See the possibilities

User's Manual

RM/TM-2030CL
RMC/TMC-2030CL

Digital Monochrome/Color
Progressive Scan, Interline-Transfer CL Camera

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Certifications

CE Compliance

The TM-2030CL series of cameras has been certified to conform to the requirements of Council Directive 89/336/EC for electromagnetic compatibility and to comply with the following European Standards:

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

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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.

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Supplement

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

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

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

重要注意事项

有毒，有害物质或元素名称及含量表

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

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

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

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

数字「15」为期限15年。

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Dual-Tap TM-2030CL Operation Manual

1 Introduction

The Dual-Tap AccuPiXEL software offered for the TM-2030CL 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-2030CL 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-2030CL series software is therefore, specifically documented in this section

1.1 Software Installation

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

1.1.1 Before Installing Dual-Tap AccuPiXEL Series Camera-Control Software

Please note the following requirements.

- Your computer must be running Microsoft 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.

1.1.2 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.

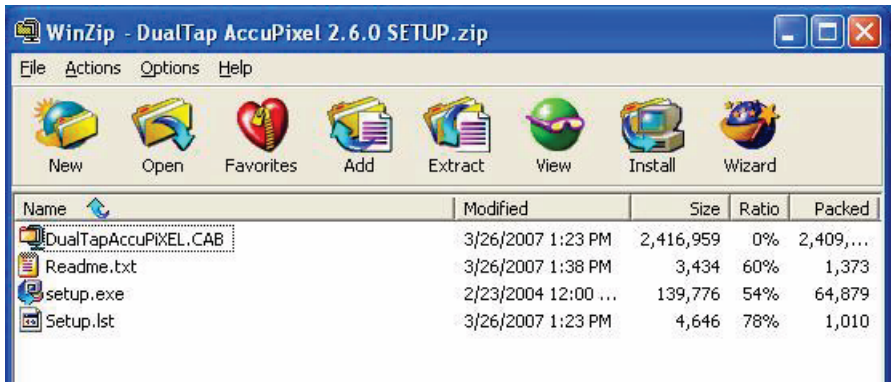
If dual tap software is already installed on your computer, uninstall the software using the steps in the Uninstall section.

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.

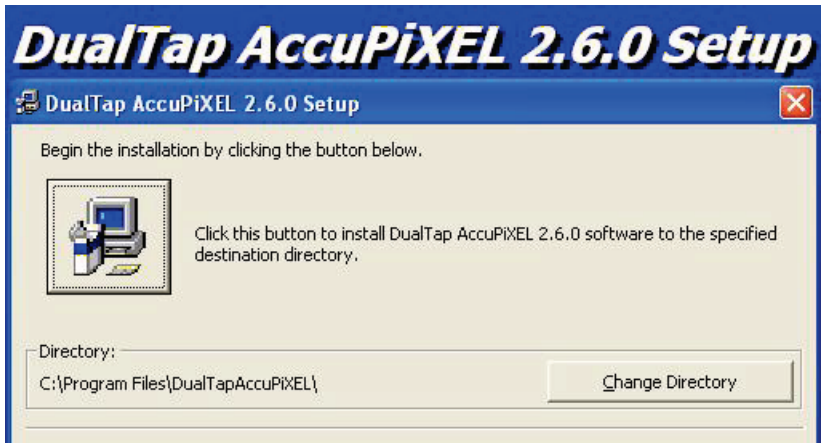
6. Open the file.
7. Double click on the JAI Inc. GigE 2.2.0.1 Install icon.

