PULNiX TM-4100CL

The TM-4100CL is a miniature, very high-resolution (4.2 Mpixels) monochrome progressive scan CCD camera with dual-tap output and a frame rate of 15 fps at full 2048 x 2048 resolution. The TM-4100CL features the latest Kodak KAI-4021 CCD imager for the best image quality and sensitivity. Applications for the TM-4100CL include machine vision, medical imaging, intelligent transportation systems, high-definition graphics, gauging, and surveillance.

- 1.2” progressive scan IT CCD imager (KAI-4021)
- 2048 x 2048 resolution @ 15 fps
- Color version (RGB Bayer CFA) is available as TMC-4100CL‡
- Miniature 50.8 x 50.8 x 81.5 mm housing
- Digital Camera Link dual-tap output and analog output (Ch. A only)
- Maximum dynamic range control with PULNiX-exclusive, patent-pending built-in look-up table
- Full frame integration for long exposures
- Image center partial scan (1000, 500, 250 lines)
- Full-frame shutter to 1/16,000 sec.
- Asynchronous reset, no-delay shutter
- Read-out-inhibit control for multiple-camera applications
- Camera Link* external control
- Automatic dual-channel compensation

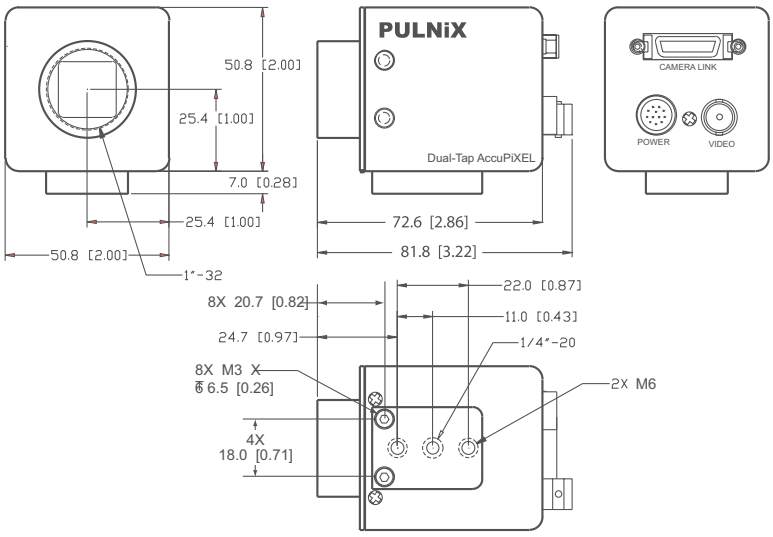
** For more information, see the Camera Link data sheet*
‡ For more information, see the Color AccuPiXEL data sheet

TM-4100CL SPECIFICATIONS

Imager	*1.2" progressive scan interline transfer CCD*
Active Area	*15.15mm x 15.15mm*
Active Pixels	*2048 (H) x 2048 (V)*
Cell Size	*7.4 µm x 7.4 µm*
Display Mode (Active Pixels) A B C D	*2048 (H) x 2048 (V) @ 15 Hz* *2048 (H) x 1000 (V) @ 28 Hz (partial scan)* *2048 (H) x 500 (V) @ 50 Hz (partial scan)* *2048 (H) x 250 (V) @ 80 Hz (partial scan)*
Sync	*Internal/External auto switch* *HD/VD, 4.0 Vp-p impedance 4.7Ω* *VD=14.79 Hz ± 2%, non-interlace* *HD=30.78 kHz ± 2%*
Data Clock Output	*40.00 MHz*
Resolution	*Digital: 2048 (H) x 2048 (V)* *Analog: over 800 TV lines (H) x 1600 TV lines (V)*
S/N Ratio	*48 dB min.*
Min. Illumination	*1.0 lux, f=1.4 (no shutter) @ 15 fps* *Sensitivity: 32µ V/e-*
Video	*Analog: 714 mV, 75Ω (900 mV white clip), Ch A only* *Digital output: 8-bit x 2 Camera Link* *10-bit x 2 Camera Link (optional)*
AGC	*OFF*
Gamma	*Programmable LUT (Gamma 1.0 std)*
Lens Mount	*C-mount (use >1" format lenses)*
Power Requirement	*12V DC ± 10%, 600 mA (current measured at 25°)*
Operating Temp.	*-10° C to 45° C*
Vibration	*7 Grms (10 Hz to 2000 Hz) Random*
Shock	*70G, 11 ms, half-sine*
Size (W x H x L)	*50.8mm x 50.8mm x 81.5mm*
Weight	*152 grams, 5.4 oz (without tripod)*

