



See the possibilities

User's Manual

RM/TM-4200CL **RMC/TMC-4200CL**

*Digital Monochrome/Color
Progressive Scan, Interline-Transfer GE Camera*



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The RM/TM-4200CL series of cameras has been certified to conform to the requirements of Council Directive 89/336/EC for electromagnetic compatibility and to comply with the following European Standards:

EMCEN55022: 1998 + A1: 2000 CLASS A
EN55024: 1998 + A1: 2001

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WARNING

Changes or modifications to this unit not expressly approved by the party responsible for FCC compliance could void the user's authority to operate the equipment.

RM/TM-1405GE Series Operation Manual

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RM/TM-4200CL Series Camera

1 Hardware Introduction

1.1 Product Description

The JAI RM-4200CL series consists of high-resolution, high-speed monochrome and color progressive scan CCD cameras with dual-tap output (Camera Link software allows 12-bit, 10-bit, or 8-bit output).[†] The interline-type CCD permits full vertical and horizontal resolution of very high speed shutter images and applications. The electronic shutter, which has speeds to 1/16,000 sec., can be reset asynchronously by external pulse control. The dual-tap frame rate is 15 fps. A single-tap mode is user-selectable at 8 fps. A square imager format with uniform square pixels provides superior image definition in any orientation. On-chip micro lenses provide increased sensitivity.

The RM-4200CL has a full dynamic range control function, which can be set to convert 12-bit input to either 10-bit or 8-bit output through the knee slopes of the externally selectable look-up table (LUT), thereby optimizing the CCD's full dynamic range in the normal output signal range. It can also be configured to produce 12-bit linear output - there is no LUT support in this mode. As a dual-tap output camera, the RM-4200CL has dual-channel auto black level balancing and auto gain balancing functions. All the key functions are controlled by means of the Camera Link serial communication interface either via a GUI or serial commands.

Synchronized data and clock phases are necessary for multi-camera operations, and a standard feature of all RM-4200CL cameras. The RM-4200CL has a phase lock loop (PLL) to synchronize on the external horizontal drive (Hd) for multi-camera operation that is offered as a standard feature.

Applications for the RM-4200CL include machine vision, medical imaging, intelligent transportation systems, high-definition graphics, on-line inspection, gauging, character reading, archiving, and high-security surveillance.

1.2 Features

- Miniature size and light weight

The printed circuit boards in the RM-4200CL have been arranged based on a new design philosophy. This creates modular electronics for the camera, giving it flexibility. In addition, the use of miniature solid-state components results in a compact, lightweight camera that is 51mm x 51mm x 74mm in dimensions, and weighs only 191 grams.

- Imager

The RM-4200CL uses a dual-tap progressive-scan interline transfer CCD that has the following features:

- Resolution of 2048 x 2048 active pixels for excellent image quality
- 7.4 x 7.4 μm square pixels for precise dimensional measurement
- High-speed electronic shutter capability, that eliminates the need for a mechanical shutter through high dynamic resolution of moving objects
- Progressive-scan CCD eliminates interlace deterioration of image and increases ease of computer interface
- High sensitivity and low noise with fast scanning rates. The CCD has an excellent S/N ratio that is greater than 58dB.
- The CCD has built-in microlens technology for increased quantum efficiency

[†] The RM-4200CL series consists of the TM-4200CL, RM-4200CL (monochrome) and the TMC-4200CL and RMC-4200CL (color). Unless otherwise noted, all information contained in this manual is relevant to all models.

- Electronic shutter

The RM-4200CL has a substrate drain-type shutter mechanism which provides superb pictures at various speeds without smearing. For more information, see Section 6.4, “Electronic Shutter,” on page 39.

- Asynchronous reset

The RM-4200CL captures async reset images and provides single-shot video output with single FDV (frame data valid). This makes it simpler for an ordinary frame grabber to capture the async reset images. The RM-4200CL’s asynchronous reset is flexible and accepts external horizontal drive (HD) for phase locking. When the VINIT (5V) pulse is applied to CC1, it resets the camera’s scanning and purging of the CCD.

The RM-4200CL has two modes to control the asynchronous reset and shutter speed:

- External VINIT with pulse width - the duration between pulse edges controls the shutter speed externally.
- Internal shutter speed control - the speed control varies from 1/125 to 1/16,000 sec. The video signal and FDV starts with internal V reset timing originally set to respond to shutter speed, although this can be changed to sensor or other input.

- Output

The RM-4200CL has dual-tap/single-tap 12-bit, 10-bit or 8-bit Camera Link output. The analog output is 714 mV p-p composite video (75 ohms) on all models.

- Dual-Channel Auto Black Level Balancing and Gain Balancing

The RM-4200CL, as a dual-tap output camera, has dual-channel auto black level balancing and auto gain balancing functions.

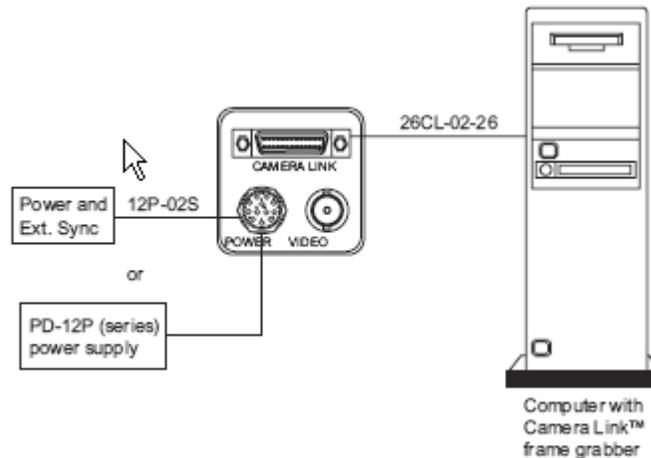
- Warranty

Please contact the JAI factory representative for details about the warranty.

1.3 System Configuration

The figure below presents a typical system configuration for the Camera Link setup.

Figure 1. CL (Camera Link) System Configuration



2 Installation

The following instructions are provided to help you to set up your camera quickly and easily. We suggest that you read through these instructions before you unpack and set up your camera system.

2.1 Getting Started

2.1.1 Unpacking Instructions

We recommend that you save the original packing cartons for the cameras and accessories in case you need to return or exchange an item.

We also recommend that you bench-test any equipment being sent to another location for field installation to assure that everything is fully operational as a system.

2.1.2 Components

When you receive your RM-4200CL series camera from JAI, the contents of the shipping box should include the camera and a document download card. If either of these items is missing, please contact your JAI, Inc. representative immediately. The document download card includes instructions and web locations for downloading the datasheet, manual, and camera-control software. If you do not have Internet access, please contact JAI to receive the material on a CD-ROM.

2.1.3 Accessories and Options

Following is a list of additional accessories and options that may be required for your application. Please check with your JAI representative before you install your camera to determine what you might need.

- PD-12U series power supply
- 12P-02S power cable
- 26CL-02-26 Camera Link cable
- TP-20 Tripod Mounting kit
(for dimensions go to: www.jai.com/EN/CameraSolutions/Products/Accessories/Pages/Home.aspx)

2.2 Camera Setup

2.2.1 Heat Dissipation

The RM-4200CL is a compact 2K by 2K camera. Since all the electronics have been packed in a compact package, the outer case of the camera can become hot due to heat dissipation. For optimal performance, JAI recommends using a cooling fan to set up a positive air flow around the camera and following the precautions below.

- Mount the camera on a large heat sink (camera bracket) made out of heat-conductive material like aluminum.
- Make sure the flow of heat from the camera case to the bracket is not blocked by a non-conductive material like plastic.
- Make sure the camera has enough open space around it to facilitate the free flow of air.

2.2.2 Connector Pin Configurations

2.2.2.1 12-Pin Connector

The RM-4200CL has a 12-pin Hirose connector for power input and signal integration. Pin #1 is Ground and pin #2 is +12V DC. The pin-out table is shown on the following page. Serial communication for camera control is accomplished by means of the Camera Link connector on the rear panel of the camera.

Table 1 12-Pin Connector

Pin	Description	Pin	Description
1	GND	7	VD in
2	+12V DC	8	Strobe
3	GND (analog)	9	HD in
4	Video out	10	NC
5	GND (digital)	11	Reserved
6	VINIT in	12	NC

Figure 2. Hirose Connector



2.2.2.2 Digital I/O Connector

The RM-4200CL has a 26-pin connector on the rear panel to output Camera Link data. The connector pin-out is shown in Table 2 below.

Figure 3. 26-pin Camera Link Connector.

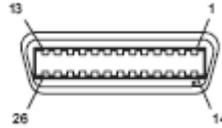


Table 2 Connector and Pin-out Configurations

Camera Link Connector					
Pin #	Description	I/O	Pin #	Description	I/O
1	GND		14	GND	
2	Tx OUT 0-	Out	15	Tx OUT 0+	Out
3	Tx OUT 1-	Out	16	Tx OUT 1+	Out
4	Tx OUT 2-	Out	17	Tx OUT 2+	Out
5	Tx CLK OUT -	Out	18	Tx CLK OUT+	Out
6	Tx OUT 3-	Out	19	Tx OUT 3+	Out
7	SerTC+	In	20	SerTC-	In
8	SerTFG-	Out	21	SerTFG+	Out
9	VINIT	In	22	VINIT+	In
10	Reserved	In	23	Reserved	In
11	EX-HD-	In	24	EX-HD+	In
12	EX-VD+	In	25	EX-VD-	In
13	GND		26	GND	

Note: SerTC: Serial To Camera
SerTFG: Serial to Frame Grabber

2.2.2.3 Analog Output Connector

The RM-4200CL has a BNC connector on the rear panel to output the analog video signal. Analog output is available to drive auto-iris lenses and for troubleshooting.

Note: This analog signal is not an RS-170 (television format) signal that can be connected to a standard CCTV monitor.

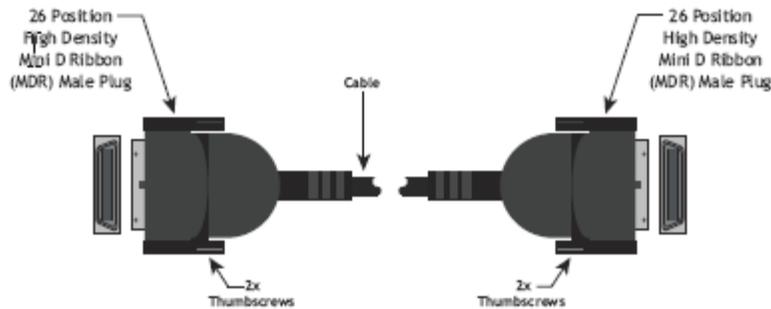
Figure 4. BNC Connector.



2.2.3 Camera Link Cable

The 26CL-02-26 cable assembly has been standardized as the Camera Link cable. This cable has a 26-pin connector on both ends. This is a straight-through cable and the pin-out configuration is shown in Table 2 on the previous page. Contact JAI for cable lengths other than 2 meters.

Figure 5. Camera Link Cable



2.2.4 Power Supplies and Power Cable Setup

2.2.4.1 Power Supplies

The RM-4200CL camera requires 12V DC power that is obtained through the 12-pin connector located on the rear panel of the camera. JAI power supplies feature a 122-240VAC / 12VDC 1.2A universal voltage power supply. JAI recommends the following power supplies:

PD-12UU	PD12UU (No 12-pin Hirose)	US Plug
PD-12UUP	PD-12UU with 12-pin connector	US plug
PD-12UE	PD-12UU (No 12-pin Hirose)	European plug
PD-12UEP	PD-12UU with 12-pin connector	European plug

For users providing power through the 12-pin connector, the PD-12P, PD-12UEP and PD-12UUP power supplies are available with the 12-pin mating connector already attached to the leads from the power supply. The PD-12UU and PD-12UE power supplies can be connected to the JAI power cable by means of a terminal strip or directly.

When wiring the PD-12UU and PD-12UE power supplies directly, please note the following:

- The lead ends must be twisted together and tin-soldered for strength and electrical continuity.
- Use shrink tubing or a similar insulator to prevent exposed leads from touching and shorting.
- The +12V lead is marked with a red stripe or white lettering; be sure not to reverse the leads.
- All connections must be properly insulated to prevent shorting.

2.2.4.2 JAI Power Cables

When using JAI power cables such as the 12P-02S, please refer to the 12-pin connector pin-out table below. The cable pin-out diagram is shown in Figure 6. The color-coded leads use Gray for Ground and Yellow for +12V.

Figure 6. 12P-02S Interface Cable (optional)

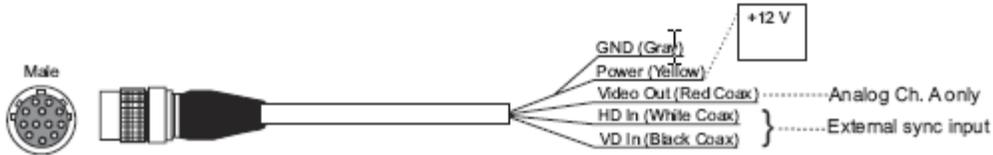


Table 3 12P-02S Interface Cable Pin Out

12P-02S Interface Cable					
Pin#	Lead Color	Function	Pin#	Lead Color	Function
1	Gray	GND	7	Black coax	VD Input
2	Yellow	+12V DC	8	White coax shield	Strobe out
3	Red coax shield	GND (analog)	9	White coax	HD Input
4	Red coax	Video Out	10	Brown	RXD
5	Orange coax shield	GND (digital)	11	Blue	Reserved
6	Orange coax	VINIT IN	12	Black coax shield	TXD

Note: Make sure that the unused leads are not touching and that there is no possibility that exposed wires could cause the leads to short.