Figure 1. The Setup icon installs Dual Tap AccuPIXel v 2.6.x.x



8. Follow the Setup instructions.

Figure 2. AccuPIXel Setup screen

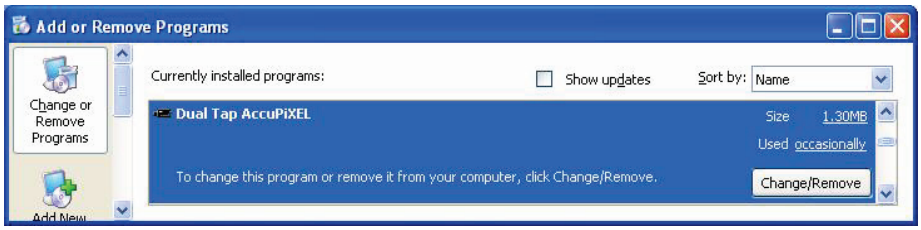


1.1.3 Uninstalling the Software

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

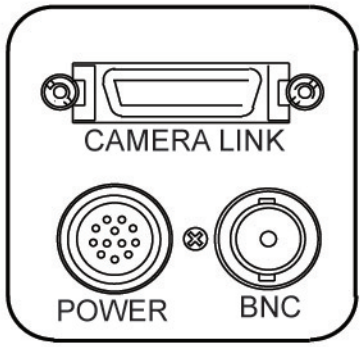
1. Open “Add or Remove Programs” in the control panel.
2. Select “Dual Tap AccuPiXEL” from the lists of the installed software.
3. Click the “Change” or “Remove” button.

Figure 3. The “Add or Remove Programs” utility can uninstall older software.



1.2 TM/TMC-2030CL Camera

Figure 4. Back of the TM/TMC-2030CL



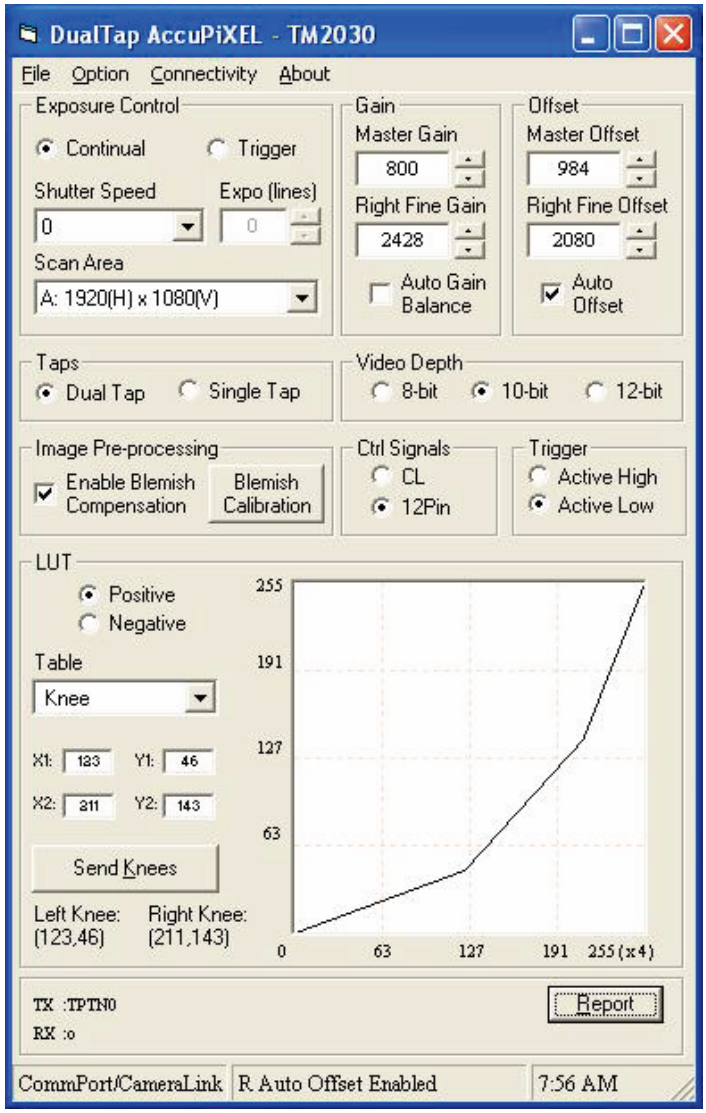
The camera must have all cables properly connected and any required adapters installed and configured to allow the software to perform the operations on the interface.

