

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

 System: **Gigabit Ethernet**

Baumer TXG02

Revision 2.1

Art. No: 11044956

- Gigabit Ethernet progressive scan CCD camera
- 656 x 494 pixel
- Up to 140 full frames per second
- GigE Vision® standard compliant
- Outstanding image quality
- High sensitivity and dynamic range
- High quality slow scan mode for lowest readout noise
- Binning and true partial scan function (ROI) for increased frame rates
- External synchronization via industrial compliant process interface (trigger / flash)
- Integrated supplementary function for flexible integration
- Sequence function up to 2³¹-1 frames per sequence
- Jumbo frames supported
- Integrated 32 MByte RAM for temporarily image data buffering
- Camera parameter programmable in real-time
- Ultra 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	TXG02
Sensor	1/4" interline progressive scan CCD EXview HAD technology
Shutter / readout mode	global shutter / progressive scan readout
Number of pixel	656 x 494
Scan area	3.67 mm x 2.76 mm
Pixel size	5.6 µm x 5.6 µm
Color filter	-
Operation modes	
Trigger mode	yes, overlapped operation
Free running mode	yes, overlapped operation
Signal processing	real-time software programmable
Pixel clock	60 MHz fast scan / 30 MHz high quality (HQ) scan
A/D converter	12 bit
Exposure control (t _{exp})	total: 4 µsec .. 60 sec step: 1 µsec
Gain control	0 .. 20 dB
Offset (black level)	0 .. 1023 LSB (14 bit)
Image data buffer	max. 31 images

Technical specifications subject to change

Image acquisition								
Camera image format modes		Format (pixel)	Gen<->Cam standard	Format ID	Pixel format	Pixel clock MHz	Frames per sec. *)	t _{readout}
Full frame HQ	slow	656 x 494	Vendor specific	00	Mono8 **)	30	70	15 msec
					Mono12			
					Mono12 Packed			
Full frame	fast	656 x 494	yes	01	Mono8 **)	60	140	8 msec
					Mono12			
					Mono12 Packed			
Binning 2x2 HQ	slow	328 x 247	Vendor specific	02	Mono8 **)	30	138	8 msec
					Mono12			
					Mono12 Packed			
Binning 2x2	fast	328 x 247	yes	03	Mono8 **)	60	277	4 msec
					Mono12			
					Mono12 Packed			
Binning 1x2 HQ	slow	656 x 247	Vendor specific	04	Mono8 **)	30	138	8 msec
					Mono12			
					Mono12 Packed			
Binning 1x2	fast	656 x 247	yes	05	Mono8 **)	60	277	4 msec
					Mono12			
					Mono12 Packed			
Binning 2x1 HQ	slow	328 x 494	Vendor specific	06	Mono8 **)	30	70	15 msec
					Mono12			
					Mono12 Packed			
Binning 2x1	fast	328 x 494	yes	07	Mono8 **)	60	140	8 msec
					Mono12			
					Mono12 Packed			
Standard features								
Image size controls								
Binning horizontal	yes, 1 or 2							
Binning vertical	yes, 1 or 2							
Pixel format	Mono8, Mono12, Mono12Packed							
Test image selector	yes, in all modes Off, GreyHorizontalRamp, GreyVerticalRamp, HorizontalLineMoving, VerticalLineMoving HorizontalAndVerticalLineMoving							
Partial scan	yes, format freely programmable in all modes (binning on partial scan ok)							
Analog controls								
Gain	yes							
Black Level (Off set)	yes							
Gamma	yes, user programmable ***) (available if LUT is enable) ****) total: 0.001 .. 2							
Brightness correction (custom)	yes, in all binning modes							

