





<b>Digital I/O</b>	
Lines	Input: Line0, Line1, Line2 Output: Line7, Line 8, Line 9
Line source (outputs only)	Line7, Line8, Line9: Off, ExposureActive, Timer1Active, FrameActive, TransferActive, TriggerReady, TriggerOverLapped, TriggerSkipped, Line0, Line1, Line2, Line3/CC1, Line4/CC2, Line5/CC3, Line6/CC4, User0, User1, User2, SequencerOutput0, SequencerOutput1, SequencerOutput2
Line debouncer	yes, low and high signal separately selectable 0 .. 5 msec step: 1µsec
Line inverter	yes, Line0 .. Line9, on or off
<b>Counters and Timers</b>	
Framecounter	-
Timer	yes, TimerSelector: Timer1 TimerTriggerSource: Off, Input: Line0/Line1/Line2, SoftwareTrigger 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>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	-
High Dynamic Range (HDR)	Yes, piecewise linear response, up to 90 dB
<b>Data quality</b>	at 20 °C, gain = 1, exposure time = 4 msec, full frame mode
Readout noise	$\sigma < 0.5$ LSB (8 bit) typical
Dynamic range	typical 60 dB
<b>Optical interface</b>	C-Mount on request: F-Mount
Optical filter	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", "framegrabber trigger" separately selectable
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, User0, User1, User2
Timer	yes, Timer1
Software reset	Yes
Asynchronous reset	-
Image info header	-
Temperature measurement	-

# Technical Data CAM-CL-HXC20

<b>Electrical interface</b>			
Data / control	Dual 26 pin Mini-CameraLink connector		
Power	Mono8, CameraLink base, dual tap, 40 MHz VCC: 9,6 VDC .. 30 VDC, I: 550 mA .. 190 mA		
	Mono8, CameraLink full, 10 tap, 48 MHz VCC: 9,6 VDC .. 30 VDC, I: 620 mA .. 200 mA		
Power consumption	approx. 5,5 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) (*5) 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 7 / Line 8 / Line 9: opto decoupled $U_{EXT} = 5 \dots 30 \text{ VDC} / 24 \text{ VDC typical}$ , $I_{OUT} = \text{max. } 100 \text{ mA}$ high active (invert = false) (***)		
LED	1: green: Power on yellow: Readout active 2: green: TX red: Configuration command processing		
<b>Environmental</b>			
Storage temperature	-10 °C .. +70 °C		
Operating temperature	+5 °C .. +60 °C		
Housing operating temperature	between +30 °C .. +60 °C, note the max. housing and internal temperature max. +65 °C (*6) (measurement point, see item 4)		
Humidity	10 % .. 90 % non condensing		
Conformity	CE, FCC Part 15 class B, RoHS compliant		
<b>Housing</b>			
Dimensions	Aluminum 52 x 52 x 38 mm <sup>3</sup> (C-Mount) 52 x 52 x 37 mm <sup>3</sup> (F-Mount)		
Weight	185 g (C-Mount) 276 g (F-Mount)		
<b>CameraLink interface</b>			
Clock	Base, Medium, Full or 10-tap 80 MHz		
Data Formats	Mono8	Base configuration	1, 2 or 3 taps
		Medium configuration	4 taps
		Full configuration	8 taps
		10-tap configuration	10 taps
	Mono10	Base configuration	1 or 2 taps
		Medium configuration	3 or 4 taps
	Mono12	Base configuration	1 or 2 taps
		Medium configuration	3 or 4 taps
<b>Software</b>			
SDK for Windows XP (32 bit) / Windows Vista (32 bit / 64bit), Supported FrameGrabber: Silicon Software microEnable IV Tool for camera configuration via CameraLink serial interface			

- (\*1) 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.
- (\*2) Limited by the speed of the CameraLink interface. In 10 and 12 bit modes only a medium configuration is possible.
- (\*3) Default pixel format
- (\*4) 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!
- (\*5) can be inverted via software
- (\*6) housing temperature is limited by CMOS sensor specification