2.2.4.3 Building Your Own Power Cable

Refer to the 12-pin connector pin-out in Table 1 on page 13. Connect the Ground lead to pin #1, and the +12V DC lead to pin #2 of the 12-pin connector. Power must be DC-regulated, and of sufficient current to properly power the camera.

2.2.4.4 Attaching the Power Cable to the Connector

The 12-pin connector is keyed and will only fit in one orientation. Follow these directions to properly attach the power cable to the camera connector:

1. Rotate the connector while applying slight pressure until the keyways line up.
2. Press the connector into place until firmly seated.
3. Plug the power cord into the 100V AC socket. This will power up the camera.

Note: If using a power supply other than the standard PD-12U Series from JAI, certain characteristics are required of the power supply and the wiring in order to properly power the camera. The camera requires 12V immediately upon start-up; no slow ramps. Once power is applied, the power supply must be able to support a 2A to 2.5A in-rush current for approximately 200µs to prevent the voltage at the camera from dropping below the 10.8V minimum required. Dropping below this will result in the camera's internal power supply lowering its impedance in an attempt to draw more current. Since no more current will be available, the voltage at the camera will drop instead. This will result in a steady-state hang-up which will damage the camera's power supply and cause the camera to cease operating or to operate in an unstable manner.

2.2.5 Attaching the Analog Video Output

When connecting the RM-4200CL to an analog frame grabber or a monitor, use the BNC connector on the back panel of the camera. The input of the monitor should be balanced for 75 ohms termination. Standard RG-59 type coaxial cable should carry a full video signal for up to 500 feet. The RM-4200CL has a two-row binning mode that can be used to display real-time images on the PVM-942 or PVM-1242 monitors. These monitors are

specially modified to accept a 30Hz progressive scan image. The multi-conductor cable 12P-02S can transmit analog video, power, sync. signals, and serial communication. The mini coaxial leads in JAI multi-conductor cables are designed for short runs of no longer than 50 feet.

Note: Make sure that no extraneous wires are visible which could cause a short.

2.2.6 Attaching the Camera Lens

The RM-4200CL camera accepts 1.2-inch or larger format size C-mount lenses. To attach the C-mount lens² to the camera, carefully engage the threads and rotate the lens clockwise until it firmly seats on the mounting ring. Do not force the lens if it does not seat properly. Please note that some lenses with extremely long flangebacks may exceed the mounting depth of the camera.

2.2.7 Adjustable Back-Focus

Before cameras are shipped, back focus is carefully set using a collimator, oscilloscope and other specialized equipment. While the factory-set focus serves well in most cases, an adjustable back focus makes it possible to improve image sharpness when using lower-cost zoom lenses, custom optics, or in unusual parameters.

There should be an obvious need to refocus the lens before attempting to change the back focus. This is a very exacting task. Some cameras have been returned to the factory to reset the back focus after failed attempts to change the focus by customers. It might be wise to label cameras whose back focus was adjusted.

1. The camera must be connected to a monitor before attempting to adjust the back focus.
2. To back focus the camera, first attach a C-mount lens in the mount. Be certain that the lens is properly seated.
3. Next set the lens focus to infinity (if the lens is a manual iris, set the iris to a high f number while still retaining a well illuminated image).
4. Loosen the three miniature hex set-screws (use a 0.9 mm hex wrench) that lock the focus ring in place (two screws for a CS-mount). Slowly turn the lens and focus ring assembly back and forth until you obtain the best image of the desired object. This sets the back focus. Once the best image is obtained, tighten the focus ring set-screws until they are snug. Do not over-tighten the screws.

Note: Mini-bayonet cameras adapted to C-mount do not have the back focus feature.

Figure 7. Back Focus Set-Screw Locations

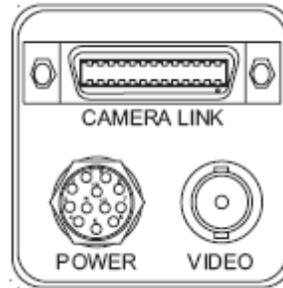


Loosen the three 2mm screws around the perimeter of the C-mount lens collar (two 2mm screws for a CS-mount) to adjust the back focus. Unless you absolutely must, do not attempt to adjust this focus.

² C-mount to F-mount and C-mount to K-mount adapters are available for larger format lenses (35mm). Check with local photography dealers for these lens adapters.

2.3 Camera Rear Panel

Figure 8. Camera Connectors



2.3.1 Digital I/O Connector (Camera Link)

Refer to Section 2.2.3 for information on digital output connectors.

2.3.2 Analog Output Connector

The camera has a BNC connector on the back panel to output the analog video signal.

2.3.3 Power and External Sync Connector

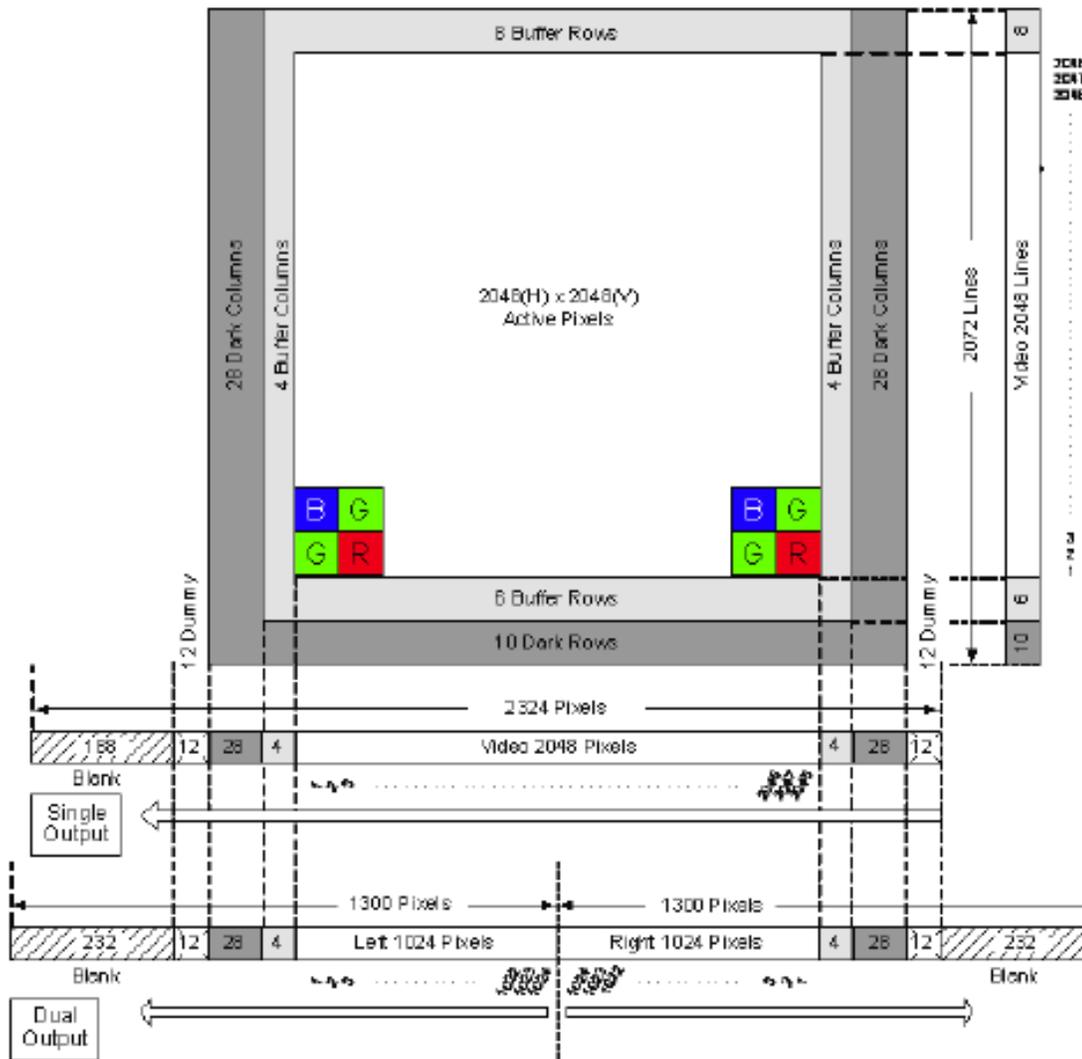
Refer to Sections 2.2.2 and 2.2.4 for information on the power and external sync connectors.

3 Functions and Operations

Sections 3.1 through 3.3 contain a variety of information about scan, shutter, and trigger modes of the RM-4200CL series cameras. See Tables 6 & 7 on pages 21 & 22 to calculate the values of the variables used in the timing diagrams shown in these sections.

3.1 Sensor Layer and Timing

Figure 9. Digital Video Output



The CCD sensor layout is shown as it is used in the timing video readout with respect to pixels and lines. For the RMC-4200CL the effective full frame Bayer sequence starts with GRG. For partial scan the sequence starts with GRG for the odd lines, and BGB for the even lines.

Figure 10. Camera Timing Chart

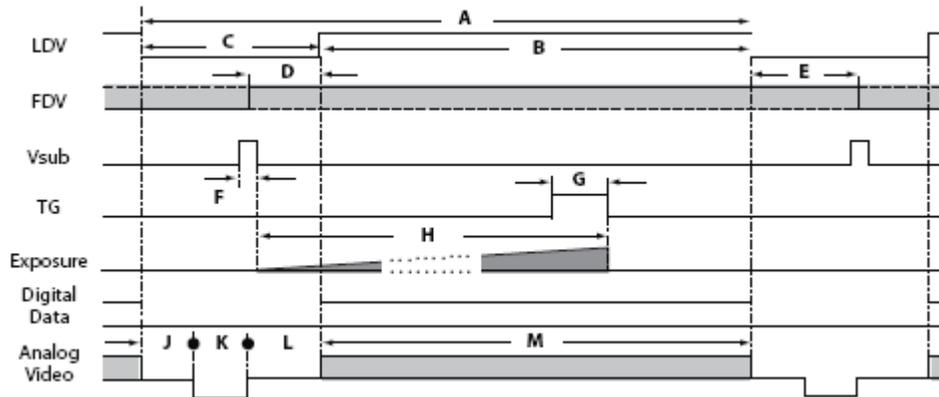


Figure 11. Digital Data Output Order for Configuration

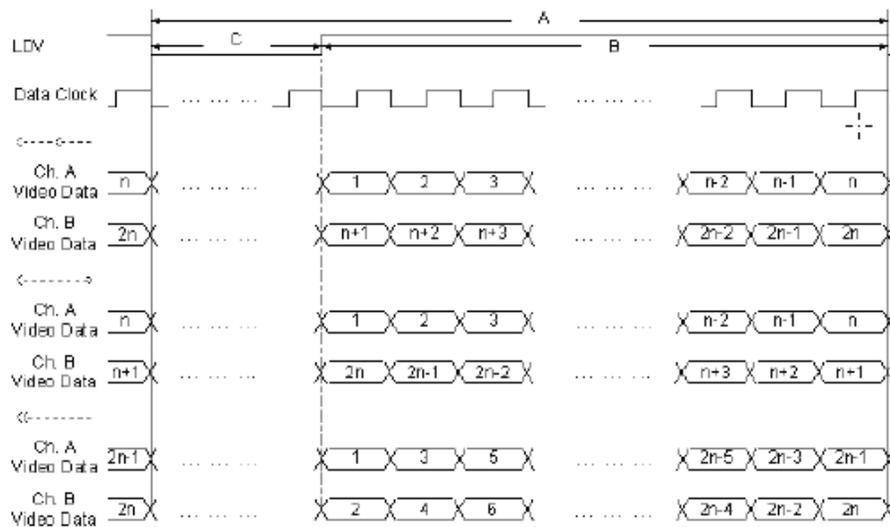
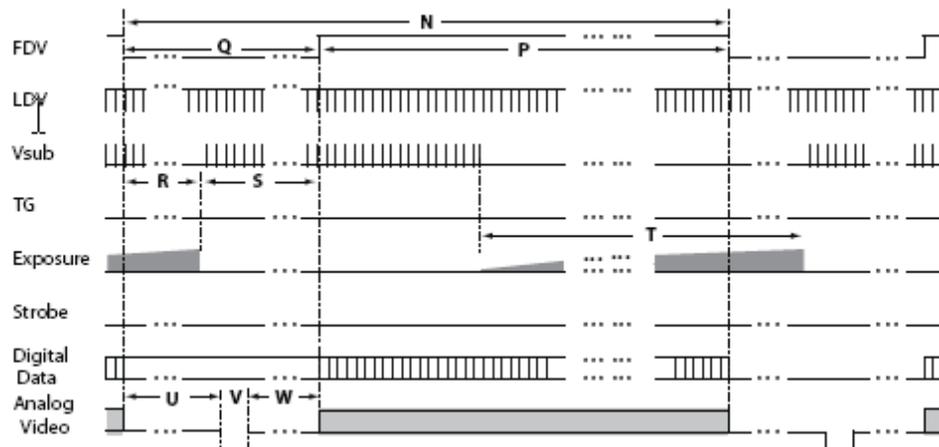


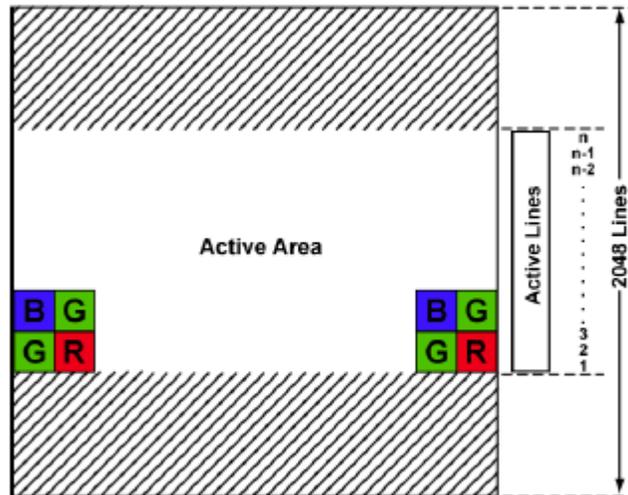
Figure 12. Field Video Timing--Continuous Mode



3.2 Scan Area

3.2.1 Preset Scan Area

RM/RMC-4200 has four fixed Scan Area modes: full scan, centered 1000 lines, centered 500 lines, and centered 250 lines. In full scan mode, all active lines of the CCD sensor, 2048 lines, are transferred out line by line. In the three centered modes - 1000 lines, 500 lines and 250 lines - only the centered lines are transferred out line by line. The rest of the lines are dumped out using the fast dump function of the CCD. This transfer method causes the frame rate of each mode to vary.