Acquisition and Trigger	
Acquisition mode	Continuous
Acquisition frame rate	yes, ON / OFF (only in freerunning mode) 0 .. 1628 Hz, step: 0.01 Hz
Trigger source	HardwareTrigger (Line0), SoftwareTrigger, CommandTrigger (ActionCommand), All or Off
Trigger delay	0 .. 2 sec, 512 trigger can be tracked, step: 1 µsec
Sequencer	Up to $2^{31}-1$ frames per sequence / one exposure time and gain value for each parameter set max. set of sequences: Up to $2^{31}-1$ frames x 256 parameter sets
Digital I/O	
Lines	Input: Line0, Output: Line1
Line source (outputs only)	Line1: Off, ExposureActive, Timer1, ReadoutActive, User0, TriggerReady, TriggerOverlapped, TriggerSkipped
Line debouncer	yes, low and high signal separately selectable 0 .. 5 msec step: 1 µsec
Event Generation	
Events	GigEVisionError, Heartbeattimeout, EventLost, Line0RisingEdge, Line0FallingEdge, Line1RisingEdge, Line1FallingEdge, ExposureStart, ExposureEnd, FrameStart, FrameEnd, TriggerReady, TriggerOverlapped, TriggerSkipped
Event Notification	yes, ON / OFF
Counters and Timers	
Framecounter	yes, 2^{32} can be set by user
Timer	yes, TimerSelector: Timer1 TimerTriggerSource: Off, Input: Line0, SoftwareTrigger, CommandTrigger (ActionCommand), ExposureStart, ExposureEnd, FrameStart, FrameEnd, TriggerSkipped TimerDelay: 0 µsec .. 2 sec, step: 1 µsec TimerDuration: 10 µsec .. 2 sec, step: 1 µsec
LUT Controls	
LUT selector	1 LUT: Luminance (12 bit) ON / OFF
Defect pixel correction (custom)	yes, ON / OFF
Defect pixel list (custom)	yes, max. 256 pixel coordinates (x, y) can be stored
GigEVisionTransportLayer	
PayLoadsize	4 Byte .. 648.400 Byte
TransmissionDelay (custom)	0 .. $2^{32}-1$ ticks
UserSets	
User set selector	Default (factory settings / read only) UserSet1, UserSet2, UserSet3 (read and write)
UserSetDefaultSelector	yes, define the start up "UserSet"
Advanced features	
Time stamp function	yes, 64 bit tick = 32 nsec
Asynchronous message channel	yes
Concatenation function	yes
User defined identifier	yes, user programmable permanent identifier
ActionCommand	yes, ID 0 = Trigger
DeviceTemperature	no
Data quality	
	at 20 °C, gain = 1, exposure time = 32 msec, full frame mode, slow scan
Readout noise	$\sigma < 0.5$ LSB (8 bit) typical
Dynamic range	typical > 54 dB
Optical interface	
	C-Mount on request: CS-Mount
Optical filter	dust protection on request: super polished, IR cut filter, daylight filter or no filter

