Optronis

CamRecord
CL300x2, CL600x2
CameraLink
Firmware 3.x

User Manual

Ref. 1846-SU-06-K

Contents

Revision

Cameramodel	Date	Description
CL600x2 SNr. 1846-ST-xxx	2.10.2008	Firmware 1.x: FPN; 10 to 8 bit LUT; Black Level; Gain; Sync External; Frame Format; Frame Rate; Exposure Time; MultiSlope; CamLink 2x8, 2x10, 4x10, 8x8; 85MHz; 9600baud; DLL, CamSetup, 1 Frame Grabber
CL600x2 SNr. 1846-SE-xxx	9.11.2009	Firmware 3.x: *(version C3110,S3010)* FPN; 10 to 8 bit LUT; Black Level; Gain; Sync External; Frame Format; Frame Rate; Exposure Time; MultiSlope; CamLink 2x8, 2x10, 4x10, 8x8, 10x8; 85MHz, 75MHz, 66MHz; 9600baud.. 115200baud; X,Y Mirror; Moving ROI, Multiple ROI, Multiple Readout, Multi Grabber, Multi Cameras, ASCII Command Set (RS232), 10 Factory Modes, 8 User Modes, StartUp Mode
	24.11.2009	Firmware 3.x: *(version C3111,S3011)* Bug fixing 10x8bits New functions: Set resolution #R(w,h), Frame Stamping #Z, Get camera state #X
	08.01.2010	Firmware 3.x: *(version C3111,S3012)* Bug fixing : - frame stamping in 8bits modes - sync_out signal
	09.02.2010	Firmware 3.x: *(version C3112,S3012)* Bug fixing : - FrameRateMax in external synchronization
CL300x2 SNr. 1842-SE-xxx	29.03.2010	Firmware 3.x: *(version C3113,S3012)* FPN; 10 to 8 bit LUT; Black Level; Gain; Sync External; Frame Format; Frame Rate; Exposure Time; MultiSlope; CamLink 2x8, 2x10; 85MHz, 75MHz, 66MHz; 9600baud.. 115200baud;

		X,Y Mirror; Moving ROI, Multiple ROI, Multiple Readout, Multi Grabber, Multi Cameras, ASCII Command Set (RS232), 4 Factory Modes, 8 User Modes, StartUp Mode
CL600x2, CL300x2	30.4.2010	Firmware 3.x: *(version C3114,S3012)* Bug Fixing (Sync. Ext. at Startup)
CL600x2, CL300x2	2.12.2010	Firmware 3.x: *(version C3114,S3013)* Bug Fixing (Noise in image after Camera Power up) Bug Fixing External Sync
CL600x2, CL300x2	8.2.2011	Firmware 3.x: *(version C3115,S3013)* Bug Fixing External Sync, Startup Mode
CL600x2	10.6.2015	New maximum frame rate calculation

General

Declaration of conformity

Manufacturer:	Optronis GmbH
Address:	Honsellstr. 8, 77694 Kehl, Germany

We certify and declare under our sole responsibility that the following apparatus

Product:	CL300x2, CL600x2

conform with the essential requirements of the EMC Directive 2004/108/EC, based on the following specifications applied:

Specifications:	EN 61000-6-3	Emission
	EN 61000-6-1	Immunity

Kehl, 29.03.2010

Optronis GmbH

Dr. Patrick Summ

Managing Director

RoHS compliance

CamRecord CL300x2 and CL600x2 cameras are Pb free manufactured.

Scope of delivery

CL300x2 Camera Link® camera

Options:	/C: Color sensor (Bayer Pattern)
	(IR Cutoff Filter, Specification: 1830-SS-10)
	/M: Monochrome sensor
Lens mount:	/CM: CMount
	/FM: FMount
Camera Link:	Base
Power supply:	+5Volt / 2Amp., 100 .. 240VAC/47-63Hz

Synchronisation Adapter cable

User Manual (CD-ROM)

CL600x2 Camera Link® camera

Options:	/C: Color sensor (Bayer Pattern)
	(IR Cutoff Filter, Specification: 1830-SS-10)
	/M: Monochrome sensor
Lens mount:	/CM: CMount
	/FM: FMount
Camera Link:	Full, Medium, Base
Power supply:	+5Volt / 2Amp., 100 .. 240VAC/47-63Hz

Synchronisation Adapter cable

User Manual (CD-ROM)

Optronis customer service

Optronis GmbH
Honsellstrasse 8
77694 Kehl
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Fax: +49 (0) 7851 9126 10
E-mail: info@optronis.com

For any questions or problems, please do not hesitate to ask our customer service. Please prepare the following information:

- Camera type: CL300x2 or CL600x2
- Serial-Number: see label at the back side of the camera
- Camera Link® configuration
- Power Supply type
- Frame Grabber
- Operating System (Windows XP/Vista/32bit/64bit …)
- Short description of the problem

Remark, Attention

This user manual is compliant with the firmware version *C3114,S3013* of the camera.

The following signs are used in the user manual

Remarks and additional information

Attention

Precautions

Camera Power

Please use the CL300x2 (CL600x2) camera power supply (Scope of delivery).

Alternatively the CL300x2 (CL600x2) Camera Link® camera can be operated from a +5 Volt +/- 5 % DC power supply. The rated current of the power supply should be at minimum 1,5 Ampere DC.

Voltage levels beyond the rated value may damage the camera. Please make sure, that the camera power is applied between Pin 1 (+5 Volt) and Pin 2 (GND, 0 Volt) of the camera.

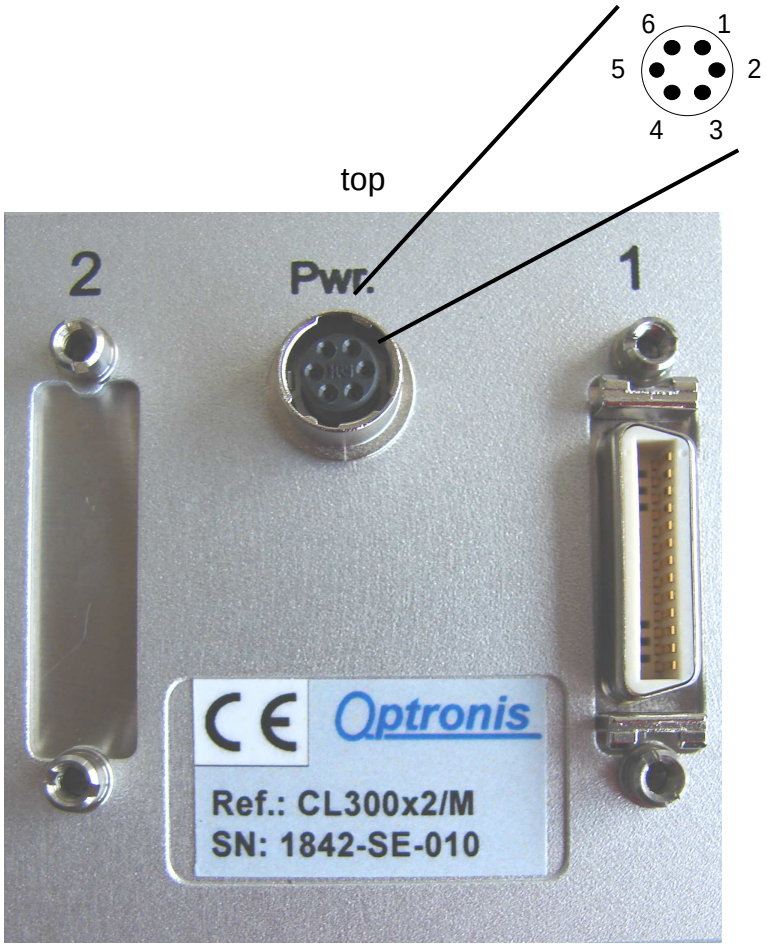


Figure: CL300x2 rear side view

Camera (Pwr.) connector type: Hirose HR10A-7R-6S

Cable Connector: Hirose HR10A-7P-6P

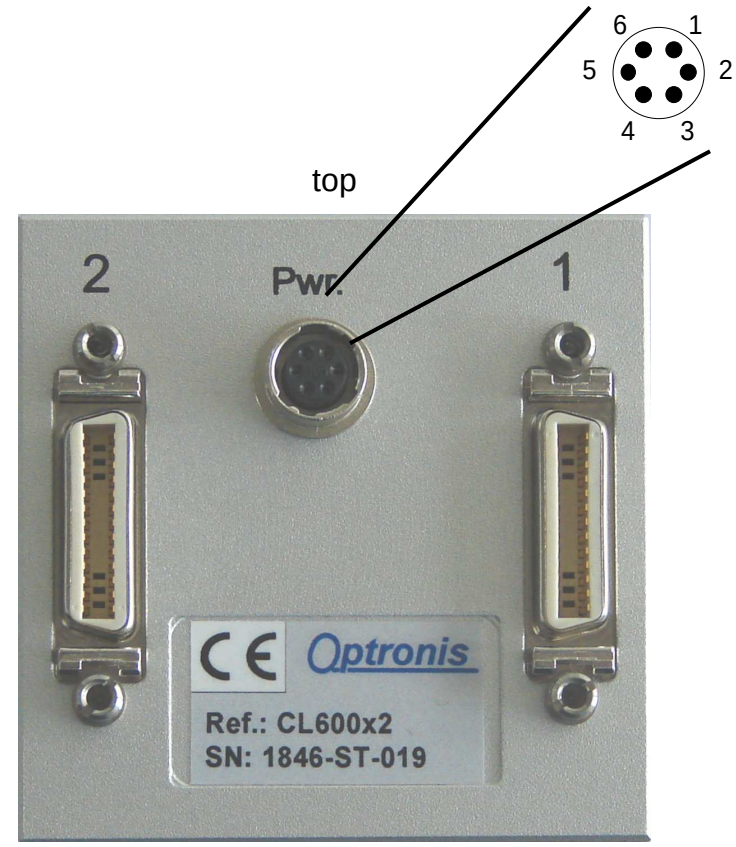


Figure: CL600x2 rear side view

Camera (Pwr.) connector type: Hirose HR10A-7R-6S

Cable Connector: Hirose HR10A-7P-6P

Power (Pwr.) connector pinout		
Pin Nr.	Description	
1	VCC	Power +5Volt +/-5% (Ripple < 100mV)
2	GND	Power Ground

Environmental Conditions

Temperature range during operation: < + 50°C (housing temperature)

> 0°C (ambient temperature)

Humidity during operation < 80% non-condensed

At high ambient or housing temperatures the camera lifetime will be reduced. Avoid camera operation beyond temperature limits.

General Precautions

Read the user manual carefully before using the camera.

Do not orientate the optical input of the camera to direct sunlight.

Keep the camera free protected from dirt, dust, grease and water.

Make sure that all the connecting cables are in good condition. Defective cables have to be replaced.