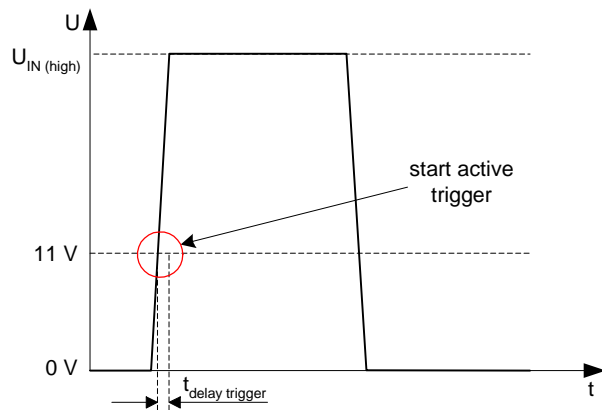
In warm environments take care of adequate dissipation of heat. It is recommended to operate the cameras in mounted condition with a good heat conductor (e.g. aluminum) or with sufficient air flow.

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

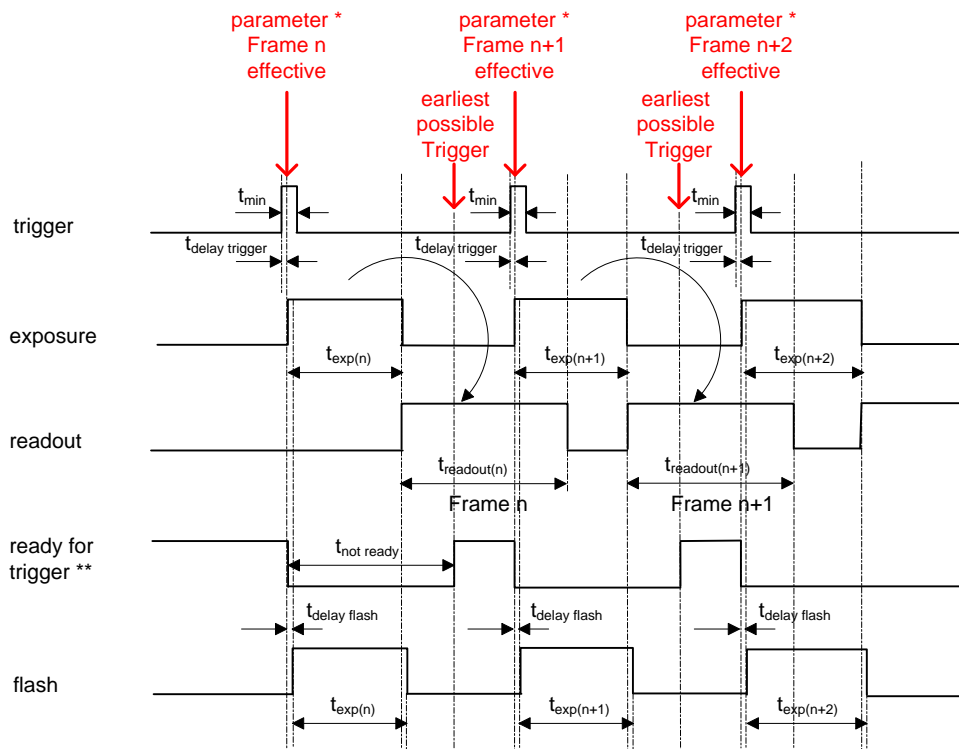
Camera factory settings after camera start-up or reboot	
<b>Operation modes</b>	free running mode, overlapped readout
<b>Signal processing</b>	
Exposure control	Internal, 4 msec
Gain control	factor 1 = 0 dB
Offset (black level)	0
<b>Image acquisition</b>	
Camera image format mode	Full frame Mono8, 16 tap readout
Pixel frequency	48 MHz
Partial scan function	not active
Acquisition frame rate	Off
Timer	Off
Test image selector	Off
Defect pixel correction	On
FPN correction	Off
<b>CameraLink interface</b>	
Configuration	Mono8, Dual tap CameraLink Base
Clock	80 MHz
<b>Electrical interface</b>	
Exposure Active (External flash sync)	disabled, digital output set to low status (high impedance) invert = false
Async. Trigger	disabled invert = false trigger source = Line0