3.2.2 Programmable Scan Area

In Programmable Scan Area mode, users can specify both the start point of the active scan area and the total active lines through the serial communication commands. The area selected by users is transferred out line by line. The rest of the lines are dumped out using the fast dump function of the CCD. The frame rate in this mode varies according to the selected active area. When the active area starts from row x , and the active lines are y lines, the frame rate can be calculated using the following formulas.

$$Frame\ Rate = \begin{cases} \frac{1}{((n_f + 16) + n_r) * 32.5\mu s} & \text{Dual Tap} \\ \frac{1}{((n_f + 16) + n_r) * 58.1\mu s} & \text{Single Tap} \end{cases}$$

Where,

$$n_f = \begin{cases} \text{int}\left(\frac{x+16}{N}\right) & \text{remainder of } \frac{x+16}{N} = 0 \\ \text{int}\left(\frac{x+16}{N}\right) + 1 & \text{remainder of } \frac{x+16}{N} \neq 0 \end{cases}$$

$$n_r = \begin{cases} \text{int}\left(\frac{2056-x-y}{N}\right) & \text{remainder of } \frac{2056-x-y}{N} = 0 \\ \text{int}\left(\frac{2056-x-y}{N}\right) + 1 & \text{remainder of } \frac{2056-x-y}{N} \neq 0 \end{cases}$$

$$N = \begin{cases} 8 & \text{Dual Tap} \\ 15 & \text{Single Tap} \end{cases}$$

For a color CCD, the upper-left Bayer pattern changes depending on the start point location. If the start point is an odd row, the upper-left Bayer pattern is G in RG (Figure 12). If the start point is an even row, the upper left Bayer pattern is B in BG (Figure 13).

Figure 13. Bayer pattern - odd row start

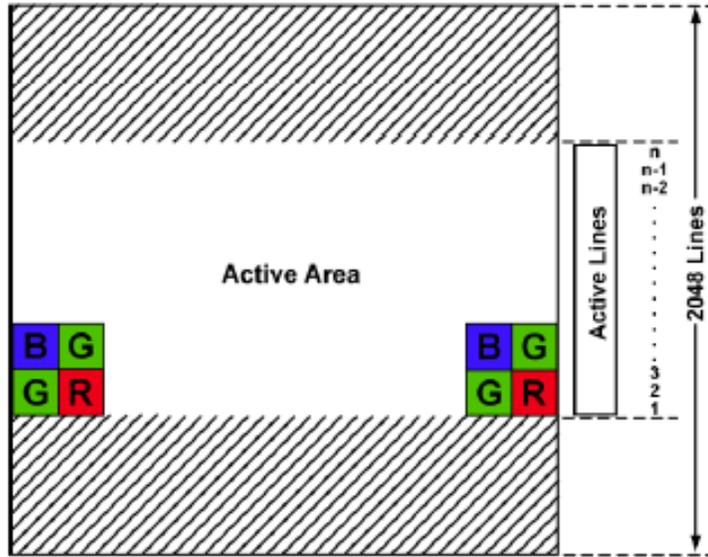
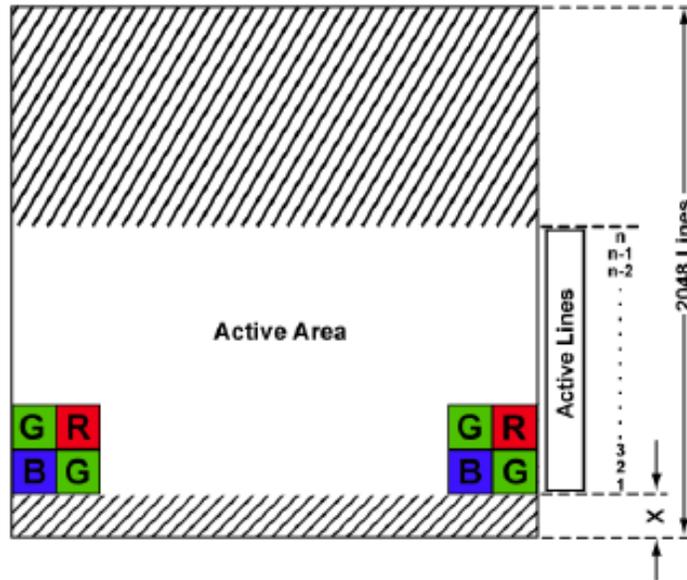


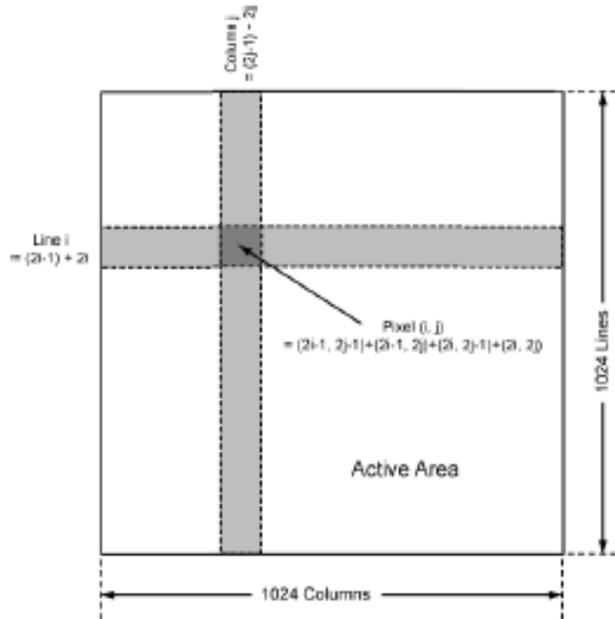
Figure 14. Bayer pattern - even row start



3.2.3 Full Scan Area 2x2 Binning

RM-4200CL offers 2x2 binning of the full scan area. In full scan 2x2 binning mode, pixel (i, j) includes all the information of pixel (2i-1, 2j-1), (2i-1, 2j), (2i, 2j-1) and (2i, 2j) in normal full scan mode (where i, j=1 2, ..., 1024). In this mode vertical binning makes frame transfer faster than normal scan mode, however, due to the mixture of pixel information, the camera resolution is low in this mode, and the Bayer pattern CCD camera loses color information.

Figure 15. 2x2 Binning

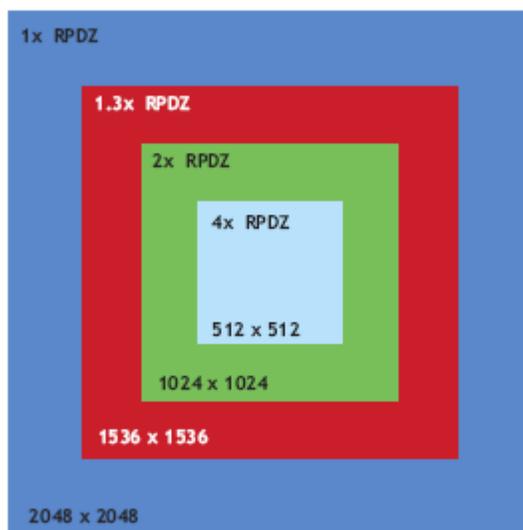


3.2.4 Resolution Proportional Digital Zoom

RM-4200CL has four resolution proportional digital zoom selections: 1x, 1.3x, 2x, and 4x. Resolution Proportional Digital Zoom (RPDZ) is a patent-pending image post processing algorithm that enables the user to digitally modify the camera's field of view while maintaining a constant data rate between the camera and the host computer. This is accomplished by sub-sampling pixels in the field of view in a manner proportional to the digital zoom level.

Note: The number of pixels used to create an image in these modes is always 512(H) x 512(V).

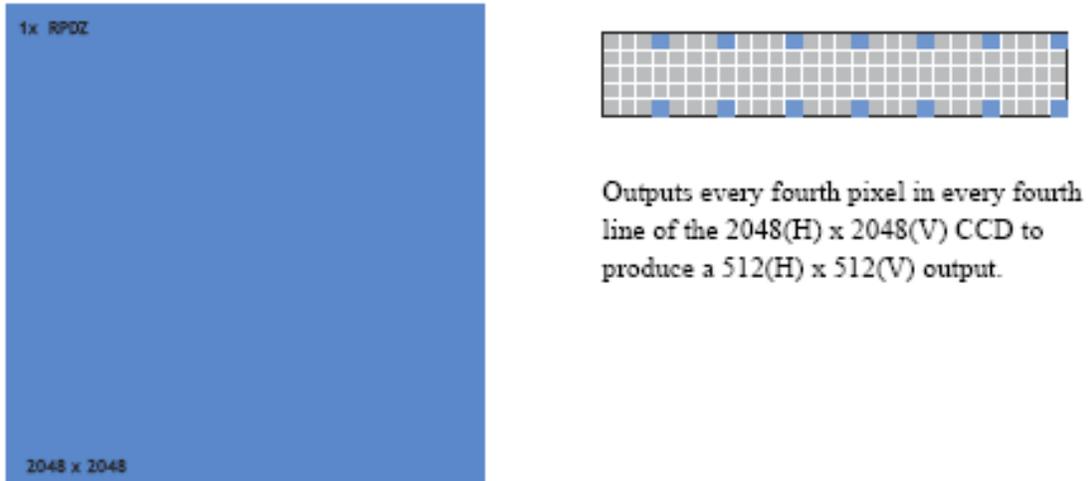
Figure 16. Overview of Resolution Proportional Digital Zoom



3.2.4.1 1x RPDZ

In 1x Mode the output video uses every fourth pixel in every fourth line of the full 2048(H) x 2048(V) CCD to produce a 512(H) x 512(V) output. The image is effectively 1x digital zoom, but with lower bandwidth.

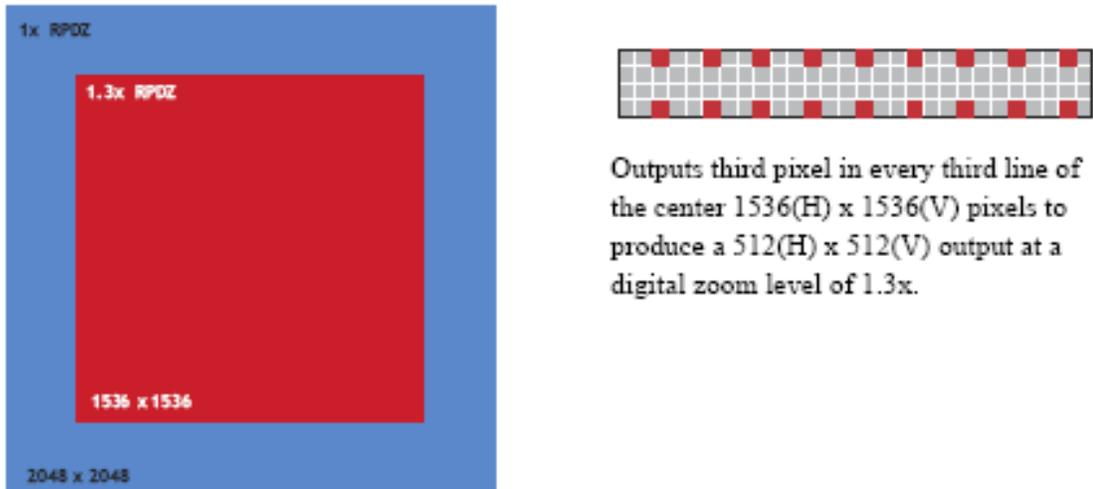
Figure 17. 1x Digital Zoom



3.2.4.2 1.3x RPDZ

1.3x Mode produces an image that is effectively 1.3x digital zoom.

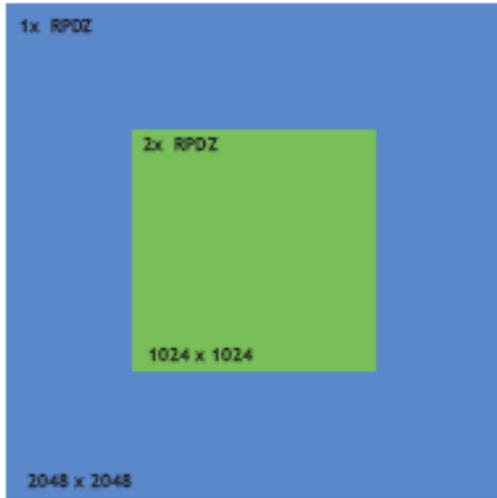
Figure 18. 1.3x Digital Zoom



3.2.4.3 2x RPDZ

2x Mode produces an image that is effectively 2x digital zoom.

Figure 19. 2x Digital Zoom

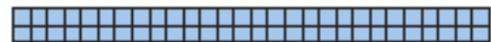
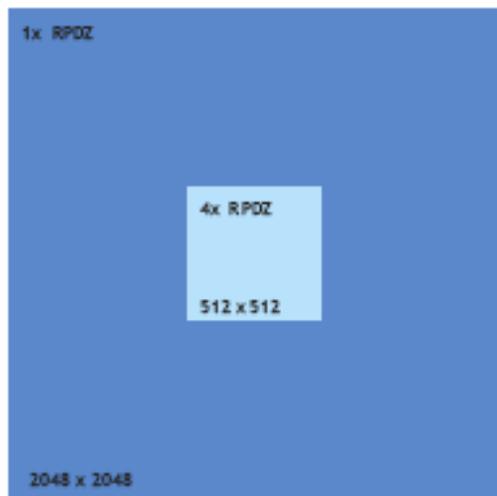


Outputs every other pixel on every second line from the center 1024(H) x 1024(V) pixels to produce a 512(H) x 512(V) output at a digital zoom level of 2x.