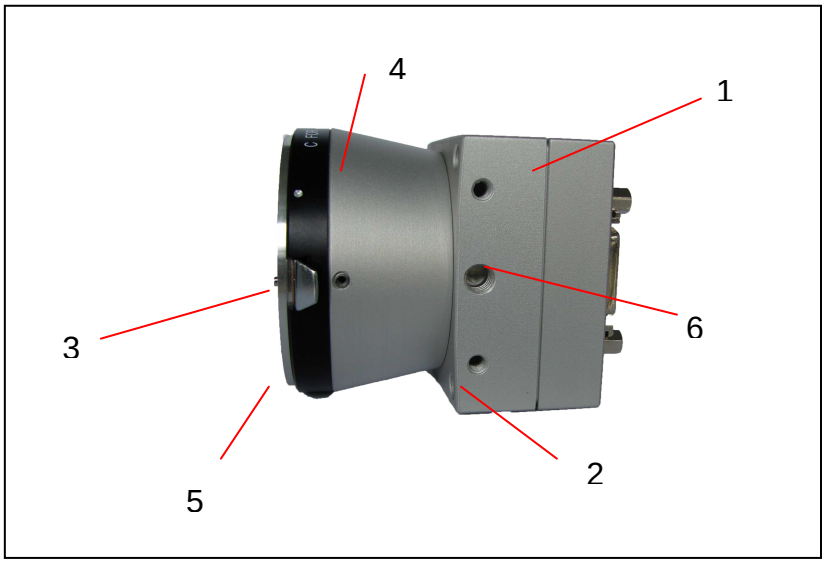
Always unplug the camera before cleaning it. Do not use cleaning liquids or sprays. Instead, use a dry and soft duster.

There are no serviceable parts inside the camera. Do not open the housing of the camera.

Warranty becomes void if the camera housing is opened.

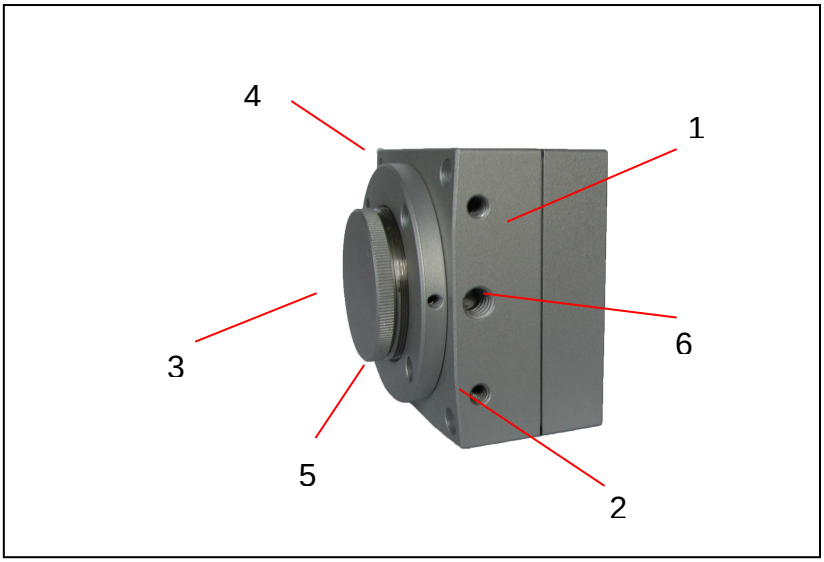
Camera

Side View (Nikon F-Mount)



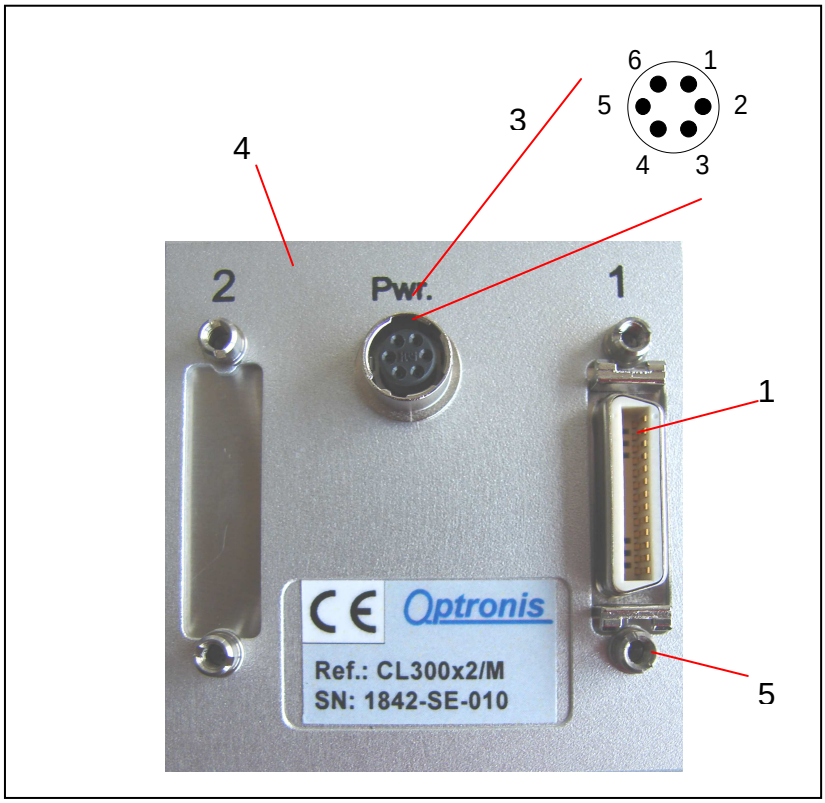
1: Camera housing
2: Mounting hole M4 x 8mm depth
3: Lens mounting clip
4: Nikon F-Mount tube
5: Nikon F-Mount adapter
6: Mounting hole 1 x ¼ `` x 6mm depth

Side View (C-Mount)



1: Camera housing
2: Mounting hole M4 x 8mm depth
3: Protective cover
4: C-Mount tube
5: C-Mount thread
6: Mounting hole 1 x ¼ `` x 6mm depth

Backside View CL300x2



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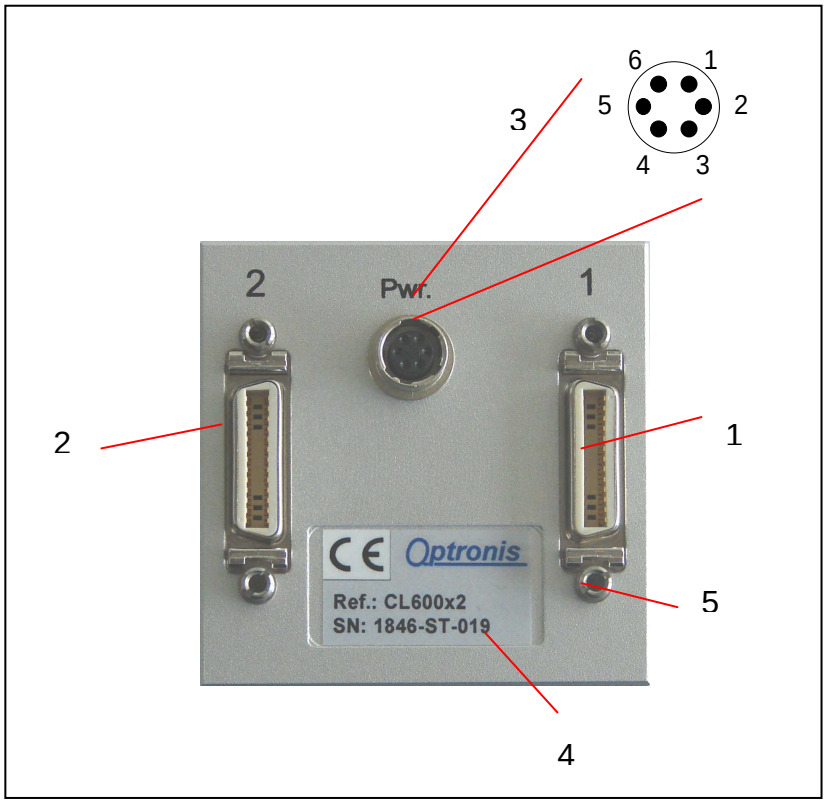
1: CameraLink Connector Nr. 1 MDR26 female (Base)
3: Power and Sync. Connector
Camera Connector: HR10A-7R-6S Hirose
Cable Connector: HR10A-7P-6P Hirose
4: CL600x2 camera housing and Serial Number
5: #4-40 thread

Backside View CL600x2



1: CameraLink Connector Nr. 1 MDR26 female (Base)
2: CameraLink Connector Nr. 2 MDR26 female (Medium, Full)
3: Power and Sync. Connector

Camera Connector:	HR10A-7R-6S Hirose
Cable Connector:	HR10A-7P-6P Hirose

4: CL600x2 camera housing and Serial Number
5: #4-40 thread

Power (Pwr.) connector pinout

Power (Pwr.) connector pinout		
Pin Nr.	Description	
1	VCC	Power +5Volt +/-5% (Ripple < 100mV)
2	GND	Power Ground
3	SyncIn	Synchronisation Input TTL level: <0,8Volt (low) > 2 Volt (high)
4	SyncOut	Synchronisation Output (open collector configuration) Sink current: 5 mA
5	GND	Synchronisation Ground
6	GND	Synchronisation Ground

Camera Link® connector pinout

The Camera Link® MDR-26 connector pin assignment is conform to the Camera Link® specification.

CL600x2 Connector Pinout	Camera Link® signal base mode Connector 1	Camera Link® signal medium mode Connector 2	Camera Link® signal full mode Connector 2
1	inner shield	inner shield	inner shield
14	Inner shield	Inner shield	Inner shield
2	X0-	Y0-	Y0-
15	X0+	Y0+	Y0+
3	X1-	Y1-	Y1-
16	X1+	Y1+	Y1+
4	X2-	Y2-	Y2-
17	X2+	Y2+	Y2+
5	Xclk-	Yclk-	Yclk-
18	Xclk+	Yclk+	Yclk+
6	X3-	Y3-	Y3-
19	X3+	Y3+	Y3+
7	SerTC+	Unused	100 Ohms Terminated
20	SerTC-	Unused	100 Ohms Terminated
8	SerTFG-	Unused	Z0-
21	SerTFG+	Unused	Z0+
9	CC1-	Unused	Z1-
22	CC1+	Unused	Z1+
10	CC2+	Unused	Z2-
23	CC2-	Unused	Z2+
11	CC3-	Unused	Zclk-
24	CC3+	Unused	Zclk+
12	CC4+	Unused	Z3-
25	CC4-	Unused	Z3+
13	Inner shield	Inner shield	Inner shield
26	Inner shield	Inner shield	Inner shield

CC1 is used for external synchronisation by the Frame Grabber

Camera Link® bit assignments

Base Camera Link® 2 x 8 bit

Unused signals (-) have Low Value

Signal: A7, B7 (MSB)

Signal: A0, B0 (LSB)

Signal DVAL equals signal LVAL

Connector 1 Channel Link No. X		
Port	Signal	Tx
A0	A0	0
A1	A1	1
A2	A2	2
A3	A3	3
A4	A4	4
A5	A5	6
A6	A6	27
A7	A7	5
B0	B0	7
B1	B1	8
B2	B2	9
B3	B3	12
B4	B4	13
B5	B5	14
B6	B6	10
B7	B7	11
C0	(-)	15
C1	(-)	18
C2	(-)	19
C3	(-)	20
C4	(-)	21
C5	(-)	22
C6	(-)	16
C7	(-)	17
LVAL	LVAL	24
FVAL	FVAL	25
DVAL	DVAL	26
SPARE	(-)	23

Base Camera Link® 2 x 10 bit

Unused signals (-) have Low Value

Signal: A9, B9 (MSB)

Signal: A0, B0 (LSB)