## 3. Timing Operation Modes

Trigger Mode: start up time



Trigger Mode: trigger mode 0, overlapped trigger



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

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

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

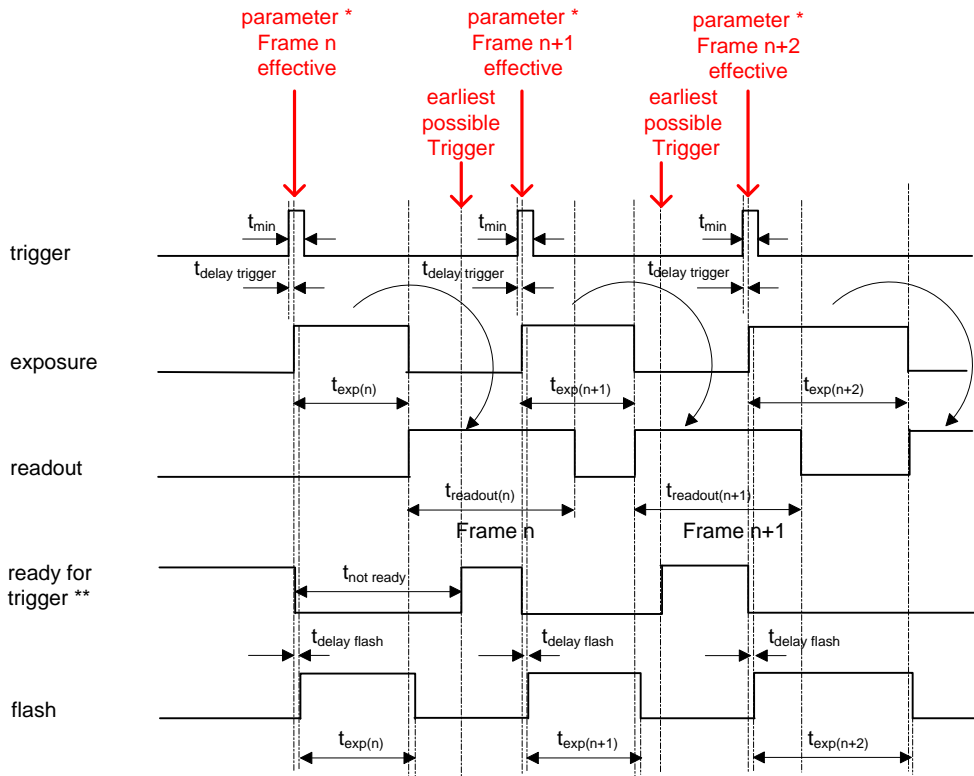
$$t_{exp} > t_{readout}: t_{not\ ready\ (n+1)} = t_{exp(n)}$$