Process interface functions			
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 ($t_{\text{delay flash}}$) $\leq 4 \mu\text{sec}$, duration_value (t_{duration}): slow mode = $t_{\text{exp}} + 28 \mu\text{sec}$ fast mode = $t_{\text{exp}} + 14 \mu\text{sec}$		
User Output	yes, ON / OFF		
Timer	yes, Timer1		
Trigger Ready	yes		
Trigger Overlapped	yes		
Trigger Skipped	yes		
Software reset	yes, delay up to 102 msec		
Asynchronous reset	Full frame / Binning 2x1	slow	delay up to 2,5 msec
		fast	1,3 msec
	Binning 2x2 / Binning 1x2	slow	delay up to 1,3 msec
		fast	0,7 msec
Image info header	yes		
Electrical interface			
Data / control	standard single cable 1000 Base-T, Cat6 recommended / minimum Cat5e option: screw lock type connector		
Power	VCC: 8 VDC .. 30 VDC I: 450 mA .. 120 mA		
Power consumption	approx. 3,6 Watt		
Digital input	Line0: trigger signal, opto decoupled $U_{\text{IN(low)}} = 0 .. 4.5 \text{ VDC}$, $U_{\text{IN(high)}} = 11 .. 30 \text{ VDC}$ $I_{\text{IN}} = 6 .. 10 \text{ mA}$ / 7 mA typical rising edge (invert = false) **** min. impulse length (t_{min}): 2 μsec trigger delay out of t_{readout} ($t_{\text{delay trigger}}$): 1 μsec max. trigger delay during t_{readout} ($t_{\text{delay trigger}}$): slow mode = 28 μsec fast mode = 14 μsec		
Digital output	Line 1: opto decoupled $U_{\text{EXT}} = 5 .. 30 \text{ VDC}$ / 24 VDC typical, $I_{\text{OUT}} = \text{max. } 16 \text{ mA}$ high active (invert = false) ****		
LED	1: green: Power on yellow: Readout active 2: green: Link Phy (1 GBit) green flash: Ethernet RX yellow: Ethernet TX yellow/red flash: Ethernet RX/TX		
Environmental			
Storage temperature	-10 °C .. +70 °C		
Operating temperature	+5 °C .. +50 °C between +26 °C .. +50 °C, note the max. housing temperature		
Housing operating temperature	max. +50 °C **** (measurement point, see item 4)		
Humidity	10 % .. 90 % non condensing		
Conformity	CE, FCC Part 15 class B, UL, RoHS compliant		
Housing			
Dimensions	aluminum, IP40 36 x 36 x 48 mm ³		
Weight	< 90 g		
Network interface			
Ethernet IP configuration	1000BASE-T (1000 Mbit / sec) persistent IP / DHCP / LLA		
Stream channel packet size	576 Byte (default) .. 65535 Byte jumbo frames supported		
Interpacketgap	0 .. 2 ³² -1 ticks		
Multicast function	yes		
Resend function	yes		

Technical specifications subject to change

Software	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® compatible programs and image processing libraries supported Windows / Linux depending on the actually driver software is used

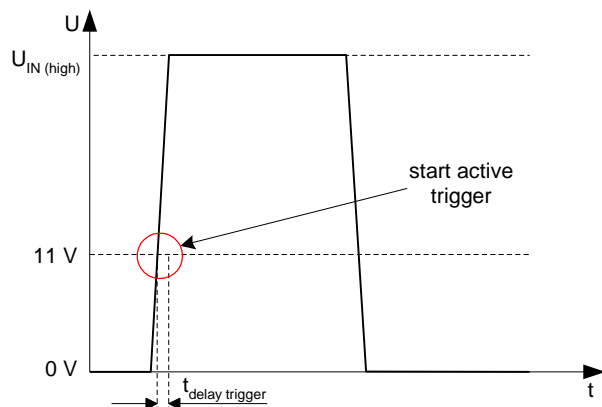
- *) maximum frame rate in free running mode, effective frame rate depending on camera image format mode settings and set exposure time ($t_{exp} < t_{readout}$)
- ***) default pixel format
- ****) the LUT function will be used for the gamma value and the calculation time of the internal used LUT need app. 2 sec, if the gamma value changed
- *****) can be inverted via software
- *****) housing temperature is limited by CCD sensor specification

