TM/TMC-4200GE Progressive Scan Cameras

Operation Manual

10394
Rev. A

JAI®

See the Possibilities

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Warranty

For information about the warranty, please contact your factory representative.

Certifications

CE Compliance

The TM-4200GE camera 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:

Immunity: EN 55024: 1998 + A1: 2001 + A2: 2003
Emissions: EN 55022: 1998 + A1: 2000 + A2: 2003

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Contact JAI Inc. Applications Engineering Department for further information regarding CE compliance.

FCC

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area may cause harmful interference, in which case the user will be required to correct the interference at his own expense.

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.

TM-4200GE Series Operation Manual
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TM-4200GE Software

Operation Manual

1   Software Introduction

1.1   Scope of the Document

This manual describes how to access and use features of the JAI Gigabit Ethernet camera, the TM-4200GE. The camera's different operation modes are described in the hardware section of this manual, which begins on page 31.

The TM-4200GE series consists of the TM-4200GE (monochrome) and the TMC-4200GE (color). Unless otherwise noted, all information contained in this manual is relevant to both models.

1.2   Related Documents

The appendix contains descriptions of the TM-4200GE camera's internal frame grabber and how to connect the camera. The appendix complements, and should be used in conjunction with the three following documents:

- *Cam2Net User's Manual*
- *Cam2Net IP Device Drivers*
- *Cam2Net C++ SDK Reference Manual*

These documents are part of the GigE software package and are added to your system when the software is installed. The software and documents are current for the TM-4200GE series as pertains to Cam2Net.

1.3   Gigabit Ethernet Camera Interface

The GigE interface provides an easy to connect, high-bandwidth imaging solution, where video data is sent as IP packets over an industry-standard GigE network. Point-to-point (unswitched) transmission is up to 100 meters. With Gigabit Ethernet switches, the transmission distance is virtually unlimited.

Software Introduction

Note: *Refer to the section on time-outs and packets in the Cam2Net User's Manual for more information on packet sizes for point-to-point and networked applications.*

Communication with a GigE camera is completely transparent to the user, so if you are used to working with Camera Link® and/or the JAI Cam2Net adapter, you will find it very easy to migrate.

The TM-4200GE camera has internal frame memory, which sends only the actual image data using the Gigabit Ethernet interface.

At the PC, the *Cam2Net Software Development Kit (SDK)* provides a communications interface that maps the RS-232 command channel through the IP link. All commands sent to and received from the camera are transparently routed to and from the host PC using the GigE link.

Refer to the *Cam2Net User's Manual* for details about network requirements, compatibility, and so on.

1.4 Software Installation

The following instructions explain how to install the JAI GigE camera-control software on a PC.

1.4.1 Before Installing the GigE Series Camera-SDK Software

Before installing the JAI GigE camera-SDK software, please note the following requirements.

- The computer must have a Pentium processor running at least 1.4GHZ, with the Microsoft Windows XP Pro or Windows 2000 operating system installed .

- Installation of the software requires approximately 75 MB of free space on the PC hard disk.

1.4.2 Installing the Software

To install the JAI GigE camera-control software, read and follow the directions included in the document download card. If the computer does not have Internet access, call JAI Inc. at 1 800 445-5444 to request the software on a CD-ROM.

Install the software using the following steps:

1. Open the folder "JAI" and run the JAI GigE 2.14.0 Installer.exe file to install the Camera Interface Application.
2. The program initiates a driver scan. Allow the network card driver installation at this time. (If you cancel the installation for some reason this dialog box can be accessed at a later time; go to *Start=>Programs=>JAI AS=>Launch Driver Installation Tool* to launch the driver install).
3. A driver installation tool dialog box displays. Read the message about canceling *found new devices* and then click *OK*.

Software Introduction

FIGURE 1.   Scanning for Drivers
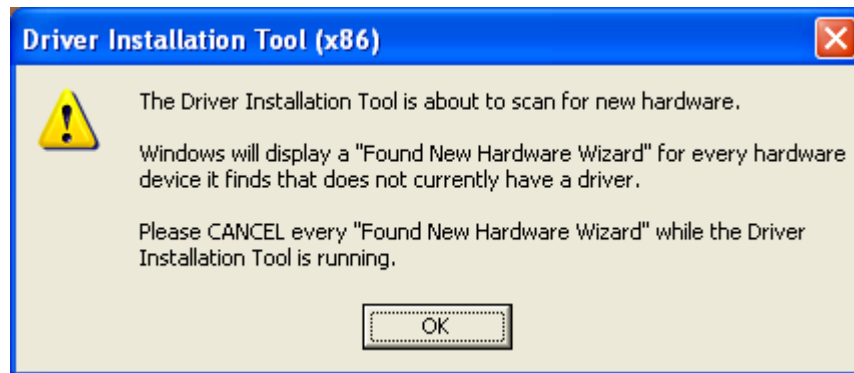
4.   The Driver Installation Tool dialog box appears with a listing of all NIC cards on the system.

5.   Right click on the net driver desired for the camera. If the driver is an Intel Pro a high performance option is available for install.

FIGURE 2.   Intel Pro Install Choices
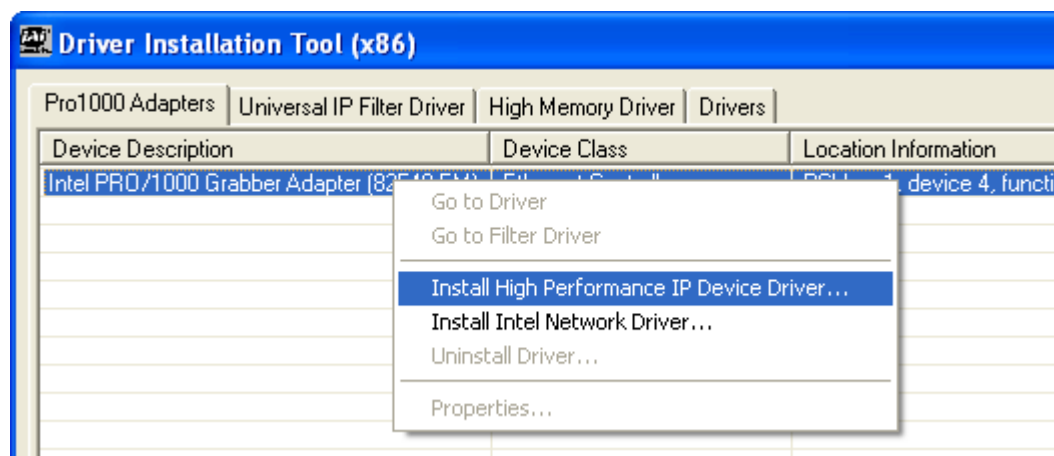
6.   Right click on the net driver desired for the camera.

7.   Select the desired driver install *Install High Performance IP Device Driver* or *Install Intel Network Driver*. The network installation options vary, based on the NIC installed on the system. A dialog box asks for verification of the selected install. Click *Yes*. Follow the instructions on any additional dialog boxes.

8.   For information on other network card installs click ***Start=>JAI A.S=>Cam2Net=>Documenta-tion=>Cam2Net IP Device Drivers***. An Acrobat file is available with instructions to help guide you through the proper install.

9.   Go to ***Start=>Programs=->JAI AS=>Cam2Net=>Launch Coyote application*** to launch the camera control tool.

1.4.3   Uninstalling the Software

To uninstall the JAI GigE camera-control software from the control panel, use the following steps:

1.   Open *Add or Remove Programs* in the control panel.

2.   Select *JAI Cam2Net* from the list of installed software.

Software Introduction

3. Click the *Change or Remove* button as shown in Figure 3 on page 4.

FIGURE 3. Change and Remove Buttons
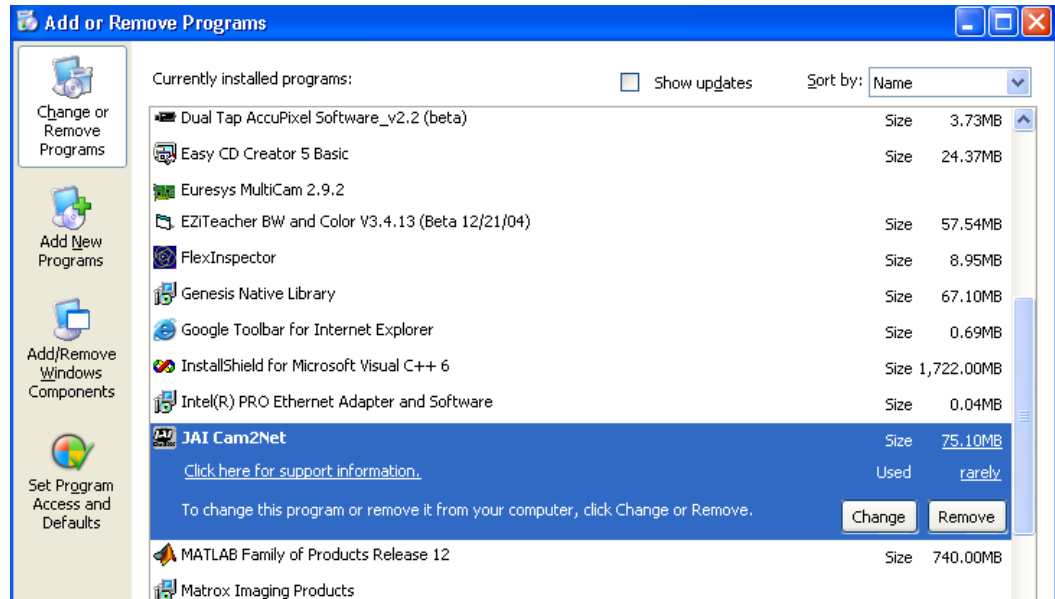
1.4.4 Quick-Start

Use the following quick-start process when the Camera Interface Application is installed on your PC.

1. Connect the camera. The Hirose pin layout is shown in Table 1 on page 6. Both the Hirose and the network cable (RJ-45) are illustrated in Figure 6. Verify that both LED's on the RJ-45 connector are green.

2. Run the Camera Interface Application.

3. Click *Detect*. Assign a suitable IP address to the camera. The window shown in Figure 2 appears.

FIGURE 4. Network Device Finder Window

4. Select the appropriate camera from the list, similar to the window shown in Figure 5 on page 5 and click **OK.**

FIGURE 5. **Select Camera Window**
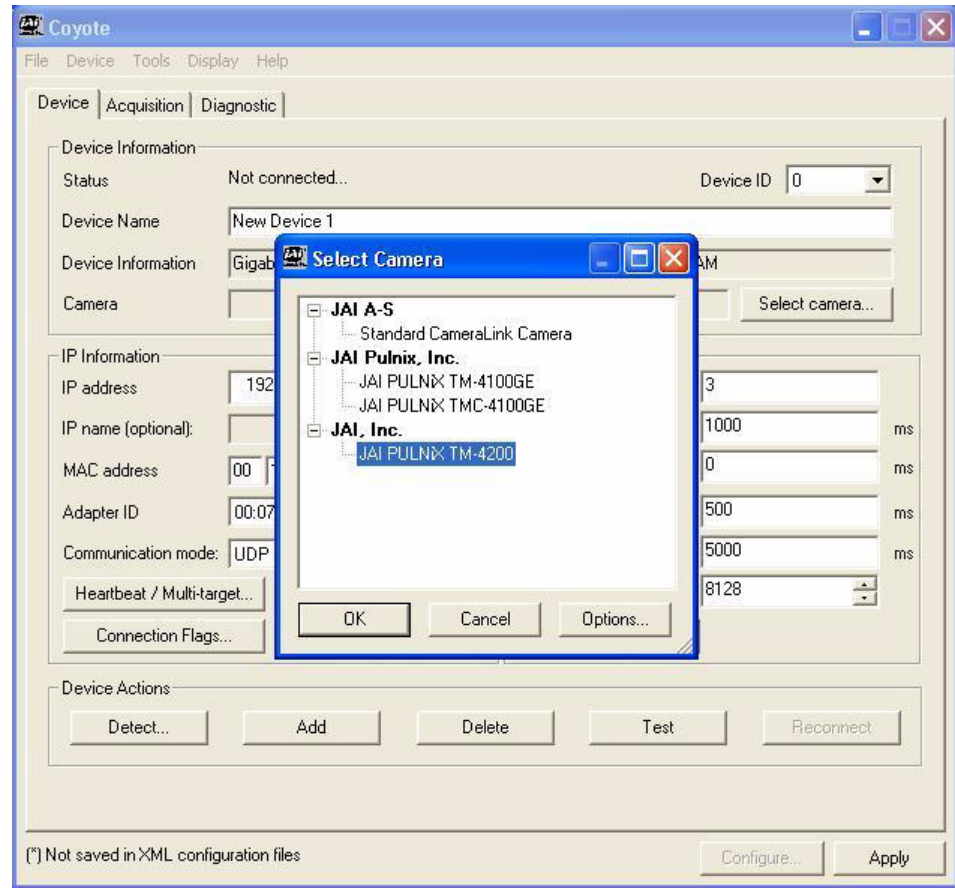
5. Go to the *Acquisition* tab and click *Start*. An image stream should appear.

6. Click on the *Configure* button at the bottom of the Coyote screen, and open the *GigE Camera Software* dialog box. This is your integrated control software.

Note: *The color version (TMC-4200GE) requires that color interpolation be performed in the frame grabber or by using the host computer's CPU. In default mode, the camera supports 2 x 2 color interpolation. For better color performance, the user can select 3 x 3 interpolation in the Camera Interface Application. Return to the* Acquisition *tab of the* Coyote *(previous) screen, and click* Configure*. In the* Advanced Configuration Window*, select the* Pixel Type *tab. Make sure the camera is set to the proper color space and pixel depth, and then click the check-box labeled* Use 3 x 3 Bayer Interpolation *in the* Conversion Options *panel. More information on color interpolation and the color filter array (CFA) can be found in Section 9.2 on page 58 of this manual.*

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2 Connectors

The camera has two sockets, as shown in Figure 6 below:

- 12-pin Hirose for power, trigger, RS-232 communication and TTL I/O.
- RJ-45 for Gigabit Ethernet.

FIGURE 6. TM-4200GE Back Panel Connectors
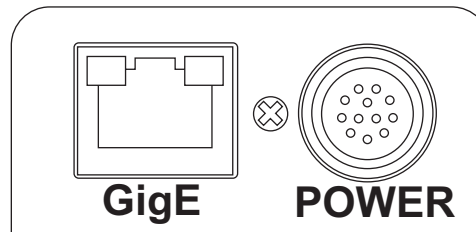
These connectors are described in Section 2.1 and Section 2.2.

2.1 Power and Signals Connector

The GE camera receives power and signal through a 12-pin Hirose connector. Table 1 lists the pin layout and describes the function of each pin. The table lists the GPIO assignments for the relevant pins. A magnified illustration of each pin's assignment follows in Figure 7 on page 7.

TABLE 1. Hirose Connector, Pin Assignment

Pin #	Definition	Description	GPIO Assignment
1	GND	Power ground	
2	+12V DC	Power supply in	
3	GND	Analog ground (video)	
4	Analog Video	For auto iris lens drive	O
5	GND	Ground	
6	Vinit	Vinit	I
7	External VD	I: Standard O: Option	I/O
8	STROBE	Strobe output	O
9	External HD	I: Standard O: Option	I/O
10	Reserved	Reserved	
11	Reserved	Reserved	
12	Reserved	Reserved	

Connectors

FIGURE 7.   HR10A-10R-12P
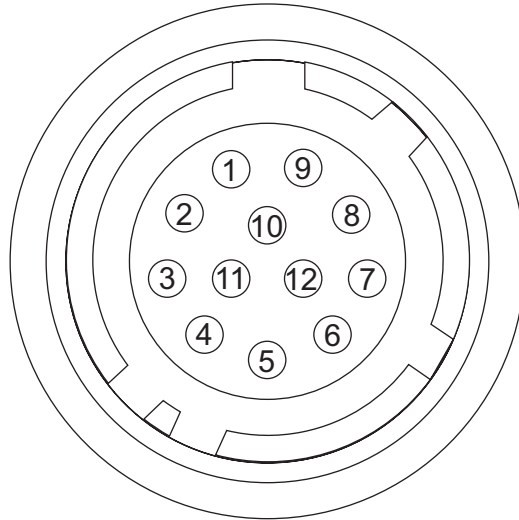
2.2 Ethernet

The GigE socket, marked on the camera's back panel as *GigE*, is a standard RJ-45 Ethernet socket. Use at least cat5e UTP cables (Cat6 cables are preferred). If you wish to connect the camera directly to a PC, you must use a cross-over cable. Refer to the *Cam2Net User's Manual* for details.[1]

FIGURE 8.   Ethernet GigE Socket
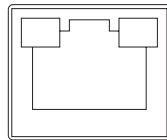
GigE

1. JAI recommends the use of shielded cables to reduce emissions and for CE/FCC compliance. Double-shielded cables further reduce emissions.

Connectors

3   Configuring the TM-4200GE Camera

The configuration of the GigE camera consists of two parts:

- The imager configuration (CCD and control circuits)
- The internal frame grabber configuration

The imager can be configured for partial scan, binning, and so on, just like a Camera Link camera. The internal frame grabber is automatically configured for the pixel type, windowing, image size, I/O and so on, by the GigE camera software.

3.1   Setup

If you have a peer-to-peer connection between the TM-4200GE camera and your PC without network switches, your packet size can be the default value (8128 bytes) as shown in Figure 7. However, if you are connecting the TM-4200GE to your PC through a network switch, then you need to know the maximum packet size that your network switch supports. Typically, if your switch supports jumbo packets, then you should keep the packet size to 8128 bytes. If your switch does not support jumbo packets, then you may need to change the packet size to 1440 bytes.

FIGURE 9.   Camera Interface Application Dialog Box

Note: If you connect the camera through a network switch, you may need to modify the packet size.

To use the integrated GigE camera software, follow these steps:

1. Start the Camera Interface Application (this is the Coyote application used above). The dialog box shown in Figure 9 appears.

2. Click the *Detect* button to detect the device and driver in the "Device Actions" panel.

3. Click *Select Camera* and select TM-4200GE or TMC-4200GE (color) from the camera list.

4. Select the *Acquisition* tab and click *Configure*. The camera configuration dialog box displays.

5. Select the *GigE Camera Software* tab. This is the Integrated GigE Camera Software shown in Figure 11.

The TM-4200GE camera operates in 8-bit, 10-bit, or 12-bit digital output mode. The 8-bit/10-bit/12-bit selection is possible through the GigE integrated software. To select the mode, open the Configure page and select the Pixel Type tab. Under the Pixel Type, select Grayscale 8, Grayscale 10, or Grayscale 12. Note that the LUT (Look-Up Table) is not available when the Grayscale 12, 2 taps mode is selected.