Signal DVAL equals signal LVAL

Connector 1 Channel Link No. X		
Port	Signal	Tx
A0	A0	0
A1	A1	1
A2	A2	2
A3	A3	3
A4	A4	4
A5	A5	6
A6	A6	27
A7	A7	5
B0	A8	7
B1	A9	8
B2	(-)	9
B3	(-)	12
B4	B8	13
B5	B9	14
B6	(-)	10
B7	(-)	11
C0	B0	15
C1	B1	18
C2	B2	19
C3	B3	20
C4	B4	21
C5	B5	22
C6	B6	16
C7	B7	17
LVAL	LVAL	24
FVAL	FVAL	25
DVAL	DVAL*	26
SPARE	(-)	23

Medium Camera Link® 4 x 10 bit

Unused signals (-) have Low Value

Signal: A9, B9 (MSB)

Signal: A0, B0 (LSB)

Signal DVAL equals signal LVAL

Connector 1 Channel Link No. X			Connector 2 Channel Link No. Y			Connector 2 Channel Link No. Z		
Port	Signal	Tx	Port	Signal	Tx	Port	Signal	Tx
A0	A0	0	D0	D0	0	G0	(-)	0
A1	A1	1	D1	D1	1	G1	(-)	1
A2	A2	2	D2	D2	2	G2	(-)	2
A3	A3	3	D3	D3	3	G3	(-)	3
A4	A4	4	D4	D4	4	G4	(-)	4
A5	A5	6	D5	D5	6	G5	(-)	6
A6	A6	27	D6	D6	27	G6	(-)	27
A7	A7	5	D7	D7	5	G7	(-)	5
B0	A8	7	E0	C0	7	H0	(-)	7
B1	A9	8	E1	C1	8	H1	(-)	8
B2	(-)	9	E2	C2	9	H2	(-)	9
B3	(-)	12	E3	C3	12	H3	(-)	12
B4	B8	13	E4	C4	13	H4	(-)	13
B5	B9	14	E5	C5	14	H5	(-)	14
B6	(-)	10	E6	C6	10	H6	(-)	10
B7	(-)	11	E7	C7	11	H7	(-)	11
C0	B0	15	F0	C8	15	I0	(-)	15
C1	B1	18	F1	C9	18	I1	(-)	18
C2	B2	19	F2	(-)	19	I2	(-)	19
C3	B3	20	F3	(-)	20	I3	(-)	20
C4	B4	21	F4	D8	21	I4	(-)	21

Connector 1 Channel Link No. X			Connector 2 Channel Link No. Y			Connector 2 Channel Link No. Z		
Port	Signal	Tx	Port	Signal	Tx	Port	Signal	Tx
C5	B5	22	F5	D9	22	I5	(-)	22
C6	B6	16	F6	(-)	16	I6	(-)	16
C7	B7	17	F7	(-)	17	I7	(-)	17
LVAL	LVAL	24	LVAL	LVAL	24	LVAL	(-)	24
FVAL	FVAL	25	FVAL	FVAL	25	FVAL	(-)	25
DVAL	DVAL	26	DVAL	DVAL	26	DVAL	(-)	26
SPARE	(-)	23	SPARE	(-)	23	SPARE	(-)	23

Table: Medium Camera Link® 4 x 10 bit continued

Full Camera Link® 8 x 8 bit

Unused signals (-) have Low Value

Signal: A7, B7, C7, D7, E7, F7, G7, H7 (MSB)

Signal: A0, B0, C0, D0, E0, F0, G0, H0 (LSB)

Connector 1 Channel Link No. X			Connector 2 Channel Link No. Y			Connector 2 Channel Link No. Z		
Port	Signal	Tx	Port	Signal	Tx	Port	Signal	Tx
A0	A0	0	D0	D0	0	G0	G0	0
A1	A1	1	D1	D1	1	G1	G1	1
A2	A2	2	D2	D2	2	G2	G2	2
A3	A3	3	D3	D3	3	G3	G3	3
A4	A4	4	D4	D4	4	G4	G4	4
A5	A5	6	D5	D5	6	G5	G5	6
A6	A6	27	D6	D6	27	G6	G6	27
A7	A7	5	D7	D7	5	G7	G7	5
B0	B0	7	E0	E0	7	H0	H0	7
B1	B1	8	E1	E1	8	H1	H1	8
B2	B2	9	E2	E2	9	H2	H2	9
B3	B3	12	E3	E3	12	H3	H3	12
B4	B4	13	E4	E4	13	H4	H4	13
B5	B5	14	E5	E5	14	H5	H5	14
B6	B6	10	E6	E6	10	H6	H6	10
B7	B7	11	E7	E7	11	H7	H7	11

Connector 1 Channel Link No. X			Connector 2 Channel Link No. Y			Connector 2 Channel Link No. Z		
Port	Signal	Tx	Port	Signal	Tx	Port	Signal	Tx
C0	C0	15	F0	F0	15	I0	(-)	15
C1	C1	18	F1	F1	18	I1	(-)	18
C2	C2	19	F2	F2	19	I2	(-)	19
C3	C3	20	F3	F3	20	I3	(-)	20
C4	C4	21	F4	F4	21	I4	(-)	21
C5	C5	22	F5	F5	22	I5	(-)	22
C6	C6	16	F6	F6	16	I6	(-)	16
C7	C7	17	F7	F7	17	I7	(-)	17
LVAL	LVAL	24	LVAL	LVAL	24	LVAL	LVAL	24
FVAL	FVAL	25	FVAL	FVAL	25	FVAL	FVAL	25
DVAL	LVAL	26	DVAL	LVAL	26	DVAL	LVAL	26
SPARE	(-)	23	SPARE	(-)	23	SPARE	(-)	23

Table: Full Camera Link® 8 x 8 bit continued

Camera Link® 10 x 8 bit

Unused signals (-) have Low Value

Signal: A7, B7, C7, D7, E7, F7, G7, H7 (MSB)

Signal: A0, B0, C0, D0, E0, F0, G0, H0 (LSB)

Connector 1 Channel Link No. X		Connector 2 Channel Link No. Y		Connector 2 Channel Link No. Z	
Signal	Tx	Signal	Tx	Signal	Tx
A0	0	D2	0	G5	0
A1	1	D3	1	G6	1
A2	2	D4	2	G7	2
A3	3	D5	3	H0	3
A4	4	D6	4	H1	4
A5	5	D7	5	H2	5
A6	6	E0	6	H3	6
A7	7	E1	7	H4	7
B0	8	E2	8	H5	8
B1	9	E3	9	H6	9
B2	10	E4	10	H7	10
B3	11	E5	11	I0	11
B4	12	E6	12	I1	12
B5	13	E7	13	I2	13
B6	14	F0	14	I3	14
B7	15	F1	15	I4	15

Connector 1 Channel Link No. X		Connector 2 Channel Link No. Y		Connector 2 Channel Link No. Z	
Signal	Tx	Signal	Tx	Signal	Tx
C0	16	F2	16	I5	16
C1	17	F3	17	I6	17
C2	18	F4	18	I7	18
C3	19	F5	19	J0	19
C4	20	F6	20	J1	20
C5	21	F7	21	J2	21
C6	22	G0	22	J3	22
C7	23	G1	23	J4	23
LVAL	24	G2	24	J5	24
FVAL	25	G3	25	J6	25
D0	26	G4	26	J7	26
D1	27	LVAL	27	LVAL	27

Table: Camera Link® 10 x 8 bit continued

Lens mount and handling

Nikon F-Mount adapter

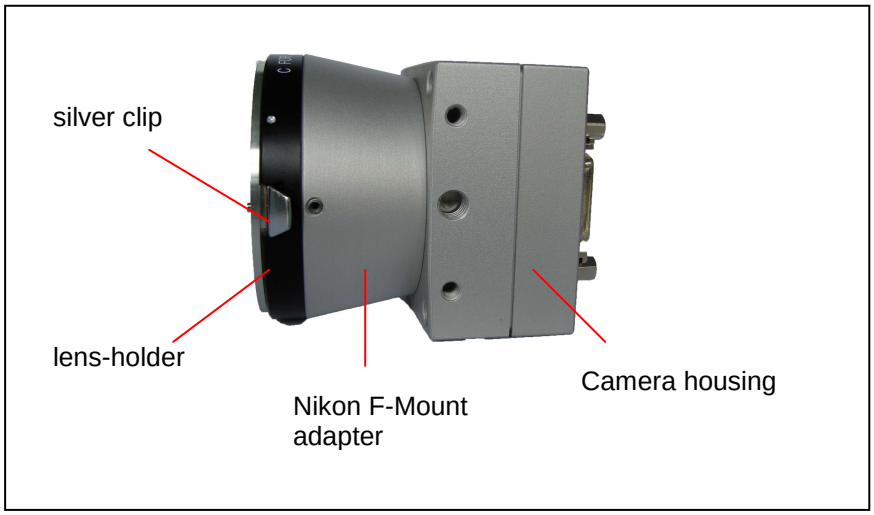
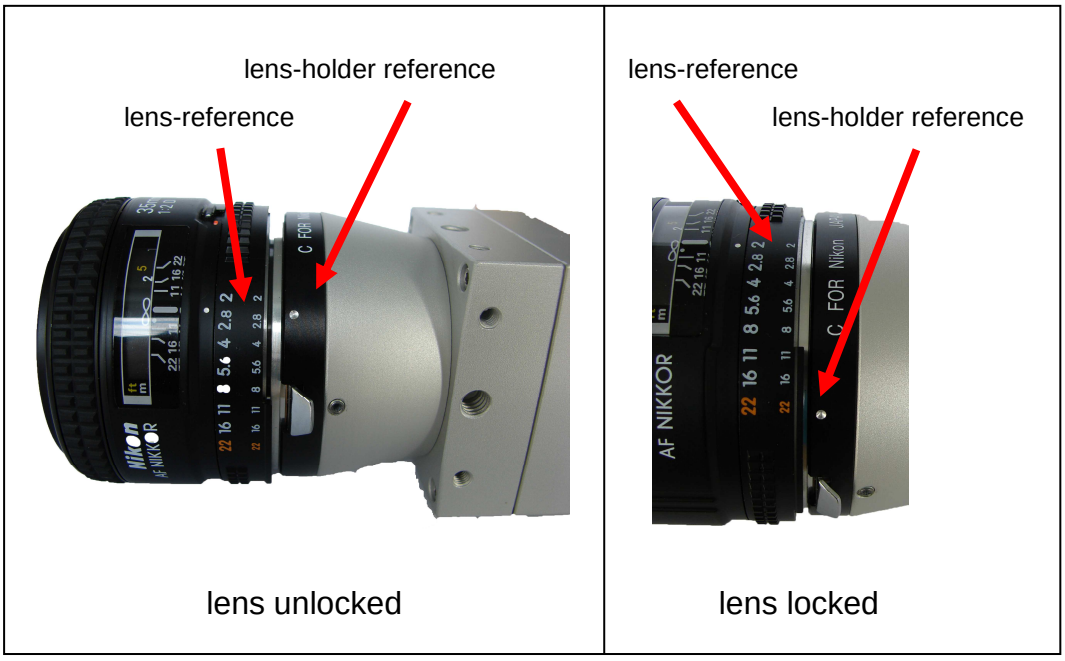


Figure: Camera with Nikon F-Mount adapter

To mount the lens, it has to be positioned on the lens-holder in a way, that the back surface of the lens is completely attached to the surface of the lens-holder.