MUST BE ORDERED SEPARATELY	
Optional Functions	*10-bit output*
Optional Accessories I/O CL cable Power Cable Power Supply	 *26CL-02-26 (2m), 26CL-05-26 (5m)* *12P-02S* *PD-12UUP series (includes power connector)*

** Image quality will degrade with increasing temperature.*

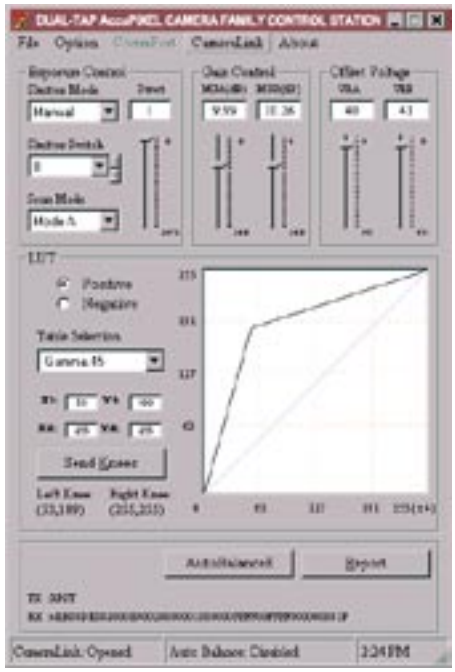


Graphical User Interface

A user-friendly GUI (graphical user interface) is provided. This interface allows users to control the following functions of the TM-4100CL camera:

- Shutter control for manual async. and pulse width control
- Gain control
- Offset control
- Save settings
- Load settings
- Report settings
- LUT setting and graphic display
- Scanning mode selection and Option selections
- Channel Auto Balancing

Camera parameters can be uploaded from the PC to the camera. Once these parameters are stored in EEPROMs, an instantaneous change from one setting to another can be done with a delay of a few frames in between.



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JAI A-S, Denmark
Phone +45 4457 8888
www.jai.com

JAI UK Ltd., England
Phone: +44 189 582 1481
www.jai.com

JAI Corporation, Japan
Phone: +81 045 440 0154
www.jai-corp.co.jp

JAI PULNiX, Germany
Phone +49-(0) 60 55-93 79-10
www.jaipulnix.com

JAI PULNiX Inc., USA
1330 Orleans Drive
Sunnyvale
CA 94089
USA

Phone +1 408-747-0300
(toll-free) 1 800 445 5444
Fax +1 408 747 0660
www.jaipulnix.com

PULNiX
www.jaipulnix.com

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Camera Link™ Cameras

Camera Link is a new digital transmission method, designed by vision product manufacturers specifically for the machine vision industry, in answer to customer requests. It is an easy way to connect digital cameras to frame grabbers.

Camera Link is a camera-to-frame grabber interface specification based on an implementation of Channel Link™ technology. It includes hardware (cable connectors), & data transmission as well as camera control and asynchronous serial communications all on a single cable. Now, only two connections (power and Camera Link) are required to operate the camera.

The specification was developed through an initiative headed by PULNiX America, Inc. Camera Link defines a single connector for both the frame grabber and the camera. This insures that all products bearing the Camera Link logo are interchangeable with each other. The official Camera Link logo is shown to the right.

As a standard that has been defined by industry members, Camera Link provides the following benefits:

- **Real-time signaling:** Camera Link supports real-time signaling. Camera Link cameras accept signals including asynchronous reset (Vinit), HD, VD, and integration through the Camera Link cable, without latency (delay).
- **High data rates:** A base configuration Camera Link interface can handle 1.2Gbps of data. The technology used in Camera Link has a maximum data rate of 3.5Gbps, insuring solutions for tomorrow's applications.
- **Flexibility:** Camera Link is independent of imager resolution, video format, and frame rate. In contrast, some other digital transmission standards are set for specific pre-defined video formats.
- **Platform independence:** Camera Link is a hardware specification designed by camera and frame grabber manufacturers specifically for the Machine Vision industry. The frame grabber software must be Windows™ 9X/2000 compatible, but is independent of support from third parties like Microsoft, Apple, or Intel.