FIGURE 10. Advanced Configuration Window

Configuring the TM-4200GE Camera
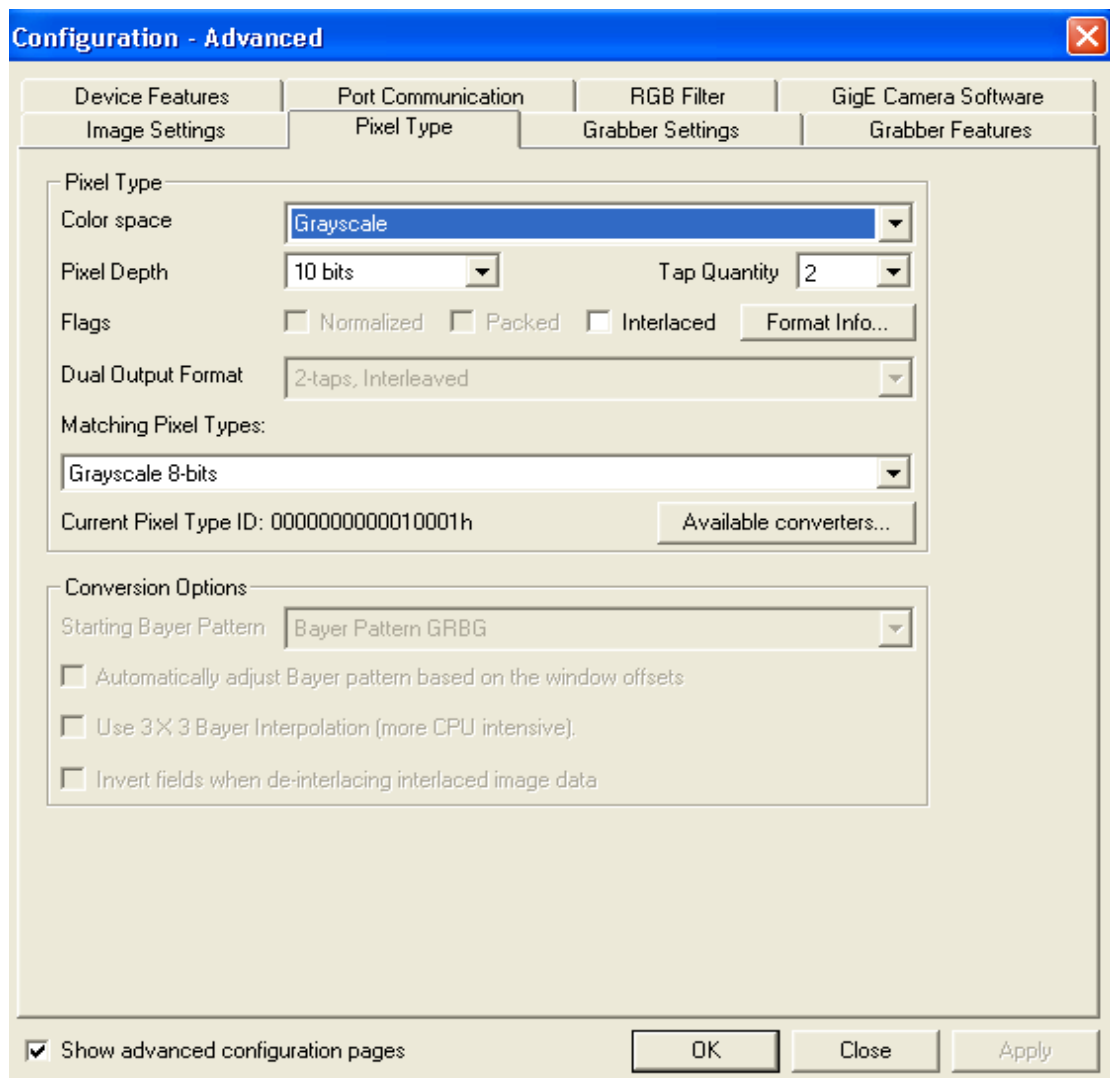
3.2   Configuring the Imager

To configure the TM-4200GE's imager, use the integrated GigE camera software that is part of the Cam2Net Camera Interface Application. You can also use the dual-tap AccuPiXEL GigE control tool, but that will not update any internal grabber settings. See "Hardware Introduction" on page 45 for a description of the different image settings of the camera.

FIGURE 11. Integrated GigE Camera Software
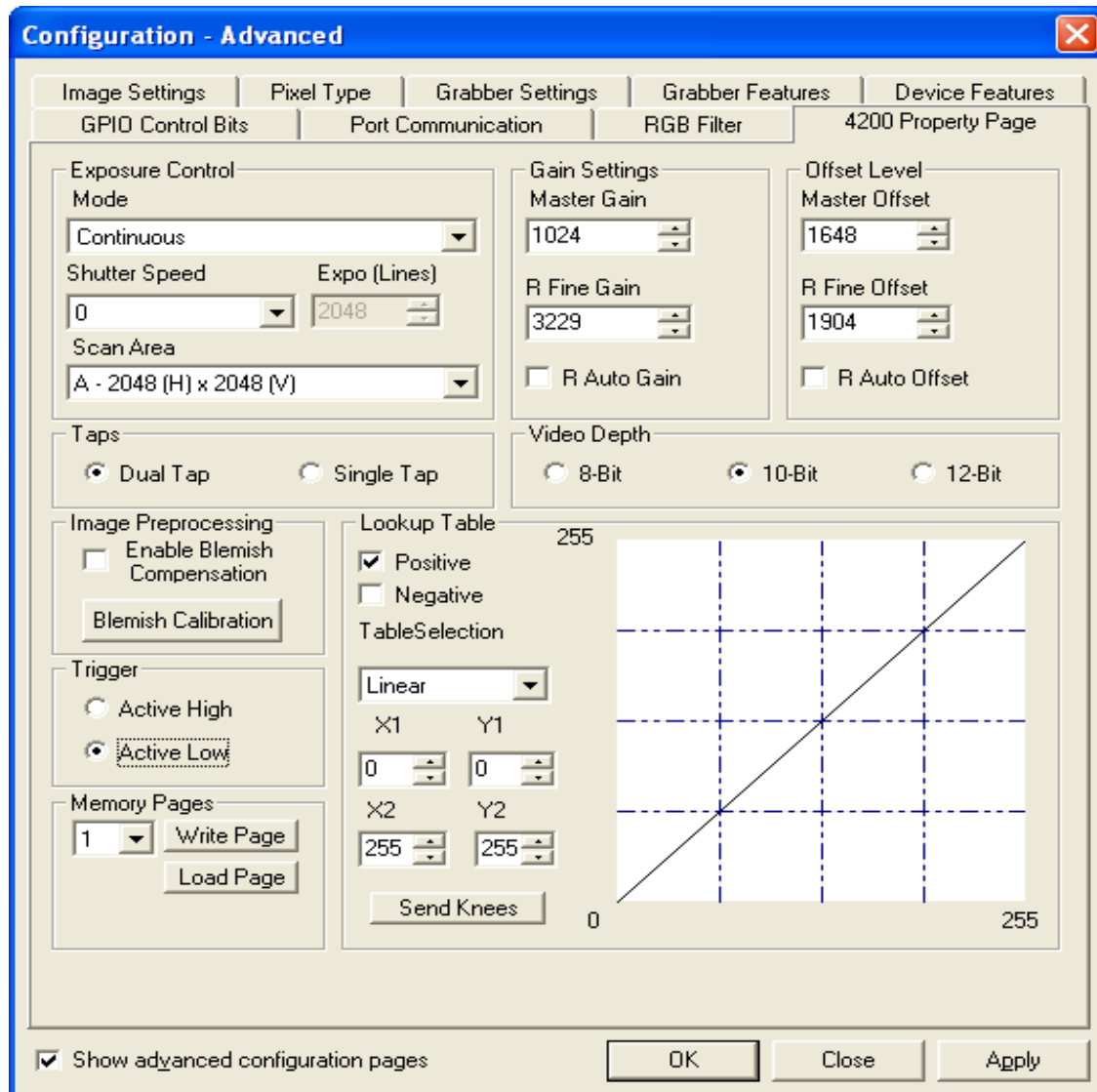
3.2.1   GUI Features

You can control the following camera functions using the integrated camera software.

- Shutter Speed and Mode
- Scan Mode
- Gain Control
- Offset Level
- Memory Pages
- LUT (Look-Up Table) Control
- 8, 10, 12-bit Selectable
- Trigger Input Location and Polarity
- Digital Zoom
- Pixel Compensation

3.3   Configuring the Internal Frame Grabber

The integrated camera software updates the internal frame grabber settings automatically. Also, because the internal frame grabber configuration is independent of the imager configuration, you can set up (that is, "window") the internal frame grabber separately, for example, the Image Settings tab in the integrated camera software. This has the added benefit of reducing unnecessary traffic on the GigE network, and freeing bandwidth for other cameras.

3.4   Modes

This section includes examples of various types of setup actions available through the camera configuration dialog box.

3.4.1   Check the Current Camera Setting

You can manually send camera commands from the *Serial Free Form* tab of the Configuration window shown in Figure 12. Use the serial port and click the *CR* check box. Enter :*RPST* and click *Send* to get the current camera setting. For detailed information about the current camera setting, refer to Table 4 on page 27.

Configuring the TM-4200GE Camera

FIGURE 12. Advanced Configuration - Port Communication
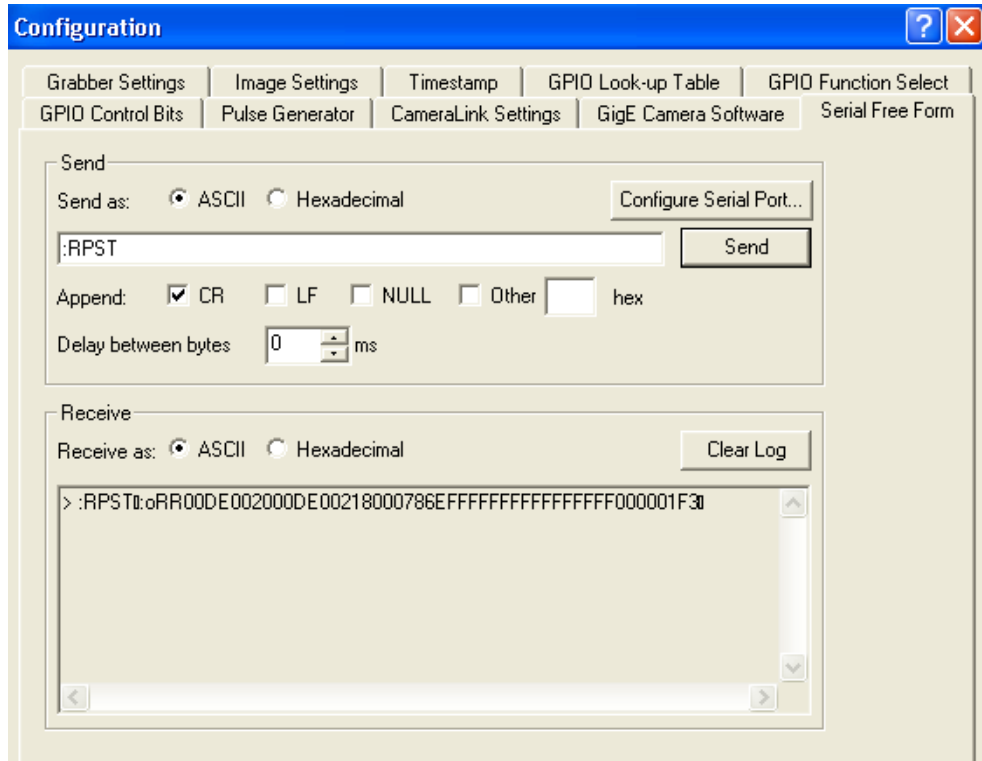
3.4.2 Exposure Control

In Exposure Control, under the GigE Camera software tab, shown in Figure 13, you can specify the shutter mode and set the shutter speed and direct shutter values.

FIGURE 13. Exposure Control
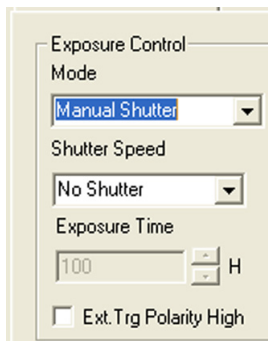
Shutter Mode

The exposure control has two different settings. Select the desired setting using the drop down list box shown in Figure 14.

FIGURE 14. Mode Control Pull-down
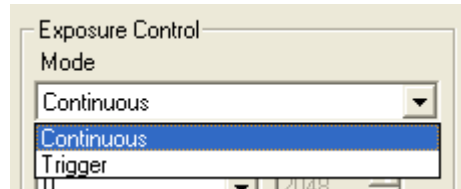
Shutter Speed

The shutter speed setting, shown in Figure 15, allows you to select the specific shutter speed for manual shutter and Async shutter. Manual shutter speed 0 is No Shutter mode; Async shutter speed 0 is Async - No Shutter mode; Async shutter speed 9 is Async - No Delay shutter mode (pulse width control). Direct Shutter allows you to select shutter speed for direct shutter count by the video line. Please note that manual shutter 1 and 2 are not available in scan mode B and D.

FIGURE 15. Shutter Speed
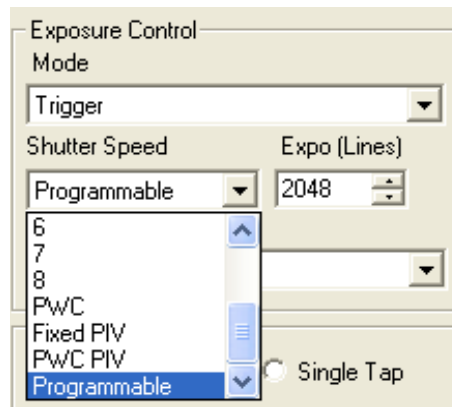
3.4.3   Scan Mode

The TM-4200GE camera has full and partial scan modes as shown in Figure 16. The partial scan area allows you to select the different scan lines. When the scan area starts from an odd line, for a color camera, an offset of 1 is added in the vertical direction. The TM-4200GE camera has no binning modes.

FIGURE 16. Scan Mode
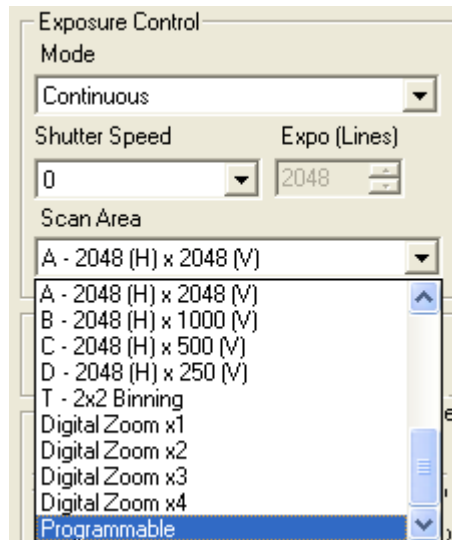
3.4.4   Programmable Scan

The TM-4200CL offers preset partial scans, or the scan size may be set by the user. The minimum available scan is one line.

3.4.5   User Programmable Variable Partial Scan

Click on the Scan Area drop down box and select Programmable

TM-4200CL allows the user to select a full scan, 1000 lines, 500 lines and 250 lines partial scan mode.

Set the beginning line number for the scan. The lowest start point is 2047 since a single line is the smallest available programmable scan.

FIGURE 17. **Programmable Scan Set Dialog Box.**
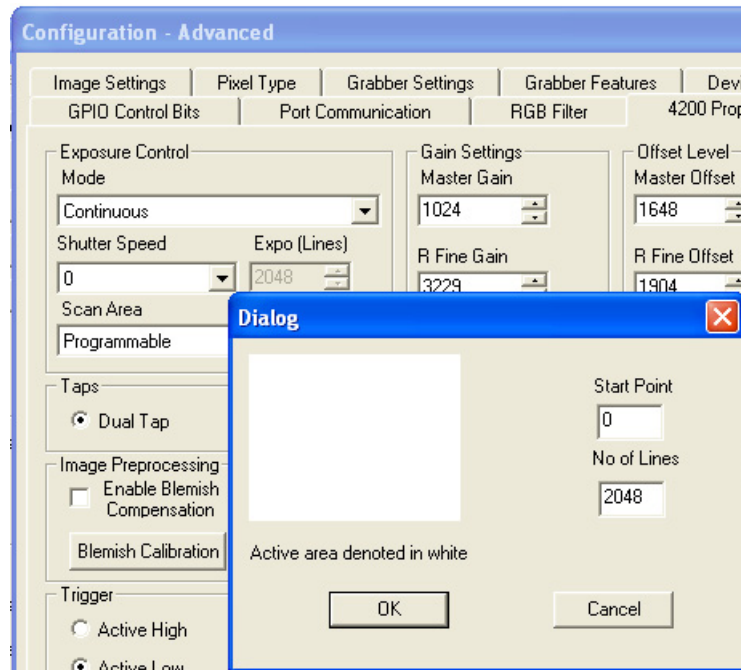
Enter the total number of lines desired in the scan inside the Lines box and click the Apply button.The small dialog box provides a visual representation of the new scan size. The dialog box remains open until a different Scan Area setting is selected, or it is closed using the close box on the upper right.

FIGURE 18. **Scan Start Point and Lines Setting.**
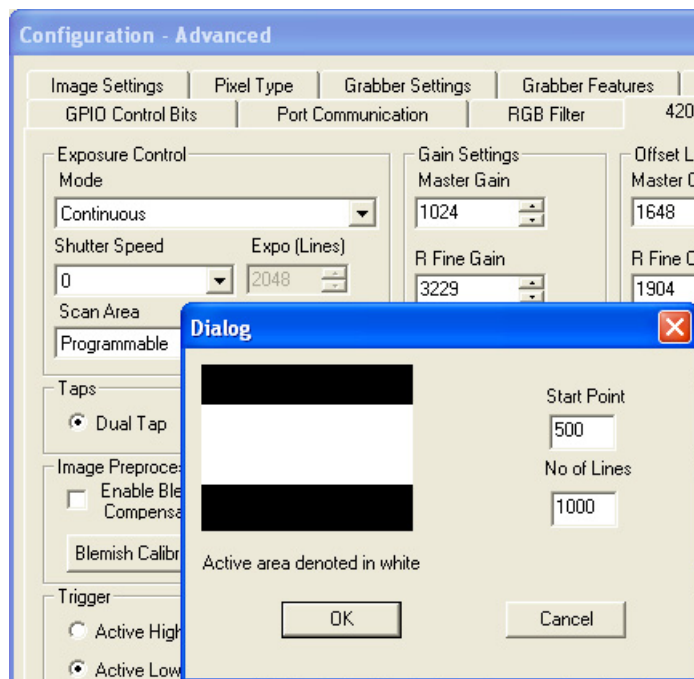
3.4.6   Gain Settings

3.4.6 (a)   Gain

The Gain Settings control box, shown in Figure , allows you to change the Gain value from 0 to 4095. To change the value, either click on the up or down button beside the current setting or enter the value directly into the text box.
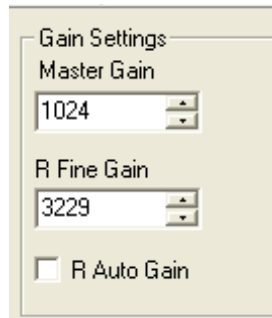
3.4.6 (b)   R Auto Gain Control

Click the *R Auto Gain* checkbox to enable gain channel balancing. The box stays checked only for the duration of the channel balancing. Once the gain channel balancing has finished, the software automatically disables this feature, and checkbox is unchecked. Please note that when channel balancing, channel B aligns to channel A. Good channel balance is obtained by exposing the camera to a uniform light source under 80% saturation. If the camera is in Async trigger mode and the trigger frequency is low (or slow), it may take longer to collect enough frames to balance the channel. Another condition in which Channel Balance may not work properly is when you use the high-speed shutter under low-frequency light, such as fluorescent light. In both cases, the channel balance will time-out in 10 seconds if the balance is not reached.