2. Camera Factory Settings after Camera Start-up

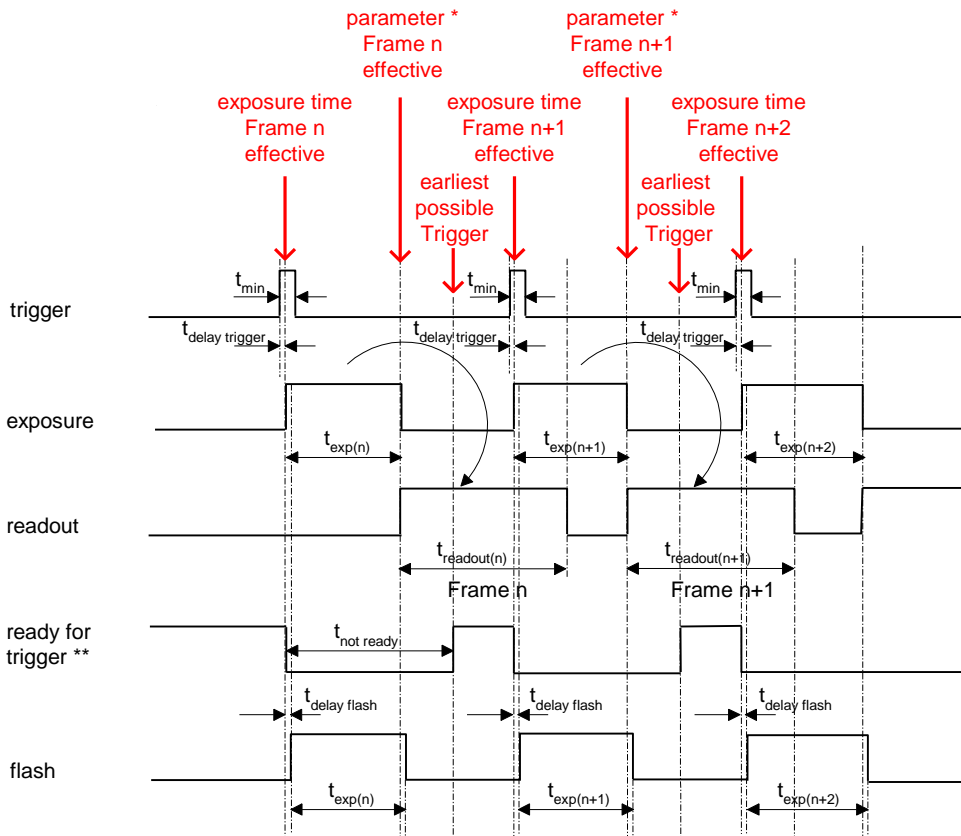
Camera factory settings after camera start-up	
Operation modes	free running mode
Signal processing	
Exposure control	32 msec
Gain control	factor 1 = 0 dB
Offset (black level)	0
Image acquisition	
Camera image format mode	mode id = 01, full frame Mono8
Partial scan function	not active
Acquisition frame rate	Off
Timer	Off
Transmission delay	0 ticks
Test image selector	Off
Defect pixel correction	On
Electrical interface	
Digital input	1: Line0 disabled, digital output set to low status (high impedance) invert = false trigger source = Line0
Digital output	1: Line1 disabled invert = false line source = Exposure Active

3. Timing Operation Modes

Trigger Mode: start up time



Trigger Mode: trigger mode 0, overlapped trigger



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

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

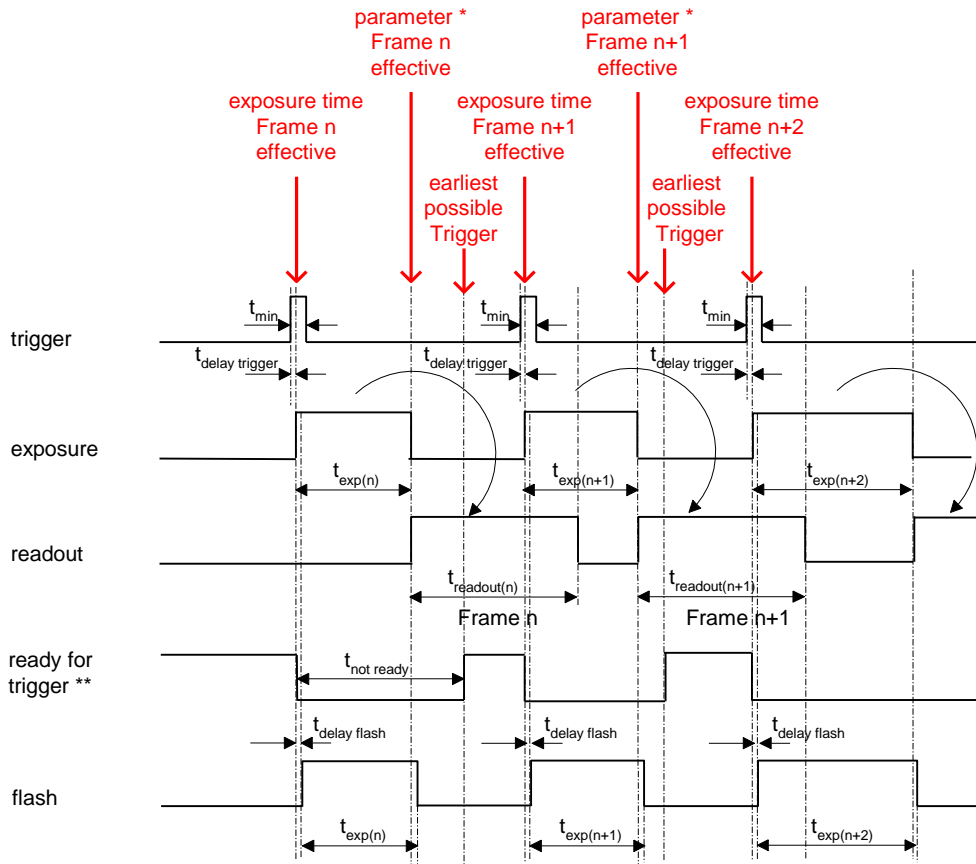
$$t_{\text{exp}} < t_{\text{readout}}: t_{\text{not ready (n+1)}} = t_{\text{exp}(n)} + t_{\text{readout}(n)} - t_{\text{exp}(n+1)}$$