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

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

# Technical Data CAM-CL-HXC20

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



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

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

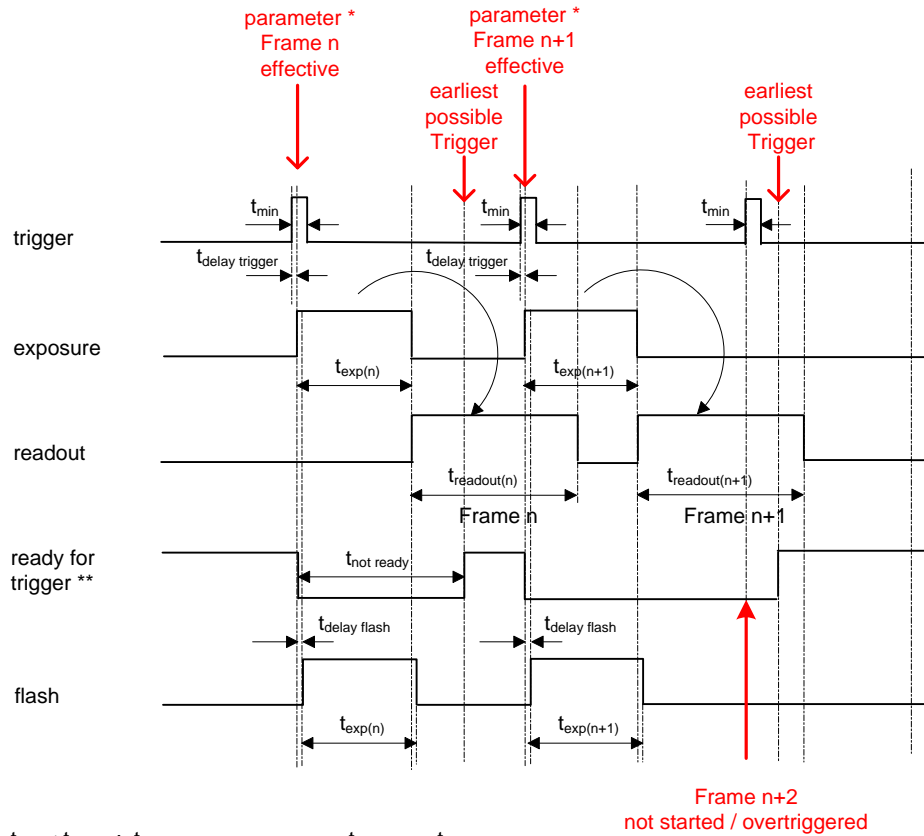
$$t_{exp} < t_{readout}: t_{not\ ready\ (n+1)} = t_{exp(n)} + t_{readout(n)} - t_{exp(n+1)}$$

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

\* 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  $t_{exp(n+2)} < t_{exp(n+1)}$



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

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

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

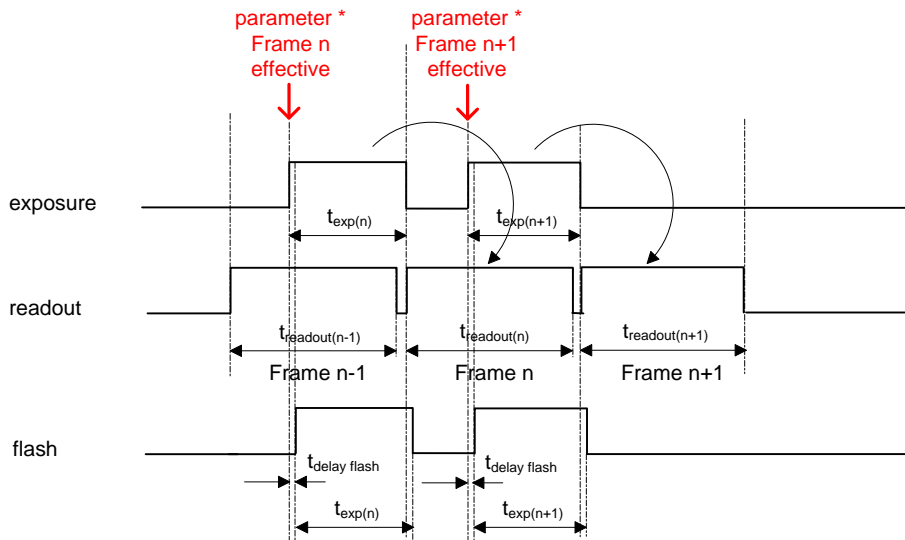
$$t_{exp} > t_{readout}: t_{not\ ready\ (n+1)} = t_{exp(n)}$$