3.2.4.4 4x RPDZ

4x Mode produces an image that is effectively 4x digital zoom taken from the center of the FOV.

Figure 20. 4x Digital Zoom



Outputs all pixels from the center 512(H) x 512(V) pixels of the CCD to produce a digital zoom level of 4x.

Note: The total zoom level will be the optical zoom established by the lens multiplied by the RPDZ mode settings.

Example: A lens that delivers a 5x optical field of view in the RPDZ 4x setting will give 20x total magnification.

Table 4 Scan Area Start Points

	Scan Area	Start Point (Line)	Effective Area (Lines x Pixels)	Frame Rate	
				Dual Tap	Single Tap
A	Full Scan	1	2048 x 2048	14.79	8.04
B	Centered 1000 Lines	525	1000 x 2048	27.97 1	5/20
C	Centered 500 Lines	775	500 x 2048	49.63	26.97
D	Centered 250 Lines	901	250 x 2048	79.92	43.43
T	Full Scan 2x2 Binning	1	1024 x 1024	26.42	15.09
Z	Resolution Proportional Digital Zoom		512 x 512	31.98	20.40
U	Programmable Scan Area	1 - 2048	1-2048 x 2048		

3.3 Electronic Shutter

The RM-4200CL has a substrate drain-type shutter mechanism which provides a superb picture at various speeds. The preset values are shown in Table 5.

3.3.1 Preset Shutter

Table 5 Electronic Preset Shutter

Shutter Speed	Dual Tap		Single Tap	
	Continuous Mode (sec)	Async Mode (sec)	Continuous Mode (sec)	Async Mode (sec)
0	No shutter	No shutter	No shutter	No shutter
1	1/60	1/16000	1/35	1/9000
2	1/125	1/8000	1/70	1/4500
3	1/250	1/4000	1/140	1/2250
4	1/500	1/2000	1/280	1/1120
5	1/1000	1/1000	1/560	1/560
6	1/2000	1/500	1/1120	1/280
7	1/4000	1/250	1/2250	1/140
8	1/8000	1/125	1/4500	1/70
9	1/16000	PWC	1/9000	PWC

3.3.2 Programmable Exposure-Continuous Mode

The exposure time of RM-4200CL can be specified from one video line to a maximum of one frame using the serial communication commands in the Continuous Mode. There is overhead where the specified exposure time is n video lines, making the real exposure time equal to

$$\text{Exposure Time} = \begin{cases} (n+1) * 32.5 \mu\text{s} + 25.6 \mu\text{s} & \text{Dual Tap} \\ (n+1) * 58.1 \mu\text{s} + 25.6 \mu\text{s} & \text{Single Tap} \end{cases}$$

When $n=0$, the exposure time is the minimum exposure time. It is equal to:

$$\text{Minimum Exposure Time} = \begin{cases} 58.1 \mu\text{s} (1/17000\text{s}) & \text{Dual Tap} \\ 83.7 \mu\text{s} (1/12000\text{s}) & \text{Single Tap} \end{cases}$$

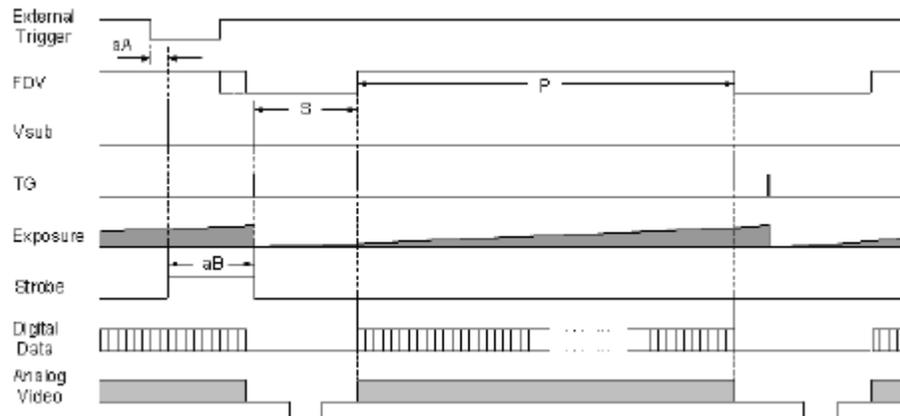
In this mode the maximum exposure time is equal to the setting for one frame. If the user specified exposure time is longer than the time allowed for one frame, it will be ignored by the camera.

3.3.3 Asynchronous No Shutter Mode

In Asynchronous No Shutter Mode, applying the external trigger starts a camera scan reset. The camera finishes the line it is scanning and scans an additional 9 video lines, this charge is sent to the horizontal register.

Because the external trigger is randomly applied, the new image charge may overlap with the previous image. To prevent an existing charge accumulation from interfering with a new image, most users set up the application in a dark area and depend on a strobe light for illumination. From the time the external trigger activates until the transfer gate turns off, about 9.5 video lines are available for integration; if everything is properly configured, the strobe flashes during this time.

Figure 21. External Trigger Timing.



3.3.4 Asynchronous Programmable Exposure Mode

In Asynchronous Programmable Exposure Mode, when an external trigger is applied, the exposure starts after one discharge signal (V_{sub}), which happens after the trigger's active edge is off. Because the discharge signal (V_{sub}) synchronizes with LDV in this mode, there is a maximum one video line of jitter between the trigger active edges to discharge signals (V_{sub}) off. In this mode, the exposure time from 1 video line to 2080 video lines can be controlled through serial communication commands in one video line steps. In this mode, the minimum exposure time is equal to 1 video line plus overhead: the maximum exposure time is equal to 2080 video lines plus overhead. Where the specified exposure time is n video lines, the real exposure time is equal to:

$$Exposure\ Time = \begin{cases} (n + 1) * 32.5\mu s + 25.6\mu s & \text{Dual tap} \\ (n + 1) * 58.1\mu s + 25.6\mu s & \text{Single tap} \end{cases} \quad (n = 0, 1, \dots, 2079)$$

When $n=0$, the exposure time is minimum exposure time. It is equal to:

$$Minimum\ Exposure\ Time = \begin{cases} 58.1\mu s \ (1/17,000s) & \text{Dual tap} \\ 83.7\mu s \ (1/12,000s) & \text{Single tap} \end{cases}$$

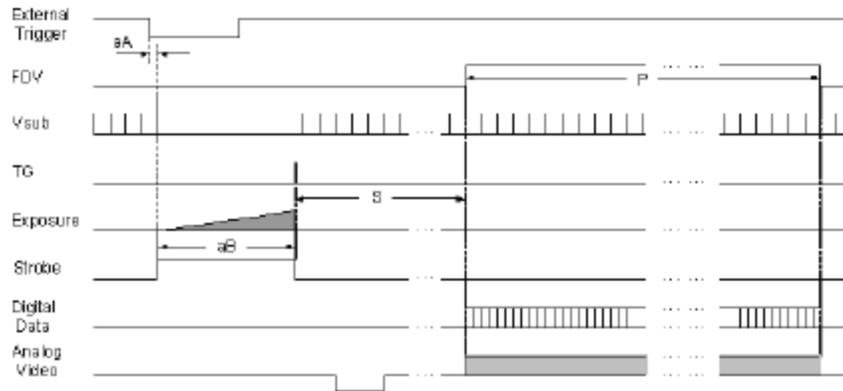
When $n=2079$, the exposure time is maximum exposure time. It is equal to:

$$Maximum\ Exposure\ Time = \begin{cases} 67625.6\mu s \ (1/15s) & \text{Dual tap} \\ 120873.6\mu s \ (1/8s) & \text{Single tap} \end{cases}$$

When $n=2079$, the exposure time is maximum exposure time. If the exposure time is less than the time available for one frame, the maximum trigger frequency is equal to 1/1 frame time. If the exposure time is longer than the time available for one frame, the maximum trigger frequency is equal to 1/exposure time.

The minimum active period of the external trigger is $5\mu s$.

Figure 22. Asynchronous Programmable External Trigger



3.3.5 Pulse Width Control Mode

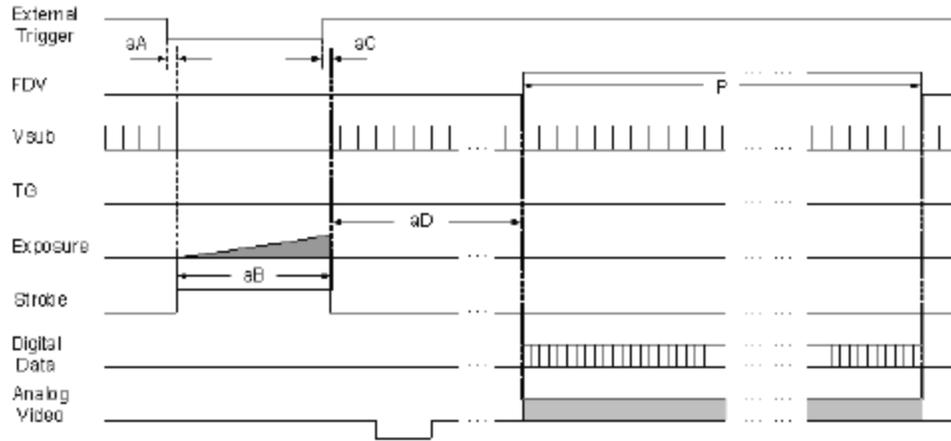
In Pulse Width Control (PWC) Mode, the exposure time is controlled by the external trigger. When an external trigger is applied, one discharge signal (V_{sub}) is generated right after the active edge of the trigger. The exposure starts when the discharge signal is in the off state. The exposure is off following the trigger active off. Exposure time is controlled by the pulse width of the external trigger. Because the CCD requires some overhead from trigger active off to the transfer gate event, the actual exposure time is equal to:

$$Exposure\ Time = Pulse\ Width + 20.6\mu s$$

Since one discharge signal (V_{sub}) is generated right after the active edge of the trigger, it is asynchronous with LDV, and the discharge signal may happen during an active video transfer period, visible reset noise may show in the current image. To avoid reset noise, the maximum trigger frequency in PWC mode should be less than $1/(exposure\ time + one\ frame\ transferring\ time)$.

The minimum active period of the external trigger is $5\mu s$. Theoretically, the maximum active period of the external trigger is unlimited. But, since images obtained at $25^\circ C$ are often very degraded due to thermal noise, it is recommended the active period of the external trigger be no longer than one second.

Figure 23. Pulse Width Control Trigger

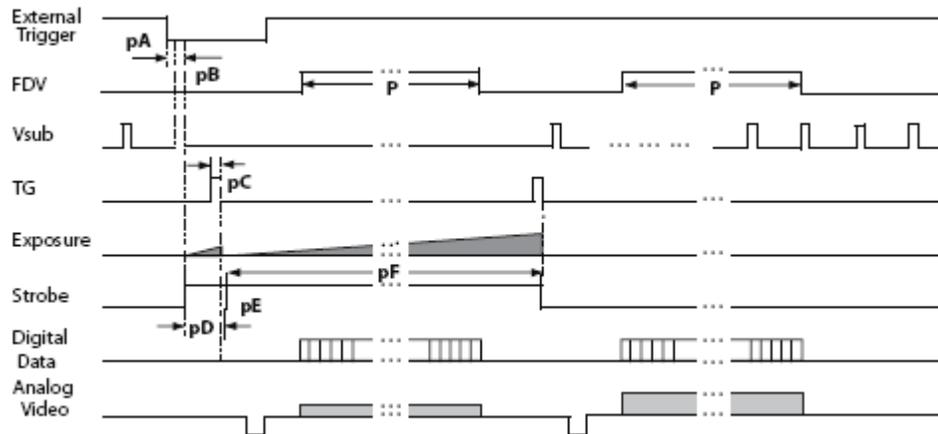


3.3.6 Particle Imaging Velocimetry Fixed Exposure Mode

In Particle Imaging Velocimetry (PIV) Fixed Exposure Mode, when an external trigger is applied, the first exposure starts the same as it does in PWC mode. It lasts a very short period (8 μ s). The second time exposure starts during the transferring time of the first image accumulated in the first exposure time. The second time exposure continues until the first image transfers completely. The second image is transferred after the second exposure. There is a short period (500ns) between the first exposure and the second exposure. In order to keep two exposure periods constant, the LDV is reset before the first image is transferred out.

The maximum trigger frequency in this mode is equal to $1 / (\text{transfer time of two frames} + 4\mu\text{s})$. The minimum active period of the external trigger is 5 μ s

Figure 24. PIV Exposure Timing Table



3.3.7 PWC PIV Mode

The PWC PIV mode is based on PIV Fixed Exposure. In this mode, the first time exposure is controlled by the pulse width of the external trigger, which is similar to PWC mode. The real exposure time of the first image is equal to the pulse width of the external trigger.

The maximum trigger frequency in this mode is equal to $1 / (\text{transfer time of two frames} + \text{exposure time of the first image})$.

The minimum active period of the external trigger is 10 pixel clocks (250ns)

Figure 25. PWC PIV Timing Table.