Camera Link℠ is a registered copymark of the AIA

- **Simple interface:** Only two connections are required to interface a camera and frame grabber: Power and Camera Link. Cameras and frame grabbers can be easily interchanged using the same cable.
- **Standardized cable assembly:** Camera Link specifies a standard cable assembly. This eliminates the need for manufacturers to provide custom cables, and allows customers to take advantage of lower cable prices. In addition, the technology used in Camera Link reduces the number of wires required to transmit data, allowing for thinner cables, which are more robust and less prone to breakage. Various cable lengths are available up to 10m.
- **Extensive application software support from frame grabber and vision software companies:** Machine vision applications require robust and field-proven software. Camera Link is a quick and simple way for users to standardize their systems for existing applications without having to verify new software.
- **Long-term, stable supply:** Channel Link technology is committed to providing long-term support to the telecommunications industry. Unlike most consumer products, the basic architecture will remain stable for many years to come.

Channel Link™ is a registered trademark of National Semiconductor.

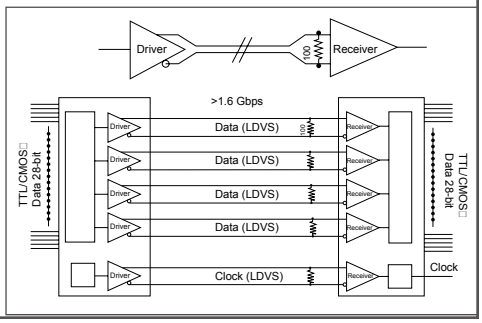
Windows 2000™ is a registered trademark of Microsoft Corporation.

Channel Link Technology

The heart of Camera Link is Channel Link, a data transmission method by National Semiconductor. Channel Link is made up of a receiver chip and a transmitter chip. This chipset is used to transmit digital data. This technology offers many advantages to machine-vision applications over the previous method, namely, RS-644 (LVDS format of RS-422).

LVDS (Low Voltage Differential Signaling) has become the most common means to transmit digital data in recent years. This method, however, has several major drawbacks. LVDS requires a pair of wires for transmission of each data bit, creating bulky cables prone to breakage if stressed. Also, the maximum data transmission rate of LVDS is 400 Mbps, fast enough for today's applications, but limiting for tomorrow's requirements. Channel Link takes LVDS to the next level.

Channel Link uses LVDS standards to transmit data. Far fewer wires, however, are needed to transmit the data. A Channel Link transmitter will convert 28 bits of data into a format that can be transmitted over 4 parallel lines. A transmit clock over a fifth line finishes the requirements for Channel Link transmission. The diagram to the right shows how just five pairs of wire are able to transmit data that would require 56 wires using standard LVDS methods.



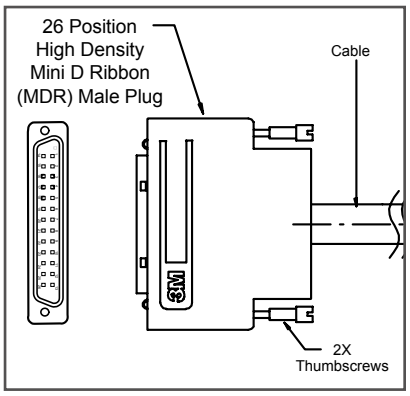
Camera Link Connector and Cable Configurations

A single Camera Link connection provides the following information on an MDR connector with 26 pins.

Image data and timing	4 pairs
	1 pair transmission clock
Serial communication	1 pair transmit
	1 pair receive
Camera Control	4 signal pairs

This configuration will transfer up to 28 bits of data. For applications that require more bandwidth, additional Camera Link connections can be used.

There are 3 configurations – base, medium and full. Please visit the PULNiX web site for detailed specifications of Camera Link.



Camera Link Cable

Note: *The MDR-26 cable assembly is manufactured by 3M Corporation.*

Camera Link Cable Ordering Information

Camera Link cables are available from multiple vendors.