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

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



Free Running Mode: overlapped operation



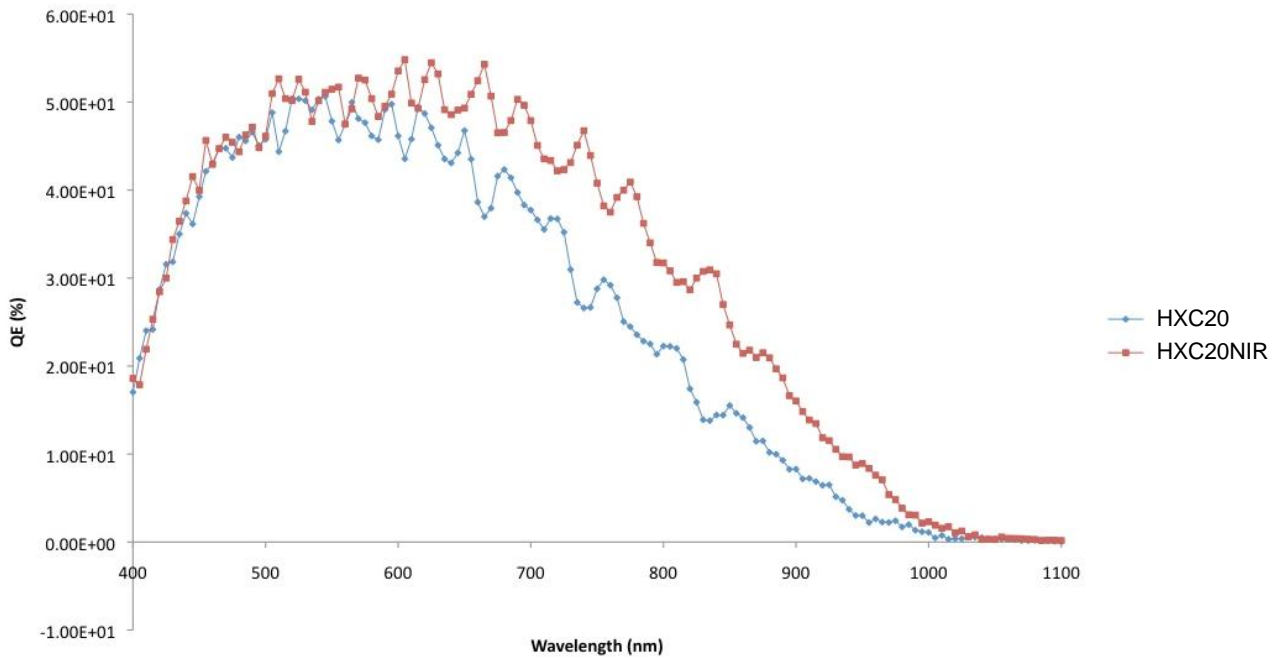
\* image parameter:  
 exposure  
 offset  
 gain  
 readout mode  
 LUT  
 flip image

## 4. Region of Interest (ROI) Examples

The following table lists achievable frame rates in 10 tap / 8 bit mode.

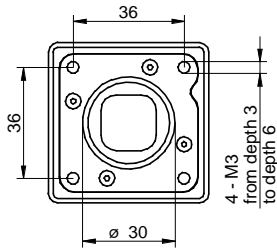
Format	Resolution	max. fps
2k	2048 x 1080	338
HDTV	1920 x 1080	338
	1280 x 720	504
XGA	1024 x 768	473
DVD	720 x 576	627
VGA	640 x 480	748
CIF	352 x 288	1.221
QCIF	176 x 144	2.319
Line Scan	2048 x 1024	357
	2048 x 512	703
	2048 x 256	1.363
	2048 x 128	2.576
	2048 x 64	4.637
	2048 x 32	7.712
	2048 x 16	11.560
	2048 x 8	15.407
	2048 x 4	18.436
	2048 x 2	20.349
	2048 x 1	21.653