The lens-reference has to be positioned in face to the lens-holder reference as shown in the figure below. Then, the lens has to be turned anti-clockwise until the silver clip on the lens-holder locks.



To unmount the lens, pull back first the silver clip in order to unlock the lens as shown below. Then (the silver clip has still to be pulled back) turn the lens clockwise until the lens is unmounted completely.

C-Mount adapter

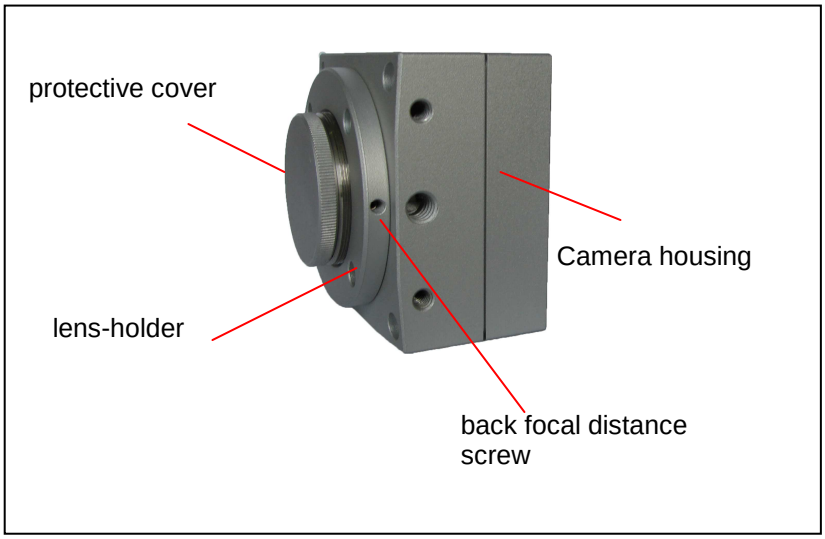


Figure: Camera with C-Mount adapter

To mount the C-Mount lens, unscrew the protective cover anti-clockwise and mount the C-Mount lens into the lens holder. The back focal distance screw allows to adjust the back focal distance. To do this, please position the lens to infinity, operate the grabbing software, open the screw and turn the lens to get a sharp image. Then fix the screw again.

To unmount the lens, unscrew the C-Mount lens anti-clockwise.

Important features

The CamRecord CL300x2 and CL600x2 Camera Link® cameras are a high resolution, high frame rate CMOS area scan camera that are designed for industrial use. The image sensor and the camera offer exceptional high performance:

- excellent image quality
- excellent sensitivity
- low noise
- 10 to 8 bit Look up table (LUT)
- monochrome and color
- internal and external synchronisation
- Region of Interest (ROI)
- High dynamic range (up to 90 dB optical / Multislope)

Frame format

The Frame format (frame resolution) of the camera is 1280 active Pixels in horizontal (x) direction and 1024 active Pixels in vertical (y) direction at full resolution.

The frame format can be reduced by selecting a region of interest (ROI).

Minimum Frame rate (@ internal synchronisation)

Minimum frame rate is limited to 16 fps in free run mode.

Maximum Frame rate (@ internal synchronisation)

The minimum frame interval (maximum frame rate) that can be reached by the camera internal synchronisation mode depends on the Camera Link® configuration mode and the frame format. It can be calculated as follows:

Full Camera Link® specification (8taps 8bits)

$$Frame\ Interval = 0{,}03226 \bullet (Fx \bullet Fy + Fx + 6 \bullet Fy + 256) \quad (micro\,\mathrm{sec}\,onds)$$

$$Frame\ Rate = \frac{1}{Frame\ Interval \bullet 10^{-6}} \quad (frames\ per\ \mathrm{sec}\,ond)$$

$Fx : Factor\ Pixel\ resolution\ in\ horizontal\ (x)\ direction\ (see\ table)$
$Fy : Factor\ Pixel\ resolution\ in\ vertical\ (y)\ direction\ (see\ table)$

Medium Camera Link® specification (4taps 10bits)

$$Frame\ Interval = 0{,}06452 \bullet (Fx \bullet Fy + Fx + 6 \bullet Fy + 256) \quad (micro\,\mathrm{sec}\,onds)$$

$$Frame\ Rate = \frac{1}{Frame\ Interval \bullet 10^{-6}} \quad (frames\ per\ \mathrm{sec}\,ond)$$

$Fx : Factor\ Pixel\ resolution\ in\ horizontal\ (x)\ direction$
$Fy : Factor\ Pixel\ resolution\ in\ vertical\ (y)\ direction$

Base Camera Link® specification (2taps 8bits)

$$Frame\ Interval = 0{,}12904 \bullet (Fx \bullet Fy + Fx + 6 \bullet Fy + 256) \quad (micro\,\mathrm{sec}\,onds)$$

$$Frame\ Rate = \frac{1}{Frame\ Interval \bullet 10^{-6}} \quad (frames\ per\ \mathrm{sec}\,ond)$$

$Fx : Factor\ Pixel\ resolution\ in\ horizontal\ (x)\ direction$
$Fy : Factor\ Pixel\ resolution\ in\ vertical\ (y)\ direction$

Fx Factor in horizontal (x) direction

Pixel resolution x-direction	1-24	25-48	49-72	73-96	97-120	121-144	145-168	169-192	193-216
Faktor Fx	1	2	3	4	5	6	7	8	9

Pixel resolution x-direction	217-240	241-264	265-288	289-312	313-336	337-360	361-384	385-408	409-432
Faktor Fx	10	11	12	13	14	15	16	17	18
Pixel resolution x-direction	433-456	457-480	481-504	505-528	529-552	553-576	577-600	601-624	625-648
Faktor Fx	19	20	21	22	23	24	25	26	27
Pixel resolution x-direction	649-672	673-696	697-720	721-744	745-768	769-792	793-816	817-840	841-864
Faktor Fx	28	29	30	31	32	33	34	35	36
Pixel resolution x-direction	865-888	889-912	913-936	937-960	961-984	985-1008	1009-1032	1033-1056	1057-1080
Faktor Fx	37	38	39	40	41	42	43	44	45
Pixel resolution x-direction	1081-1104	1105-1128	1129-1152	1153-1176	1177-1200	1201-1224	1225-1248	1249-1272	1273-1280
Faktor Fx	46	47	48	49	50	51	52	53	54

Fy Factor in vertical (y) direction

Pixel resolution y-direction	1	2	3	4	…	1021	1022	1023	1024
Faktor Fy	1	2	3	4	…	1021	1022	1023	1024

Max. Frame Rate Examples:

Camera Link® mode	Pixel resolution x (Pixel)	Pixel resolution y (Pixel)	Max. Frame Rate (fps)
full	1280	1024	500
full	800	600	1270
full	640	480	1922
full	320	240	6110
medium	1280	1024	250
medium	800	600	635
medium	640	480	961
base	1280	1024	125
base	800	600	310
base	640	480	480

(Max. Frame Rate values are rounded values)

Frame Rate (@ external synchronisation)

For external synchronisation please apply a TTL signal to the Sync In and Sync Out BNC adapter of the adapter cable (scope of delivery). External synchronisation may be operated in edge detection or in level detection mode. Please see the external synchronisation timing for more information about resulting frame rates and exposure times.

Alternatively SyncIn can be applied directly between Pin 3 and Pin 5 on the camera power (Pwr.) connector, Sync Out between Pin 4 and Pin 6. The synchronisation output can be used to synchronise other facilities as e.g. external light flashes.

External synchronisation frame rate range can reach any value between 0 fps and maximum Frame Rate @ internal synchronisation.

External synchronisation frame rate of > 1 fps is recommended due to thermal noise and limited shutter efficiency.

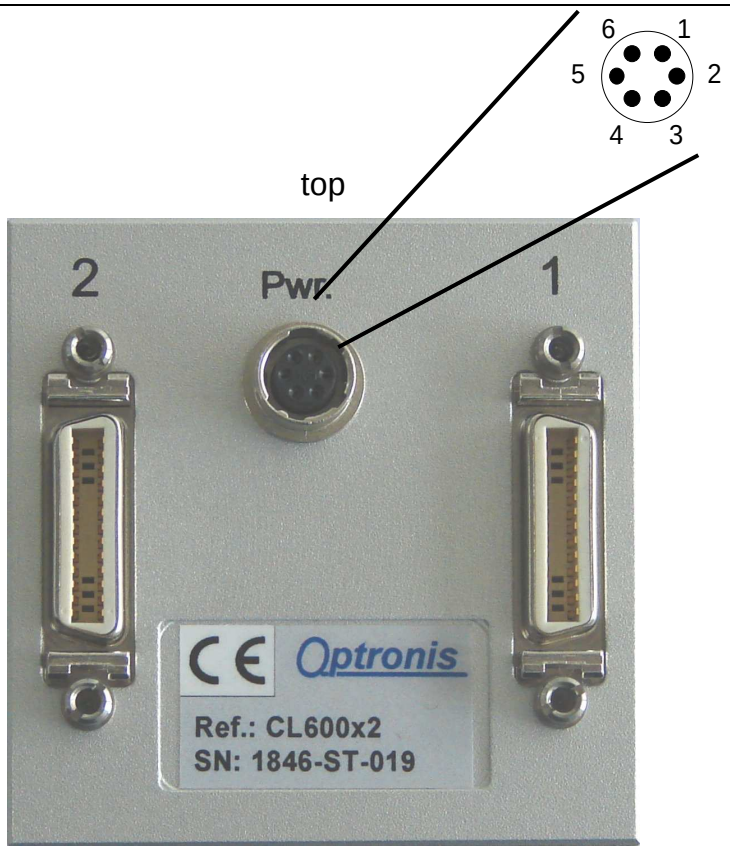


Figure: CL600x2 rear side view

Camera (Pwr.) connector type:	Hirose HR10A-7R-6S
Cable Connector:	Hirose HR10A-7P-6P

Power (Pwr.) connector pinout		
Pin Nr.	Description	
3	SyncIn	Synchronisation Input TTL level: <0,8Volt (low) > 2 Volt (high)
4	SyncOut	Synchronisation Output (open collector configuration) Sink current: 5 mA
5	GND	Synchronisation Ground
6	GND	Synchronisation Ground

To operate SyncIn correctly, a SyncIn driver circuit has to be used.

Minimum Sink Current (TTL Low Level) of the SyncIn Driver has to be 5mA. At 5mA Sink Current the input level at the SyncIn camera input drops below 0,8Volts.

Source Current (TTL High Level).of the SyncIn Driver is neglible (0mA)

Easiest driver circuit is a Transistor working in open collector configuration.

SyncIn input voltage limit ranges from – 5 Volts to + 30 Volts. Voltages applied beyond these limits may damage the SyncIn Input.

To operate SyncOut correctly, a SyncOut driver has to be used.

Maximum Sink Current capability of the SyncOut Pin is 5 mA (open collector configuration). At 5 mA the Sink Current output level at the SyncOut camera output drops below 0,8 Volts. There is no Source Current capability of the SyncOut camera output.

SyncOut voltage limit ranges from 0 Volt to + 5 Volts. Voltages applied beyond these limits may damage the SyncOut Output.

Camera Operation Modes

The camera offers one startup mode, 10 predefined operation modes (factory modes) as well as 8 operation modes that can be defined by the user (user modes). All operation modes are stored in the cameras non-volatile memory. User modes can be overwritten by the user, factory modes are predefined by Optronis and can not be overwritten.