While the channel balancing is occurring the configuration software may seem to freeze. The software may become unresponsive for about ten seconds during this process.

3.4.7   The Gain

Offset Level

The Channel A offset level is the master, channel B is the slave. The offset level box, shown in Figure 19, allows you to change Channel A offset voltage. To change the value, click on the up or down arrow, or enter the value directly into the box. The camera itself automatically adjusts Channel B offset voltage, every other frame. Please note that offset level control is not available in scan modes C and D

FIGURE 19. Offset Level.

3.4.8   Look-Up Table

The look-up table (LUT) control, shown in Figure 20, allows you to change two knee point values.

FIGURE 20. Look-Up Table

Enter X_1, Y_1, X_2, Y_2 values directly to adjust the knee curve. In the integrated camera software, the look-up table can also be controlled interactively. The Table Selection pull-down menu allows you to select the Linear or Gamma 45 option. This control also allows you to check the positive or negative box to choose an image option. There is no LUT for 12-bit output.

3.4.9   Memory Pages

All the camera parameters such as shutter mode, shutter speed, gain, offset level, scan mode, and LUT can be saved into seven available memory pages on the EEPROM in the camera. The pages are numbered 0-6. The Load Page button loads the corresponding camera settings from the EEPROM while the write page button writes the current camera settings to the corresponding memory page in the EEPROM.

Page 1, shown in Figure 21, is the power-up default page. Page 0 is the factory default. To save your current camera settings for power up default, write the settings to memory page 1.

Configuring the TM-4200GE Camera

FIGURE 21. Memory Pages
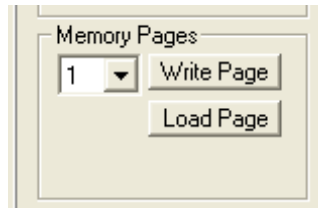
To reset memory page 1 to the factory default settings, load memory page 0 and save those settings to memory page 1. Page 0 is password-protected and you cannot write to it. If you find that you do need to write to page 0, contact JAI Inc. for password access.

Note: Configurations such as grabber settings, pulse generator, GPIO, and image setting must be saved into the XML file. Refer to Section 3.4.1, "Check the Current Camera Setting," on page 11 for more information.

3.4.10 Free-Running Mode

The camera must be in *Manual Shutter* or *Direct Shutter* mode. In the example below, there is no partial scan.

1.   Connect to the camera.
2.   Under the *Device Features* tab, set the GPIO look-up table to Q5=1.
3.   Under the *GigE Software* tab, change the manual shutter or direct shutter values.
4.   Click *Start***.**

You should now see a free-running video stream.

3.4.11 Externally Triggered

The external trigger is sent through pin 6 of the 12-pin Hirose connector. To use the software to enable the external trigger, follow these steps:

1.   Change the GigE camera software shutter mode to Async. Shutter.
2.   Set the GPIO look-up table to Q4 = I0 and Q5 = 1.

3.4.12 Internally Triggered

The camera-control software includes pulse generators that you can use to trigger the camera internally. To do this, follow these steps:

1.   Select *Pulse Generator 0* under the *Device Features* tab. Set the pulse width and delay and check the *Periodic* option if needed.
2.   Set the GPIO look-up table to *Q5=1* and *Q4=I7*.
3.   Set the shutter mode in the GigE camera software page to async shutter. For more information, refer to Section 3.4.2, "Exposure Control," on page 12.

3.4.13 Save/Restore Settings to Your Hard Disk

To save your current settings into the XML file, go to the main menu, select "File" and click on **Save As**. The XML file saves all your configurations such as grabber settings, pulse generator, GPIO and language settings.

The XML file will not, however, save camera parameters such as shutter mode, shutter speed, gain settings, offset level, scan mode, and LUT. For more information about saving these camera parameters, please refer to Section 3.4.9, "Memory Pages," on page 17.

3.4.14 White Balance Control (Color Versions Only)

To determine white balance, use the following steps:

1. Select scan mode A and no binning in the GigE Camera Software tabbed dialog. shown in Figure 11 on page 10.
2. Start the live video by clicking *Start* in the Acquisition tab of the Camera Interface Application dialog box.
3. Select *Color Adjustment* under tools in the main menu. Show the camera a piece of white paper to make sure that the image is not saturated.
4. Click *Analyze* to automatically calculate the white balance.
5. Once white balance has been calculated, click *Apply Results* to apply the white balance. You can also assign custom gain and offset values to the R, G, and B channels. If you choose to assign custom values, click *Apply Results*.

FIGURE 22. White Balance Control Settings.
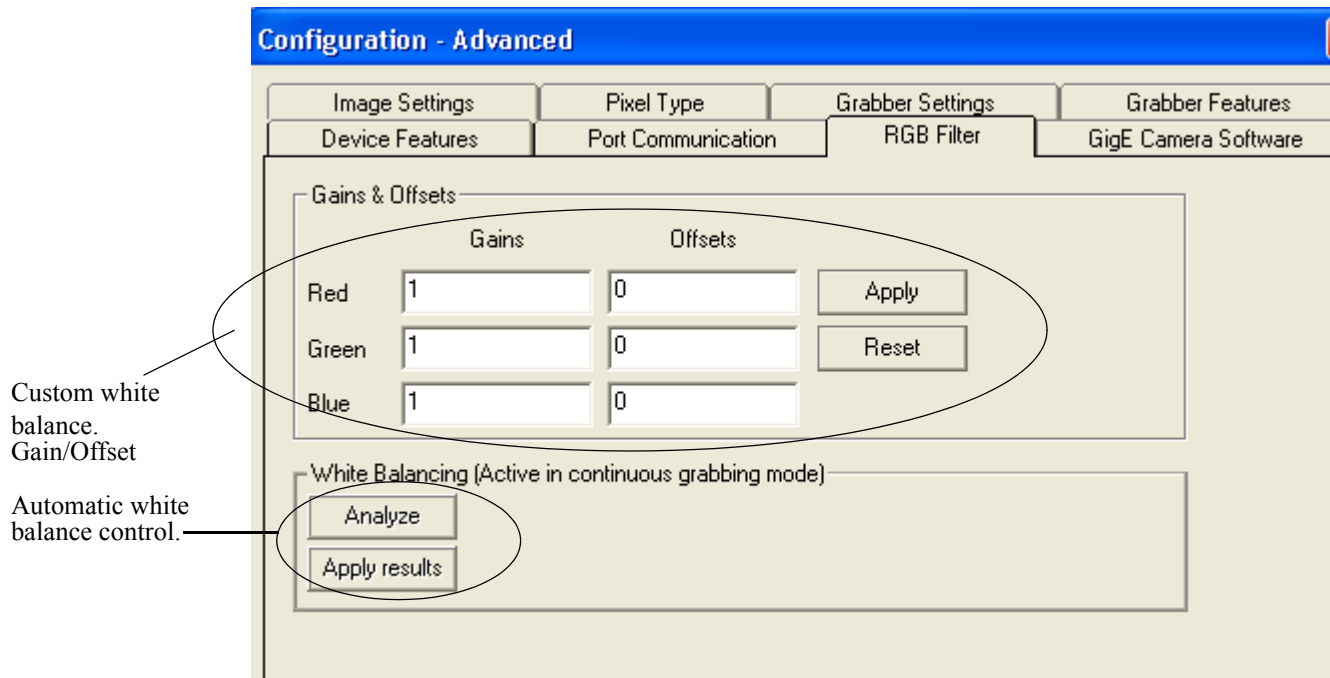
3.4.15 Main Menu: "Option"

3.4.15 (a)   Test Pattern

The Grabber Settings tabbed dialog box has a check box to enable the test pattern that is internally generated by the integrated camera software.

3.4.16 Version

View the version number of the Cam2Net camera interface application by clicking on **Help=>About.** The version number of the integrated GigE camera software is seen in a text box control called *Version* in the GigE Camera tabbed dialog box.

3.4.17 Exit

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

4   Signal Handling

This section briefly describes the signal handling of the GE cameras in the following sections:

- See "Camera Inputs" on page 21
- See "GPIO Control Block" on page 21
- See "GPIO Look-Up Table" on page 23
- See "GPIO Label Table" on page 24
- See "Pulse Generators" on page 25

Refer to the *Cam2Net User's Manual* for additional details.

4.1 Camera Inputs

For information on the polarity and type of the signals required to support specific camera functions, refer to See "Asynchronous reset" on page 46.

The TM-4200GE has four externally controllable standard signals:

- Trigger (VINIT or EXT_TRIG) (CC1 equivalent)
- Integration Control (INTEG/ROI) (CC2 equivalent)
- VD in (EXT_VD) (CC3 equivalent)
- HD in (EXT_HD) (CC4 equivalent)

The labels for these signals in the GPIO Control Block programming language are:

- I0, for VINIT (must be configured as EXT_TRIG)
- I1, for VD in (must be configured as EXT_VD)
- I2, for HD in (must be configured as EXT_HD)
- I4, for Integration control (must be configured as INT)

For normal exposure operation, the INTEG signal must be high. In the GPIO lookup table language: Q5=1. When it is low, the CCD readout is inhibited. To use the Integration Control, set Q5=I3 in the GPIO lookup table.

4.2 Camera Outputs

When the Asynchronous Trigger is used, the strobe output indicates the exposure period.

- I-4 for strobe output (must be configured as CAM_STROBE)

4.3 GPIO Control Block

Figure 23 below shows the GPIO Control Block signals for the GE Cameras.

Signal Handling

FIGURE 23. GE Camera GPIO Control Block
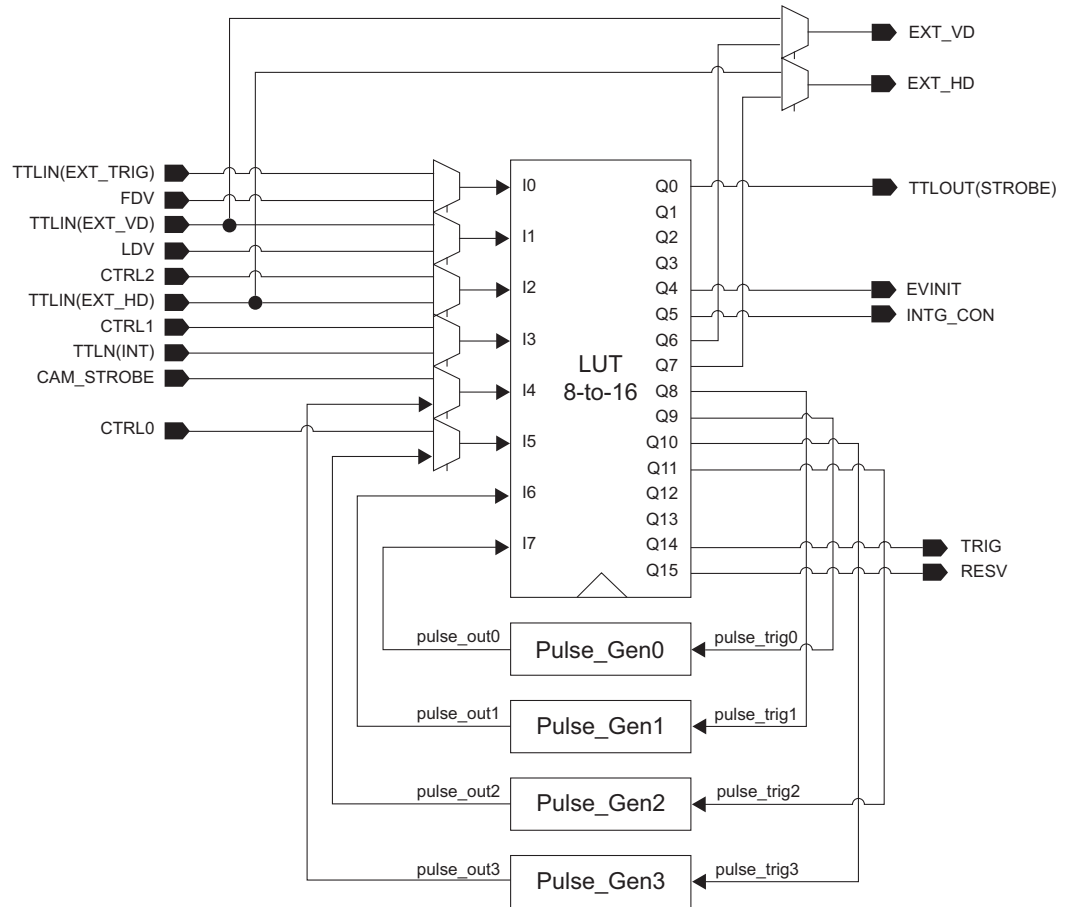
Inputs I0 through I7 can be either external or internal inputs to the look-up table. The outputs are used by the imager part of the GE camera.

The HD and VD signals can be passed through, bypassing the GPIO lookup table. Figure 25 on page 24 shows a screen dump of the GPIO function select page, where HD/VD bypass selection can be made. The default value 0 (zero) is through the lookup table. Value 1 (one) is bypassing the lookup table.

The SDK and the Cam2Net Camera Interface Application both supply methods to select GPIO bypass of the external VD and HD (I1 and I2).

It is also possible to select which signal source to lead to the GPIO inputs. This is done in the GPIO look-up table page as shown in Figure 24.

Signal Handling

FIGURE 24. GPIO Look-Up Table
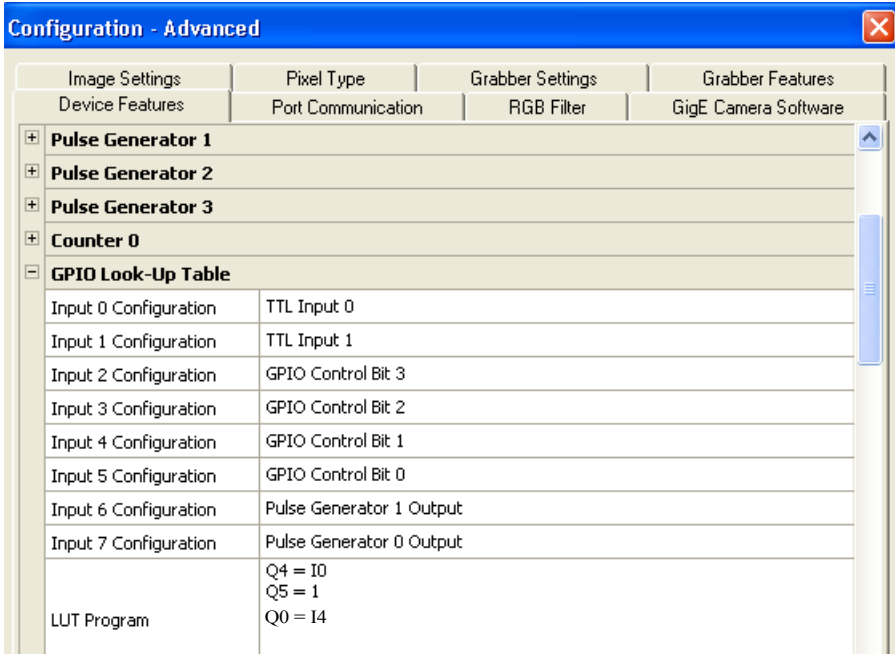
FIGURE 25.   **The GPIO Configuration**
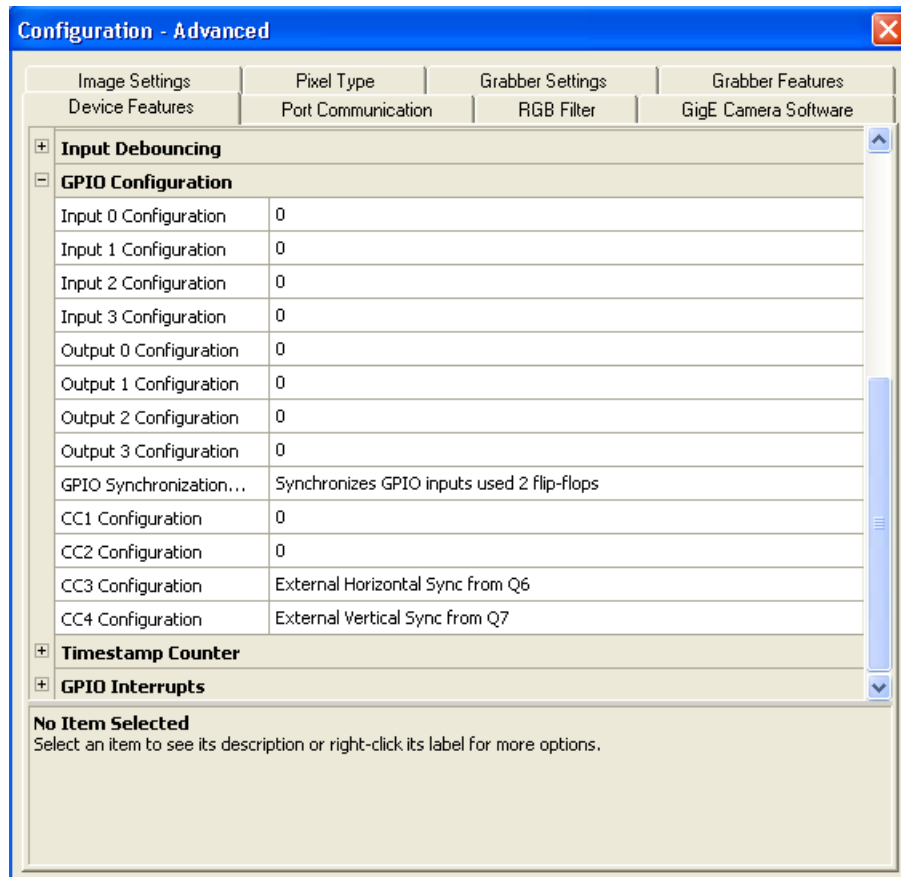
4.4   GPIO Label Table

Table 2 shows which GPIO inputs carry the different signals. The top line for each label contains the default signal.

TABLE 2.   **GPIO Look-Up Table Input Labels**

Input Label	Signal	Description
I0	TTL_IN(EXT_TRIG)	TTL-input 0. Used for external trigger.
	FDV	Internal signal. Frame Data Valid.
I1	TTL_IN(EXT_VD)	TTL-input 1. Used for external vertical drive.
	LDV	Internal signal. Line Data Valid.
I2	CTRL2	Internal control signal.
	TTL_IN(EXT_HD)	TTL-input 2. Used for external horizontal drive.
I3	CTRL1	Internal control signal.
	TTL_IN(INT)	TTL-input 3. Used for external integration control.
I4	CAM_STROBE	Internal signal. Strobe Input.
	PULSE_GEN3	Pulse Generator 3 signals go here.

Input Label	Signal	Description
I5	CTRL0	Internal control signal.
	PULSE_GEN2	Pulse Generator 2 signals go here.
I6	PULSE_GEN1	Pulse Generator 1 signals go here.
	N/A	
I7	PULSE_GEN0	Pulse Generator 0 signals go here.
	N/A	

Table 3 shows which output labels carry the output signals.