JAI PULNiX P/N	3M	Intercon I	Length
Molded Cables			
	14T26-SZLB-100-0LC	CLCP-1.0-p	
26CL-02-26	14T26-SZLB-200-0LC	CLCP-2.0-p	
	14T26-SZLB-300-0LC	CLCP-3.0-p	
	14T26-SZLB-500-0LC	CLCP-5.0-p	
	14T26-SZLB-700-0LC	CLCP-7.0-p	
	14T26-SZLB-A00-0LC	CLCP-10-p	
	14T26-SZLB-450-0LC	CLCP-4.5-p	
Shell Kit Cables			
	14B26-SZLB-100-0LC	CLCPH-1.0-p	
	14B26-SZLB-200-0LC	CLCPH-2.0-p	
	14B26-SZLB-300-0LC	CLCPH-3.0-p	
	14B26-SZLB-450-0LC	CLCPH-4.5-p	
	14B26-SZLB-500-0LC	CLCPH-5.0-p	
	14B26-SZLB-700-0LC	CLCPH-7.0-p	
	14B26-SZLB-A00-0LC	CLCPH-10-p	

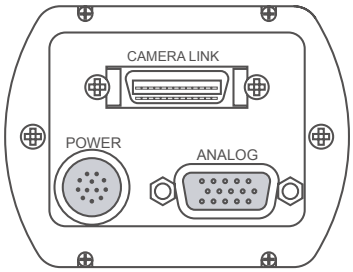
Connector and Pin Configurations

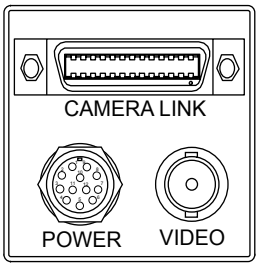
Camera Link Connector (MDR 26-pin connector)

Rear Panel top view

Rear Panel

TMC-6700CL/TMC-1000CL AccuPiXEL™ Series

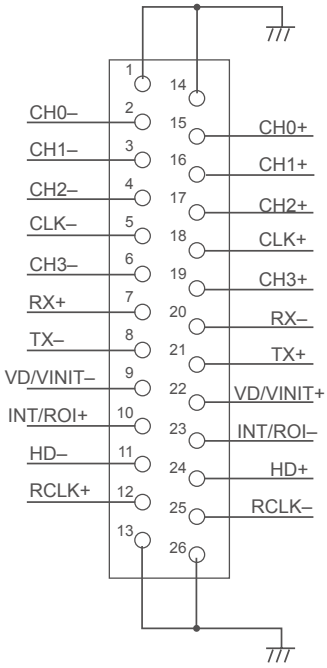




MDR 26-pin Connector 10226-6212VC

Pin#	Description	I/O
1	GND (shield)	
2	X0- (CH0-)	Out
3	X1- (CH1-)	Out
4	X2- (CH2-)	Out
5	Xclk- (CLK-)	Out
6	X3- (CH3-)	Out
7	SerTC+ (Rx+)	In
8	SerTFG- (Tx-)	Out
9	CC1- (Vinit/VD-)	In
10	CC2+ (Integ/ROI+)	In
11	CC3- (HD-)	In*
12	CC4+ (RCLK+)	In**
13	GND	
14	GND (shield)	
15	X0+ (CH0+)	Out
16	X1+ (CH1+)	Out
17	X2+ (CH2+)	Out
18	Xclk+ (CLK+)	Out
19	X3+ (CH3+)	Out
20	SerTC- (Rx-)	In (LVDS or RS-232)
21	SerTFG+ (Tx+)	Out
22	CC1+ (Vinit/VD+)	In
23	CC2- (Integ/ROI-)	In
24	CC3+ (HD+)	In*
25	CC4- (RCLK-)	In**
26	Inner shield	

The 26-pin Connector Pin Assignment
(Camera Side)



Node description:
CH0: Data B0, A5, A4, A3, A2, A1, A0
CH1: Data C1, C0, B5, B4, B3, B2, B1
CH2: Data DVAL, FVAL, LVAL, C5, C4, C3, C2
CH3: Data SPARE, C7, C6, B7, B6, A7, A6
CLK: Data clock
RX, TX: Serial communication, RX = Ser to Cam□
□ TX = Ser to FG
VD/VINIT: Ext. VD in or VINIT (Triger) in
INT/ROI: Integration control in or □
□ Read-Out-Inhibit in
HD: External HD in
RCLK: External read clock in

* *HD, VD for external sync input. (Please contact PULNiX for Ext. HD input)*
** *RCLK is reserved for read clock input.*

Camera Link Signal Assignment to Channel Link Chip (RGB 8-bit x 3)