Startup Mode

User can use one factory or user mode as startup mode. Startup mode is active during power on or after a Software Reset.

Default startup mode is factory mode ‘A’.

Factory Modes (CL300x2)

Mode	Resolution	Frame rate	Camera link output
A	640x480	480 fps	Base 2x8bits
B	1280x1024	125 fps	Base 2x8bits
C	640 x 480	480 fps	Base 2x10bits
D	1280x1024	125 fps	Base 2x10bits

Factory Modes (CL600x2)

Mode	Resolution	Frame rate	Camera link output
A	640x480	480 fps	Base 2x8bits
B	1280x1024	125 fps	Base 2x8bits
C	640 x 480	480 fps	Base 2x10bits
D	1280x1024	125 fps	Base 2x10bits
E	640 x 480	961 fps	Medium 4x10bits
F	1280x1024	250 fps	Medium 4x10bits
G	640 x 480	1922 fps	Full 8x8bits
H	1280x1024	500 fps	Full 8x8bits
I	640 x 480	1922 fps	Full-Extended 10x8bits
J	1280x1024	500 fps	Full-Extended 10x8bits

User modes

By default all 8 user modes are predefined as factory mode ‘H’.

This mode can be overwritten using the “Record mode” command.

Look Up Table

The camera can store a look up table (LUT) 10 bits to 8 bits. A new LUT is automatically stored at the end of the “Update LUT” command.

Camera Commands

'↵' is the symbol used in this user's manual for the character "carriage return" (0x0D). A command always begins with '#' (0x23) character and ends with '↵' (0x0D) character.

E.g. HyperTerminal from Windows™ sends out a '↵' character when the <enter> button of the keyboard is pushed.

When '↵' is sent, the camera analysis the last command and returns 'ACK' (acknowledge) on success or 'NAK' (not acknowledge) on failure. If the command has to return a value, the value is returned before ACK.

ACK and NAK are always followed by characters 0x0D and 0x10.

' ♠ ' is the symbol shown by the Windows HyperTerminal program when it receives the character ACK (0x06).

' § ' is the symbol shown by the Windows HyperTerminal program when it receives the character NAK (0x15).

CameraLink commands are case sensitive

Camera Identifiers:

Serial Number: Command #N

Returns the serial number of the camera.

Send: #N↵
Received: *serial number*

Remarks: *serial number* always begins with “1846-“.

Firmware Version: Command #f

Returns 3 Firmware values (B*x*), (C*y*) and (F*z*).

Send: #f↵
Received: B*x*,C*y*,F*z*

Get Last Error Command #E

Return a string indicating the last error.

Send: #E↵
Received: *last error*

Remarks: When an error occurred, the function returns NAK and the last error indicates what happened. When a function is successful, it returns ACK and last error become “No error!”.

Get Camera State Command #X

Return some information on Camera’s state (ROI, frame rate, CameraLink mode…)

Send: #X↵
Received: List of parameters

CameraLink Specification:

Define BaudRate: Command **#B**

Get/Set the serial communication Baud rate.

Send: #B↵
Received: *x*

Send: #B(*x*)↵
Received: None

x	0	1	2	3	4
Baud Rate	9600	19200	38400	57600	115200

Be sure the serial communication program works with the same baud rate as the camera.

CameraLink Mode: Command **#C**

Get/Set the CameraLink output mode.

Send: #C↵
Received: *x*

Send: #C(*x*)↵
Received: None

x	0	1	2	3	4
CameraLink mode	Base 8bits	Base 10bits	Medium 10bits	Full 8bits	Full-Extended 8bits
CameraLink modus (taps)	2		4	8	10

Please make sure, that the frame grabber CameraLink mode is the same as the camera CameraLink mode.

Changing the CameraLink mode may change resolution, frame rate and state of FPN.

Modes 2, 3 and 4 are only available with CL600x2 Camera.

CameraLink Frequency: Command **#c**

Get/Set the CameraLink pixel frequency. Default value is 85 MHz, but it can be reduced to set the camera compatible with frame grabbers which accepts only lower pixel frequency. Reducing frequency may also be used to increase maximum allowed CameraLink cable length.

Send: #c↵
Received: *x*

Send: #c(*x*)↵
Received: None

x	0	1	2
CameraLink frequency	66MHz	75Mhz	85Mhz

Reducing the CameraLink frequency reduces the maximum frame rate.

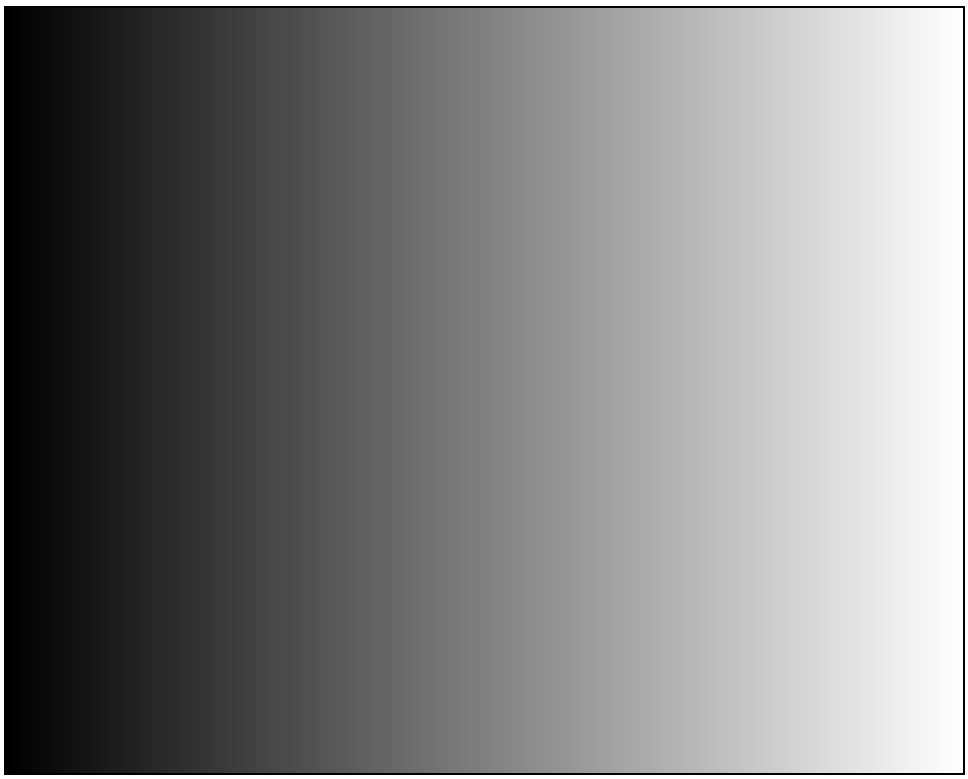
Power down / Test Image: Command **#I**

Power down the sensor and send a gray scale pattern image through CameraLink.

Send: #I↵
Received: *x*

Send: #I(*x*)↵
Received: None

Remarks: x = 0 or 1 (disable or enable)



CameraLink Test Image

Calibration Mode: Command **#K**

Allows, if necessary, to optimize CameraLink channels (Medium, full or full extended modes). When sticks (chicken wire) appear on the left side of the frame this may need to calibrate the CameraLink channels.

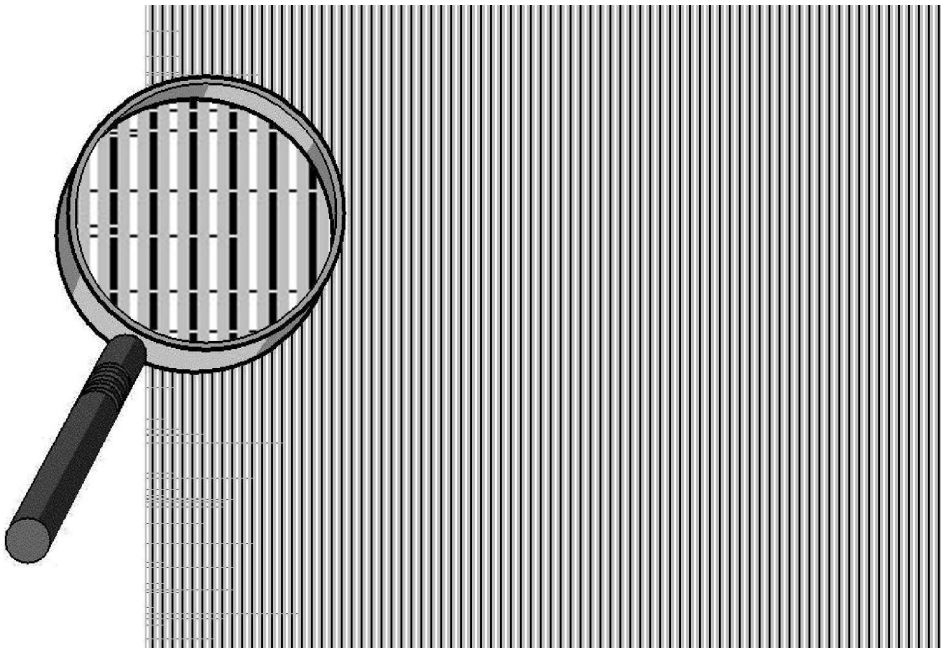
Send:	#K(*x*)↵	to enter calibration mode
	+ or - (0x2B or 0x2D)	to calibrate
	↵	to validate calibration
Received:	None	
Remarks:	x = 0 or 1.	

The size of the calibration image is always 1280x1024 pixels.

'0' is sent to calibrate CameraLink channel 2. It's available in medium and full mode.

'1' is sent to calibrate CameraLink channel 3. It's only available in full mode.

The odd columns are always gray. Sticks are located on white and black columns. **The second column has to be white**. When no sticks are visible, the calibration is done.



This mode is only available in CL600x2 Camera.

Image size and position:

Frame Format: Command **#R**

Get/Set the Resolution of the frame. The frame defined is the ROI number 0.

Send: #R↵
Received: *x*,*y*,*w*,*h*

Send: #R(*x*,*y*,w,*h*)↵
Received: None

Send: #R(w,*h*)↵
Received: None

Remarks: *x* is the coordinate of the up-left pixel of the frame, its value is a multiple of 8.

y is the coordinate of the up-left pixel of the frame.

w is the width of the frame, its value is a multiple of the CameraLink modus.

h is the height of the frame.

If only *w* and *h* are written, the ROI is at the sensor's center.

The maximum size is 1280x1024 pixels.

x + *w* is always less or equal than 1280.

y + *h* is always less or equal than 1024.

CameraLink mode	Base	Medium	Full	Full-Extended
CameraLink modus (taps)	2	4	8	10

Be sure the frame grabber resolution is the same as camera resolution.

Increasing the resolution could potentially reduce the frame rate

Number of ROI: Command **#h**

Get/Set the number of active ROI. There could be up to 4 different ROI.

Send: #h↵
Received: *x*

Send: #h(*x*)↵
Received: None

Remarks: x = {0, 1, 2, 3} is the ROI identifier.

Origin of a new ROI is always (0,0)

Width and height of all ROIs are the same and are defined by the Frame Format function

ROI Origin: Command **#H**

Get/Set the origin of a specified ROI.