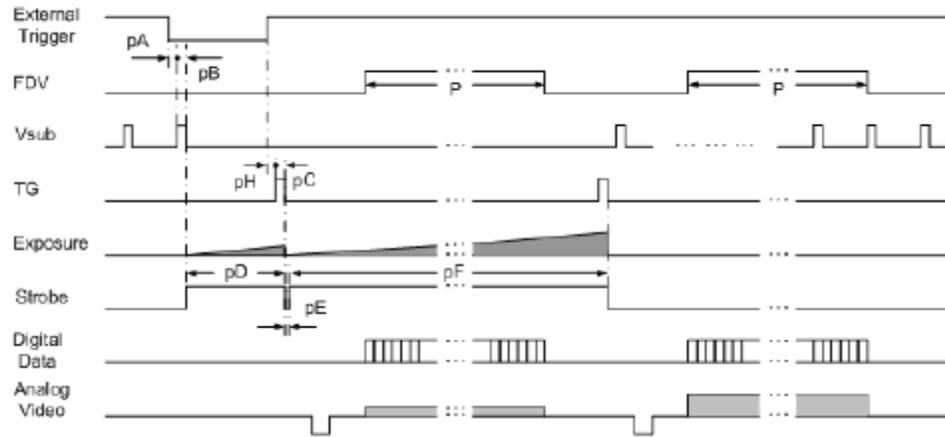


Table 6 Timing Chart

Timing		Scan Mode							Unit
		A	B	C	D	U	T	Z	
tA	dual	1300	1300	1300	1300	1300	728	1924	Unit
	single	2392	2393	2393	2393	2393	1274	3016	
tB	dual	1024	1024	1024	1024	1024	512	256	Pixel Clock
	single	2048	2048	2048	2048	2048	1024	512	
tC	dual	276	276	276	276	276	216	1668	
	single	344	344	344	344	344	250	2504	
tD	dual	176	176	176	176	176	166	800	
	single	176	176	176	176	176	166	800	
tE	dual	100	100	100	100	100	50	868	
	single	168	168	168	168	168	84	1704	
tF	dual	80	80	80	80	80	40	80	
tG	single	224	224	224	224	224	112	224	
tH	A, B, D, D, U and Z: $n \cdot tA + 822$ (n=1, 2, 3, ...) T: $n \cdot tA + 411$ (n=1, 2, 3, ...)							Pixel Clock	
tJ	dual	100	100	100	100	100	50	868	Pixel Clock
	single	166	166	166	166	166	83	1702	
tK		100	100	100	100	100	50	100	
tL	dual	76	76	76	76	76	116	700	
	single	78	78	78	78	78	117	702	
tM		2048	2048	2048	2048	2048	1024	512	
tN		2080	1100	620	385		1040	650	
tP		2048	1000	500	250		1024	512	
tQ		32	100	120	135		16	138	
tR					tU-3				
tS					tW+6				
tT					tH				
tU	dual	16	50	58	61		8	x1: 67	
								x2: 46	
								x3: 25	
								x4: 4	
	single	16	50	58	61		9	x1: 44	
								x2: 30	
							x3: 17		
							x4: 4		
tV	3								
tW	dual	13	47	59	71		5	x1: 68 x2: 89 x3: 113 x4: 131	
	single							x1: 91 x2: 105 x3: 118 x4: 131	

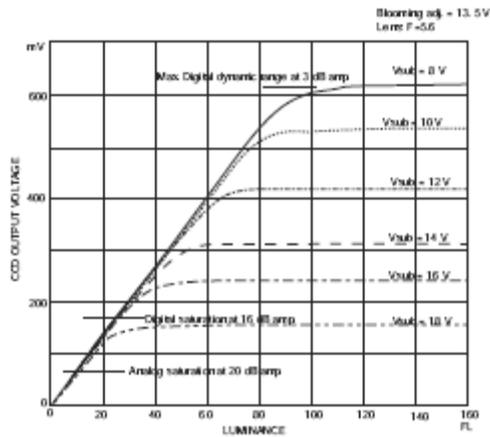
Table 7 Asynchronous Mode Chart

	Async no Shutter	Async Preset and Prog. Shutter	PWC
aA	<1 line	<1 line	6 clk
aB	9.5 line	(n + 1) lines + 1024 clk	Pulse width + 1024 clk
aC			1024 clk

	PIV Fixed Expo	PIV PWC	Unit
pA	6	6	Pixel
pB	200	200	
pC	160	160	
pD	320	320	
pE	20	20	
pF	1	1	Frame

3.4 Dynamic Range Control

Figure 26. Output and Blooming



The typical interline transfer CCD has fixed noise levels based on dark current (thermal or KT noise), pattern noise, and the operating clock speed. In general, the level of the 20 MHz pixel clock CCD at room temperature is around 20 to 50 electrons. The maximum capacity of CCD charges is limited by the well capacity at saturation. The range is limited by the structure and the pixel size.

The RM-4200CL uses a CCD with 7.4 μm x 7.4 μm pixel and two-phase vertical shift register structure. The well capacity is 40,000 electrons. The theoretical dynamic range is 40,000:30 = 1333:1 (60 dB).

A typical CCD camera does not use the full dynamic range due to the nominal gain and the output specification such as RS-170. The typical CCD camera's gain is set at 16 to 22 dB and the RS-170 video level is 714 mV. Using 20 dB gain for the calculation, CCD output is limited to 714/10 = 71.4 mV. Since the CCD's saturation voltage is 400 mV to 500 mV, it uses less than 1/5 of the full dynamic range.

Machine vision and outdoor applications cannot afford to miss image information behind the saturation, which is why the dynamic range adaptation is critical.

3.4.1 Programmable Look-Up Table (LUT) and Knee Control

The RM-4200CL has a built-in LUT (look-up table) for dynamic range control.

At a specific gain setting, the offset (minimum level... dark point) and A/D reference top voltage (maximum level... saturation point) are set to 12-bit A/D input so that the full dynamic range of the CCD is utilized at 12-bit references as the input and the LUT output is converted into either 8-bit or 10-bit to adjust the gamma correction. There is no 12-bit LUT.

The look-up table has two knee points (variable gamma selection) that allow the 10-bit input to be segmented into three regions. The look-up table selection can be made by knee curve direct input.

3.5 External Sync and Pixel Locking

The RM-4200CL accepts an external sync of standard HD and VD at TTL level for general locking to a system sync and clock. The frequency requirement is as follows:

Full Progressive Scan:

$f_{HD} = 30.769 \text{ KHz} \pm 2\%$

$f_{VD} = 14.79 \text{ Hz} \pm 2\%$

(Internal Master clock = 80.00 MHz,

Pixel clock = 40.00 MHz)

1000L Partial Scan:

$f_{HD} = 30.769 \text{ KHz} \pm 2\%$

$f_{VD} = 27.97 \text{ Hz} \pm 2\%$

500L Partial Scan:

$f_{HD} = 30.769 \text{ KHz} \pm 2\%$

$f_{VD} = 49.63 \text{ Hz} \pm 2\%$

250L Partial Scan:

$f_{HD} = 30.769 \text{ KHz} \pm 2\%$

$f_{VD} = 79.92 \text{ Hz} \pm 2\%$

4 Control Software Installation and Use

4.1 Introduction

The Dual-Tap AccuPiXEL series cameras are high-resolution, progressive scan cameras with JAI proprietary LUT control and other excellent features. The software for these cameras was developed to function as standard software for the entire Dual-Tap AccuPiXEL series, and can open either the RS-232 serial port (COM) or Camera Link. Camera Link users must physically install the Camera Link frame grabber board into the PC to which the camera is connected. They must also install the Camera Link API (clserXXX.dll) software. These cameras are specially designed to capture images in progressive scan (non-interlace) format, producing a full frame of electronic shutter images, as well as normal images.

Although this software works with all AccuPiXEL cameras, the interface for the RM-4200CL series appears different from other cameras compatible with this same software, and has various capabilities, depending on the camera model the software is accessing. The 4200CL series includes the RM-4200CL, TM-4200CL (monochrome), RMC-4200CL and TMC-4200CL. The RM-4200CL series software is therefore, specifically documented in this section.

4.2 Software Installation

Following are the instructions to install the Dual-Tap AccuPiXEL series camera-control software on a PC.

4.2.1 Before Installing the Dual-Tap AccuPiXEL Series Camera-Control Software

Please note the following requirements.

- Your computer must be running Microsoft Windows NT 4.0, Windows 2000, or Windows XP.
- The software requires one available communication port that is not in conflict with other peripherals such as the mouse or modem.
- Installation of the software requires 2.4 MB of free space in your PC hard disk.

4.2.2 Installing the Software

To install the Dual-Tap AccuPiXEL series camera-control software, obtain the software from the JAI web site and run "Setup.exe." The installer will direct you to install the application code.

If dual tap software is already installed on your computer, uninstall the software using the steps in the Uninstall section.

Note: The link to the frame grabber must be configured after the new software installation. The program asks for the location.

5. To obtain the Dual Tap software visit the JAI, Inc. web site at <http://www.jai.com>
6. Hover over the Camera Solutions label in the top menu bar and select "Support & downloads > Downloads" from the drop-down menus that appear underneath
7. Scroll through the list to locate any RM-4200CL series camera (list is organized by scan type and color)
8. In the Software download column (far right) click the Dual-tap software listing

Note: The latest version of Dual-Tap AccuPiXEL software will be listed. This manual uses v2.7.0 in its examples. If a later version is downloaded, some of the screens may vary slightly from those shown in the manual.

9. Select either *Open* or *Save* on the install dialog box

Note: The file is compressed, and uses the decompression program installed on your computer. WinZip is used in this example. Windows XP has an unzip capability as part of the operating system.

10. Open the file.
11. Double click on the Setup icon.
 - It is not necessary to decompress the DualTapAccuPiXEL.CAB file

Figure 27. Setup installs Dual Tap AccuPiXel v 2.7.0



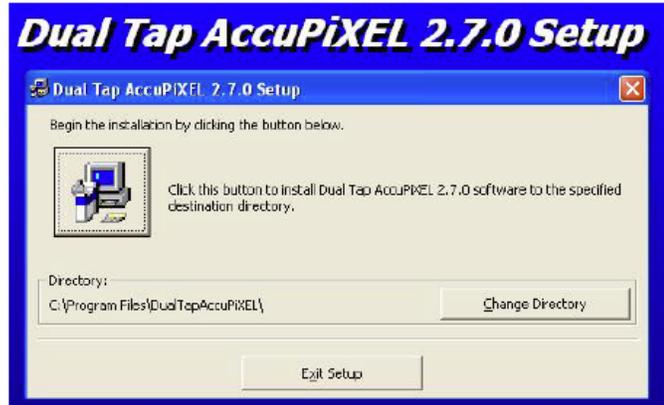
12. 8. Follow the Setup instructions.

Figure 28. AccuPiXel Setup screen



Note: Change the installation directory if desired.

Figure 29. Follow the installation directions



4.2.3 Installing the Camera Link API DLL (clserXXX.dll)

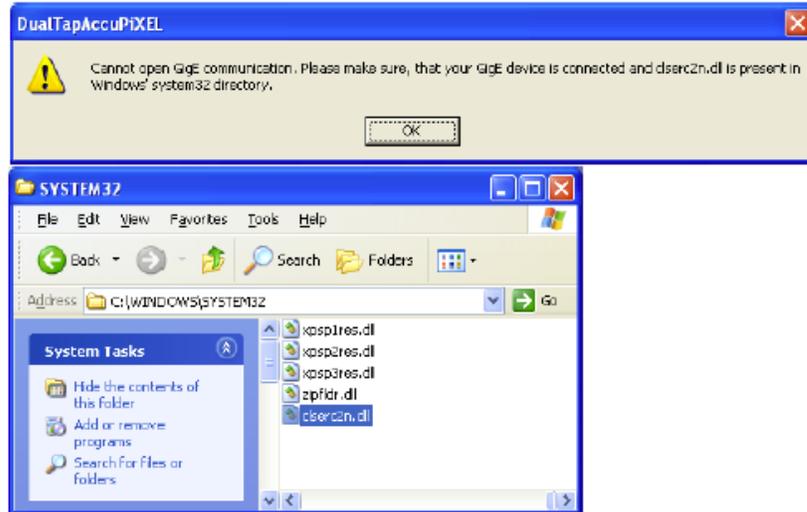
To install the Camera Link control software with frame grabber software, please consult the frame grabber company or JAI, Inc.

4.2.4 Running Dual Tap AccuPIXEL

Click Start=>All Programs=>DualTapAccuPIXEL=>DualTapAccuPIXEL to run the software.

The Dual Tap software fails to start if the frame grabber .dll is missing. This may happen because the link to the .dll is lost, if the previous version of dual tap software was uninstalled, or if a frame grabber has not been installed. If JAI Cam2Net software is being used and was installed with the default pathway, the screen grabber is located at C:\CameraLink. If necessary use the Windows Search feature to find the needed dll file. Probably the most effective search is to look for the .dll extension. Copy the extension and paste it in the required location.

Figure 30. The screen grabber has an essential .dll file.

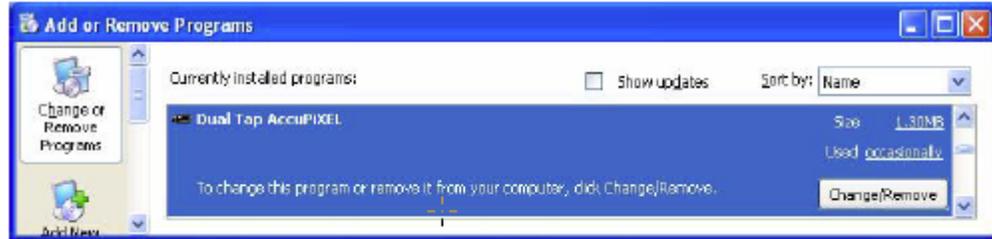


4.2.5 Uninstalling the Software

To uninstall the Dual-Tap AccuPIXEL series camera-control software from the control panel, follow the steps below.

1. Open “Add or Remove Programs” in the control panel.
2. Select *Dual Tap AccuPIXEL* from the lists of the installed software.
3. Click the *Change or Remove* button.