## 5. Spectral Response (QE)

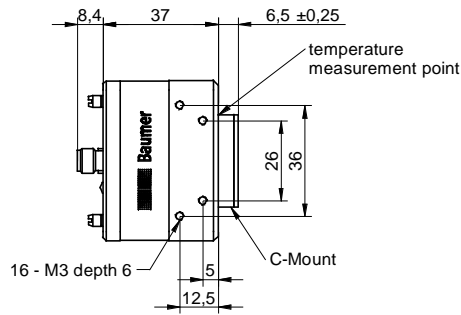


## 6. Housing

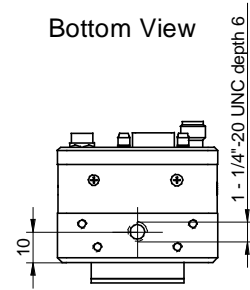
### 6.1 C-Mount



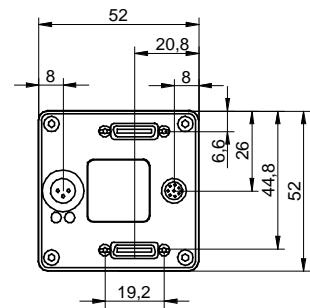
Front View



Side View



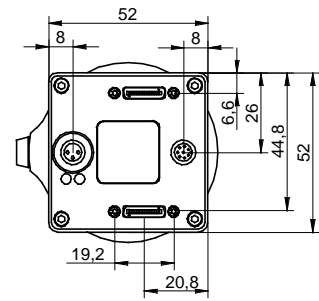
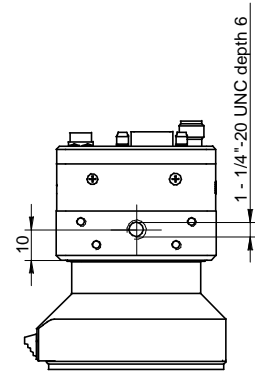
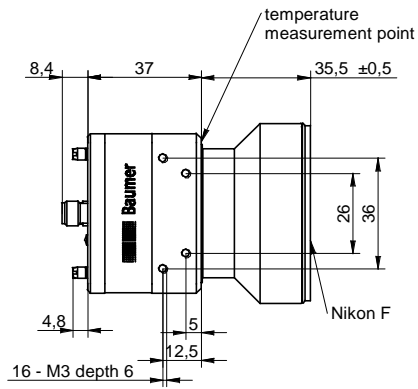
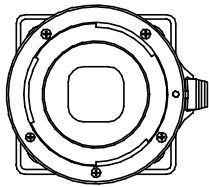
Bottom View



Back View


# Technical Data CAM-CL-HXC20

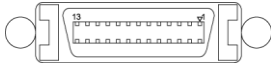
## 6.2 F-Mount

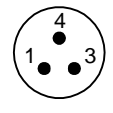


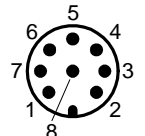
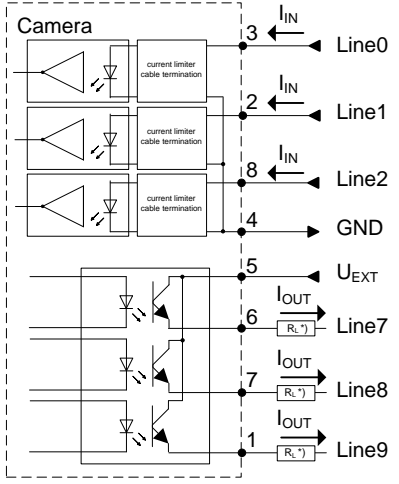
## 7. Connectors / Electrical Interfaces

### 7.1 Pin assignment:

Data / Control CameraLink Base	Type: 3M SDR26 MiniCL
	1: GND 2: X0- 3: X1- 4: X2- 5: XCLK- 6: X3- 7: SERTC+ 8: SERTFG- 9: CC1- 10: CC2+ 11: CC3- 12: CC4+ 13: GND 14: GND 15: X0+ 16: X1+ 17: X2+ 18: XCLK+ 19: X3+ 20: SERTC- 21: SERTFG+ 22: CC1+ 23: CC2- 24: CC3+ 25: CC4- 26: GND