Send: #H(*i*)↵
Received: *x,y*

Send: #H(*i,x,y*)↵
Received: None

Remarks: i = {0, 1, 2, 3} is the ROI identifier.

x is the horizontal coordinate of the up-left pixel of the ROI.

y is the vertical coordinate of the up-left pixel of the ROI.

Invert (Mirror) Readout: Command **#Q**

Invert (Mirror) the ROI in X and/or Y direction.

Send: #Q↵
Received: *x*

Send: #Q(*x*)↵
Received: None

x	0	1	2	3
Invert X	-	X	-	X
Invert Y	-	-	X	X

Moving Window: Command **#M**

This mode allows to change the origin of the ROI during readout. CC2 and CC3 are used to control the move while CC4 is used for reset.

A rising edge on CC2 shifts the image 24 pixels to the right.

A rising edge on CC3 shifts the image *y* pixels to the bottom, with *y* selectable from 1 to 15 pixels.

A rising edge on CC4 resets the frame origin (This may be not necessarily (0,0)).

The new origin values are updated at the end of readout and the update takes 100µs.

Send: #M↵
Received: *x*

Send: #M(*x*,*y*)↵
Received: None

Remarks: x = 0 or 1 (disable or enable)

y is the step in Y direction from 1 to 15.

This mode is not compatible with multiple ROI and with InvertX or InvertY.

Shutter Management:

Acquisition mode: Command #S

Get/Set the acquisition mode of the camera. It can be

Off, “free run”: (0) or

On, “external synchronization”: (1).

Send: #S↵
Received: *x*

Send: #S(*x*)↵
Received: None

External Source: Command #s

Get/Set the source for external synchronization:

Sync External Pin (Sync_in): (0) or

Frame Grabber (CC1 pin): (1).

Send: #s↵
Received: *x*

Send: #s(*x*)↵
Received: None

External Synchronization Shutter Mode: Command #m

Get/Set the mode of the external synchronization shutter mode:

internal timer (edge): (1) or

pulse width (level): (0).

Send: #m↵
Received: *x*

Send: #m(*x*)↵
Received: None

External Synchronization Polarity: Command **#P**

Get/Set the polarity of the external synchronization: internal timer begins on positive (1) or negative (0) edge, or pulse width is active on high (1) or low (0) level of the external signal.

Send: #P↵
Received: *x*

Send: #P(*x*)↵
Received: None

Frame rate: Command **#r**

Get/Set the frame rate in free run mode in frame per second.

Send: #r↵
Received: *x*

Send: #r(*x*)↵
Received: None

Remarks: The maximum frame rate depends on the size and the number of ROI, on the CameraLink mode and the pixel clock frequency. The minimum frame rate is 20fps in free run mode.

Check maximum frame rate with #A.

Frame rates use internal oscillator with 1 microsecond precision for available frame rates. If the desired frame rate is not available, automatically the next higher available frame rate is used. Please check this available frame rate then with #r if necessary.

Maximum frame rate: Command **#A**

Get the maximum allowed frame rate in frame per second.

Send: #A↵
Received: *x*

Exposure time: Command **#e**

Get/Set the internal exposure time in microsecond.

Send: #e↵
Received: *x*

Send: #e(*x*)↵
Received: None

Remarks: The maximum exposure time depends on the frame rate. The minimum exposure time is 1µs.

Exposure time available from “Maximum exposure time #a” (1/FrameRate – 5 microseconds) to 1 microsecond in steps of 1 microsecond

Maximum exposure time: Command **#a**

Get the maximum exposure time allowed in microsecond.

Send: #a↵
Received: *x*

Dual slope: Command **#D**

Dual Slope

On (Enable): (1) or

Off (Disable): (0).

Send: #D↵
Received: *x*

Send: #D(*x*)↵
Received: None

Dual slope time: Command **#d**

Get/Set dual slope integration time.

Send: #d↵
Received: *x*

Send: #d(*x*)↵
Received: None

Triple slope: Command **#T**

Triple Slope

On (Enable): (1) or

Off (Disable): (0) triple slope.

Send: #T↵
Received: *x*

Send: #T(*x*)↵
Received: None

Triple slope time: Command **#t**

Get/Set triple slope integration time.

Send: #t↵
Received: *x*

Send: #t(*x*)↵
Received: None

Image quality:

Define Gain: Command **#G**

Get/Set the analog gain of the Camera

Send: #G↵
Received: *x*

Send: #G(*x*)↵
Received: None

x	0	1	2	3	4	5
Gain	1	1.5	2	2.25	3	4

FPN Correction: Command **#F**

Enable (1) or Disable (0) the Fix Pattern Noise Correction.

Send: #F↵
Received: *x*

Send: #F(*x*)↵
Received: None

Enable LUT: Command **#L**

Enable (1) or Disable (0) the Look Up table.

Send: #L↵
Received: *x*

Send: #L(*x*)↵
Received: None

Update LUT: Command **#l**

Send a new Look Up Table to the camera.

Send:	#l↵	enter UpdateLUT mode
	value0↵*value1*↵ … ↵*value1023*↵	send new values
	q↵	exit UpdateLUT mode
Received:	None	
Remarks:	*Values* are integer from 0 to 255. *Value0* replaces sensor value 0, value1 replaces sensor value 1 up to *value1023* which replaces sensor value 1023.	
	If there is an error while sending the values, or if 'q' is sent, the camera returns NAK and exits the UpdateLUT mode. The camera automatically exits from the UpdateLUT mode when the 1023th value is sent and returns ACK. The new LUT is stored in a non-volatile memory in the camera.	

Black level: Command **#z**

Get/Set the camera black level from 0 to 255.

Send:	#z↵
Received:	*x*
Send:	#z(*x*)↵
Received:	None
Remarks:	z is between 0 and 255.

Black level changes the dark voltage reference of the image sensor. Best black level values range between 120 and 170 depending on Gain (Sensitivity) settings. Low values (typically below ~120) tend to saturate some Pixel to 0 LSB, High values (typically above 170) tend to saturate some Pixel to 1023 LSB. In both situations, FPN correction may fail and may add vertical stripes to the image.

Black Level for Gain 1 is mostly uncritical and ranges at typically 128. Black level for higher Gain up to 4 becomes more critical and has to be analysed in detail. Here typically higher values (> 128) are suggested to avoid Pixel saturation below 0. But as higher values may lead to Fixed Pattern in the upper saturation range, it is suggested to use then the Look up table to fit the output range to usefull range of the sensor.

Non Destructive readout: Command **#k**

This mode allows to accumulate up to 7 exposures. Each exposure is read out and the pixel reset is made after the last defined one.

Send: #k↵
Received: *x*

Send: #k(*x*)↵
Received: None

Remarks: x is between 0 and 6.

Frame Stamping Command **#Z**

Enable (1) or Disable (0) the frame stamping mode.

This mode creates, instead of the 2 first pixels of the frame, a counter which increase at each image. Pixel (0,0) is LSB and pixel (1,0) is MSB. When the camera is in one of the 8bits mode, it is a 16 bits counter. When the camera is in one of the 10bits mode, it is a 20bits counter.

Send: #Z↵
Received: *x*

Send: #Z(*x*)↵
Received: None

Memory usage:

Record user mode: Command **#u**

This function allows to store the state of the camera in one of the 8 user modes.

Send: #u(*x*)↵
Received: None

Remarks: x is between 0 and 7.

Load mode: Command **#v**

This command loads a user or factory mode or it returns the last loaded mode.

Send: #v↵
Received: *x*

Send: #v(*x*)↵
Received: None

Remarks: x is between 0 and 7 for the user modes.

x is between ‘a‘ and ‘j’ for the factory modes in CL600x2. (not case sensitive)

x is between ‘a‘ and ‘d’ for the factory modes in CL300x2. (not case sensitive)

Startup mode: Command **#V**

Get/Set the mode loaded when the camera starts.

Send:	#V↵
Received:	*x*
Send:	#V(*x*)↵
Received:	None
Remarks:	x is between 0 and 7 for the user modes.
	x is between ‘a‘ and ‘j’ for the factory modes in CL600x2. (not case sensitive)
	x is between ‘a‘ and ‘d’ for the factory modes in CL300x2. (not case sensitive)

Reset: Command **#o**

This function resets the camera. The camera automatically loads and runs the startup mode.