2 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 2030 CL cameras.

Figure 5. Main Dual Tap AccuPiXEL Window

- Exposure Control
  - Continual
  - Trigger
  - Shutter Speed
  - Expo / Lines
  - Scan Area
- Gain Settings
  - Master Gain
  - Right Fine Gain
  - Auto Gain Balance check box
- Offset
  - Master Offset
  - Right Fine Offset
  - Auto Offset
- Taps
- Video Depth
- Image Pre-processing
- Control Signals
- Trigger
- LUT
  - Positive
  - Negative
  - Table Selection
  - X1, Y1, X2, Y2
  - Send Knees
- TX RX Report



Note: White Balance—Color models of this camera (TMC-2030CL and RMC-2030CL) provide raw Bayer color output which requires interpolation by means of third party software on the host PC. Similarly, any white balancing must be performed by hostbased software. There is no white balance control in the camera hardware or software.

2.1 Operating The Control Software

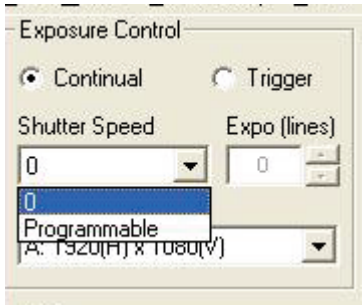
2.1.1 Exposure Control

The TM-2030CL exposure control allows you to select Continuous or Trigger modes using the appropriate radio button. Notice that Continuous and Trigger mode offer slightly different menus.

2.1.1 (a) Continuous Mode Shutter Speed

The Shutter Speed 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 9 is Async no delay shutter mode (pulse width control). A = PIV fixed exposure, B = PIV PWC. For detailed shutter information, please see “Electronic Shutter” on page 28.

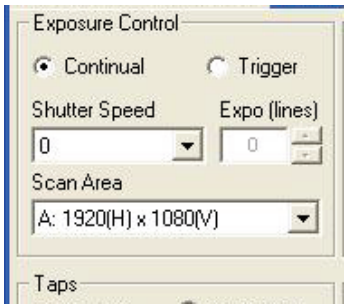
Figure 6. Continuous mode operates the shutter based on the camera settings.



2.1.1 (b) Continuous mode Scan Area

“Scan Area” offers a full scan or 2x2 binning when “Shutter Speed” is set at zero. Notice the “Expo (lines)” setting is disabled.

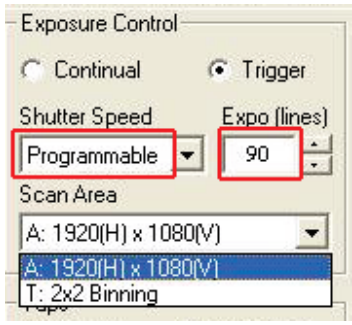
Figure 7. The camera offers full scan or binning.



2.1.1 (c) Programmable Shutter Speed

“Programmable” Shutter Speed is set by entering a number in the “Expo (lines)” text box. Programmable is available in Continuous or Trigger mode. The Expo setting is used instead of the Scan Area selection.

Figure 8. To use Programmable shutter speed, select Programmable.



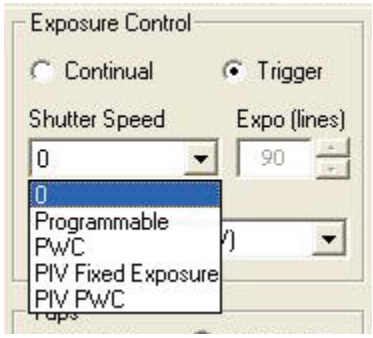
2.1.1 (d) Expo (lines)

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 text box beside the “Expo (lines)” box. The control is inactive unless “Shutter Speed” is set to “Programmable”.