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

* image parameter: offset
global gain
mode
partial scan

** signal will be notified as event "TriggerReady"

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



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

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

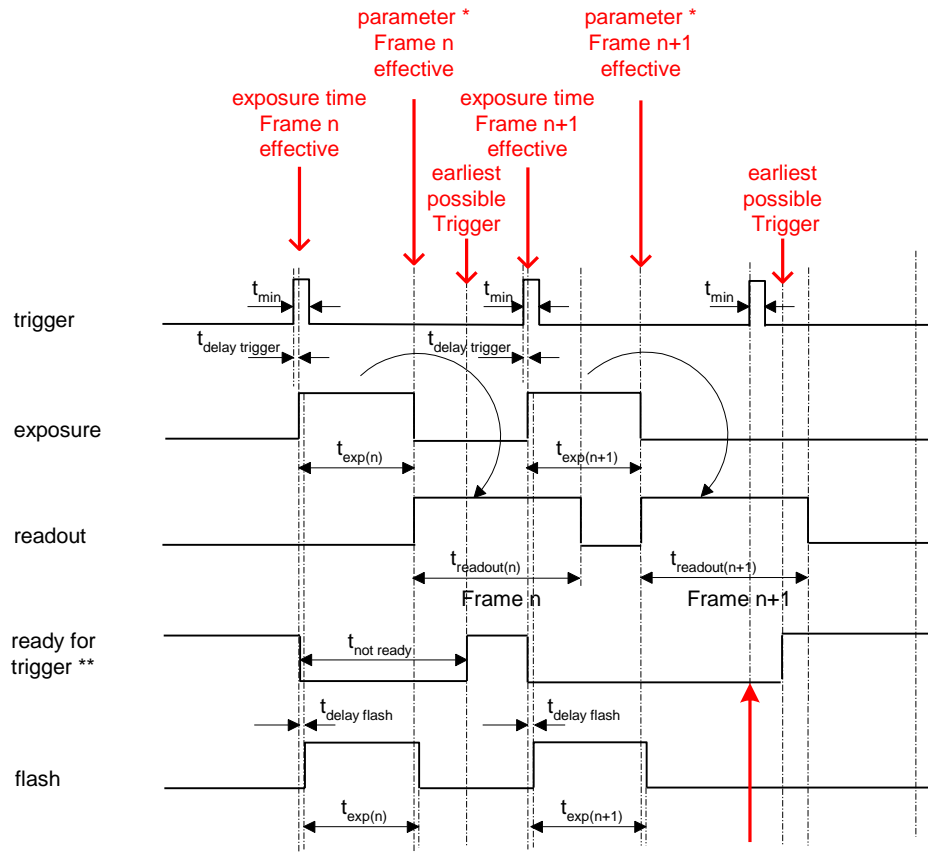
$$t_{exp} < t_{readout}: t_{not\ ready\ (n+1)} = t_{exp(n)} + t_{readout(n)} - t_{exp(n+1)}$$

