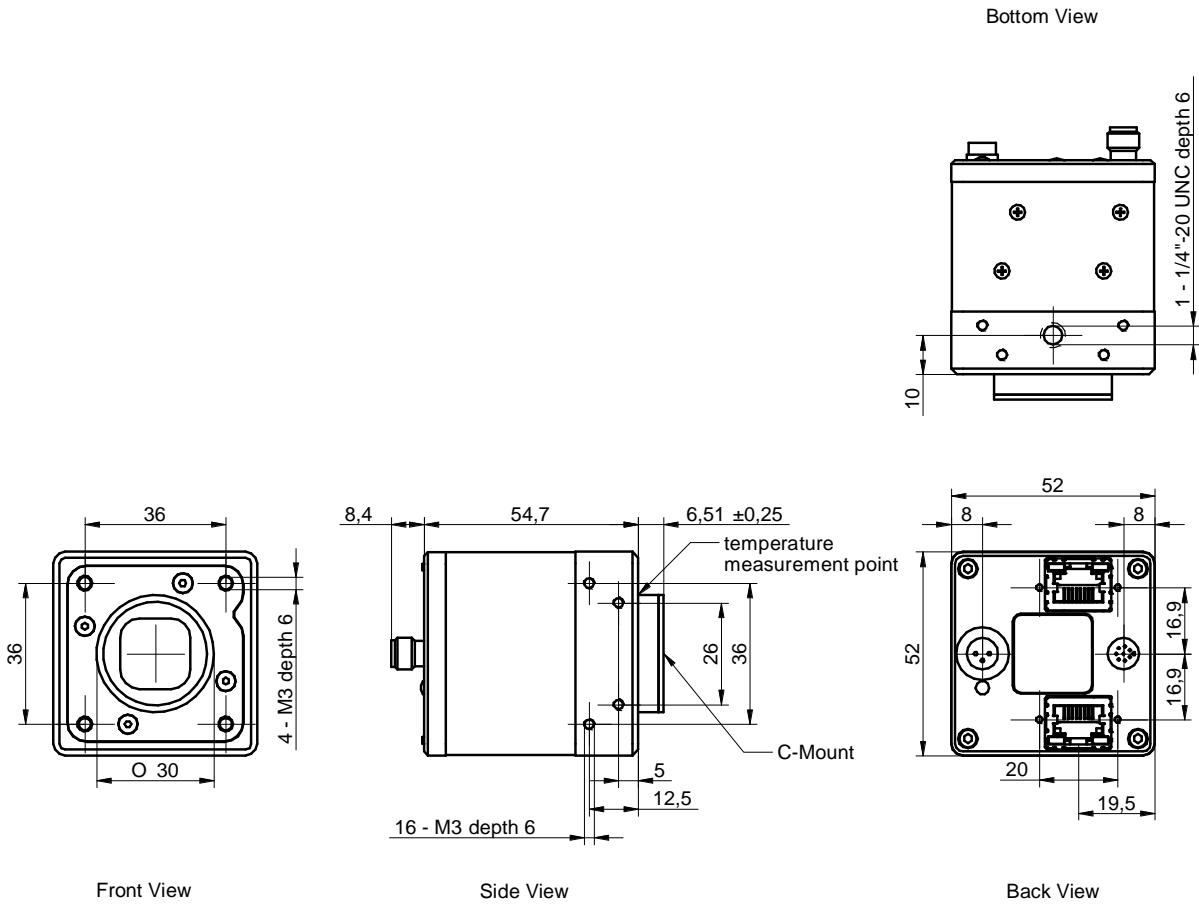
(\*1) For small ROI settings many packets are transmitted and have to be processed by the PC. The actual frame rate depends on the PC performance. If the PC is not fast enough to process the incoming packets an overload situation may occur.