Figure 31. “Add or Remove Programs” utility uninstalls older software.



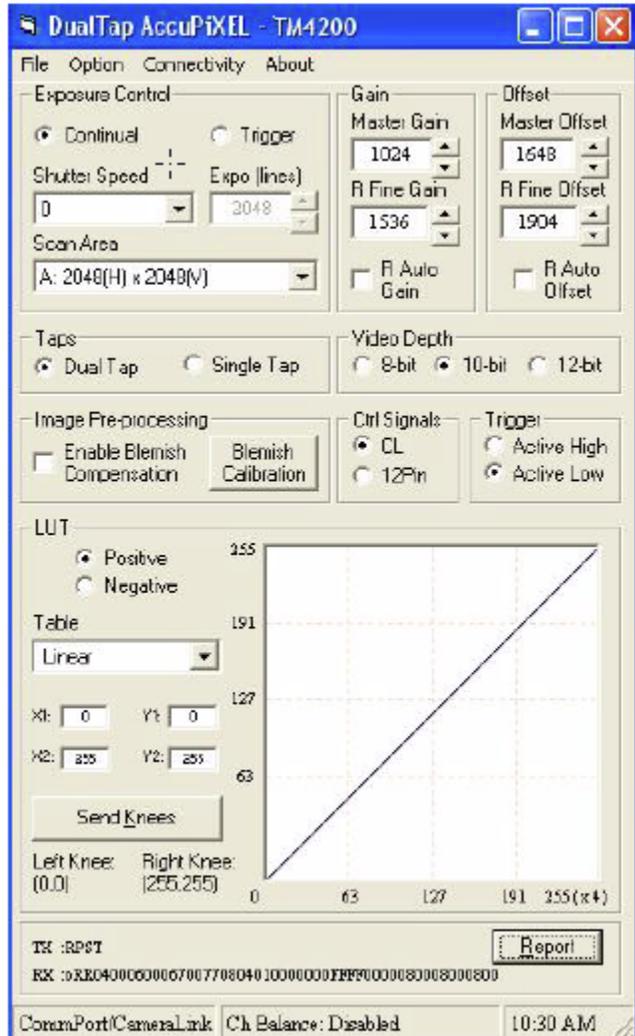
5 Graphical User Interface

5.1 GUI Features

The following is a list of camera functions that PC serial commands control. The Dual-Tap AccuPiXEL series Camera Link cameras use differential serial communication through the Camera Link connector on the rear panel of the camera. The interface shown here is for the RM/RMC 4200 CL cameras.

Figure 32. Main DualTap AccuPiXEL Window

- Exposure Control
 - Continuous
 - Trigger
 - Shutter Speed
 - Expo(Lines)
- Scan
 - Area
 - Mode
- Gain Control
 - Master Gain
 - R Fine Gain
 - R Auto Gain check box
- Offset Voltage
 - Master Offset
 - R Fine Offset
 - R Auto Offset
- Taps
 - Dual Tap
 - Single Tap
- Video Depth
 - 8-bit
 - 10-bit
 - 12-bit
- Image Pre-processing
 - Enable Blemish Compensation
 - Blemish Calibration
- Control Signals
 - CL
 - 12Pin
- Trigger
 - Active High
 - Active Low
- LUT
 - Positive
 - Negative
- Table
 - Linear
- X1: 0 Y1: 0
- X2: 255 Y2: 255
- Send Knees
- Left Knee: (0,0) Right Knee: (255,255)
- Production
- Report



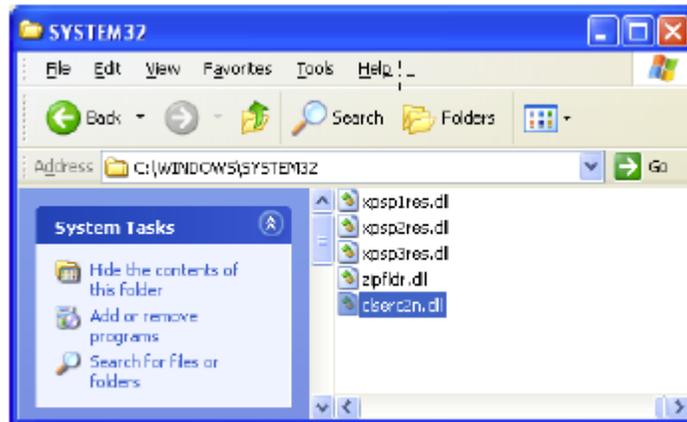
5.2 Using the CamLink Mode

- When CamLink mode is selected, the camera searches for the DLL to the frame grabber. Click the GO button. Choose the dll for the desired frame grabber.

Figure 33. Setting up CamLink



Figure 34. Choose the desired frame driver .dll



- If the frame grabber that corresponds to the dll is not present, an error message displays.

Figure 35. An error message appears if the .dll application is missing.



- Click Start=>All Programs=>DualTapAccuPiXEL=>DualTapAccuPiXEL to open the Dual Tap software.

5.2.1 GigE Mode

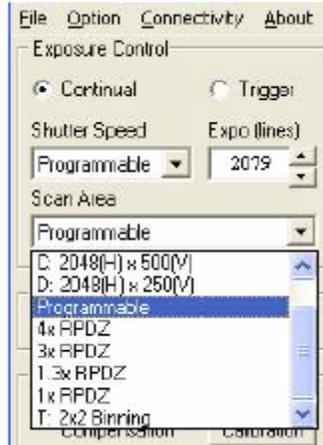
GigE mode is not supported for CL cameras.

5.3 Operating The Control Software

5.3.1 Check Current Camera Setting

Click the “Report” button to get the current camera setting from the camera. The Report button also queries for the camera’s current settings and refreshes the screen. To read the detailed report, refer to the Table 8 for existing codes.

Figure 39. To use Programmable shutter speed, select Programmable:



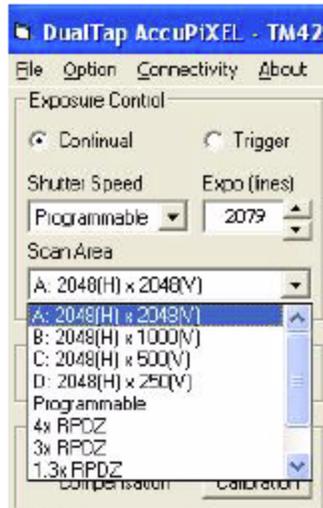
5.3.2.2 Expo (lines)

The Expo (lines) selection of the Exposure Control frame determines how long the shutter remains open, since a certain amount of time is allotted to expose each line. A minimum of one line of pixels must be exposed. The maximum number of lines is 2079 in Trigger mode. Continual mode is limited to the size of the frame. Enter the number of lines desired either by clicking on the arrows in the interface, or by inputting a number directly into the box beside the “Expo (lines)” box.

5.3.2.3 Scan Area

Changing the scan area affects the image resolution. If desired, the size of the scan area can be selected from the drop-down list box. When the Scan Area setting is used to designate the number of lines, the rest of the Exposure Control frame is disabled.

Figure 40. The Scan Area drop down box.

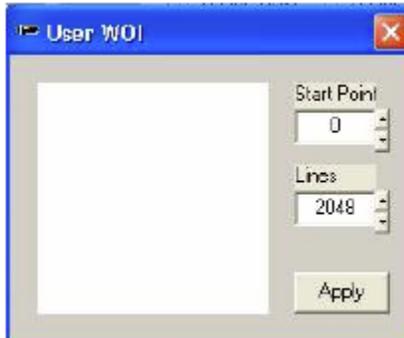


Scan area can vary from a, b, c, or d, to Programmable, and various RPDZ levels.

Figure 41. Enter the starting line number for a programmable scan.



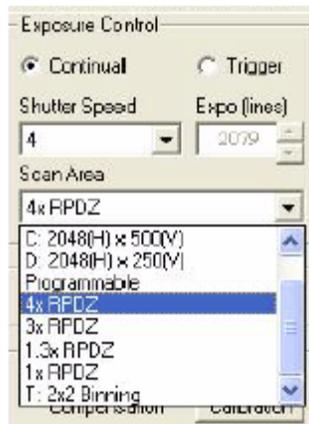
Figure 42. Click the Apply button after programming the scan.



5.3.2.4 Resolution Proportional Digital Zoom

The RPDZ control allows the user to zoom in on a specific portion of the CCD. For a more detailed explanation see Section 3.2.4 “Resolution Proportional Digital Zoom”.

Figure 43. RPDZ Selection



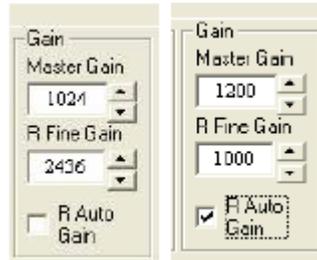
5.3.3 Gain Control

5.3.3.1 Gain

Gain controls the brightness of an image. If the gain number is increased, (for example, 1000 to 2000) the image becomes brighter. If the gain number is decreased, the image becomes dimmer. The Gain Control box allows you to change the Gain value.

When R Auto Gain is checked the camera automatically sets the gain. While the camera is setting the gain the user interface is disabled. Once the gain is set the checkbox clears. Be careful not to send other configuration commands during this process because the camera may not receive the commands.

Figure 44. Gain is being set if the R Auto Gain box appears checked.



5.3.4 Offset Voltage

Offset is changed by raising or lowering the number in the “Master Offset” or “R Fine Offset” box either by clicking on the arrows or typing a new value in the box.

Checking the “R Auto Offset” checkbox causes the camera to automatically adjust the offset. The camera continues to adjust the offset unless the user un-checks the auto offset; in that case the offset is left off.

When the offset is changed the software does not confirm the new setting with an acknowledgement. It is necessary to click on the “Report” button to refresh the screen if you want to confirm the new setting.

Figure 45. R Auto Offset box is checked only while the camera sets the command.



Tap Selection:

The RM-4200CL is capable of Dual-Tap or Single-Tap operation. Click the option button for the operation you prefer. Single-Tap operation does not support the higher data rate permitted by the Dual-Tap output.

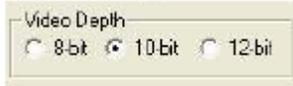
Figure 46. Click the corresponding option button to set the tap.



5.3.5 Video Depth

Use the option buttons to select 8-bit, 10-bit, or 12-bit output.

Figure 47. Click the option button to select Video Depth.



5.3.6 Image Pre-Processing

Cover the lens with the lens cap before enabling the blemish calibration. To activate blemish compensation click the "Blemish Calibration" button and then check the "Enable Blemish Compensation" check box. The blemish compensation activates.

Note: Blemish Calibration is necessary only after a camera has been powered off and restarted. Once enabled, blemish compensation remains active unless the user unchecks the "Enable Blemish Compensation" checkbox.

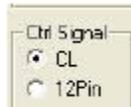
Figure 48. Checking "Enable Blemish Compensation" activates Image Pre-Processing.



5.3.7 Ctrl Signals

Use the option buttons to select the control signal that matches your cabling setup, either CL or 12Pin

Figure 49. Set "Ctrl Signal" by clicking the option button matching your cabling.



5.3.8 Trigger

Use the option buttons to select either Active High or Active Low.

Figure 50. Set "Trigger" by clicking the desired option button.



5.3.9 LUT (Look-Up Table)

The Knee Control box allows you to set your own knee value to each LUT.

5.3.9.1 Positive or Negative LUT Selection

The LUT control panel allows you to select the positive or negative LUT. Choosing "Positive" provides a normal image. Choosing the "Negative" option causes the image to appear reversed, as in a film negative.

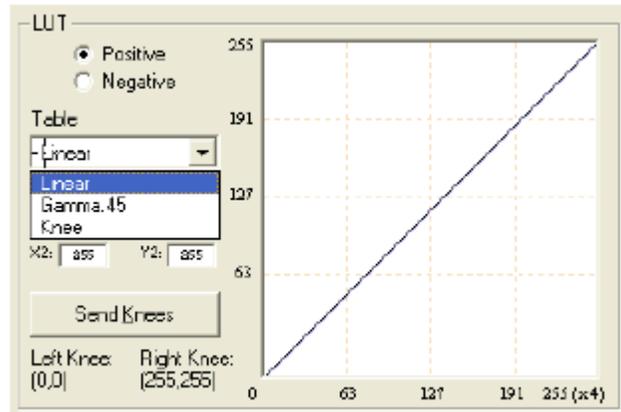
Figure 51. Set “Positive” or “Negative” LUT.



5.3.9.2 LUT (Look-Up Table) Table Selection

The LUT Table drop-down box offers Linear, Gamma .45 or Knee selections.

Figure 52. Table drop down menu:

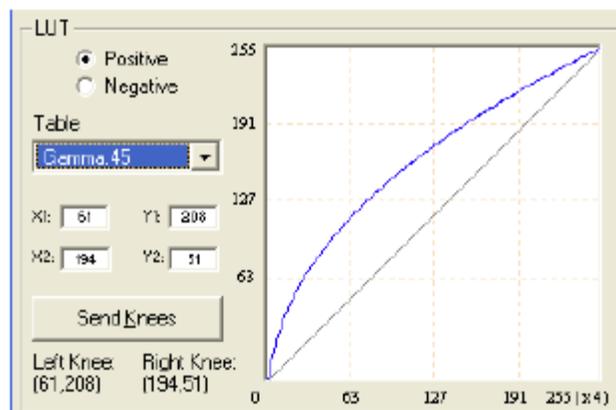


The Table drop down menu offers three options.

The Linear option gathers light in a proportional manner. In this particular selection the LUT is configured to speed the light gathering capability at the beginning of the exposure.