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

* image parameter: offset
 global gain
 mode
 partial scan

** 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

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

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

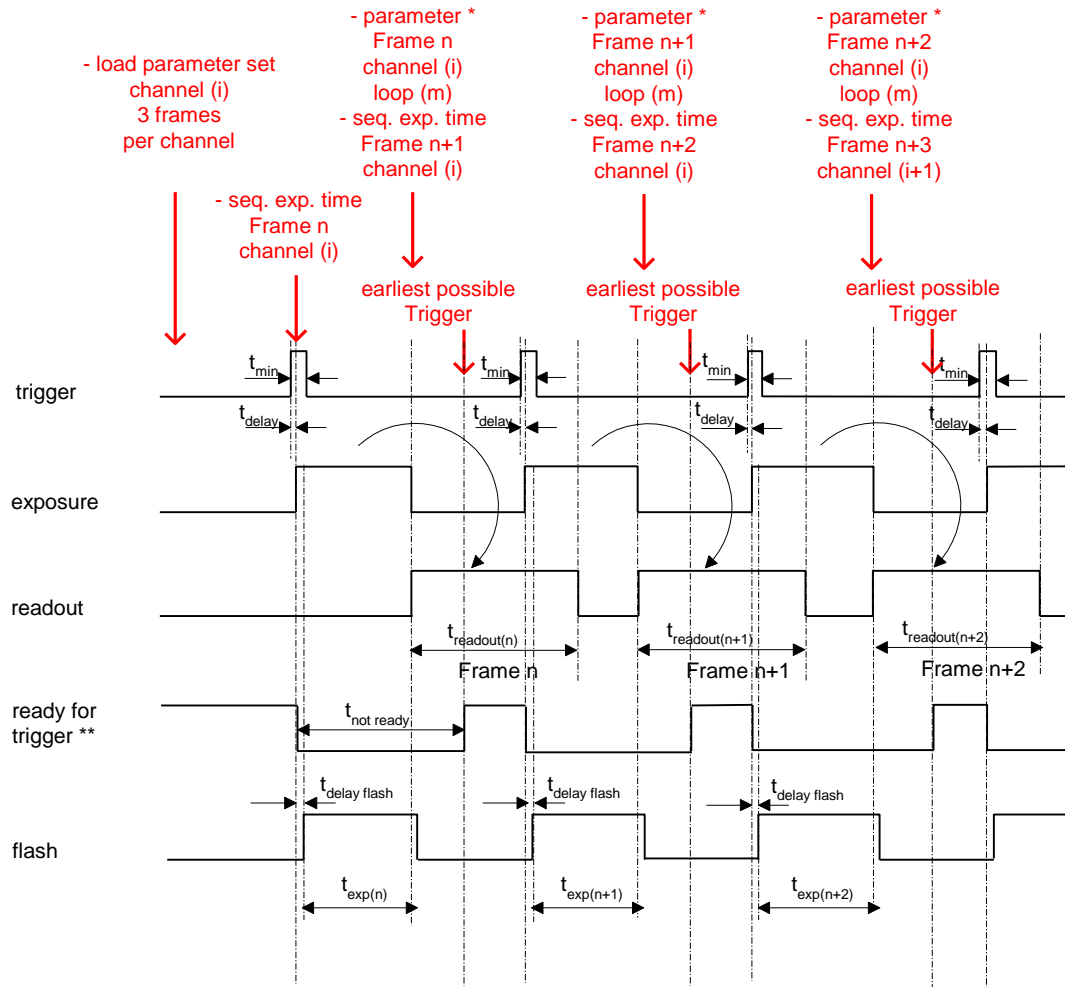
$$t_{exp} < t_{readout} : t_{not\ ready\ (n+1)} = t_{exp(n)} + t_{readout(n)} - t_{exp(n+1)}$$