5. Spectral response (QE)



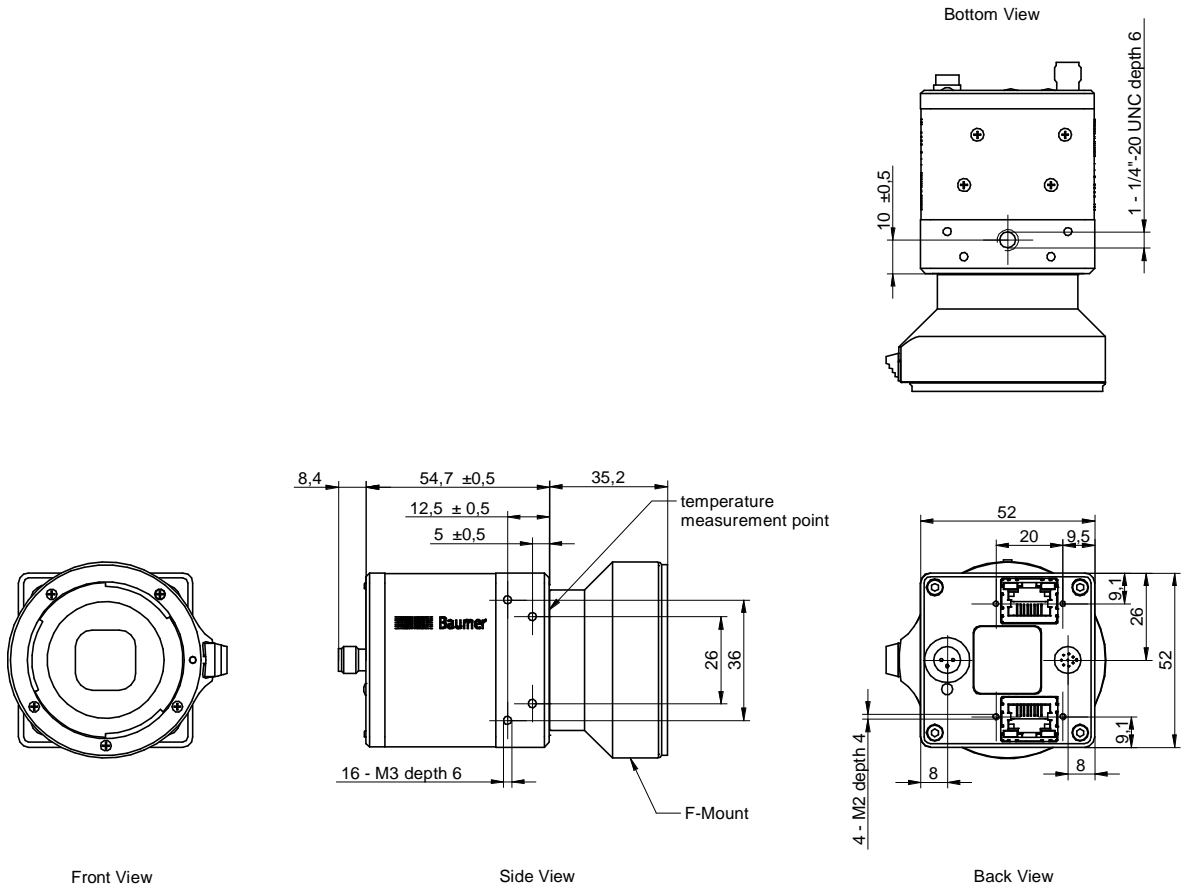
6. Housing

6.1 C-Mount



Technical specifications subject to change

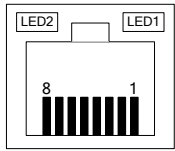
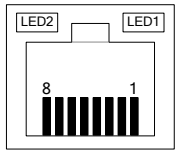
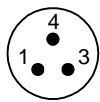
6.2 F-Mount

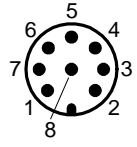
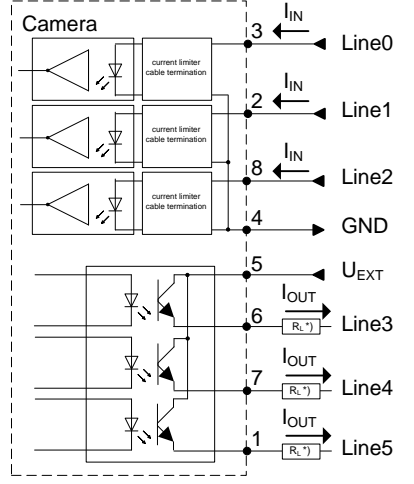


Technical specifications subject to change

7. Connectors / Electrical Interfaces

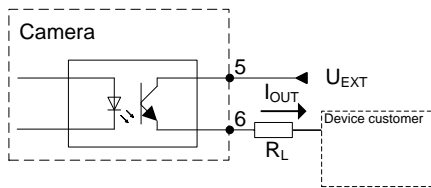
7.1 Pin assignment:

<b>Data / Control</b> <b>1000 Base-T (Port 1)</b>	Type: RJ45 8P8C mod jack
	1: MX1+ 2: MX1- 3: MX2+ 4: MX3+ 5: MX3- 6: MX2- 7: MX4+ 8: MX4-
<b>Data / Control</b> <b>1000 Base-T (Port 2)</b>	Type: RJ45 8P8C mod jack
	1: MX1+ 2: MX1- 3: MX2+ 4: MX3+ 5: MX3- 6: MX2- 7: MX4+ 8: MX4-
<b>Power</b>	Type: Lumberg RSMESD / 3 pin
	1: Power VCC+ 3: GND 4: not used
	Power cable wires color: 1 = brown 3 = blue 4 = black

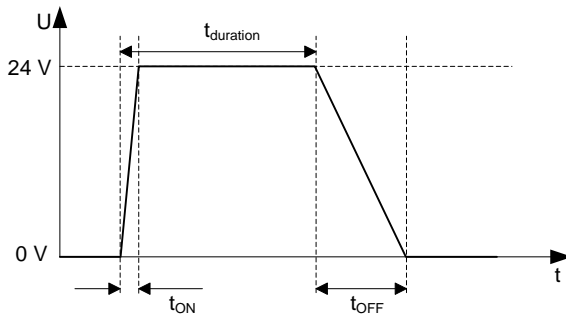
<b>Input / Output</b>	Type: Lumberg RSMESD 8pin.
	