TABLE 3.   GPIO Look-Up Table Output Labels

Output label	Signal	Description
Q0	TTL-OUT(STROBE)	Strobe output
Q1	N/A	
Q2	N/A	
Q3	N/A	
Q4	EVINIT	Trigger
Q5	INTG_CON	Integration control
Q6	EXT_VD	Vertical Drive
Q7	EXT_HD	Horizontal Drive
Q8	pulse_trig1	Pulse Generator 1 gets its trigger here
Q9	pulse_trig0	Pulse Generator 0 gets its trigger here
Q10	pulse_trig3	Pulse Generator 3 gets its trigger here
Q11	pulse_trig2	Pulse Generator 2 gets its trigger here
Q12	N/A	
Q13	N/A	
Q14	TRIG	Trigger for camera's internal frame grabber
Q15	RESV	Reserved

4.5 Pulse Generators

The TM-4200GE camera has four independently programmable pulse generators. These generators can run as either periodic or triggered. To run the pulse generators as triggered, they can be triggered on either levels or signal edges. These generators can be tied to the camera inputs (camera-control lines). For example, you can set pulse generator 0 in the Device Features tabbed dialog box to the following values:

Delay = 600

Width = 14,000

Signal Handling

Granularity = 1

Now check the Periodic option and change the camera settings to Async 9. This triggers the camera, based on the pulse width set in the Pulse Generator page.

Be careful with the pulse generator's GPIO input and output polarity. If the delay and pulse-width duration are switched around, the output polarity must be negated in the GPIO lookup table.

The pulse generators are configured in the *Pulse Generator* section of the *Device Features* tab of the Advanced Configuration window as shown in Figure 26.

FIGURE 26. Pulse Generator Page
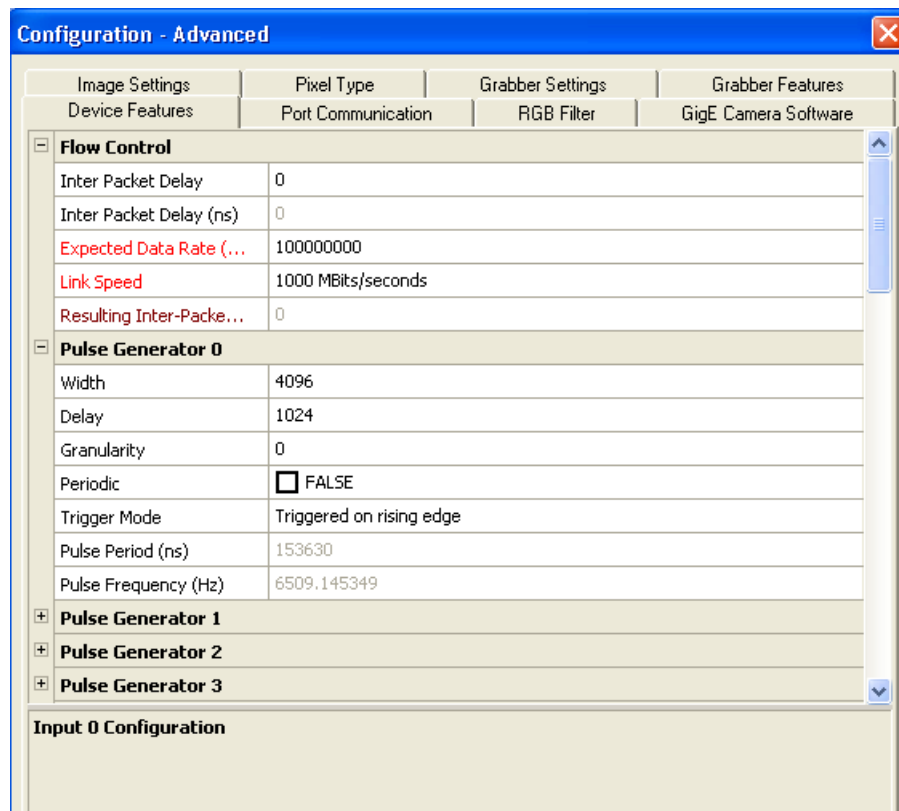
5 GigE Series Camera Serial Commands

You can control the GigE series cameras by serial command either using RS-232 or Camera Link. The Start character is always ":" and the End character is always <CR> (return). For example, to set Asynchronous Pulse Width Mode, send the command :ASH=9<CR> to the camera. Table 4 lists serial commands that can be used to control the camera.

TABLE 4.   **TM/TMC-4200 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 (XXXX=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)

GigE Series Camera Serial Commands

Command	Parameter	End of Cmd	Ack. Response	Description
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				
: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)
Command	Parameter	End of Cmd	Ack. Response	Description
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)

GigE Series Camera Serial Commands

Command	Parameter	End of Cmd	Ack. Response	Description
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)
: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 5.   **Command Responses**

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)
Command	**Parameter**	**End of Cmd**	**Description**
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
	Bit 1	Shutter 1	Trigger Mode:

GigE Series Camera Serial Commands

Command	Parameter	End of Cmd	Description
	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
	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	
Command	**Parameter**	**End of Cmd**	**Description**
	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)

GigE Series Camera Serial Commands

Dual-Tap TM-4200GE AccuPiXEL Series
Camera-Control Software

Operation Manual

TM-4200GE series.

6   Introduction

The Dual-Tap AccuPiXEL software offered for the TM-4200GE is *camera control* software. It is not used in image capture, but rather to configure camera functionality. The Cam2Net software and Dual-Tap AccuPiXEL software have the same capabilities. The Dual-Tap AccuPiXEL software is not needed to use the camera.

If you find it more comfortable to use, or the AccuPiXEL software seems more compatible with your system, then it may be used instead of Cam2Net to configure camera functionality. The Cam2Net and AccuPiXEL software can not run simultaneously.

The Dual-Tap AccuPiXEL series cameras are high-resolution, progressive scan cameras with JAI Inc.-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. 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 TM-4200GE 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 TM-4200GE series software is therefore, specifically documented in this section

6.1   Software Installation

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

6.1.1   Before Installing 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.

6.1.2   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.

1. To obtain the Dual-Tap software visit the JAI Inc. web site at http://www.jai.com
2. Click the Support link
3. Click the Software Downloads link under the Customer Support menu
4. Select the camera model number by clicking in the option button.
5. 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.

6. Open the file.
7. Double click on the JAI Inc. GigE 2.2.0.1 Install icon.

FIGURE 27. **The Setup icon installs Dual Tap AccuPIXel v 2.2.x.x**
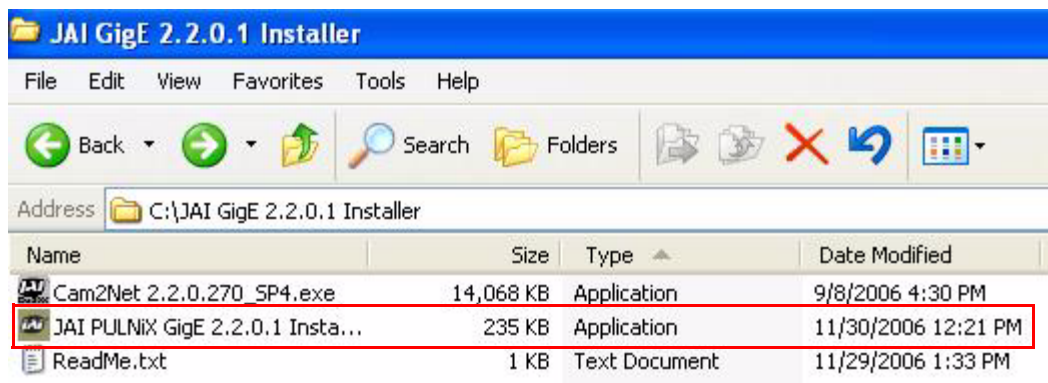
8. Follow the Setup instructions.

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FIGURE 28. AccuPIXel Setup screen
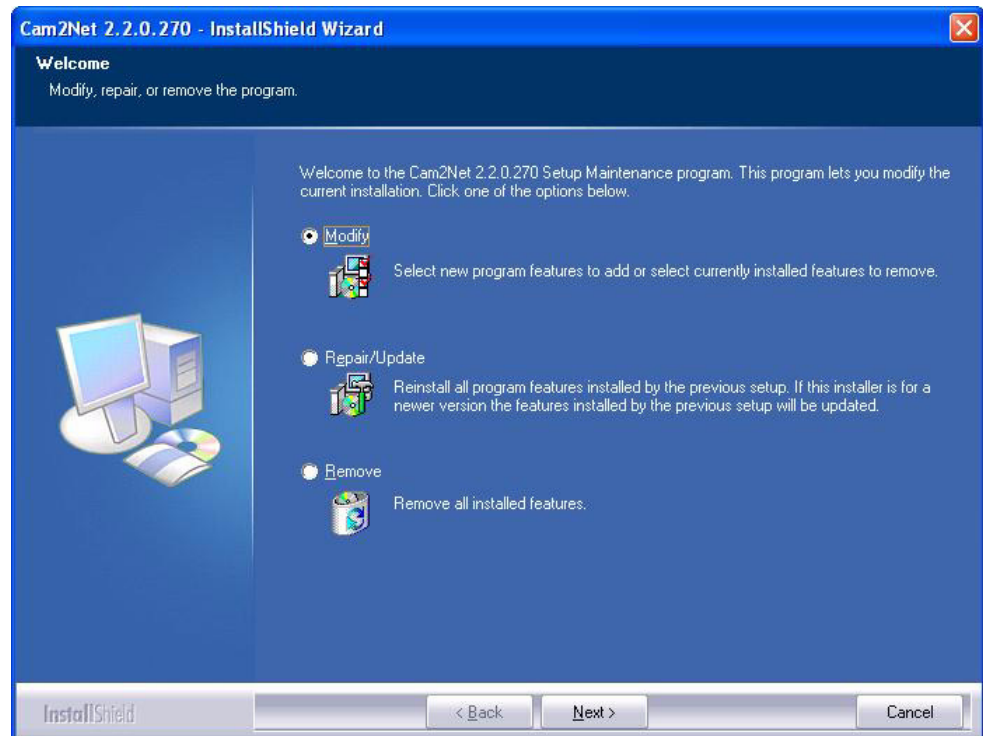
6.1.3 Uninstalling the Software

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.

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FIGURE 29. **The "Add or Remove Programs" utility can uninstall older software.**
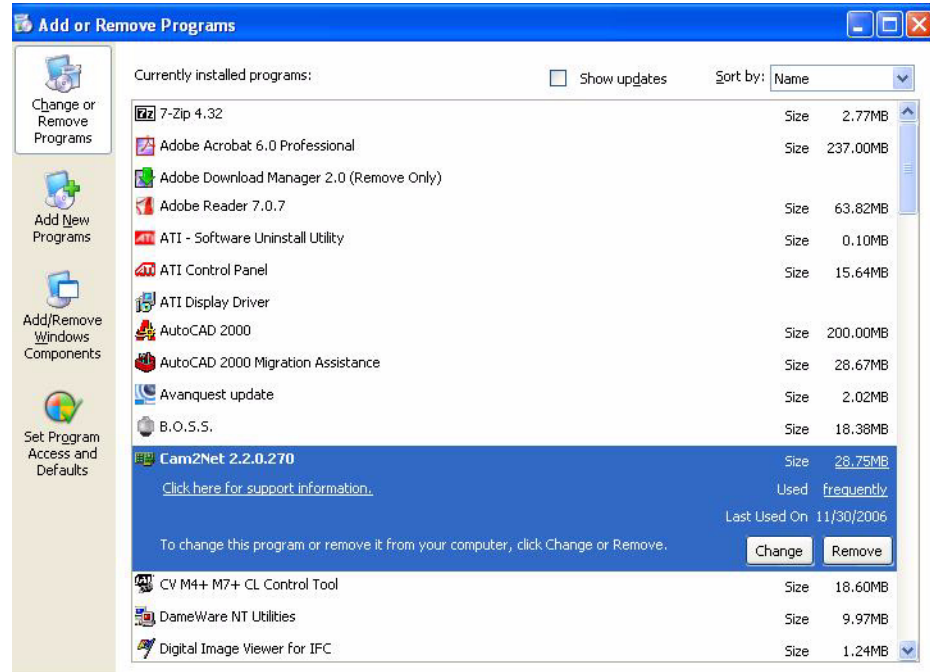
6.2 TM/TMC-4200GE Camera

FIGURE 30. **Back of the TM/TMC-4200GE**
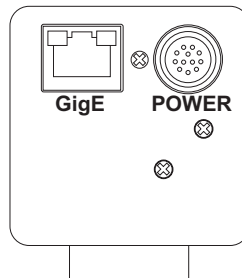
The camera must have all cables properly connected and any required adapters installed and configured to allow the software to perform the operations on the interface.

6.3 Using the GigE mode

- The IP address is initially configured using the Coyote software provided by JAI. To obtain the software visit the JAI web site, customer support link (http://www.pulnix.com/Support/SWdownload.php). To review IP address assignment see "Quick-Start" on page 4

Introduction

6.4 GUI Features

The following is a list of camera functions that PC serial commands can 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 TM/TMC 4200 CL cameras.

FIGURE 31. Main DualTap AccuPiXEL Window

- Exposure Control
    - Mode
    - Shutter Speed
    - Expo / Lines
    - Scan Area
- Scan
    - Area
    - Mode
- Gain Settings
    - Master Gain
    - R Fine Gain
    - R Auto Gain check box
- Offset Voltage
    - Master Offset
    - R Fine Offset
    - R Auto Offset
- Taps
- Video Depth
- Image Pre-processing
- Control Signals
- Trigger
- LUT
    - Positive
    - Negative
    - Table Selection
    - X1, Y1, X2, Y2
    - Send Knees
- Show advanced configuration pages check box

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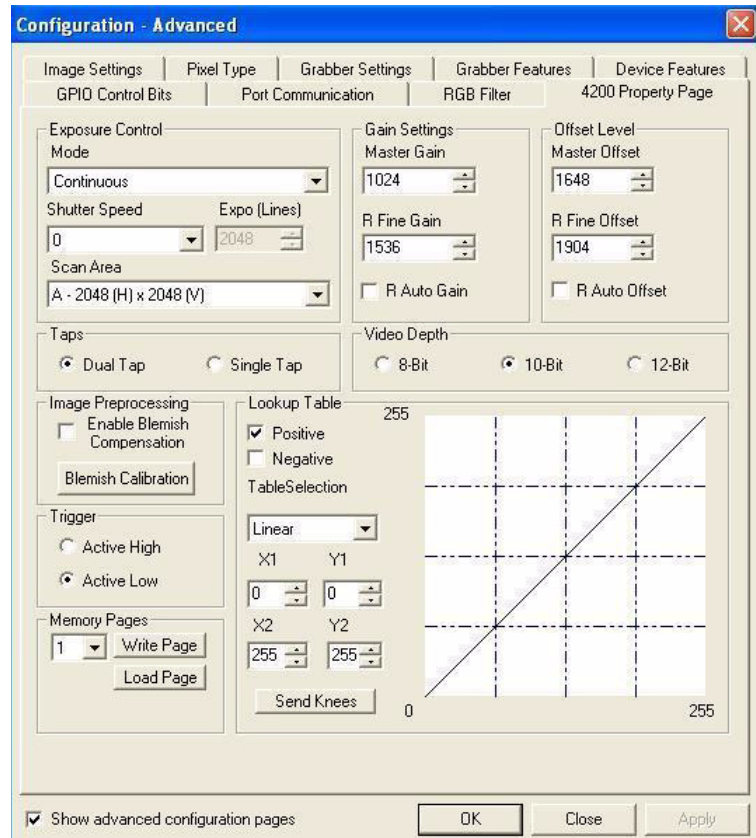
6.5 Operating The Control Software

6.5.1 Exposure Control

The TM-4200GE exposure control allows you to select Continuous or Trigger modes using the appropriate option button. Notice that Continuous and Trigger mode offer slightly different menus.

6.5.1 (a) Shutter Speed

The Shutter Time drop-down list box allows you to select the specific shutter speed for manual shutter and Async shutter. Manual shutter speed 0 is no shutter mode; Async shutter speed 0 is Async No Shutter mode; Async shutter speed 1~8 is Async preset shutter mode; Async shutter speed 9 is Async no delay shutter mode (pulse width control). For detailed shutter information, please see "Electronic Shutter" on page 63.

FIGURE 32. Continuous mode opens and closes the shutter based on the camera settings.
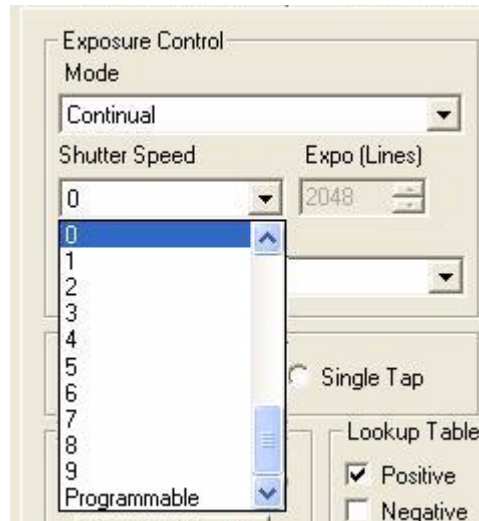
FIGURE 33.
Trigger mode uses a manual or sensor command to open and close the shutter.
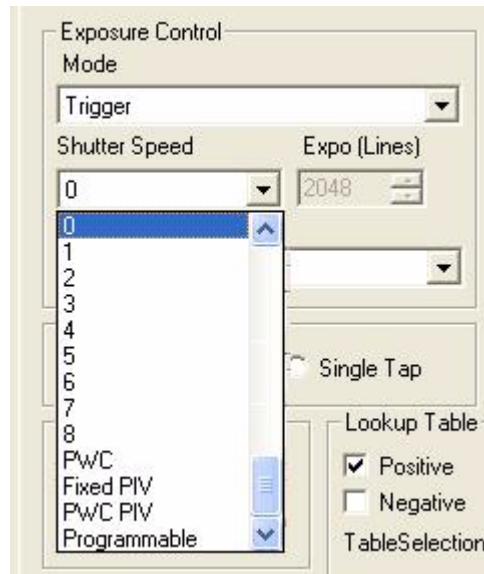
FIGURE 34. **To use Programmable shutter speed, select Programmable.**
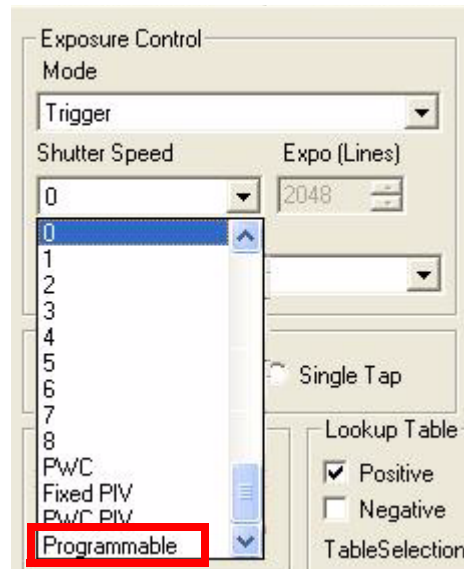
6.5.1 (b)   Expo (lines)

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 2048. 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.

Introduction

6.5.1 (c) 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. For more information on programmable scans see "Programmable Scan Area" on page 53

FIGURE 35. The Scan Area drop down box.
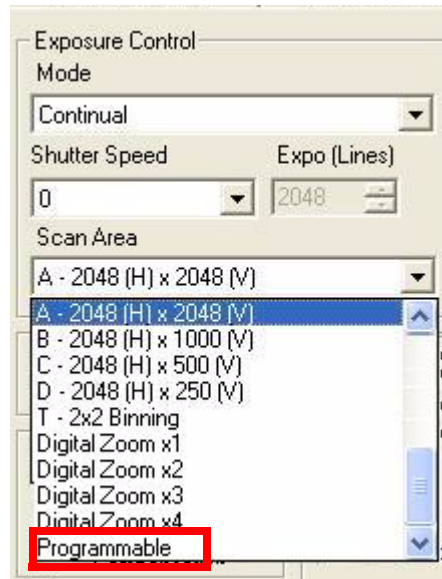
Scan area can vary from a, b, c, or d, to Programmable, various Zoom levels, and more.