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

* image parameter: offset
 global gain
 mode
 partial scan

** signal will be notified as event "TriggerReady"

Trigger Mode: overlapped trigger sequence (example for 3 frames per channel with hardware trigger)



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

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

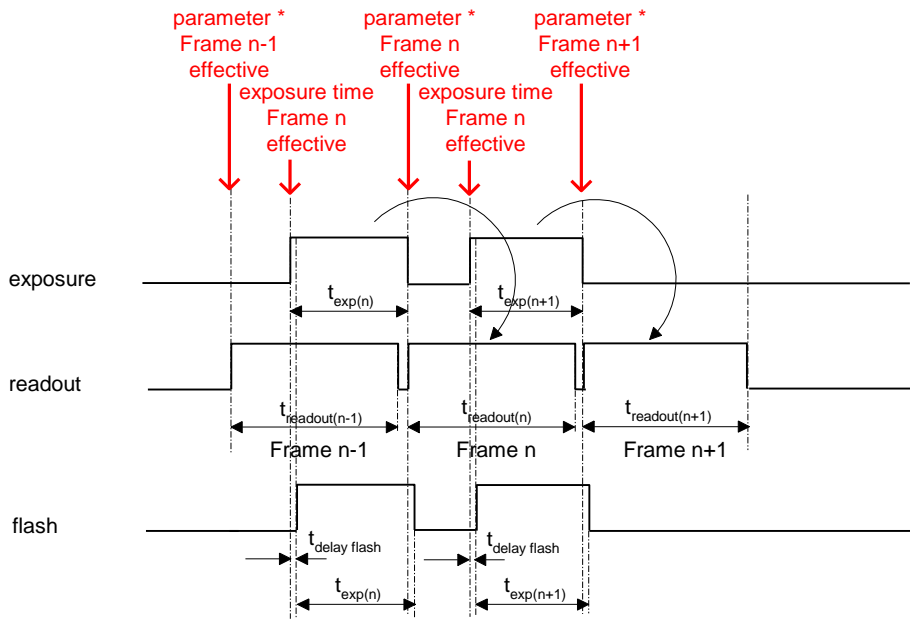
$$t_{exp} < t_{readout}: t_{not\ ready\ (n+1)} = t_{exp(n)} + t_{readout(n)} - t_{exp(n+1)}$$

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

* image parameter: offset
sequence global gain
mode

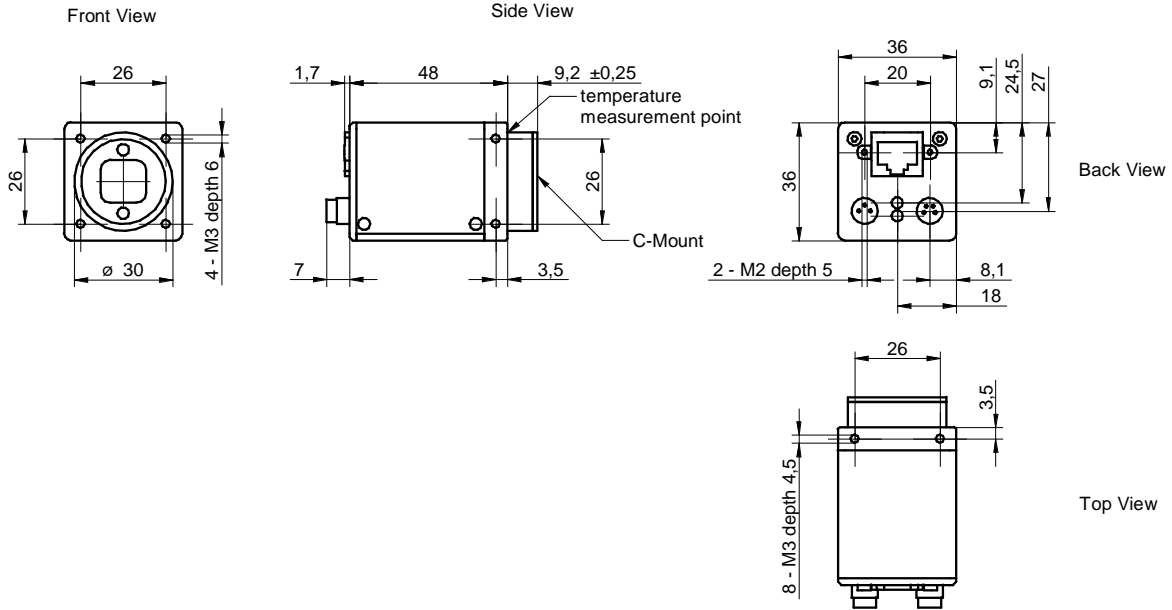
** signal will be notified as event "TriggerReady"