	*) resistor must be used, drawing shown above example for using high active signal
	I/O cable wires color *): 1 = white 2 = brown 3 = green 4 = yellow 5 = grey 6 = pink 7 = blue 8 = red

\*) shielded trigger / flash cable should be used and ordered separately

7.2 Flash sync sample  $U_{EXT} = 24 \text{ VDC}$  high active:

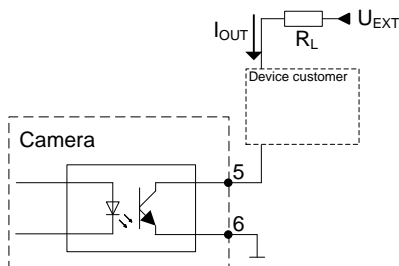


Timing example:  
 measurement condition  $U_{EXT} = 24 \text{ VDC} / I_{OUT} = 16 \text{ mA}$   
 $R_L = 1.5 \text{ kOhm}$

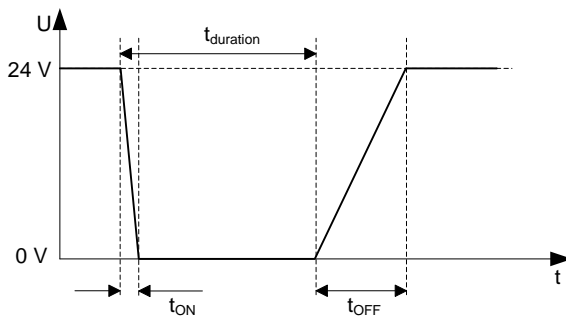


$t_{ON}$  time = typ.  $2 \mu\text{sec}$   
 $t_{OFF}$  time = typ.  $40 \mu\text{sec}$

7.3 Flash sync sample  $U_{EXT} = 24 \text{ VDC}$  low active:



Timing example:  
 measurement condition  $U_{EXT} = 24 \text{ VDC} / I_{OUT} = 16 \text{ mA}$   
 $R_L = 1.5 \text{ kOhm}$



$t_{ON}$  time = typ.  $2 \mu\text{sec}$   
 $t_{OFF}$  time = typ.  $40 \mu\text{sec}$

End of Document

## History of TDS Baumer HXG40

Date	Version	Name	Pages/ Chapter	Change
21.06.2011	0.1	mibe	all	Initial version based on HXC40, SXG80
05.10.2011	0.1	mibe	1	SAP# F-Mount, Image HXG C-Mount, F-Mount tbd., GigE payload
04.11.2011	0.2	mibe	all	Factory settings, F-Mount image from SXG
21.11.2011	0.3	mibe	all	FPN, PoE only on Port 1, Payload Size
06.12.2011	0.4	mibe	all	F-Mount, voltage range, power consumption, operating temperature
13.12.2011	0.5	mibe	10	ROI frame rate
09.01.2012	0.6	mibe	4	Operating temperature
20.01.2012	0.7	mibe	13	New F-Mount drawing without Nikon dust protection
26.01.2012	0.8	mibe	2,10	Slightly reduced frame rates
01.02.2012	1.0	mibe	1	Removed preliminary note
27.02.2013	1.0	mibe	1, 3	Changes for Firmware Revision 2 Support of v3 Sensors (not mentioned) Modified DSNU/PRNU (FPN), added HDR/Multi ROI Removed Temperature measurement
30.5.2013	1.0	mibe	2	Burst mode frame rate with 10 bit corrected (=8bit) Added V3 Sensor Notification
23.07.2013	1.1	zira	1	according SFNC: Naming changed from <i>User</i> to <i>UserOutput</i> , <i>CounterTriggerSource</i> to <i>CounterEventSource</i> , <i>SoftwareTrigger</i> to <i>Software</i> , <i>ActCmdTrigger</i> to <i>Action1</i> , added <i>CounterActive</i> ReadoutTime unit in $\mu$ s
06.8.2013	1.1	mibe	1	Minimum exposure = 20 $\mu$ s
12.08.2013	1.0	mibe	1	Change name <i>_R2_</i> , corrected read out time Footer <a href="http://www.baumeroptronic.com">www.baumeroptronic.com</a> -> <a href="http://www.baumer.com">www.baumer.com</a>

Technical specifications subject to change