FIGURE 36. A dialog box asks for a starting line number for the programmable scan.

FIGURE 37. **Click the Apply button once the desired scan is programmed.**
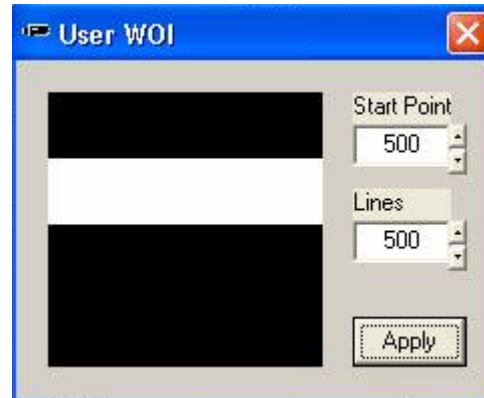
6.5.2 Gain Control

6.5.2 (a) 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 check box clears. Be careful not to send other configuration commands during this process because the camera may not receive the commands.

FIGURE 38. **The Gain is being set when the R Auto Gain box appears checked.**
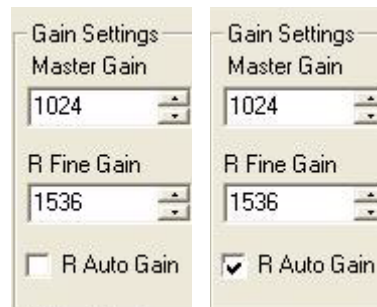
6.5.3 Offset Voltage

Offset is changed by raising on 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" check box causes the camera to automatically adjust the offset. The camera continues to adjust the offset unless the user unchecks the auto offset; in that case the offset is left off.

When the offset is changed the new setting does not show in the interface. It is necessary to click on the "Report" button to refresh the screen.

Introduction

FIGURE 39. **The R Auto Offset box is checked only while the command is being set by the camera.**
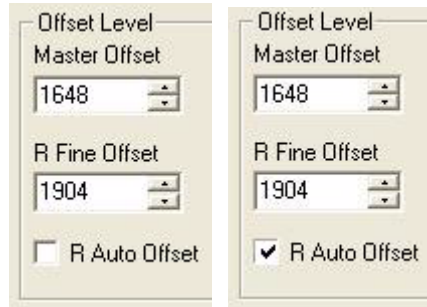
Tap Selection:

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

FIGURE 40. **Click on the option button to set the preferred option.**

6.5.4 Video Depth

FIGURE 41. **Use the option buttons to select 8-bit, 10-bit, or 12-bit output.**

FIGURE 42. **Image Pre-processing**
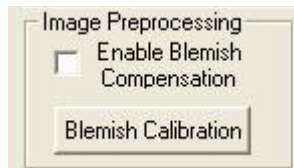
Cover the lens with the lens cap before enabling the blemish calibration. Activate this control by clicking the Blemish Calibration button and then check the "Enable Blemish Compensation" check box. The blemish compensation activates.

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" check box.

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FIGURE 43. **Image Pre-Processing is activated by checking "Enable Blemish Compensation".**
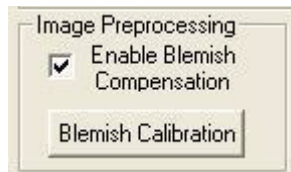
6.5.5 LUT (Look-Up Table)

The Knee Control box allows you to set your own knee value to each LUT. See "Look-Up Table" on page 17 for more detail regarding the knee control.

6.5.5 (a) 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 44. **Choose either a positive or negative image.**

6.5.5 (b) LUT (Look-Up Table) Table Selection

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

FIGURE 45. **Table drop down menu:**
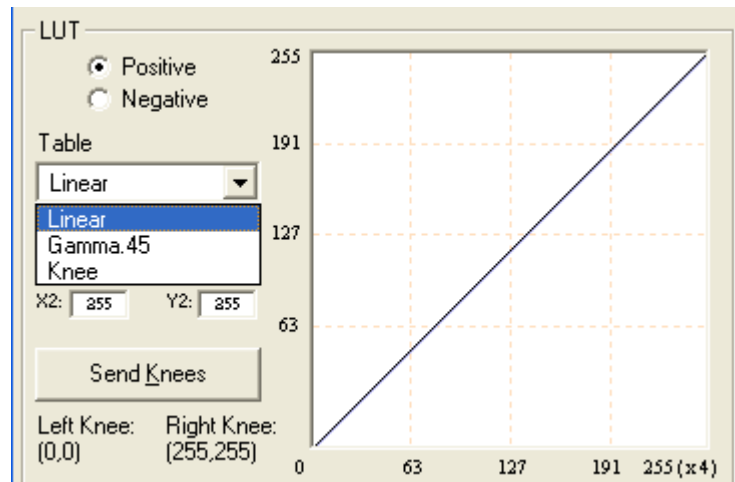
The Table drop down menu offers three options.

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.

Introduction

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 46. Gamma.45 imitates human eye sensitivity when creating an image.
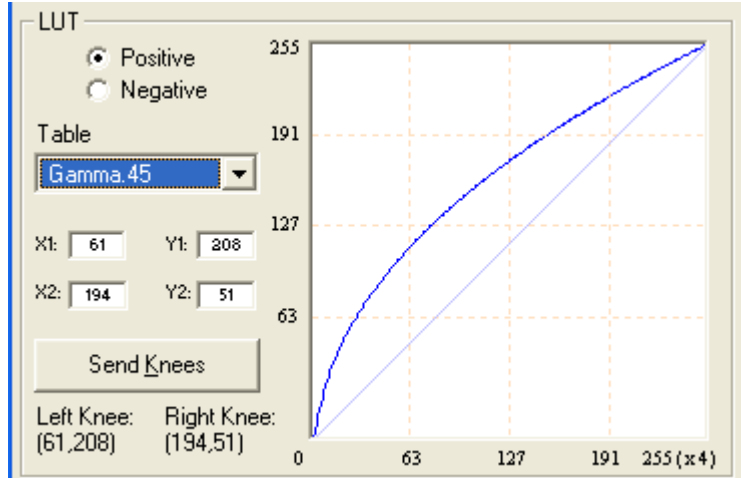
The knee setting allows two adjustments in the light gathering configuration of the LUT to permit the camera to correct images as they are captured. It is possible to set knees on any of the drop down settings by clicking on the existing curve and moving it to the desired configuration. If a drop-down menu setting is selected without adjusting the knees, the camera sets the default.

FIGURE 47. The setting does not activate until the Send Knees button is clicked.
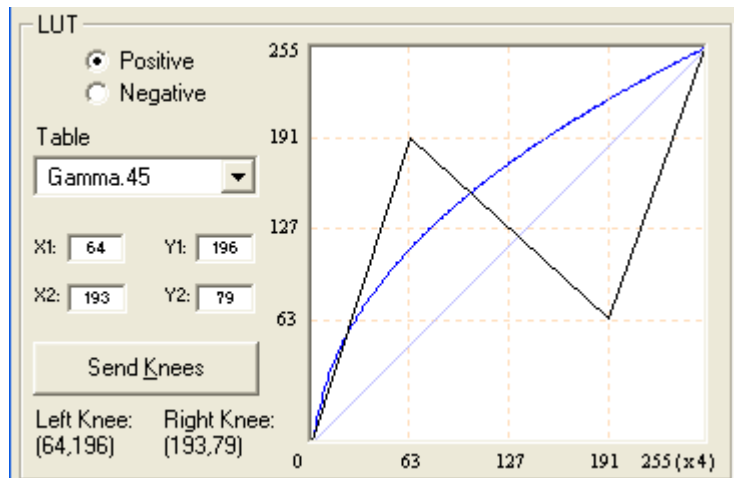
6.5.5 (c) Knee Control

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 X_1, Y_1, X_2, Y_2 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.

Introduction

6.5.6   Main Menu: "Option"

6.5.6 (a)   Password

FIGURE 48. Please contact JAI Inc. for password access. The password allows access to the EEPROM to rewrite factory default settings.

6.5.7   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 setting to load at power up.

6.5.7 (a)   Load Page

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

6.5.7 (b)   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.

6.5.7 (c)   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.

Introduction

Introduction

TM-4200GE Hardware

Operation Manual
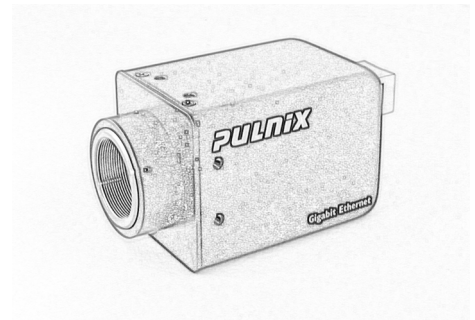
7 Hardware Introduction

7.1 Product Description

The JAI Inc. TM-4200GE series[1] is a Gigabit Ethernet output, high-resolution progressive scan CCD camera. 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 frame rate for a full image is 15 fps. A square imager format with uniform square pixels provides superior image definition in any orientation. On-chip micro lenses provide increased sensitivity.

The TM-4200GE[2] has a full dynamic range control function, which can be set at externally selectable look-up table (LUT) knee slopes to convert 10-bit input to 8-bit output, thereby optimizing the CCD's full dynamic range in the normal output signal range. As a Gigabit Ethernet output camera, the TM-4200GE has semi-auto-gain balancing functions. The camera does not have a LUT for the 12-bit output.

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

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1. Unless otherwise stated, all information in this manual applies to both cameras in the TM-4200GE series, the TM-4200GE and the TMC-4200GE.
2. The TM-4200GE output is available with either 8-bit, 10-bit or 12-bit processing.

Hardware Introduction

7.2 Features

- Small size and light weight

  The printed circuit boards in the TM-4200GE have been arranged to create modular electronics, giving the camera 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 155 grams.

- Imager

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

  - Resolution of 2k x 2k active pixels for excellent image quality.

  - 7.4 x 7.4 μm square pixels for precise dimensional measurement.

  - High-speed electronic shutter capability for high dynamic resolution of moving objects that eliminates the need for a mechanical shutter.

  - Progressive scan CCD eliminates interlace deterioration of image and increases ease of computer interface.

  - High sensitivity and low noise during fast scanning. The CCD has an excellent S/N ratio at the default setting that is greater than 58dB.

  - The CCD has a built-in microlens for increased quantum efficiency.

- Electronic shutter

  The TM-4200GE has a substrate drain-type shutter mechanism which provides superb pictures at various speeds without smearing. For more information, please see Section 9.3 on page 63.

- Asynchronous reset

  The TM-4200GE 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 asynchronous reset images. The TM-4200GE'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 TM-4200GE has three modes to control the asynchronous reset and shutter speed:

  - *Async, no shutter.* The video signal and FDV are reset by external VINIT.

  - *Internal shutter speed control.* The speed control varies from 1/60 to 1/16,000 sec. The video signal and FDV starts with internal V reset timing related to shutter speed.

  - *External VINIT with pulse width.* The duration between pulse edges controls the shutter speed externally.

- Output

  The TM-4200GE has a dual-tap 10-bit/8-bit Gigabit Ethernet output.

- Dual-channel auto black level balancing and semi-auto gain balancing

  The TM-4200GE, as a dual-tap output camera, has auto black level balancing and semi-auto gain balancing functions.

- Warranty

  Please contact your factory representative for details about the warranty.

8   Installation

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

8.1   Getting Started

8.1.1   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.

8.1.2   Components

When you receive your TM-4200GE camera from JAI Inc., the contents of the shipping box should include the camera and a document download card. If either of these items are 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 Inc. to receive this material on a CD-ROM.

8.1.3   Accessories and Options

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

- PD-12U series power supply
- 12P-02S power cable
- Cat5e or cat6 shielded Ethernet cable (not supplied by JAI Inc.)

Installation

8.2 Camera Setup

8.2.1 Heat Dissipation

The TM-4200GE 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 Inc. 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.

Please contact JAI Inc. at (800) 445-5444 or send an E-mail to imaging@jai.com if you have any questions.

8.2.2 Connector Pin Configurations

8.2.2 (a) 12-Pin Connector

The TM-4200GE has a 12-pin Hirose connector for power input as shown in Figure 49.

FIGURE 49. 12-Pin Connector Pinouts
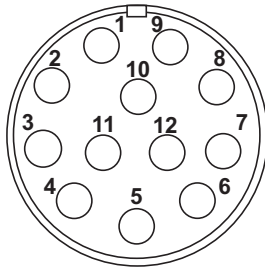
Pin #1 is Ground and pin #2 is +12V DC. Table 6 shows the pin-out table.

TABLE 6.   12-Pin Connector

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

8.2.2 (b)   Ethernet Connector

The GigE socket, marked on the camera's back panel as *GigE*, is a standard
RJ-45 Ethernet socket as shown in Figure 50.

FIGURE 50. GigE Ethernet Connector

GigE
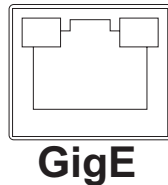
Use at least cat5e UTP cables (cat6 cables are preferred). Refer to the *Cam2Net User's Manual* for
details. JAI Inc. recommends the use of shielded cables to reduce emissions and for CE/FCC
compliance. Double-shielded cables further reduce emissions.

8.2.3   Power Supplies and Power Cable Setup

8.2.3 (a)   Power Supplies

The TM-4200GE camera requires 12V DC power that is obtained through the 12-pin connector located
on the rear panel of the camera. JAI Inc. recommends the following power supplies:

PD-12UU	100-240V AC/12V DC	1.2A universal voltage power supply, US Plug
PD-12UUP	PD-12UU with12-pin connector	US plug
PD-12UE	PD-12UU	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 Inc. power
cable either directly or using a terminal strip.

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.
- Shrink tubing or a similar insulator should be used 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.

Installation

8.2.3 (b)   JAI Inc. Power Cables

If you are using JAI Inc. power cables such as the 12P-02S, please refer to the 12-pin connector pin-out diagram below. The cable pin-out diagram is shown in Figure 51. The color-coded leads use Gray for Ground and Yellow for +12V.

FIGURE 51. 12P-02S Interface Cable (optional)
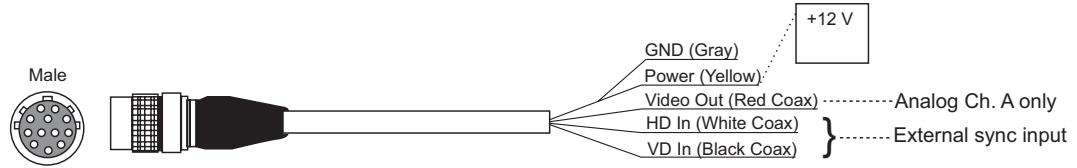
12P-02S Interface Cable					
Pin#	Lead Color	Function	Pin#	Lead Color	Function
1	Gray	GND	7	Black coax	TTL IN (EXT_VD)
2	Yellow	+12V DC	8	White coax shield	TTL OUT (STROBE)
3	Red coax shield	GND(analog)	9	White coax	TTL IN (EXT_HD)
4	Red coax	RESV	10	Brown	Reserved
5	Orange coax shield	GND(Digital)	11	Blue	Reserved
6	Orange coax	TTL IN (EXT_TRIG)	12	Black coax shield	Reserved

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.

8.2.3 (c)   Building Your Own Power Cable

Refer to the 12-pin connector pin-out in Figure 49 on page 48. 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.

8.2.3 (d)   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 powers-up the camera.

8.2.4 Attaching the Camera Lens

The TM-4200GE camera accepts 1.2-inch or larger format size C-mount lenses. To attach the C-mount lens[1] 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. Some lenses with extremely long flange backs may exceed the mounting depth of the camera.

8.2.5 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 52. 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.

---

1. 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.

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9   Operation

9.1   Progressive Scanning

Standard TV-system scanning is 525 lines interlace scanning as specified in the RS-170 protocol. Every other horizontal line (odd lines and even lines) is scanned at a 60Hz rate per field, and the scanning is completed with two fields (one frame) at 30Hz rate. Because of the interlace scanning, the vertical resolution of CCD cameras is limited at 350 TV lines, regardless of the horizontal resolution. When electronic shutter is applied, the CCD can hold only one field of charge at each exposure. This means that the vertical resolution of the electronic-shutter camera is only 244 TV lines. The situation is the same for an HDTV-format camera, since it has interlaced scanning and the vertical resolution of the shuttered image is 500 lines.

The TM-4200CL uses a state-of-the-art progressive scanning interline transfer CCD which scans all lines sequentially from top to bottom at one frame rate. Like a non-interlace computer screen, it generates a stable, crisp image without alternating lines and provides full vertical TV resolution of 1000 lines (a normal TV monitor display may not be able to show 1000 lines due to monitor resolution of 30Hz scanning).

The interline transfer architecture is also important to generate simultaneous shuttering. This is different from full frame transfer architecture which requires a mechanical shutter or strobe light in order to freeze the object motion.

9.1.1   Preset Scan Area

TM/TMC-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 centered mode 1000 lines are transferred out, in 500 line and 250 line mode, 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.
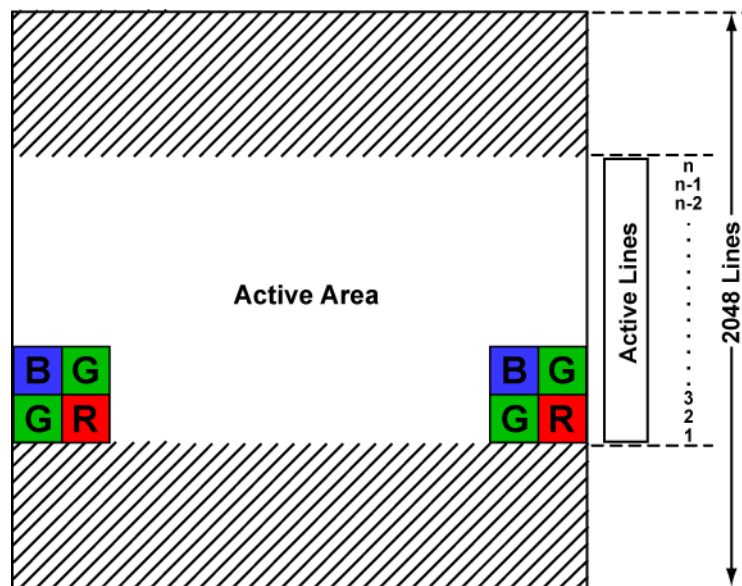
9.1.2 Programmable Scan Area

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 x row, and the active lines are y lines, the frame rate can be calculated using the following formulas.

$$Frame\ Rate = \begin{cases} \dfrac{1}{((n_f +16)+ n_r)*32.5\mu s} & Dual\ Tap \\[4mm] \dfrac{1}{((n_f +16)+ n_r)*58.1\mu s} & Single\ Tap \end{cases}$$

Where,

$$n_f = \begin{cases} \text{int}(\dfrac{x+16}{N}) & remainder\ of\ \dfrac{x+16}{N} = 0 \\[4mm] \text{int}(\dfrac{x+16}{N})+1 & remainder\ of\ \dfrac{x+16}{N} \neq 0 \end{cases}$$

$$n_r = \begin{cases} \text{int}(\dfrac{2056-x-y}{N}) & remainder\ of\ \dfrac{2056-x-y}{N} = 0 \\[4mm] \text{int}(\dfrac{2056-x-y}{N})+1 & remainder\ of\ \dfrac{2056-x-y}{N} \neq 0 \end{cases}$$

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

For a color CCD, the upper-left Bayer pattern changes, depending on the start point location. If the start point is the odd row, the upper-left Bayer pattern is G. In RG if the start point is the even row, the upper-left bayer pattern is B in BG.