2.1.2 Configuring Trigger Settings

Trigger mode uses a manual or sensor command to control the shutter. The Trigger mode offers several settings not available in Continuous mode.

Figure 9. Trigger mode shutter settings.



2.1.2 (a) Pulse Width Control Mode

Pulse Width Control (PWC) is controlled by the external trigger. An external trigger is used to generate one discharge signal (Vsub) right after the active edge of the trigger. The exposure starts when time is controlled by the pulse width of the external trigger.

2.1.2 (b) PIV Fixed Exposure

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.

2.1.2 (c) PIV PWC

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)

2.1.3 Gain Control

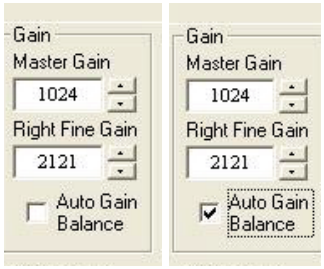
2.1.3 (a) Gain

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. Also, if operating the camera in dual-tap mode, the Gain Control allows you to adjust the balance of the gain between the two channels.

To manually adjust the overall gain, increase or decrease the number in the Master Gain field. In dual-tap mode, you can manually adjust the balance of channel B (right channel) by altering the number in the Right Fine Gain field.

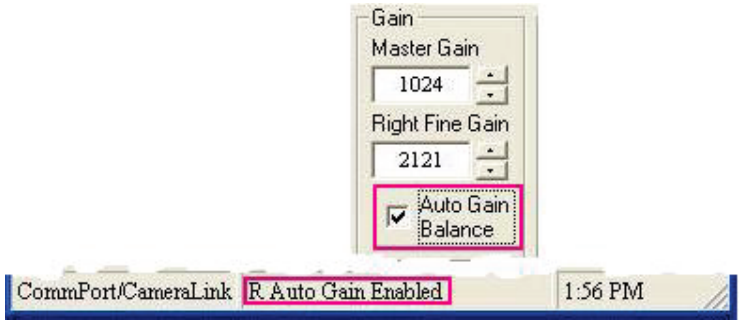
To automatically balance the gain between the two channels, check the box labeled Auto Gain Balance. While the camera is balancing the gain, the user interface is disabled and the label for the check box changes to "Balancing Please Wait." Once the right channel gain has been balanced, the check box clears. Be careful not to send other configuration commands during this process because the camera may not receive the commands.

Figure 10. The Gain is being set when the Auto Gain box appears checked.



Verify that the channel balance process has completed by checking the message area at the bottom of the GUI window. The message "R Auto Gain Enabled" will appear when completed.

Figure 11. The message bar confirms channel balance status.



During channel balancing, channel B is aligned to channel A. Good channel balance is obtained by exposing the camera to a uniform light source at 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 channels. Another condition in which auto balancing may not work properly is when you use the high-speed shutter under a low-frequency light, such as a fluorescent light.

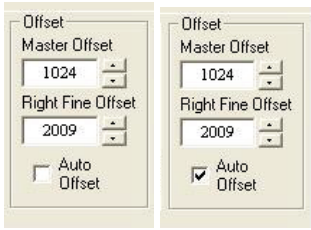
2.1.4 Offset Voltage

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

Checking the “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.

Figure 12. Auto Offset is checked only while the command is being set by the camera.



2.1.5 Tap Selection:

The TM-2030CL 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 13. Click on the option button to set the preferred option.

2.1.6 Video Depth

Figure 14. Use the option buttons to select 8-bit, 10-bit, or 12-bit output.

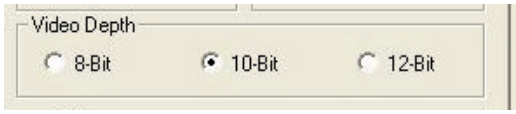
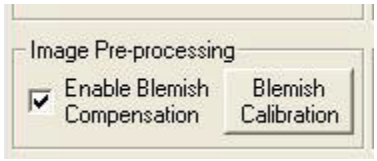


Figure 15. Image Pre-processing

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.