Tx IN0	Data R0 (LSB)	Tx IN8	G1	Tx IN16	B6	Tx IN24	LDV
Tx IN1	Data R1	Tx IN9	G2	Tx IN17	B7	Tx IN25	FDV
Tx IN2	Data R2	Tx IN10	G6	Tx IN18	B1	Tx IN26	LPULSE
Tx IN3	Data R3	Tx IN11	G7	Tx IN19	B2	Tx IN27	R6
Tx IN4	Data R4	Tx IN12	G3	Tx IN20	B3	Tx CLK	Data clock
Tx IN5	Data R7 (MSB)	Tx IN13	G4	Tx IN21	B4		
Tx IN6	Data R5	Tx IN14	G5	Tx IN22	B5		
Tx IN7	Data G0	Tx IN15	B0	Tx IN23	(YCC CLK)		

Note1: CLK: data clock, LDV: Line data valid, FDV: Frame data valid, INTEG: Integration control, VINIT: Async Trigger Input, ROI: Read-out-inhibit.
Note2: Data R_{0-7} is defined as A_{0-7}, Data G_{0-7} is defined as B_{0-7}. Data B_{0-7} is defined as C_{0-7}. For 8-bit B/W, only A_{0-7} is used. For 8-bit x 2 A_{0-7} and B_{0-7} are used.
Note3: Camera control via 12-pin connector (RS-232) is available as an option.

Camera Link Camera Models

Camera models B/W Cameras	CCD (In)	Resolution	Frame rate (frame/sec.)	Data Clock (MHz)	Data	Analog video	Size (HxWxL mm)
TM-6760CL	1/2	648 x 484	60/30	25.49/12.75	Ch-A 8-bit	BNC: VGA video	44 x 44 x 64
TM-6710CL	1/2	648 x 484	120/60	25.49/12.75	Ch-A & B 8-bit x 2	BNC: 120 fps @ 50MHz	39 x 46 x 140
TM-1400CL	1/2	1392 x 1040	20	33.3	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TM-1320A-15CL	2/3	1300 x 1030	15	25.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TM-1320A-24CL	2/3	1300 x 1030	24	40.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TM-1325CL	2/3	1392 x 1040	15/30	33.3	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TM-1020-15CL	1	1008 x 1018	15	20.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TM-2016-8CL	1	1920 x 1080	8	20.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TM-2016-15CL	1	1920 x 1080	15	40.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TM-4000CL	1.2	2048 x 2048	15	40.0	8-bit x 2	BNC: progressive scan	51 x 51 x 82
Color Cameras							
TMC-6700CL	1/2	648 x 484	60	25.49	Ch-R,G,B 8-bit x 3	Dsub: RGB video VGA video	51 x 67 x 117
TMC-1000CL	1	1008 x 1018	15	20.0	Ch-R,G,B 8-bit x 3	Dsub: RGB video progressive scan	51 x 67 x 117
TMC-6760CL$^{\Delta}$	1/2	648 x 484	60	25.49/12.75	Ch-A 8-bit	BNC: VGA video	44 x 44 x 64
TMC-6710CL	1/2	648 x 484	120	25.49	Ch-A & B 8-bit x 2	BNC: 120 fps @ 50MHz VGA video	39 x 46 x 140
TMC-1400CL$^{\Delta}$	1/2	1392 x 1040	20	33.3	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1320A-15CL$^{\Delta}$	2/3	1300 x 1030	15	25.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1320A-24CL$^{\Delta}$	2/3	1300 x 1030	24	40.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1325CL	2/3	1392 x 1040	15/30	33.3	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1020-15CL$^{\Delta}$	1	1008 x 1018	15	20.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-2016-8CL$^{\Delta}$	1	1920 x 1080	8	20.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-4000CL$^{\Delta}$	1.2	2048 x 2048	15	40.0	Ch-A & B 8-bit x 2	BNC: progressive scan	51 x 51 x 82

$^{\Delta}$ AccuPiXEL color cameras require software interpolation.

Please contact PULNiX for availability. For detailed camera specifications, please refer to the standard camera data sheet for each model.

For product updates and data sheets, see our web site:

www.jaipulnix.com

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JAI A·S, Denmark
Phone +45 4457 8888
www.jai.com

JAI UK Ltd., England
Phone: +44 189 582 1481
www.jai.com

JAI Corporation, Japan
Phone: +81 045 440 0150
www.jai-corp.co.jp

JAI PULNiX, Germany
Phone +49-(0) 60 55-93 79-0
www.jaipulnix.com

JAI PULNiX Inc., USA
1330 Orleans Drive
Sunnyvale
CA 94089
USA

Phone +1 408-747-0300
(toll-free) 1 800 445 5444
Fax +1 408 747 0660
www.jaipulnix.com

PULNiX
www.jaipulnix.com