Operation

FIGURE 53. Bayer 1
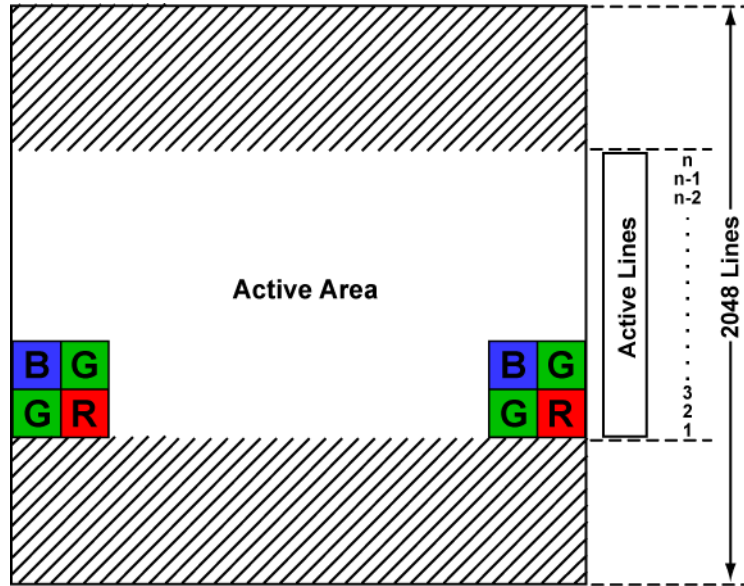
FIGURE 54. Bayer 2
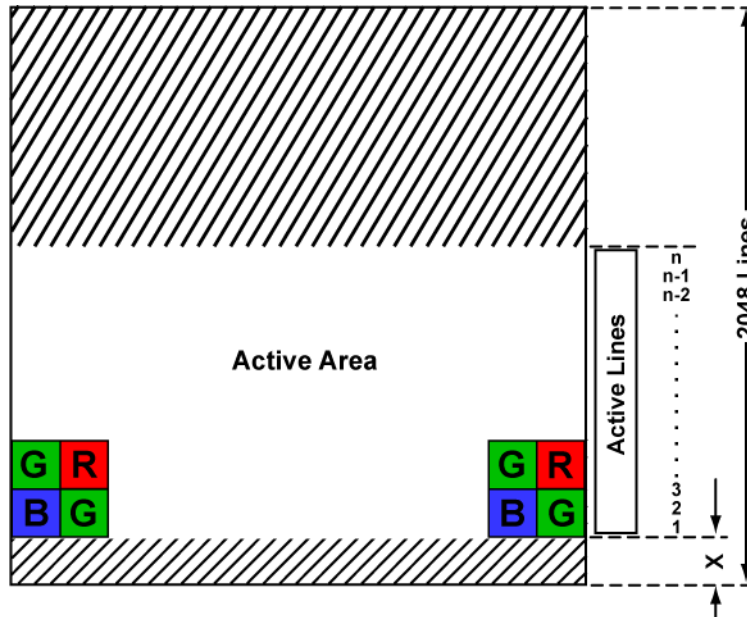
9.1.3 Full Scan Area 2x2 Binning

TM/TMC-4200 CL has a 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.

Operation

FIGURE 55. 2x2 Binning
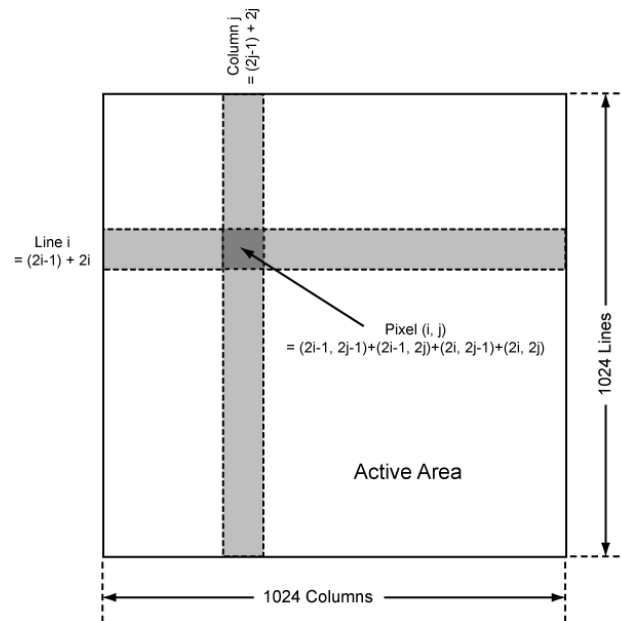
9.1.4   Sub-sampling Digital Zoom

TM/TMC-4200CL has four sub-sampling digital zoom modes:1x, 2x, 3x, and 4x. Effective pixels in these modes are 512(H) x 1024(V). In 1x mode, the output video uses all the pixels in the center 512(H) x 512(V) of the CCD sensor. In 2x mode the output video is every other pixel in the horizontal row, and every other line in the vertical rows at the center 1024(H) x 1024(V) of the CCD sensor. In the 3x mode the output video is every other two pixels in the horizontal row and every other two lines in the vertical row of the center 1536(H) x 1536(V) of the CCD sensor. In 4x mode output video is every other three pixels in the horizontal row, and every-other three lines in the vertical rows of the full scan area, which is 2048(H) x 2048(V).

Operation

FIGURE 56. Sub-sampling Digital Zoom
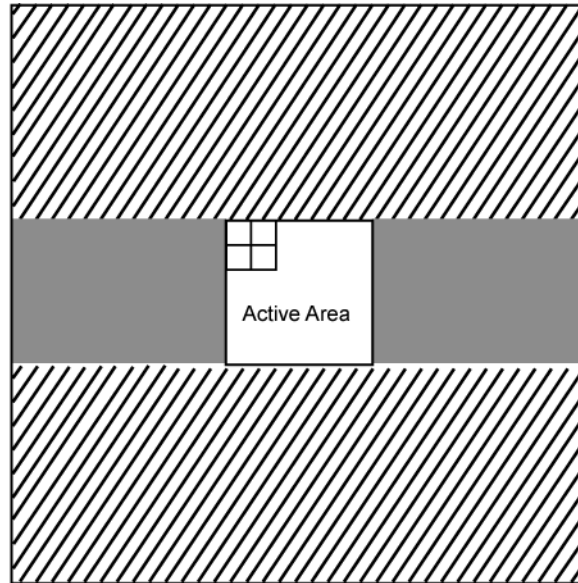
☐ Active Pixel   ■ Skipped Pixel   ▨ Dumped Line

FIGURE 57. Sub-sampling Digital Zoom 2x

Operation
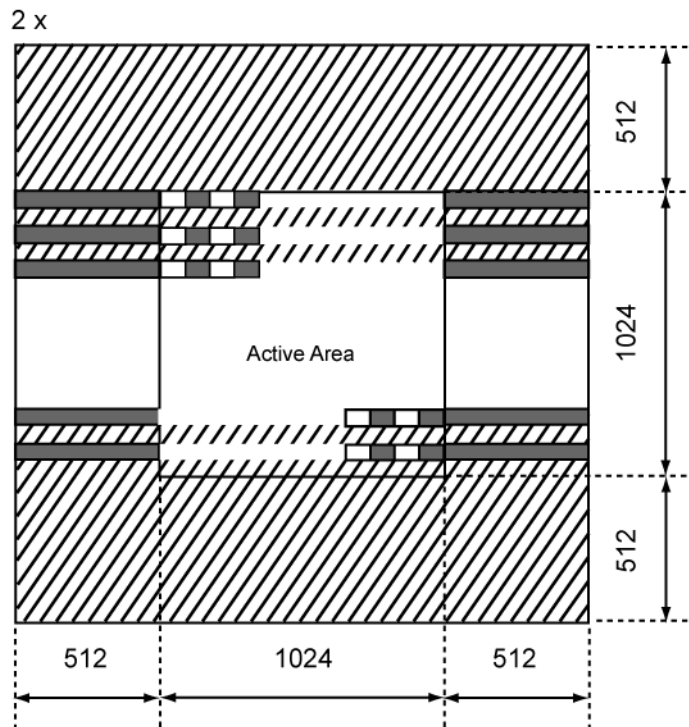
FIGURE 58. Sub-sampling Digital Zoom 3x

3 x

256

1536

256

Active Area

256   1536   256

☐ Active Pixel   ■ Skipped Pixel   ▨ Dumped Line

Operation
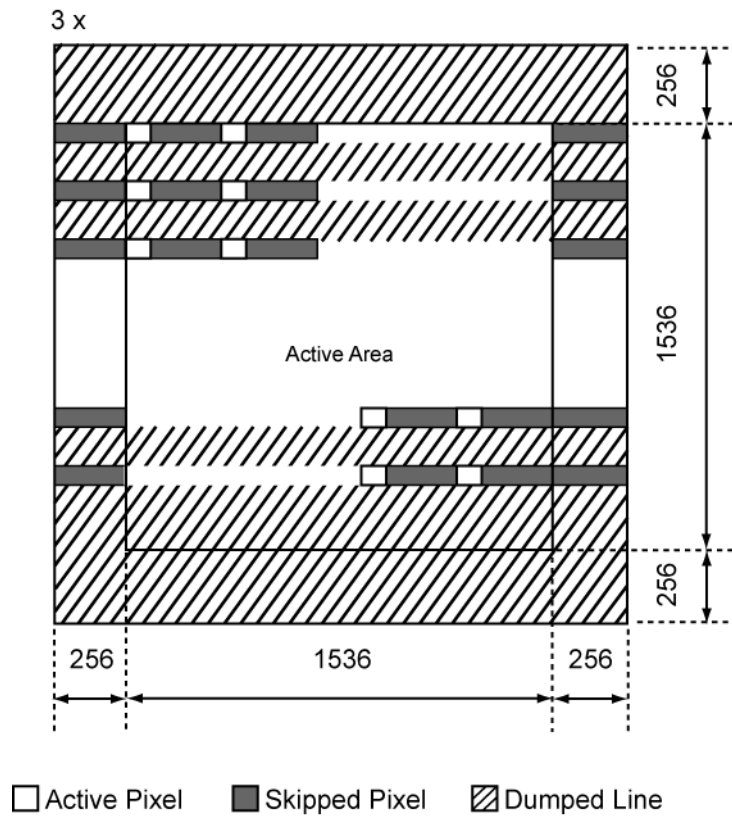
FIGURE 59. Sub-sampling Digital Zoom 4x
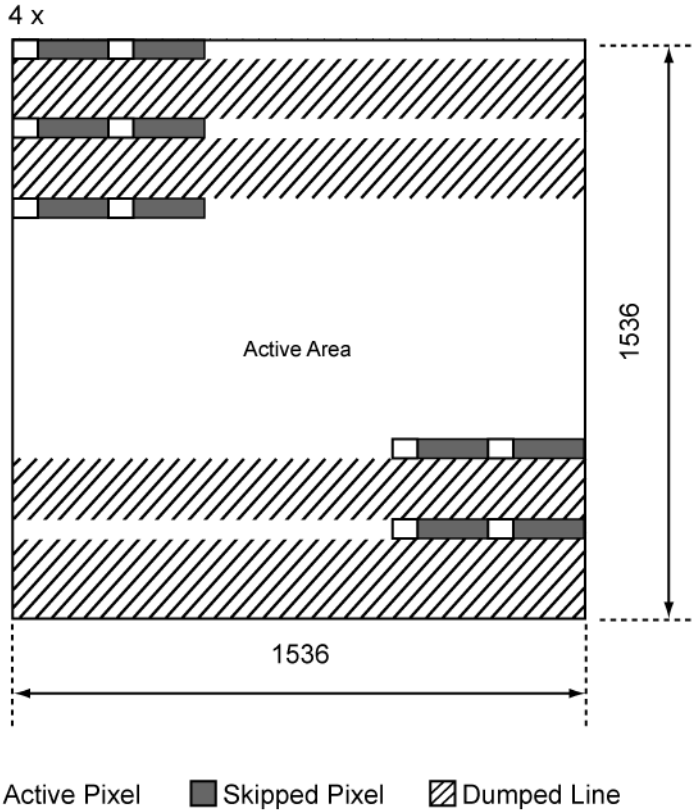
TABLE 7.   Scan Area Start Points

	Scan Area	Start Point (Line)	Effective Area (Lines x Pixels)	Frame Rate (FPS) Dual Tap	Single Tap
A	Full Scan	1	2048 x 2048	14.79	8.04
B	Centered 1000Lines	525	1000 x 2048	27.97	15.20
C	Centered 500Lines	775	500 x 2048	49.63	26.97
D	Centered 250Lines	901	250 x 2048	79.92	43.43
T	Full Scan 2x2 Binning	1	1024 x 1024	26.42	15.09
Z	Sub-sampling Digital Zoom		512 x 512	31.98	20.40
U	Programmable Scan Area	1 – 2048	1–2048 x 2048		

9.2 Bayer Color Filter (Color Versions)

JAI Inc. AccuPiXEL series color cameras are high-resolution, high-speed progressive scan CCD cameras. The interline transfer, progressive scan CCD permits full vertical and horizontal resolution of images acquired at very high shutter speeds. The electronic shutter, which has speeds to 1/16,000 sec., can be reset asynchronously by external pulse control. Uniform square pixels provide superior image definition in any orientation. On-chip micro lenses mean increased sensitivity.

9.2.1 Color Filter Array

JAI Inc. AccuPiXEL cameras use Bayer CFA (color filter array) as their standard primary color filter. This filter provides the most popular color interpolation supported by numerous software suppliers.

The digital format allows the camera to output accurate pixel data, including the color information. When the data is stored in the frame buffer of a frame grabber or computer, the color information is easily manipulated to restore the original color images. Because the color filter array contains only a single R, G or B color in each pixel, the restored image has to fill in colors in the missing pixel locations. The software uses neighboring pixel information to "guess" the missing colors to make smooth, clear images. This is called "color interpolation." Today's high-speed computers allow such color interpolation to be done almost in real time. Because these cameras do not contain internal color-processing circuitry, they are smaller and less expensive than full-function color cameras.

9.2.2 Bayer Color Filter Array (CFA)

The Bayer CFA is an R, G, B primary color filter array. This is the most widely accepted CFA for the single-chip CCD progressive scan format. This type of array layout has a specific order for each color's pixels. Since the human eye's resolution and color recognition are highest at green, the CFA contains two greens per each red and blue.

It is critical for the frame grabber and color interpolation to know where the individual color pixels exist relative to sync (LDV and FDV) timing.

This requirement makes digital output the preferred choice, because the timing relationships are very accurate

FIGURE 60. Bayer Color Filter Response.
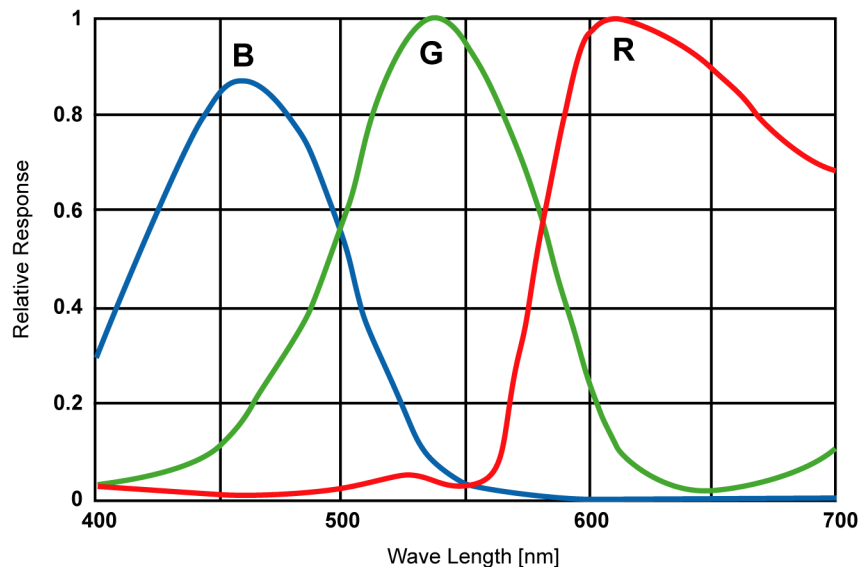
9.2.3 Starting Pixel Configuration

All manufacturers produce identical Bayer CFAs, but there are slight differences between the CCDs produced by different manufacturers. The first line is generally R and G. The camera timing can be adjusted to start with either G or R by skipping the very first pixels at each line. The majority of color interpolation software can select between a variety of pixel relations, such as R/G start or G/R start, as well as G/B start and B/G start. Once the correct scanning is configured, the rest of the interpolation is exactly the same. Contact JAI Inc. for further information regarding CCD manufacturers.

FIGURE 61. Example of Color CCD CFA Pattern
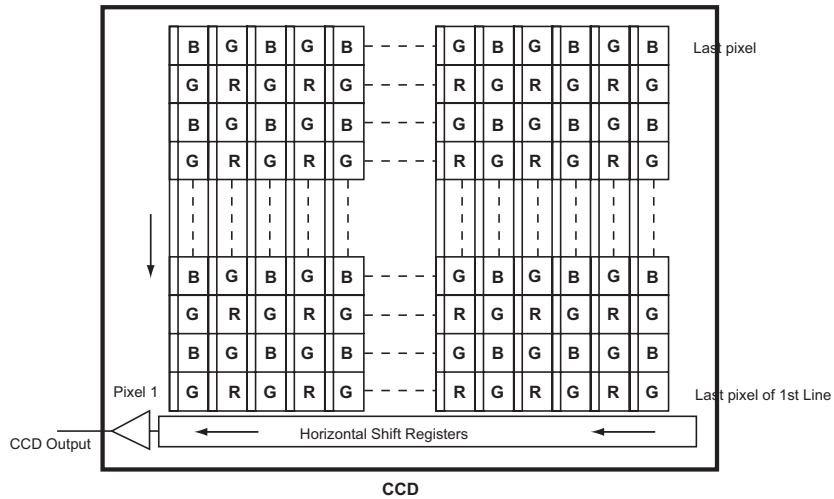
9.2.4 Sync and Data

The individual color data is exactly the same as the pixel data. This means that the timing relationships of the color cameras are also the same as of the monochrome cameras.

For a detailed timing chart, please refer to each monochrome camera's data sheet and manual.

The following diagram is an example of the TMC-4200GE default mode. FDV and LDV are used internally for the GigE interface.