Send:	#o↵
Received:	None

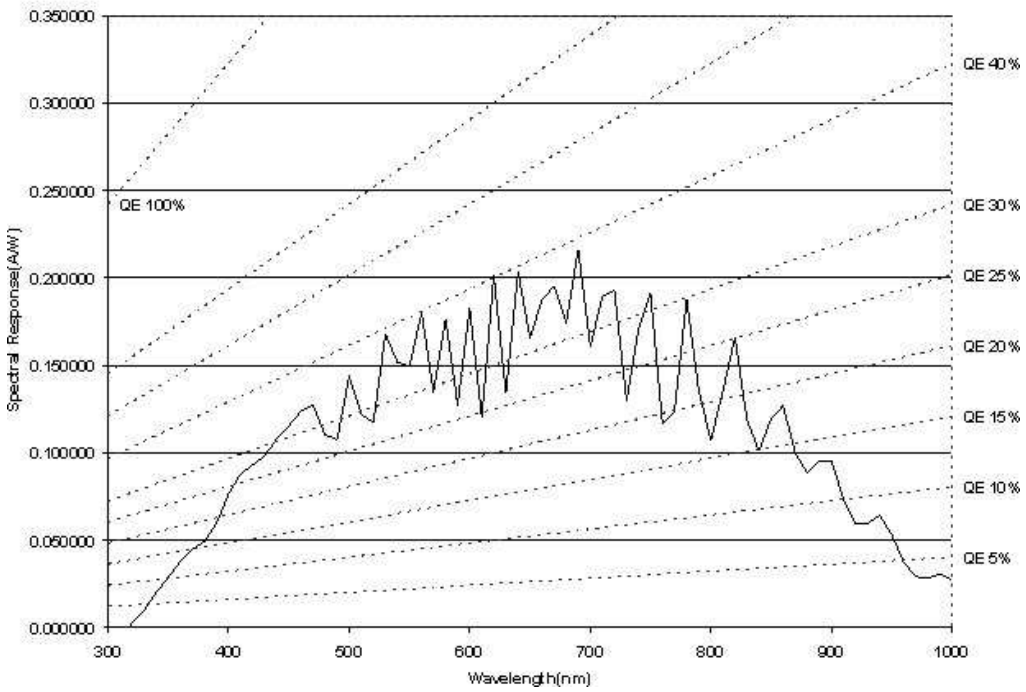
Technical Data

General

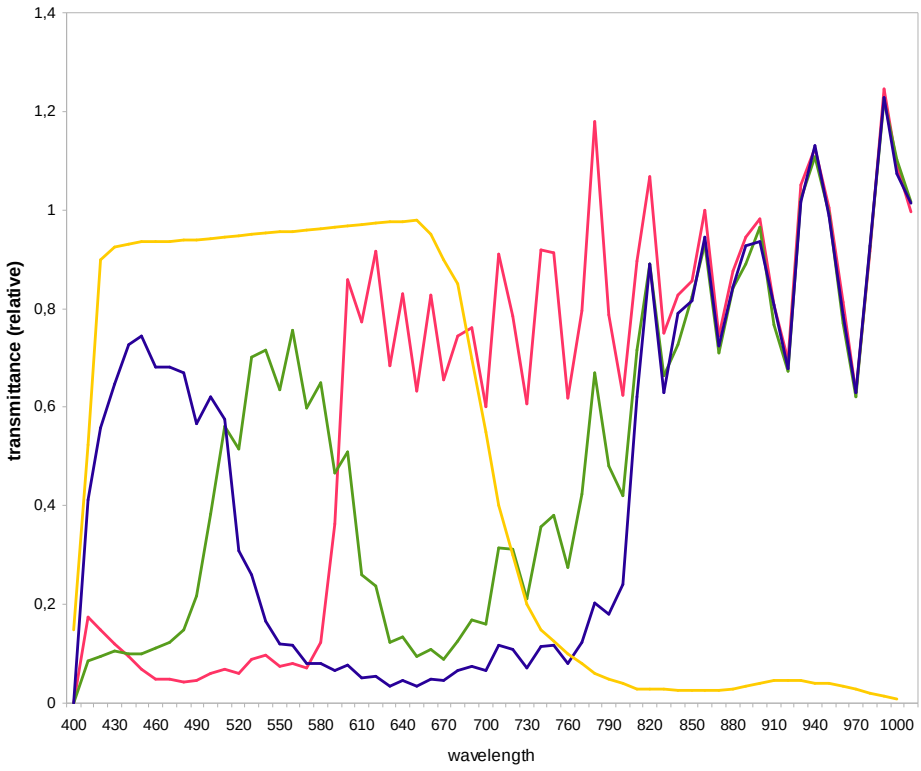
Power Source	+ 5 Volt +/. 5% DC < 100mV ripple
Power	approx. 6 Watt
Pixel Number	1280 x 1024
Pixel size	14 µm x 14 µm
Acitve area	17,92 mm x 14,336 mm
Sensor responsitivity	25 V/lux.s
Sensor S/N ratio	57,81 dB (Linear) Up to 90 dB optical (Multislope)
Shutter	Global
Minimum Ambient Temperature	0 °C
Maximum Housing Temperature	+ 50 °C
Humidity	< 80% relative, non-condensed
Interface	CameraLink (Base-Medium-Full) 66-75-85 MHz
Serial communication	RS-644 over Camera Link® 9600 to 115200 baud 8bits, 1 stop, no parity
Video interface	Camera Link® Base / Medium / Full / Full extended
Size	56 mm x 56 mm x 44 mm (C-Mount) 56 mm x 56 mm x 73 mm (F-Mount)
Weight	approx. 250g without lens

Spectral Response / Transmittance

Spectral response (Monochrome Sensor)



Transmittance (Color Sensor / IR Cutoff Filter)



RGB Pixels (red, green, blue),

IR Cutoff Filter characteristics (orange), Filter Specification: 1830-SS-10

Bayer Pattern

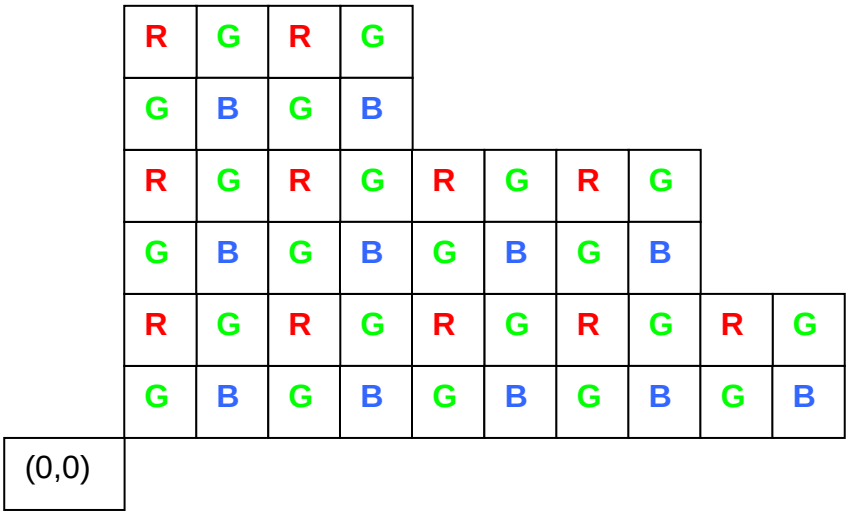
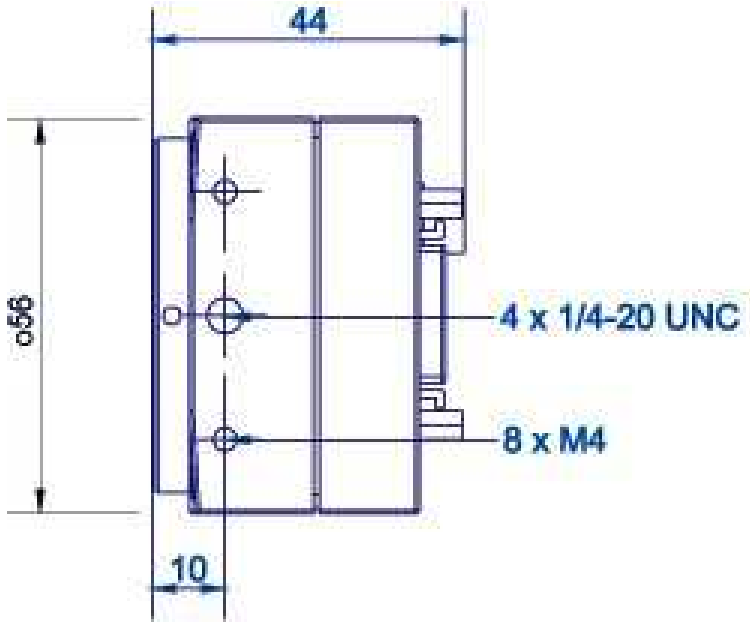


Figure: Bayer Pattern of the Color Sensor

Mechanical Dimensions

C-Mount Lens (/CM)



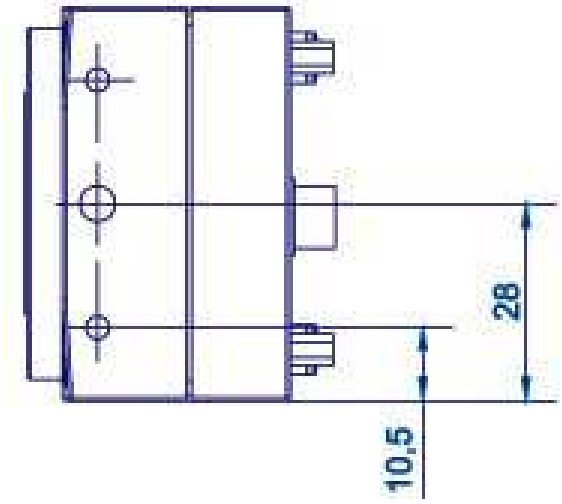


Figure : Side View (all dimensions in mm)

Screw threads in socket:	2 x M4 min. 8 mm depth
	1 x ¼ `` min. 6 mm depth
	(in the middle)

F-Mount Lens (/FM)

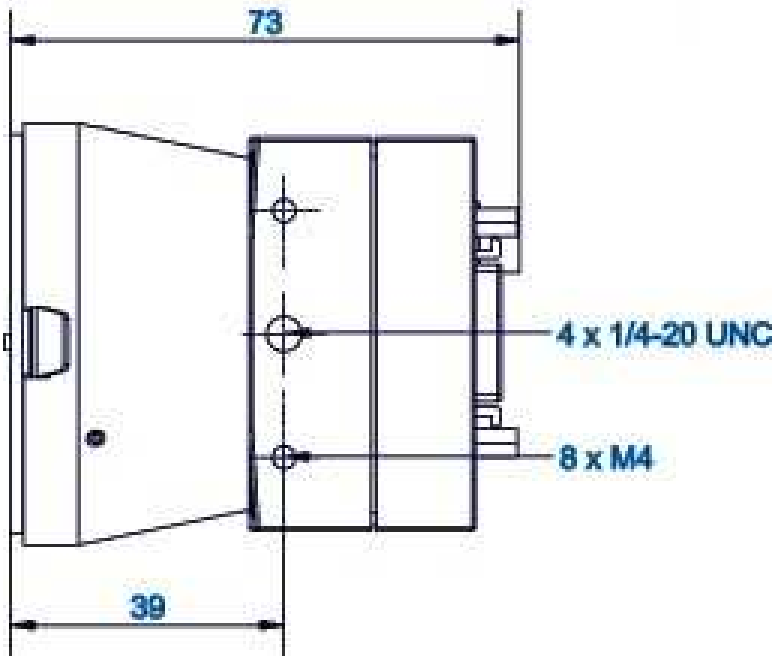


Figure : Side View (all dimensions in mm)

Screw threads in socket:	2 x M4 min. 8 mm depth
	1 x ¼ `` min. 6 mm depth
	(in the middle)

Synchronisation Input schematics

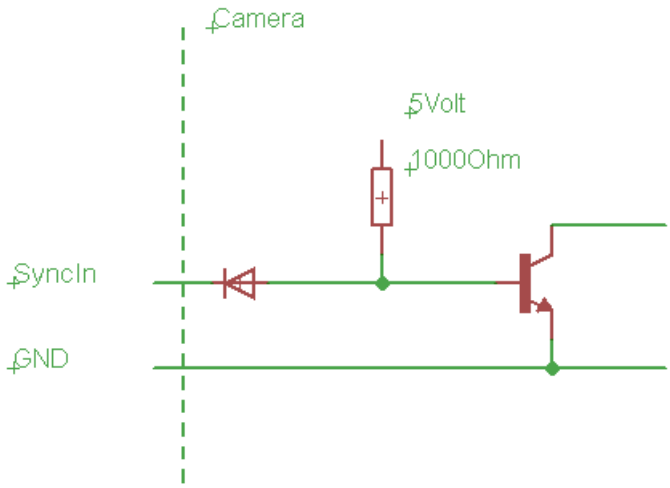


Figure: SyncIn Schematics (for illustration only)

Synchronisation Output schematics

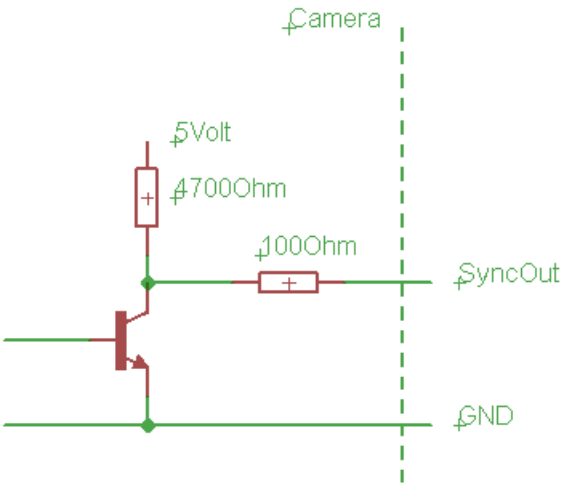
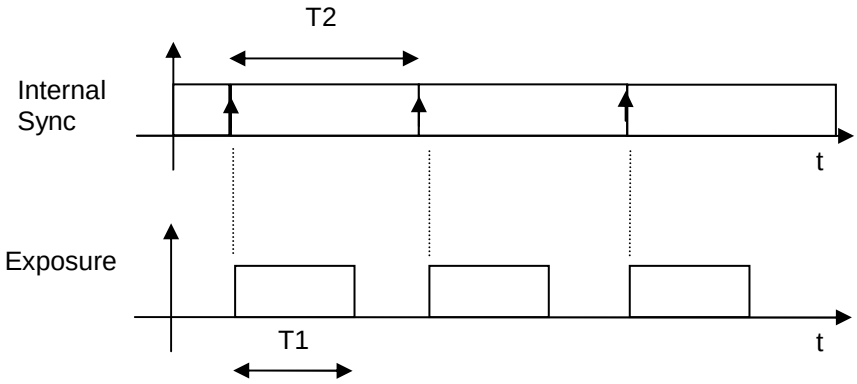