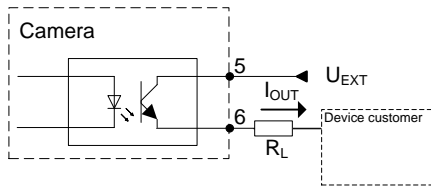
Data CameraLink Full	Type: 3M SDR26 MiniCL
	1: GND 2: Y0- 3: Y1- 4: Y2- 5: YCLK- 6: Y3- 7: 100 Ω Term. 8: Z0- 9: Z1- 10: Z2- 11: ZCLK- 12: Z3- 13: GND 14: GND 15: Y0+ 16: Y1+ 17: Y2+ 18: YCLK+ 19: Y3+ 20: 100 Ω Term 21: Z0+ 22: Z1+ 23: Z2+ 24: ZCLK+ 25: Z3+ 26: GND

Power	Type: Lumberg RSMESD / 3 pin
	1: Power VCC+ 3: GND 4: not used
	Power cable wires color: 1 = brown 3 = blue 4 = black

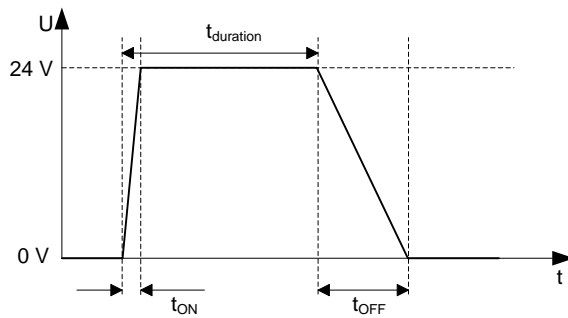
Input / Output	Type: Lumberg RSMESD 8pin.
	 <p>*) resistor must be used, drawing shown above example for using high active signal</p> <p>I/O cable wires color *):            1 = white            2 = brown            3 = green            4 = yellow            5 = grey            6 = pink            7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

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

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



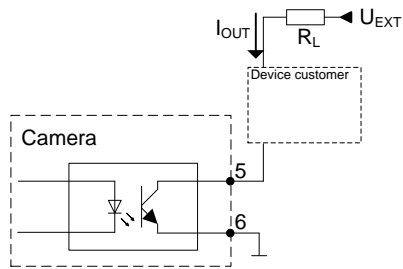
Timing example:  
 measurement condition  $U_{EXT} = 24 \text{ VDC}$  /  $I_{OUT} = 16 \text{ mA}$   
 $R_L = 1.5 \text{ kOhm}$



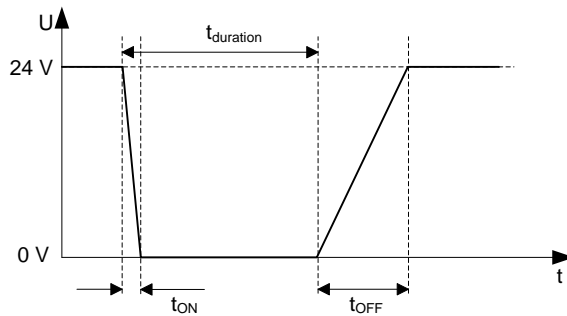
$t_{ON}$  time = typ.  $2 \mu\text{sec}$   
 $t_{OFF}$  time = typ.  $40 \mu\text{sec}$

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

Note: This setup can only be used for a single output because  $U_{EXT}$  is connected for all three outputs.



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.  $40 \mu\text{sec}$

## 8. Application Notes

The following application notes regarding the camera are available from Q.VITEC:

- Sensor frame rate calculation and interface speed (BTI\_HXC20\_HXC40\_Frame\_Rate\_Calculation)
- Pixel defect and sensor cover glass specification (BTI\_HXC20\_HXC40\_Pixel\_Glass\_Specification)

The following additional information regarding the image sensor is currently known and can be obtained from the sensor manufacturer's website ([www.cmosis.com](http://www.cmosis.com)):

- CMV2000 and CMV4000 Application note AN2 (black sun artefact, horizontal line artefact)