Operation

FIGURE 62. Example of TMC-4200GE (Same as TM-4200GE)
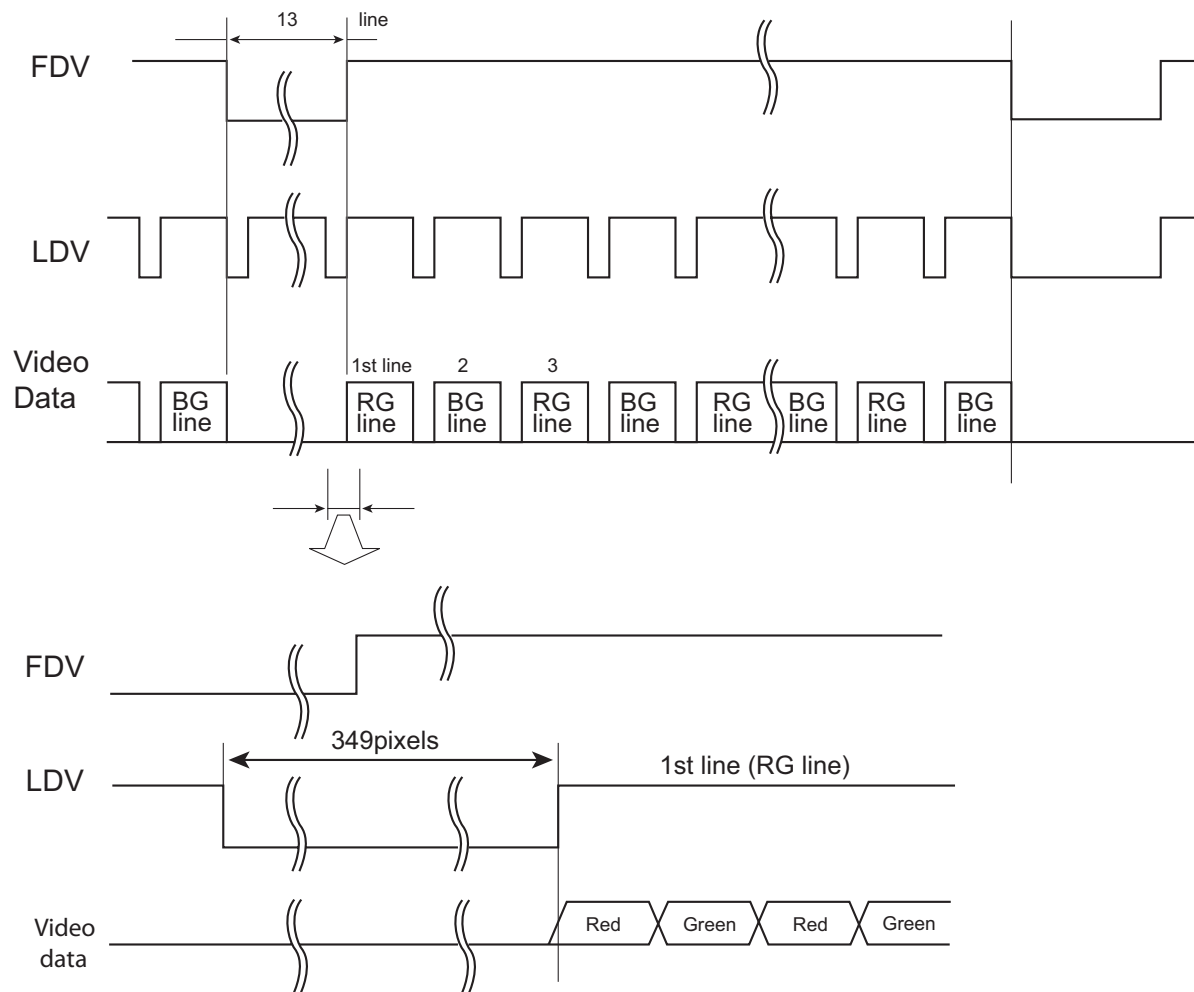
9.2.5 Camera Functions

AccuPiXEL color cameras perform all functions the same way as monochrome cameras. However, because of color characteristics, the LUT (Look-up Table) is different. The LUT is a powerful tool to adjust the dynamic range as well as color dynamic range. Since human color perception is non-linear, LUT selection can help optimize color contrast by selecting the LUT value. Gamma 0.45 is logarithmic and is closed to human perception.

When LUT is selected, black-level adjustment must be more accurate than for monochrome cameras.

Operation

9.2.6 Timing Chart

FIGURE 63. **TM-4200GE Timing Chart**

		Scan Mode						
		A	**B**	**C**	**D**	**U**	**T**	**Z**
tB	dual single	1300 2392	1300 2392	1300 2392	1300 2392	1300 2392	728 1274	1924 3016
tC	dual single	1024 2048	1024 2048	1024 2048	1024 2048	1024 2048	512 1024	256 512
tD	dual single	276 244	276 244	276 244	276 244	276 244	216 250	1668 2504
tE	dual single	100 168	100 168	100 168	100 168	100 168	166 166	800 800
tF		80	80	80	80	80	40	80
tG		224	224	224	224	224	112	224
tH		A, B, C, D, U & Z: n*tA + 822 (n=1, 2, 3, ...) T: n*tA + 411 (n=1, 2, 3, ...)						
tJ	dual single	100 166	100 166	100 166	100 166	100 166	50 83	868 1702
tK		100	100	100	100	100	50	100
tL	dual single	76 78	76 78	76 78	76 78	76 78	116 117	700 702
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 single	16 16	50 50	58 58	61 61		8 8	x1: 67 x2: 46 x3: 25 x4: 4 x1: 44 x2: 30 x3: 17 x4: 4

		Scan Mode		
		A	**B**	**C**	**D**	**U**	**T**	**Z**
tV								
tW	dual	13	47	59	71		5	x1: 67 x2: 46 x3: 25 x4: 4
	single							x1: 44 x2: 30 x3: 17 x4: 4

9.2.7   Interpolation Software

The color interpolation can be performed in the frame grabber or by using the host computer's CPU. Most major frame grabbers with processing capability provide tools for color interpolation. Software vision packages also provide color interpolation capability, but speed and performance may be determined by the PC's resources and by the complexity of the interpolation routine.

9.2.8   Color Interpolation

The Bayer pattern color filter array (CFA) consists of R, G, and B primary colors. Each pixel represents one of three colors. In order to display or print color images, the signal has to be converted to RGB output, which has three independent channels (outputs) and sync signals.

Color interpolation software or firmware performs the color preprocessing by filling the missing color pixels with neighboring pixels. It then separates the stream of data, (8-bit or 10-bit) into 3 (RGB) data (8-bit x 3) and adds the color matrix to adjust and balance each of the R,G, and B channels (white balance or color balance).

Green	Red	Green
Blue	Green	Blue
Green	Red	Green

The image quality depends on the camera's own pixel data (including pixel data independency from neighboring pixels, noise and color filter), and interpolation of the software algorithm such as 3 x 3 interpolation, 2 x 2 interpolation, color matrix, white balance capability, and so on.

All AccuPiXEL color cameras are carefully designed for maximum color performance. JAI Inc. strongly suggests that you use digital output for the best performance.

Some software is used on board (FPGA or DSP) to perform the interpolation. Other software simply uses the host computer's memory and CPU. The process speed may vary depending on the architecture and speed of the computer.

9.3 Electronic Shutter

The TM-4200CL has a substrate drain-type shutter mechanism which provides a superb picture at various speeds without smearing.

Operation JAI®

9.3.1   Preset Shutter

TABLE 8.   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

9.3.2   Programmable Exposure-Continuous Mode

The exposure time of TM/TMC-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

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

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

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

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.

9.3.3   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.

Operation

FIGURE 64. External Trigger Timing.
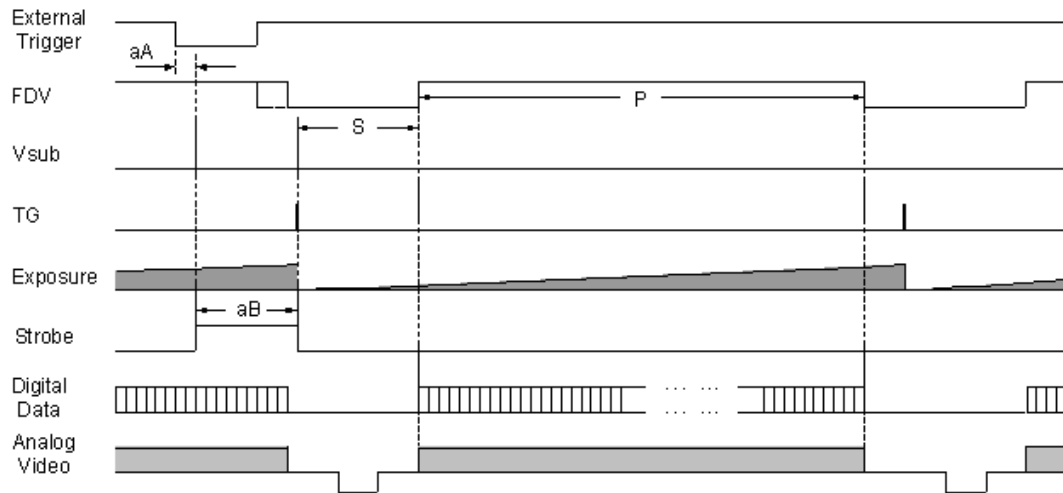
9.3.4   Asynchronous Programmable Exposure Mode

In Asynchronous Programmable Exposure Mode, when an external trigger is applied, the exposure starts after one discharge signal (Vsub), which happens after the trigger's active edge is off. Because the discharge signal (Vsub) synchronizes with LDV in this mode, there is a maximum one video line of jitter between the trigger active edges to discharge signals (Vsub) 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:

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

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

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

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

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

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

- If the exposure time is less than one frame time, the maximum trigger frequency is equal to 1/1 frame time.

- If the exposure time is longer than one frame time, the maximum trigger frequency is equal to 1/ exposure time.

- The minimum active period of the external trigger is 5μs.

Operation

FIGURE 65. **Asynchronous Programmable External Trigger**
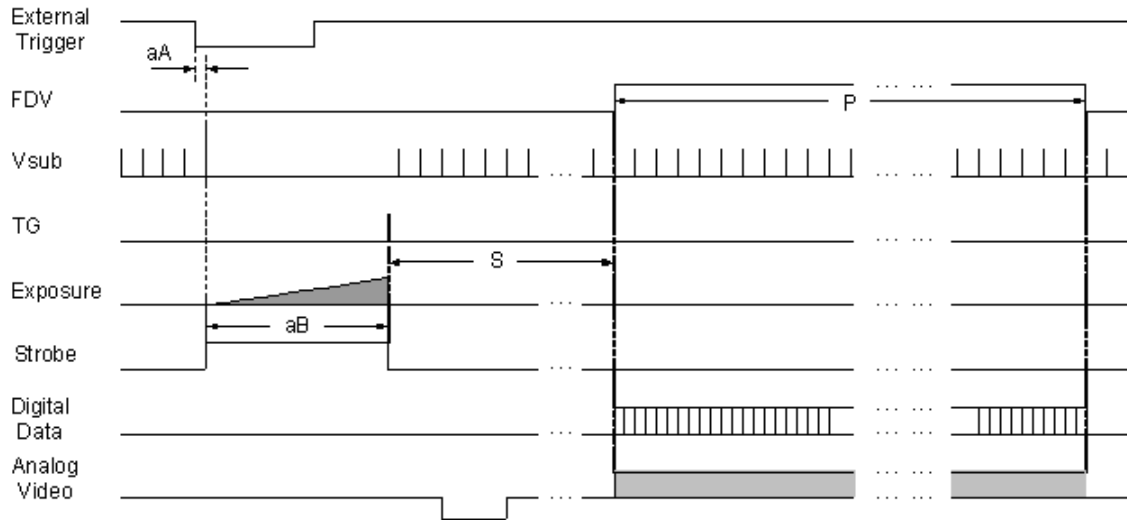
9.3.5   Pulse Width Control Mode

In Pulse Width Control (PWC) Mode, the exposure time is controlled by the external trigger. When an external trigger is applied, one discharge signal (Vsub) 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 +20.6μs

Since one discharge signal (Vsub) 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 5μs. Theoretically, the maximum active period of the external trigger is unlimited. But, due to the usability of images at 25°C it is recommended the active period of the external trigger be no longer than one second.

Operation

FIGURE 66. Pulse Width Control Trigger
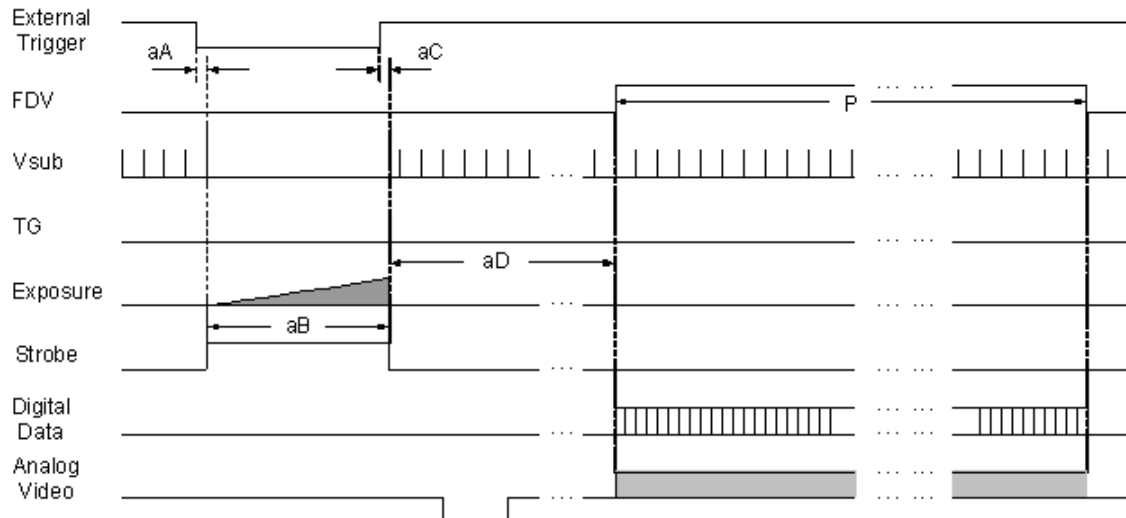
9.3.6   Particle Imaging Velocimetry Fixed Exposure Mode

In Particle Imaging Velocimetry (PIV) Fixed Exposure Mode, when an external trigger is applied, the first time exposure starts the same as PWC mode does. It lasts a very short period (8μs). 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/ (transfer time of two frames + 4μs). The minimum active period of the external trigger is 5μs

FIGURE 67. PIV Exposure Timing Table
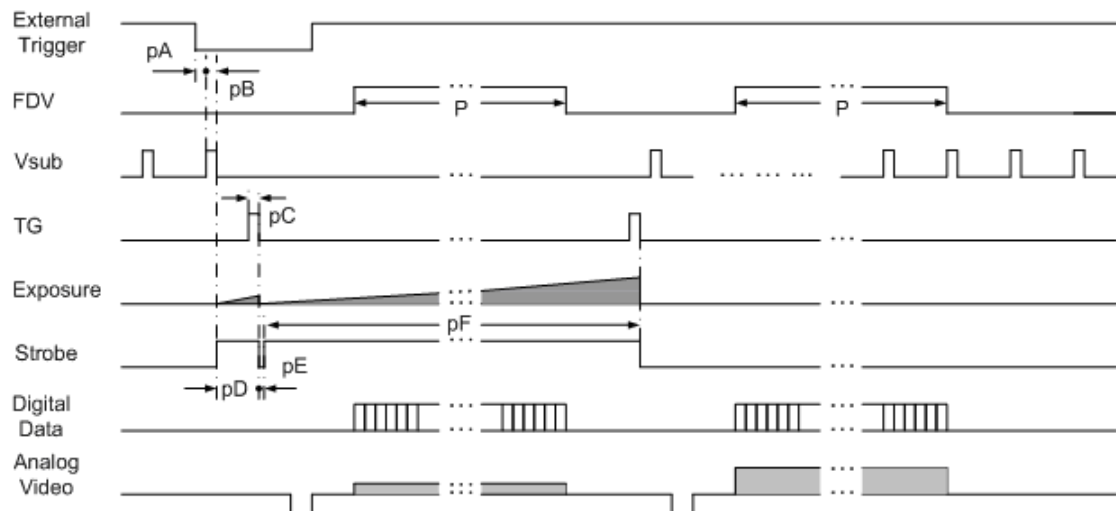
9.3.7 PWC PIV Mode

The PWC PIV 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/ (transfer time of two frames + exposure time of the first image).

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

FIGURE 68. PWC PIV Timing Table.
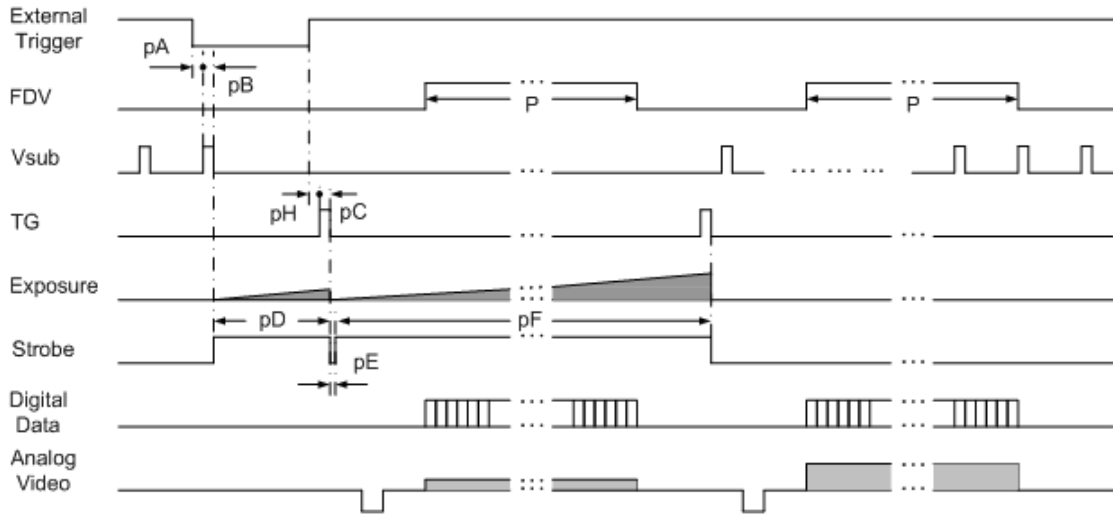
TABLE 9.   Asynchronous Mode Chart

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

Operation

9.4 Dynamic Range Control

FIGURE 69. Output and Blooming
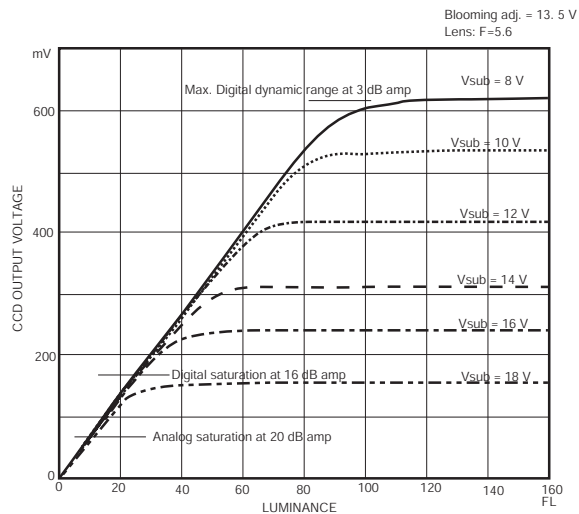
The typical interline transfer CCD has fixed noise levels based on dark current (thermal or KT noise), pattern noise, and the operating clock speed. In general, the level of the 20 MHz pixel clock CCD at room temperature is around 20 to 50 electrons. The maximum capacity of CCD charges is limited by the well capacity at saturation. The range is limited by the structure and the pixel size.