Figure: SyncOut Schematics (for illustration only)

Internal Synchronisation Timing



T1: Exposure time, selected by software
T2: Frame Interval (1/Frame Rate), selected by software

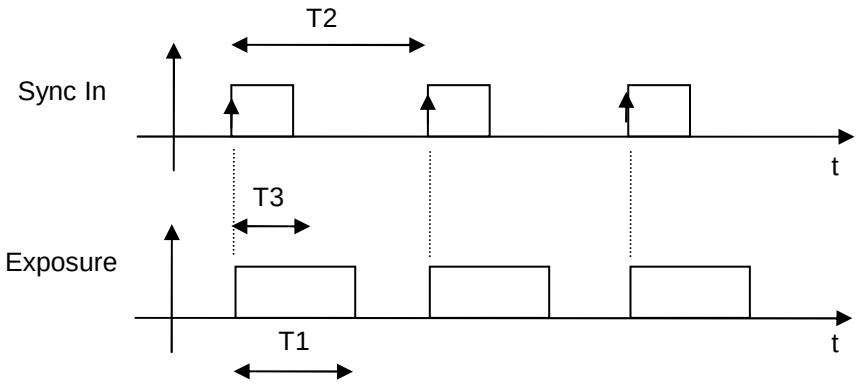
Synchronisation Output

Logic 1 during Exposure Time (T1)

External Synchronisation Timing

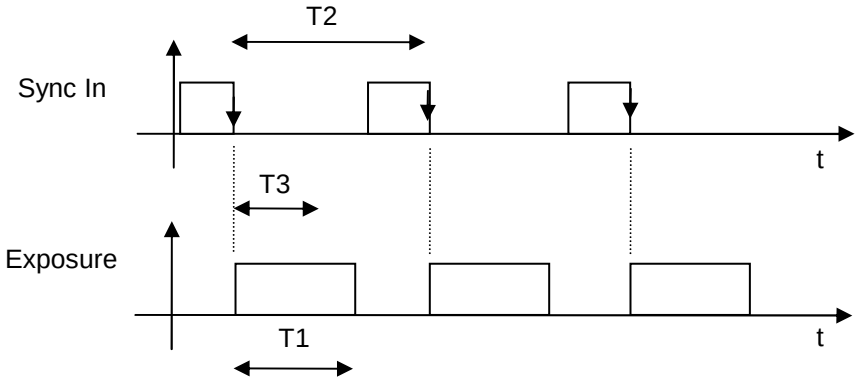
Synchronisation Input “edge detection”

positive edge:



Sync In rising edge to Exposure Delay: ~6,0usec +/- 530nsec typical

negative edge



Sync In falling edge to Exposure Delay: ~3,8 usec +/- 530nsec typical

T1: Exposure time
T2: 1/Frame Rate
T3: 1/Maximum Frame Rate (limited by readout of the sensor)
depends on frame format and Camera Link® mode

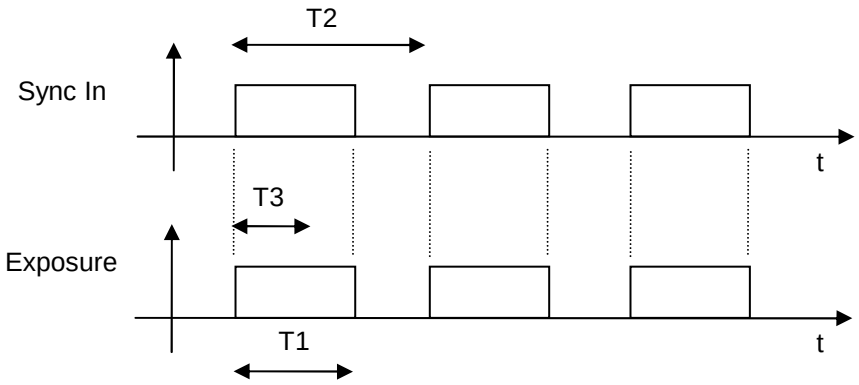
T1>T3:	**T1<T3:**
T1: Selected by software T2 max: no limit < 1sec recommended due to shutter efficiency and thermal noise T2 min: T1	T1: Selected by software T2 max: no limit < 1sec recommended due to shutter efficiency and thermal noise T2 min: T3

Synchronisation Output “edge detection”

Logic 1 during Exposure Time (T1)

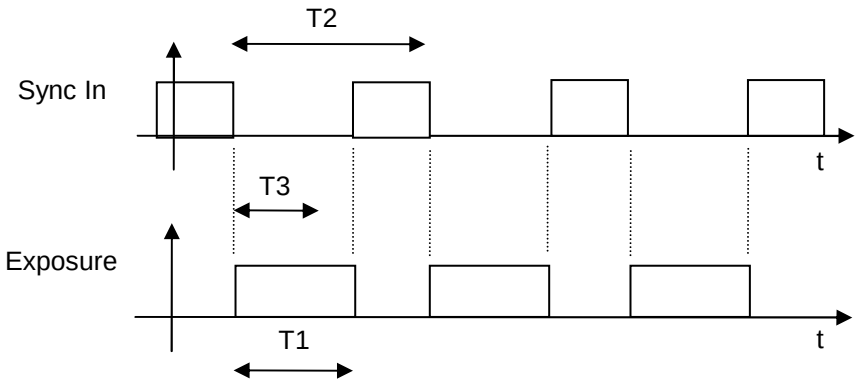
Synchronisation Input "level detection"

positive level:



Sync In rising level to Exposure Delay: ~6,0usec +/- 530nsec typical

negative level:



Sync In falling level to Exposure Delay: ~3,8usec +/- 530nsec typical

T1: Exposure time
T2: 1/Frame Rate
T3: 1/Maximum Frame Rate (limited by readout of the sensor)
depends on frame format and Camera Link® mode

T1>T3:	**T1<T3:**
T1 max: : no limit < 1sec recommended due to shutter T2 max: no limit < 1sec recommended due to shutter efficiency and thermal noise T2 min: T1	T1 max: : no limit < 1sec recommended due to shutter efficiency and thermal noise T2 max: no limit < 1sec recommended due to shutter efficiency and thermal noise T2 min: T3

Synchronisation Output “level detection”

Logic 1 during Exposure Time (T1)

Camera Link Cable

Cable assemblies are available from 3M. For more information on 3M products, see the 3M Web site at www.3M.com.

Cable Assembly Part Numbers:

14X26-SZLB-XXX.0LC

Shell Retention Options:

B = Thumbscrew shell kit

T = Thumbscrew overmold shell

100 = 1 meter

200 = 2 meters

300 = 3 meters

450 = 4.5 meters

500 = 5 meters

700 = 7 meters

A00 = 10 meters

The clock repletion rate of the CL300x2 and CL600x2 Camera Link® Sys Clock is rated at 85 MHz. It is recommended to use a maximum Camera Link® cable length of 5 Meter. For full Camera Link® specification, two cables of the same length have to be used.

The table shows a typical Camera Link® cable used for the CL600x2 camera:

Manufacturer / Distributor:	Description	Part Number:
3M Interconnect Solutions / Spoerle, www.spoerle.de	Camera Link® Cable 5 m	14B26-SZLB-500-OLC (500) CAMERA LINK ASSY/5,0 M/ ROHS-konf. JE-1502-8009-5 ROHS

Focal Length Calculation

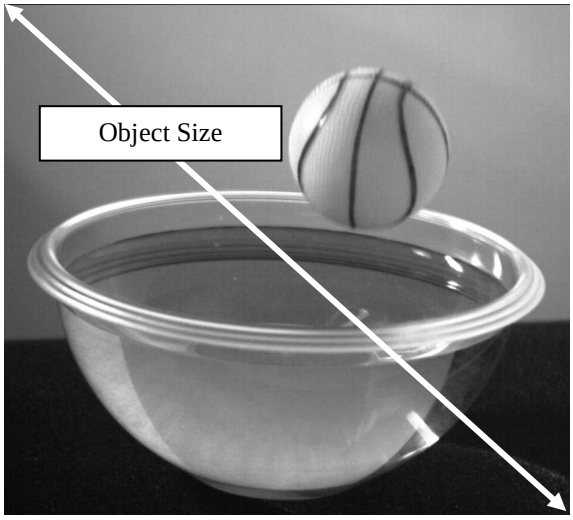
Full Sensor Resolution

The required focal length of the lens at full sensor resolution (1280 x 1024 Pixel) is calculated as follows:

$$\text{Focal Length [mm]} = \frac{A}{1+\frac{B}{23}}$$

A: Distance from lens to object in mm

B: Size of the object in mm



Example:

A: Distance from lens to object = 300 mm

B: Object Size = 100 mm

calculated focal length = (300 : (1 + (100 : 23))) = 56 mm

selected focal length = 50 mm

Reduced Sensor Resolution

At reduced sensor resolutions (e.g. 800 horizontal x 600 vertical pixels) the focal length is calculated as follows:

$$\text{Sensor Size [mm]} = 0{,}014 \cdot \sqrt{C^2 + D^2}$$

$$Focal\ Length\ [mm] = \frac{A}{1 + \frac{B}{Sensor\ Size\ [mm]}}$$

A: Distance from lens to object in mm

B: Object size in mm

C: Number of horizontal pixels

D: Number of vertical pixels

$$\text{Sensor Size}\ [\text{mm}] = 0{,}014 \cdot \sqrt{800^2 + 600^2} = 14$$

Example:

C: Number of horizontal pixels = 800

D: Number of vertical pixels = 600

A: Distance from lens to object = 300 mm

B: Object size = 100 mm

calculated focal length = (300 : (1 + (100 : 14))) = 36,8 mm

when a lens with focal length of 35 mm has to be used, and the object size has to be kept at 100 mm, the distance from lens to object has to be changed as follows:

$$Distance\ to\ Object\ [mm] = Focal\ Length \cdot \left(1 + \frac{Object\ Size}{Sensor\ Size}\right)$$

at a focal length of 35mm, an object size of 100mm and a sensor size of 14mm the new distance from lens to object is calculated as:

35 · (1 + (100 : 14)) = 285 mm

The distance from lens to object has to be reduced from 300mm to 285mm

Vice versa, when the distance from lens to object has to be reduced, the focus of the lens will come to its limit. and the required magnification factor can no more performed by the lens itself. In this case, a distance washer has to be placed between the lens interface of the camera and the lens.

Distance Washer

The length of the distance washer can be calculated as follows:

$$Length\ of\ \ the\ Distance\ Washer\ [mm] = Focal\ Length \cdot \frac{Sensor\ Size}{Object\ Size}$$

Example:

Sensor Size as calculated above = 14mm

required Object Size=14mm

(The required magnification factor is = 1 : 1)

focal length of the lens = 35mm

calculated Length of the Distance Washer = 35 · (14 : 14) = 35mm