Free Running Mode: overlapped operation



* image parameter: offset
global gain
mode
partial scan

4. Housing



5. Connectors / Electrical Interfaces

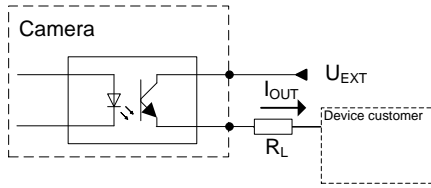
5.1 Pin assignment:

Data / Control 1000 Base-T	Type: RJ45 8P8C mod jack
	1: MX1+ 2: MX1- 3: MX2+ 4: MX3+ 5: MX3- 6: MX2- 7: MX4+ 8: MX4-
Power	Type: Lumberg RSME5D / 3 pin
	1: Power VCC+ 3: Power GND 4: not used
	Power cable wires color: 1 = brown 3 = blue 4 = black

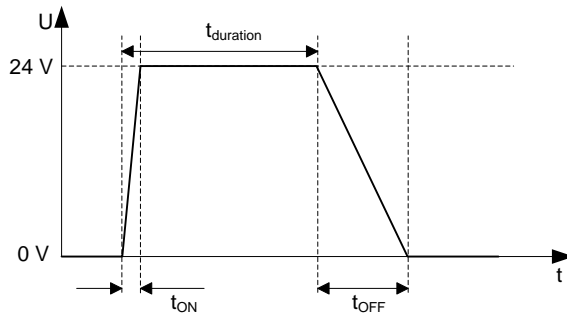
Trigger / Flash	Type: Lumberg RSME5D 4pin.
	*) resistor must be used, $I_{OUT} = 16 \text{ mA}$ by $U_{EXT} = 24 \text{ VDC}$ recommended, drawing shown above example for using high active signal
	Trigger / Flash cable wires color *): 1 = brown 2 = white 3 = blue 4 = black

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

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

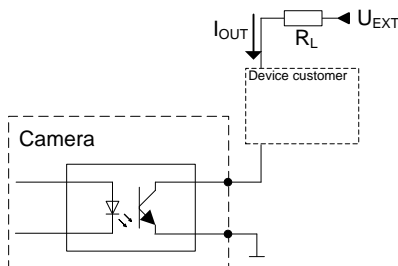


Timing example:
 measurement condition $U_{EXT} = 24 \text{ VDC} / I_{OUT} = 16 \text{ mA}$
 $R_L = 1.5 \text{ k}\Omega$

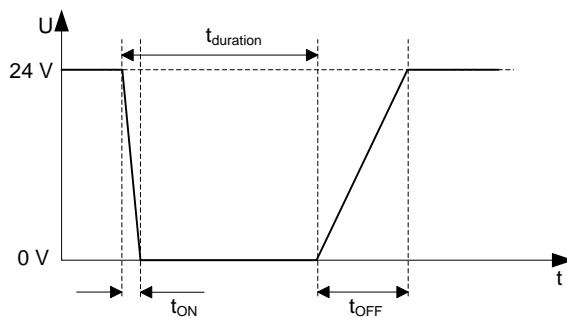


t_{ON} time = typ. $2 \mu\text{sec}$
 t_{OFF} time = typ. $40 \mu\text{sec}$

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



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



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