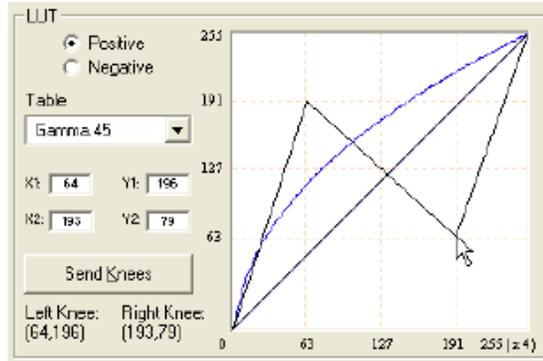
The Gamma.45 option is designed to cause the camera to gather light for a result very similar to what the human eye sees. The heavier curved blue line represents the Gamma.45 LUT adjustment.

Figure 53. Gamma.45 imitates human eye sensitivity when creating an image.



The knee setting allows two adjustments in the light gathering configuration of the LUT to permit the camera to correct images as they are captured. It is possible to set knees on any of the drop down settings by clicking on the existing curve and moving it to the desired configuration. If a drop-down menu setting is selected without adjusting the knees, the camera sets the default.

Figure 54. The knee setting activates when “Send Knees” is clicked.



5.3.9.3 Knee Control

The Knee Control graphical control allows you to change two knee point values visually by clicking and dragging the “knee line.” You may also enter X1, Y1, X2, Y2 values directly to adjust the knee curve. When you have chosen the value you want and are ready to set this value to the camera, click the “Send Knees” button.

5.3.10 Report Section

The report frame on the bottom of the DualTap AccuPiXEL window provides information about the current settings. The report usually shows the last action, so you can verify at a glance if the camera received a command. After taking an action, such as Send Knees, go to the bottom of the Dual Tap AccuPiXEL RM-4200 screen and click on the Report button. The frame updates to show the most recent action carried out by the camera.

Figure 55. The report frame shows the recent camera actions.



To check the entire configuration click on the report button and note the string that appears. To read this string refer to “RM-4200CL Command Response Table” on page 53.

Figure 56. A table helps users understand the report screen.



5.3.11 Main Menu: “Option”

5.3.11.1 Password

Please contact JAI, Inc. for password access. The password allows access to the EEPROM to rewrite factory default settings.



5.3.11.2 Test Pattern

From the main menu, select “Option” and click ‘Test pattern’ to enable or disable the test pattern

Figure 57. Use the “Option” menu to access the test pattern.



5.3.11.3 Pixel Output Order

Figure 58. Use the “Option” menu to access the video output order.



From the main menu, select “option” and “Video data output order” and click “<--- <---” or “<--- --->” or “<<--- ---”

“<--- <---” = First video data are pixel no. 1 and no. 1025.

“<--- --->” = First video data are pixel no. 1 and no. 2048.

“<<--- ---” = First video data are pixel no. 1 and no. 2.

5.3.12 EEPROM

Dual-tap AccuPiXEL cameras have seven pages available to restore the cameras’ settings. Page 0 is the factory default page and cannot be edited without a password. Page 1 is power up default. This page will allow you to save default settings for loading at power up.

5.3.12.1 Load Page

From the main menu, select “file” and “load page” and click the page number and load camera setting from EEPROM.

5.3.12.2 Save Page

From the main menu, select “File,” “Save Page,” and click the page number to save the current camera setting to EEPROM.

Note: Page 0 is the factory default page and is protected by password.

5.3.12.3 Read Page

From the main menu, select “File” “Read Page,” and click the page number to read the EEPROM. When you read the page from EEPROM, the current camera setting will not be changed.

5.3.13 Main Menu “Connectivity”

If the camera has a small receive buffer, it is important to set the “Receive buffer is small” option from the Connectivity menu. Otherwise the information in the Report section may display in a manner that can not be understood.

Figure 59. Use the “Connectivity” menu to set buffer size.



5.3.14 Main Menu “About”

Figure 60. The “About” menu provides hardware and software information.



5.3.14.1 Camera Model

From the main menu, select “About” and click “Camera Model” to check the camera information.

5.3.14.2 CPU Firmware Version

From the main menu, select “About” and click “CPU Firmware Version” to check the CPU firmware information.

5.3.14.3 About Control Software

From the main menu, select “About” and click “About Control Software” to check the software information.

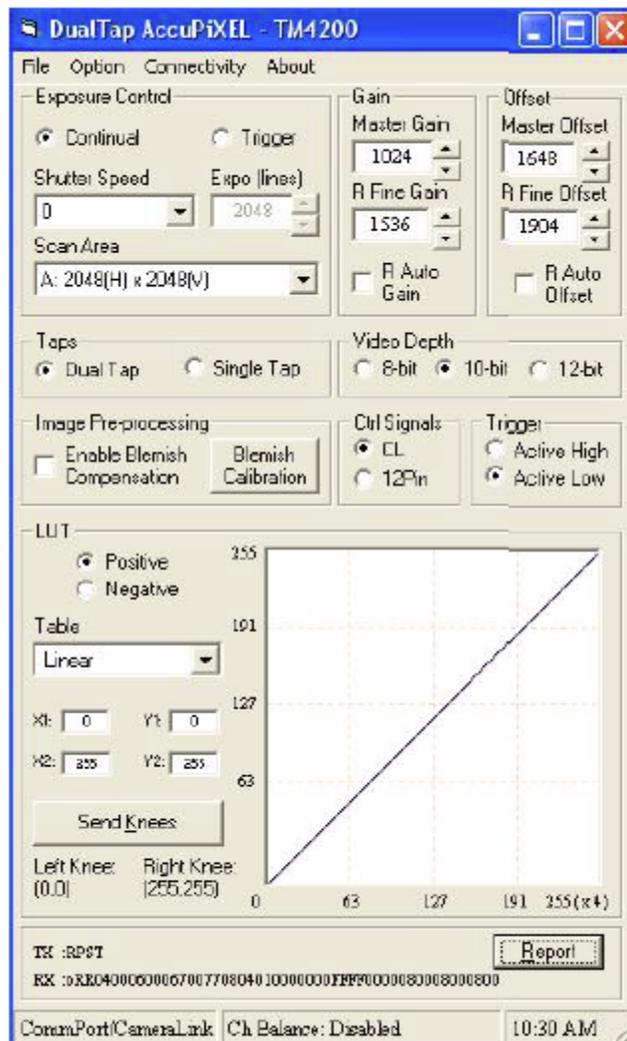
5.3.15 Exit

From the main menu, select “File,” and click “Exit” to exit the software.

6 Serial Communication Kit

6.1 Serial Communication Kit

The Camera Link control software is included in the AccuPIXEL Camera Control software. For a detailed description of the software’s operation, please see the software portion of this manual “Graphical User Interface”.



6.2 RM-4200CL Command List

The LVDS version of this camera can be controlled via RS-232 commands. The Start character is always “:” and the End character is always “CR” (return). For example, to set Asynchronous Pulse Width Mode, send the command :SA9“CR” to the camera. The following table contains RS-232 commands that can be used to control the camera.

Table 8 RM-4200CL Command List

Command	Parameter	End of Cmd	Ack. Response	Description
Scan Mode				
:SMD	X	<cr>	:o<cr>	Set Preset Scan Area (X=A,B,C,D,T)
:SMDZ=	X	<cr>	:o<cr>	Set Digital Zoom (X=0,1,2,3)
:SMDU=	XXXXYYYY	<cr>	:o<cr>	Set Programmable Scan Area (XXX=0000 - 07FF, YYYY=0001 - 0800)
:SMD?		<cr>	:oMD[X]<cr>	Inquire current scan mode (X=A,B,C,D,T,Z,U)
Shutter Mode and Shutter Speed				
:MSH=	X	<cr>	:o<cr>	Set Continuous Mode Preset Shutter (X= 0 - 9)
:DSH=	XXX	<cr>	:o<cr>	Set Continuous Mode Programmable Shutter (XXX=000 - total lines)
:ASH=	X	<cr>	:o<cr>	Set Async Mode Preset Shutter (X=0 - 9, A, B) (X=0 async no shutter, (X=1-8 Preset Shutter, X=9 PWC, X=A Fixed exposure PIV, X=B PWC PIV)
:ADS=	XXX	<cr>	:o<cr>	Set Async Mode Programmable Shutter (XXX=000 - 81F)
:SHR?		<cr>	:o[shtr]<cr>	Inquire current shutter mode
Gain and Offset				
:MGA=	XXX	<cr>	:o<cr>	Set Master Gain (XXX = 000 - FFF)
:MGB=	XXX	<cr>	:o<cr>	Set R channel Fine Gain (XXX = 000 - FFF)
:VRA=	XXX	<cr>	:o<cr>	Set Master Offset (XXX = 000 - FFF)
:VRB=	XXX	<cr>	:o<cr>	Set R channel Fine Offset (XXX = 000 - FFF)
:MGA?		<cr>	:oMG[XXX]<cr>	Inquire Master Gain (XXX = 000 - FFF)
:MGB?		<cr>	:oSG[XXX]<cr>	Inquire R channel Fine Gain (XXX = 000 - FFF)
:VRA?		<cr>	:oMF[XXX]<cr>	Inquire Master Offset (XXX = 000 - FFF)
:VRB?		<cr>	:oSF[XXX]<cr>	Inquire R channel Fine Offset (XXX = 000 - FFF)
Lookup Table				
:LINR		<cr>	:o<cr>	Set linear table
:GM45		<cr>	:o<cr>	Set gamma .45 table
:KNEE=	X1Y1X2Y2	<cr>	:o<cr>	Set knees (X1, Y1, X2, Y2 = 00 - FF)
:NLUT	X	<cr>	:o<cr>	Set Positive Knee or Negative Knee (X = 0 Positive, X = 1 Negative)
:LUT?		<cr>	:o[lut]<cr>	Inquire current LUT setting
Channel Balance				



Command	Parameter	End of Cmd	Ack. Response	Description
:EABL		<cr>	:oAB0<cr>	Enable Gain Balancing
:DABL		<cr>	:o<cr>	Disable Gain Balancing
:ABL?		<cr>	:oAB[X]<cr>	Check Gain Balancing Status (X = 1 Enable, X = 0 Disable)
:ACL=	X	<cr>	:o[AC][X]<cr>	Enable/Disable Optical Black Balancing and Inquire Status (X = 0 Disable, X = 1 Enable, X = ? Inquire Status)
Vsub				
:DCI=	XXX	<cr>	:o<cr>	Set Vsub (XXX = 600 - D00)
:DCI?		<cr>	:oDC[XXX]<cr>	Inquire Vsub (XXX = 600 - D00)
EEPROM				
:WRPG	X <	cr>	:o<cr>	Write Page (X = 0 - 6) (Unlock the Password first if writing to page 0) (Page 0 is the factory default setting, Page 1 is the power up default setting)
:LDPG	X	<cr>	:o<cr>	Load Page (X = 0 - 6)
:RDPG	X	<cr>	:o[settings]<cr>	Read Page (X = 0 - 6)
:RPST		<cr>	:o[settings]<cr>	Report Current Settings
Dual Tap Digital Video Output Order				
:VDO	X	<cr>	:o[VD][X]<cr>	Set Dual Tap Digital Video Output Order (X = A, B, C, ?) (A <---<---, B <---<--->, C <---<--->, ? Inquire video output order)
Image Pre-processing				
:BLC=	0	<cr>	:o<cr>	Set White Blemish Calibration Flag
:EBL=	X <	cr>	:o[BL][X]<cr>	Enable/Disable Blemish Compensation and Inquire Status (X = 0 Disable, X = 1 Enable, X = ? Inquire Status)
Miscellaneous				
:DUL=	X	<cr>	:o<cr>	Single Tap/Dual Tap Selection (X = 0 Dual Tap, X = 1 Single Tap)
:DDP=	X	<cr>	:o<cr>	Set Output Data Depth (X = 0 8-bit, X = 1 10-bit, x = 2 12-bit)
:CCS=	X	<cr> :	o<cr>	Select Camera Control signals (X= 0 CL Conn, X = 1 Hirose Conn)
:TAH=	X	<cr>	:o<cr>	External Trigger Polarity (X = 1 Active High, X = 0 Active Low)
:TPTN	X <	cr>	:o<cr>	Enable/Disable Test Pattern (X = 1 Enable, X = 0 Disable)
:CAM?		<cr>	:o[model]<cr>	Inquire Camera Model
:VER?		<cr>	:o[version]<cr>	Inquire MPU firmware version
:SGE=	X	<cr>	:o<cr>	Set Digital Output Interface (X = 0 CameraLink, X = 1 GigE)

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Command	Parameter	End of Cmd	Ack. Response	Description
:CCD=	X <	cr>	:o<cr>	CCD information (X = 1)
:PuLX	X	<cr>	:o<cr>	Password (X = 1 Administrator, X = 0 Users)

Note: If a command is not accepted for any reason, the camera will return a “nack” response. “:e” <cr> *Not available yet.