The TM-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.

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

The TM-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.

Operation

9.5 External Sync and Pixel Locking

The TM-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:

fHD = 30.769 KHz ± 2%
fVD = 14.79 Hz ± 2%
(Internal Master clock = 80.00 MHz,
Pixel clock = 40.00 MHz)

100L Partial Scan:

fHD = 30.769 KHz ± 2%
fVD = 27.97 Hz ± 2%

500L Partial Scan:

fHD = 30.769 KHz ± 2%
fVD = 49.63 Hz ± 2%

250L Partial Scan:

fHD = 30.769 KHz ± 2%
fVD = 79.92 Hz ± 2%

9.6 Camera Timing Charts

FIGURE 70. Camera Timing Chart
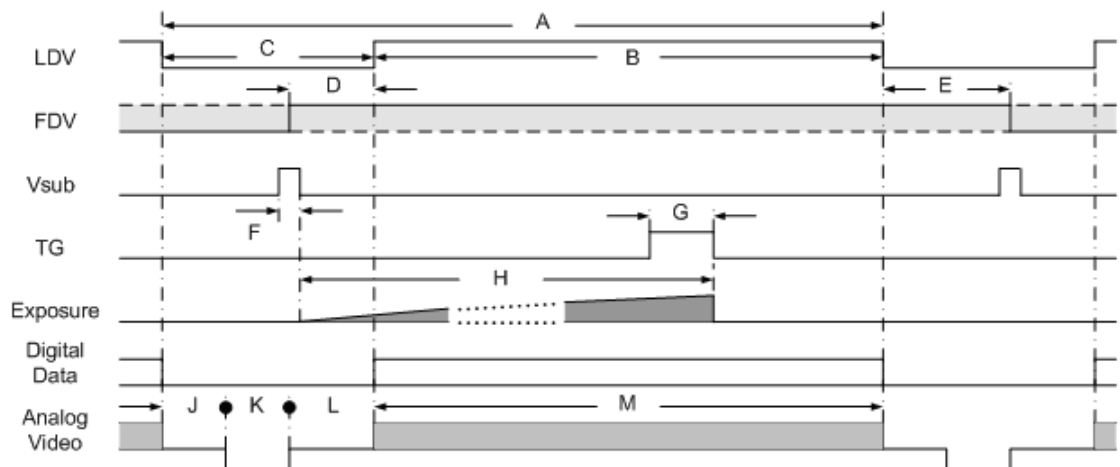
FIGURE 71. Digital Data Output Order for Configuration
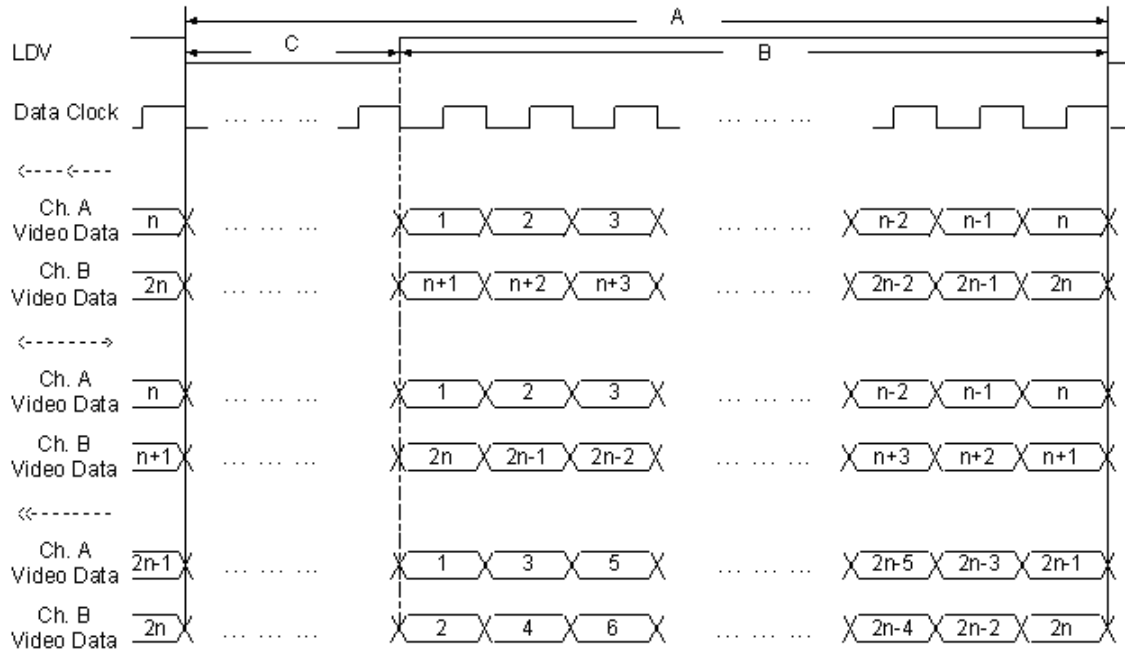
FIGURE 72. Field Video Timing--Continuous Mode
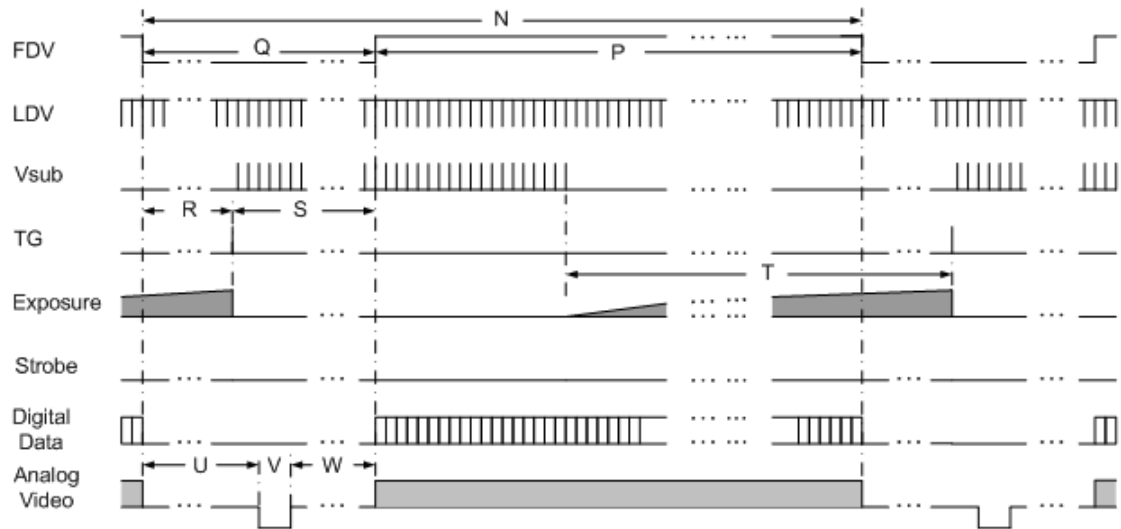
TABLE 10. Video Output

Scan Area	Data Clock	Horizontal (pixels)					Vertical (lines)				
		A	B	C	D	E	K	L	M	N	O
A							2080	32	2048		
B	40MHz	1300	276	1024	0	0	1100	100	1000	0	0
C	25 ns						620	120	500		
D							385	135	250		

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TABLE 11. External HD Locking and External VD Reset

Scan Area	Pixel Clock	Horizontal		External HD Locking Timing (pixels)					Vertical		Vertical VD Reset Timing (lines)				
		Freq. (kHz)	Time (μsec)	eA	eB	eC	eD	eE	Freq. (Hz)	Time (msec)	eF	eG	eH	eI	eJ
A	40MHz 25ns	30.77	32.5	<20ns	1300	100	1200	0	14.79	67.6	<2	2080	9	2071	1
B									27.7	35.75		1100		1091	
C									49.63	20.15		620		611	
D									79.92	12.51		385		376	

TABLE 12. Async Reset

Scan Area	Async Reset Timing											
	aA (lines)	aB (μsec)	aC	aD	aE	aF (μsec)	aG (lines)	aH (lines) s1-8	aH (lines) s9	aI (lines	aJ (sec)	aK (lines)
A	>1 & <2				s1-8: <1 line s9: <125ns			33	>aH & <aH +1	>aH + 1 & <aH +2	<1	<2
B								101				
C								121				
D								136				

> *Note:*   *s1=1*
> *s2=3*
> *s3=7*
> *s4=15*
> *s5=30*
> *s6=61*
> *s7=122*
> *s8=245*
> *s9=PW*

Operation

10 Troubleshooting

10.1 Problems and Solutions

Following are troubleshooting tips for common problems. In general, the problems listed in this section are solved by following these instructions. If there is no solution listed to the problem you are encountering, contact a JAI Inc. representative.

10.1.1 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

10.1.2 Symptom: Dark Video

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

- Shutter selection
- Iris opening on the lens

10.1.3 Symptom: Non-Synchronized Video

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

- Proper mode output
- Frame grabber software camera selection

Troubleshooting JAI®

10.1.4 Symptom: Video does not Display Properly

Remedies: Open the Coyote software and click on the *Display* heading. If the display is set to *Use video memory* change it to *Use system memory*.
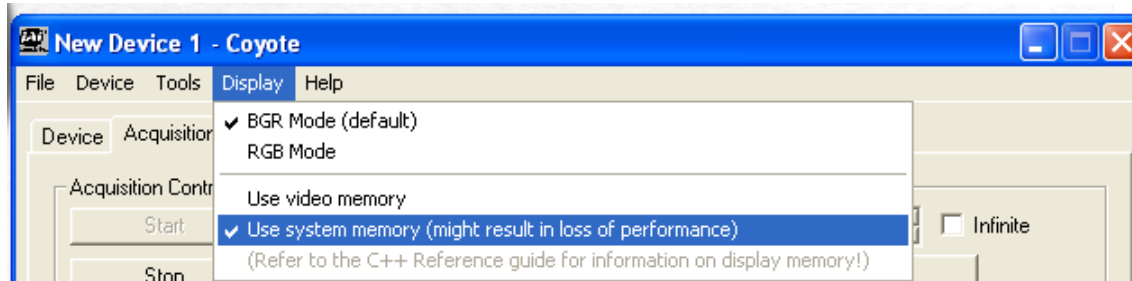
10.1.5 Symptom: Notebook Computer Driver Installation Problems

Remedies: The IBM T-42 laptop is unable to properly install.

10.1.6 Information and Support Resources

For further information and support:

Phone:	(408) 383-0300
	(800) 445-5444
Fax:	(408) 383-0301
E-mail:	imaging@jai.com
Mail:	JAI Inc.
	Sales Department
	625 River Oaks Parkway
	San Jose, CA 95134
	ATTN: Video Applications
Web Site:	www.jai.com

Troubleshooting

11 Appendix

11.1 Specifications

TABLE 13.   **TM-4200GE Camera Specifications Table**

Feature	TM-4200GE
Imager	1.2" progressive scan interline transfer CCD
Active Area	15.15mm x 15.15mm
Active Pixels	2048 (H) x 2048 (V)
Cell Size	7.4μm x 7.4μm
Display Mode (Active Pixels)	2048 (H) x 2048 (V) @ 15 Hz (full image) 2048 (H) x 1000 (V) @ 28 Hz (partial scan) 2048 (H) x 500 (V) @ 50Hz (partial scan) 2048 (H) x 250 (V) @ 80Hz (partial scan)
Sync	Internal/External auto switch HD/VD, 4.0 Vp-p impedance 4.7 K ohms VD=14.79±2%, non-interlace HD=30.78kHz±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.
Min. Illumination	Monochrome: 0.24 lux. Color: 2.56 lux. f = 1.4 (no shutter) @ 15 fps. Sensitivity: 31uV/e-
Video Output	Digital output: 8-bit x 2 / 10-bit x 2 Gigabit Ethernet (selectable at factory)
Gamma	Programmable LUT (1.0 std.)
Lens Mount	C-mount (use >1.2" format lenses or larger)
Power Requirement	12V DC, ±10%, 600mA (typical at 25°C)
Operating Temp.	-10°C to 50°C[*]
Vibration	7 Grms (10Hz to 2000Hz) Random, 11 ms half sine
Shock	70G
Size (W x H x L)	51mm x 51mm x 85mm
Weight	214 grams (7.5 oz.) without tripod
Optional Functions	OP3-1 Internal IR Filter Added; OP3-2 Optical Filter Removal; OP21 Glassless CCD Imager; OP21-1UV Ultraviolet Imager; OP65-6 F-Mount; OP65-7 M-Mount; OP65-8 M-Mount with 10 mm Backfocus
Optional Accessories Power Cable Power Supply	12P-02S PD-12UUP series (includes power connector)

*. Refer to Section 8.2.1 on page 48 for information on camera heat dissipation. Image quality will degrade with increasing temperature.
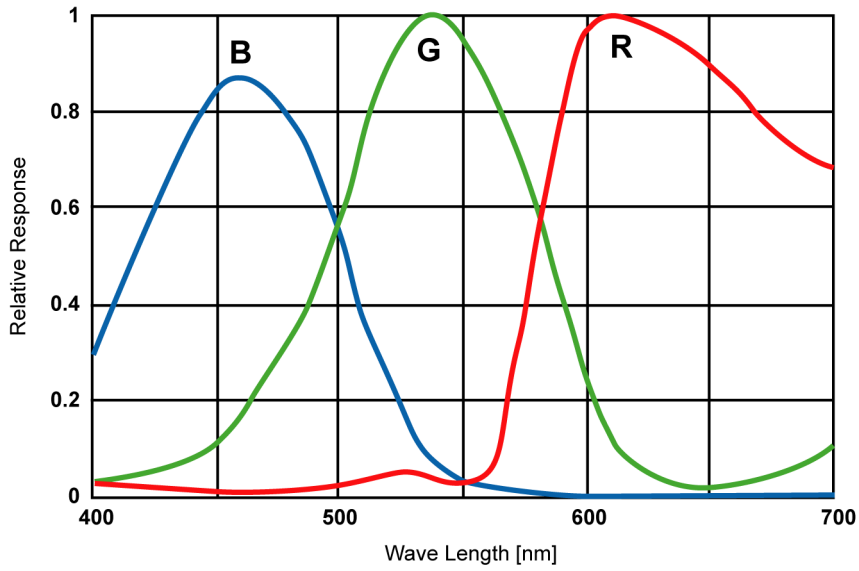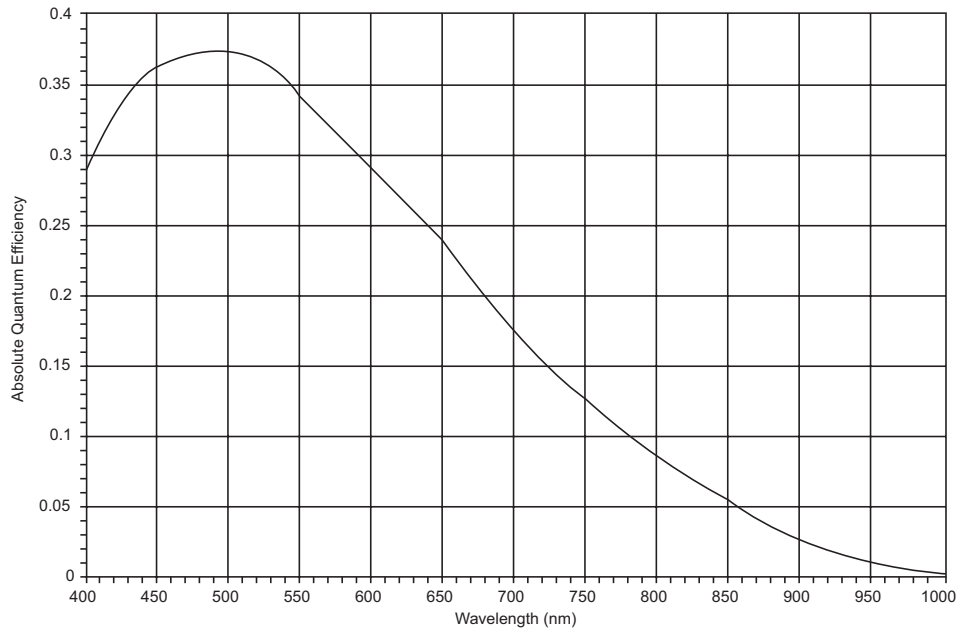
Appendix

11.1.1 TM-4200GE Physical Dimensions

FIGURE 73. **Physical Dimensions**

Appendix
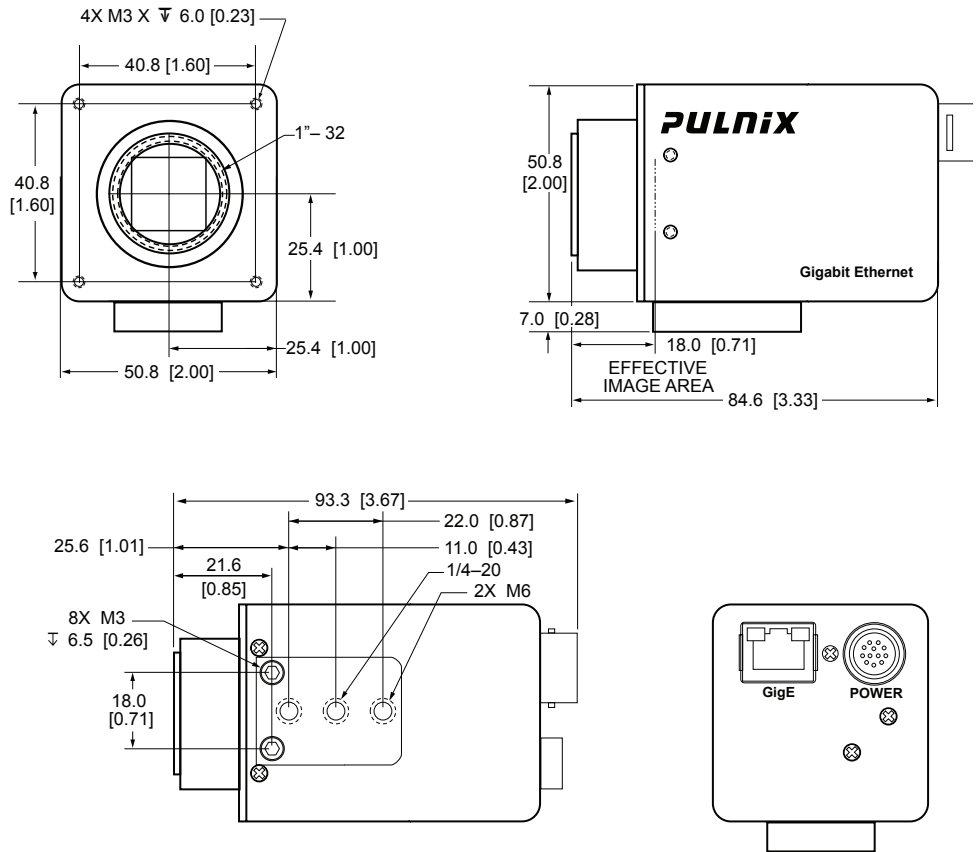
11.1.2 Spectral Response

FIGURE 74. Spectral Response

See the Possibilities

JAI Inc.   Tel: 408-383-0300
625 River Oaks Parkway   Tel: 800-445-5444
San Jose, CA 95134   Fax: 408-383-0301

Email: imaging@jai.com

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