Table 9 RM-4200CL Command Response Table

Command	Parameter	End of Cmd	Description
Byte 1, 2	Master Gain		Master Gain (H'0000 - H'0FFF: -3dB - +12dB)
Byte 3, 4	R Channel Fine Gain		R Channel Fine Gain (H'0000 - H'0FFF)
Byte 5, 6	Master Offset		Master Offset (H'0000 - H'0FFF)
Byte 7, 8	R Channel Fine Offset		R Channel Fine Offset (H'0000 - H'0FFF)
Byte 9	Function Flag 0		
	Bit 0	Scan Area 0	0000=2048x2048 0001=2048x1000 0010=2048x500 0011=2048x250
	Bit 1	Scan Area 1	0100=2x2 binning of 2048x2048 1111=User Programmable Scan Area
	Bit 2	Scan Area 2	1000=Digital Zoom x1 1001=Digital Zoom x2
	Bit 3	Scan Area 3	1000=Digital Zoom x3 1001=Digital Zoom x4
	Bit 4	Rsvd	
	Bit 5	Rsvd	
	Bit 6	Pixel Output Order 0	00=<----- 01=<----->
	Bit 7	Pixel Output Order 1	10=<-----
Byte 10	Function Flag 1		
	Bit 0	Shutter 0	Continuous Mode: 0000 - 1001=Continuous preset shutter 0 - 9
Byte 10	Bit 1	Shutter 1	Trigger Mode:
	Bit 2	Shutter 2	0000=Async no shutter 0001 - 1000=Async preset shutters 1-8
	Bit 3	Shutter 3	1001=PWC 1010=PIV Fixed Exposure 1011=PIV PWC
	Bit 4	Shutter Mode 0	00=Continuous Preset Shutter 01=Trigger Preset Shutter
	Bit 5	Shutter Mode 1	10=Trigger Programmable Shutter 11=Continuous Programmable Shutter
	Bit 6	Data Depth	0 00=8bit 01=10bit
	Bit 7	Data Depth 1	10=12bit
Byte 11	Function Flag 2		
	Bit 0	Look-up table 0	00=Linear 01=Gamma.45
	Bit 1	Look-up table 1	10=User Knee Table
	Bit 2	Rsvd	
	Bit 3	Camera Control Signals	0=CameraLink Connector 1=Hirose 12pin Connector
	Bit 4	Rsvd	
	Bit 5	Trigger Signal Polarity	0=Active Low 1=Active High
	Bit 6	Dual / Signal Tap	0=Dual Tap 1=Single Tap

Command	Parameter	End of Cmd	Description
	Bit 7	Positive /Negative LUT	0=Positive LUT 1=Negative LUT
Byte 12	Function Flag 3		
	Bit 0	R Channel Auto Fine Gain	0=Disable 1=Enable
	Bit 1	R Channel Auto Fine Offset	0=Disable 1=Enable
	Bit 2	Rsvd	
	Bit 3	Rsvd	
	Bit 4	Blemish Compensation	0=Disable 1=Enable
	Bit 5	Rsvd	
	Bit 6	Password	0=Disable 1=Enable
	Bit 7	Test Pattern	0=Disable 1=Enable
Byte 13, 14	(X1, Y1)		Coordinate for Knee 1 (X1, Y1=H'00 - H'FF)
Byte 15, 16	(X2, Y2)		Coordinate for Knee 2 (X2, Y2=H'00 - H'FF)
Byte 17, 18	Start Line of Programmable Scan Area		Start Line of Programmable Scan Area (H'0000 - H'07FF)
Byte 19, 20	Total Lines of Programmable Scan Area		Total Lines of Programmable Scan Area (H'0001 - H'0800)
Byte 21, 22	Shutter Speed of Programmable Shutter		Shutter Speed of Programmable Shutter (H'0000 - H'081F)
Byte 23, 24	Vsub Voltage		Vsub Voltage (H'0600 - H'0D00=7.8V - 17V)

7 Problems and Solutions

Following are troubleshooting tips for common problems. In general, problems can easily be solved by following these instructions. If the following remedies fail to offer a solution to your problems, please contact a JAI representative.

7.1 Symptom: No Video

Remedies: Check that the following are properly connected and operational.

- Power supplies
- Power cables
- Main power source
- Shutter control
- Async mode
- Lens
- Digital output cable
- Analog video cable

7.2 Symptom: Dark Video

Remedies: Check that the following are properly connected and operational.

- Shutter selection
- Iris opening on the lens

7.3 Symptom: Non-synchronized Video

Remedies: Check that the following are properly connected and operational.

- Proper mode output
- Frame grabber software camera selection

7.4 Information and Support Resources

For further information and technical support:

North American Technical Support

Phone: (408) 383-0300
Email: Camerasales.americas@jai.com

European Technical Support

Phone: +45 4457-8950
Email: camerasupport@jai.com

Japan/Asia Technical Support

Phone: +81 45 440-0154
Email: camerasupport@jai.com

Mail to: JAI, Inc
625 River Oaks Parkway
San Jose, CA 95134

ATTN: Video Applications

8 Appendix

8.1 Specifications

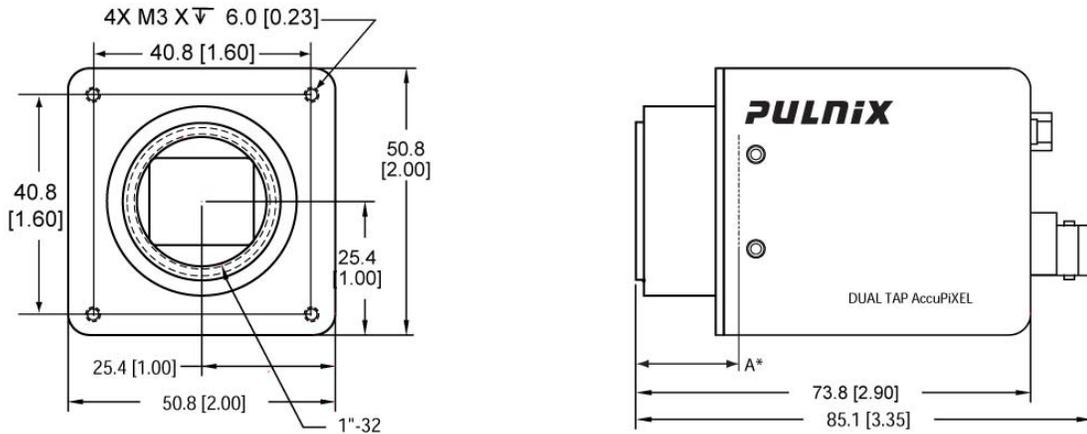
Table 10 RM-4200CL Camera Specifications Table

Feature	RM-4200CL
Imager	1.2" progressive scan interline transfer CCD (KAI-4021)
Active Area	15.15mm x 15.15mm
Active Pixels	2048 (H) x 2048 (V)
Cell Size	7.4µm x 7.4µm
Display Mode (Active Pixels)	A 2048 (H) x 2048 (V) @ 15 Hz B 2048 (H) x 1000 (V) @ 28Hz (partial scan) C 2048 (H) x 500 (V) @ 50Hz (partial scan) D 2048 (H) x 250 (V) @ 80Hz (partial scan) U User-programmable partial scan
Sync	Internal/External auto switch HD/VD, 4.0 Vp-p impedance 4.7K Ω 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	>58dB
Min. Illumination	Monochrome 0.12 lux. f = 1.4 (no shutter) @ 15 fps Color: 0.8 lux. f = 1.4 (no shutter) @ 15 fps Pixel sensitivity: 31µV/e-
Video Output	Analog 714 mVp-p composite video, 75 Ω Digital output 12-bit /10-bit/8-bit single tap/dual tap
AGC	OFF
Gamma	Programmable LUT (Gamma 1.0 std.)
Lens Mount	C, F, M 42 mount (use >1" format lenses)
Power Requirement	12V DC, ± 10%, 520 mA ± 20mA (typical at 25°)
Operating Temp.	-10°C to 50°C*
Vibration	7 Grms (10Hz to 2000Hz) Random
Shock	70G, 11 ms, half-sine
Size (W x H x L)	51mm x 51mm x 74mm
Weight	191 grams (without tripod)
Optional Functions	Internal IR Filter Added (OP3-1); Optical Filter Removal (OP3-2); Glassless CCD Imager (OP21); Glassless UV CCD Imager (OP21-UV)
Optional Accessories	I/O CL cable 26CL-02-26 (2m), 26CL-05-26 (5m) Power Cable 12P-02S Power Supply PD-12UUP series (includes power connector) Tripod Mounting Kit TP-20

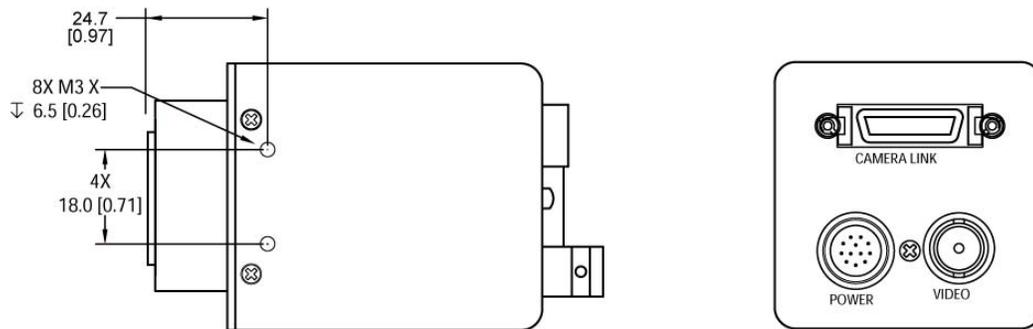
*. Refer to Section 2.2.1 on page 12 for information on camera heat dissipation. Image quality will degrade with increasing temperature.

8.1.1 RM-4200CL Physical Dimensions

Figure 61. Physical Dimensions



*A = 18.0 ± 1.0 mm absolute distance measured to front of lens mount
(Effective flange back distance = 17.53 ± 0.5 mm)



Caution: When mounting the camera to any fixture, do not use screws that extend more than 5 mm into the camera housing to avoid possible damage to the internal circuitry. For attaching the tripod mounting plate, only the supplied screws should be used.

8.1.2 Spectral Response

Figure 62. Monochrome Spectral Response

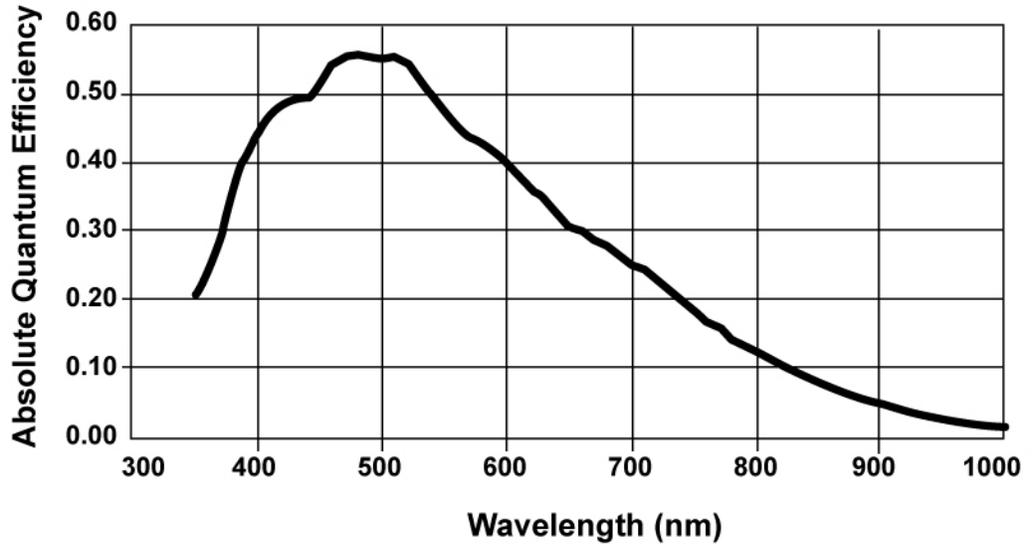
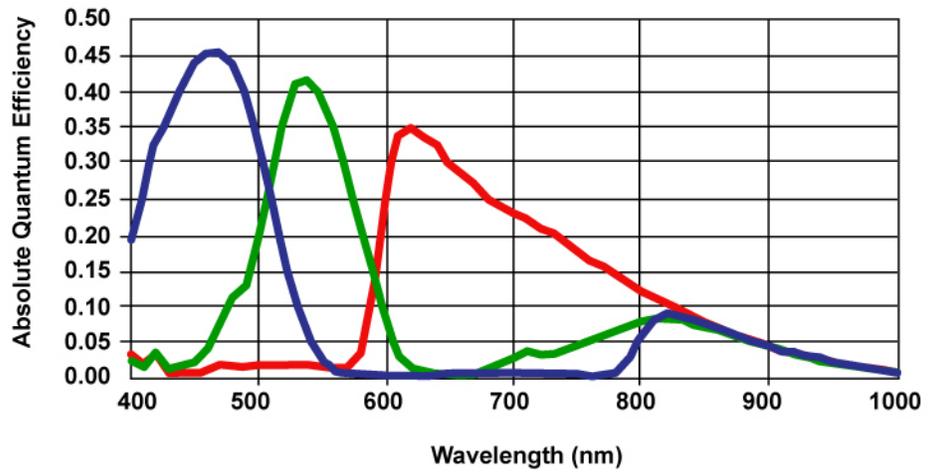


Figure 63. Color Spectral Response



Supplement

This applies to cameras in this manual that are RoHS compliant, which are noted by RM or RMC.

The following statement is related to the regulation on “ Measures for the Administration of the control of Pollution by Electronic Information Products “ , known as “ China RoHS “ . The table shows contained Hazardous Substances in this camera.

 mark shows that the environment-friendly use period of contained Hazardous Substances is 15 years.

重要注意事项

有毒，有害物质或元素名称及含量表

根据中华人民共和国信息产业部『电子信息产品污染控制管理办法』，本产品《有毒，有害物质或元素名称及含量表》如下。

部件名称	有毒有害物质或元素					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PPB)	多溴二苯醚 (PBDE)
外壳	×	○	○	○	○	○
光学滤色镜	×	○	×	○	○	○
.....

○：表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006规定的限量要求以下。
 ×：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006规定的限量要求。
 (企业可在此处、根据实际情况对上表中打“×”的技术原因进行进一步说明。)



环保使用期限

电子信息产品中含有的有毒有害物质或元素在正常使用的条件下不会发生外泄或突变、电子信息产品用户使用该电子信息产品不会对环境造成严重污染或对基人身、财产造成严重损害的期限。

数字「15」为期限15年。

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