Figure 16. Image Pre-Processing is activated by checking "Enable Blemish Compensation".



2.1.7 LUT (Look-Up Table)

The Knee Control box allows you to set your own knee value to each LUT. See "LUT (Look-Up Table)" on page 28 (section 5.3.1) for more detail regarding the knee control.

2.1.7 (a) Positive or Negative LUT Selection

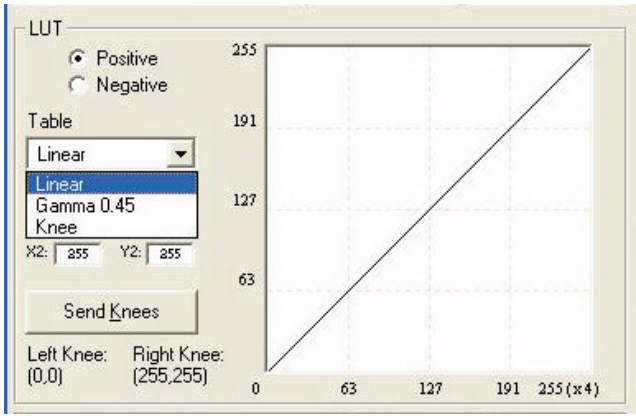
The LUT control panel allows you to select the positive or negative LUT. Choosing "Positive" provides a normal image. Choosing the "Negative" option causes the image to appear reversed, as in a film negative.

Figure 17. Choose either a positive or negative image.

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

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

Figure 18. Table drop down menu:

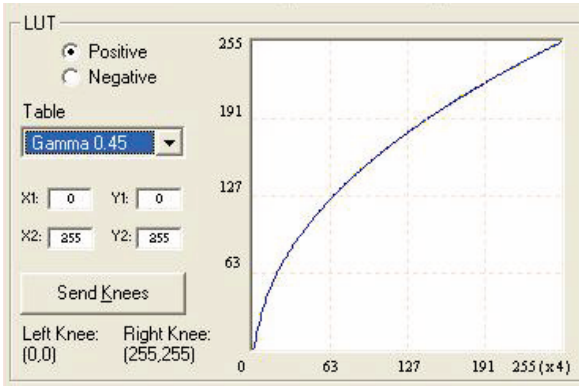


The Table drop down menu offers three options.

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

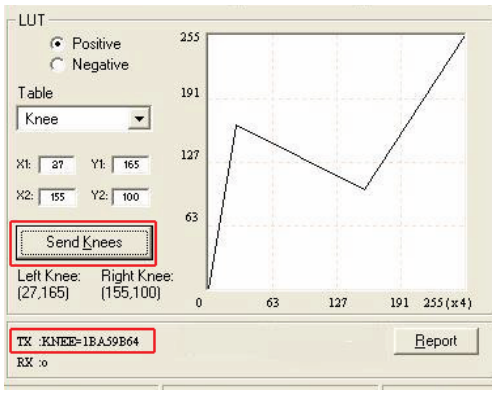
The Gamma.45 option is designed to cause the camera to gather light for a result very similar to what the human eye sees. The heavier curved blue line represents the Gamma.45 LUT adjustment (Figure 19).

Figure 19. 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 20. The setting does not activate until the Send Knees button is clicked.



2.1.7 (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 X1, Y1, X2, Y2 values directly to adjust the knee curve. When you have chosen the value you want and are ready to set this value to the camera, click the “Send Knees” button.

Note: The use of the Knee LUT may interfere with the Auto Level Control (ALC).

2.1.8 Rx TX Report Frame

This frame of the main GUI window allows you to view the result of actions taken with the Dual-Tap AccuPiXEL software. Clicking on the “Report” button also sends a command which reads out the current Dual-Tap AccuPiXEL software settings. This reading can be read using Table 7, “Command Responses,” on page 36.

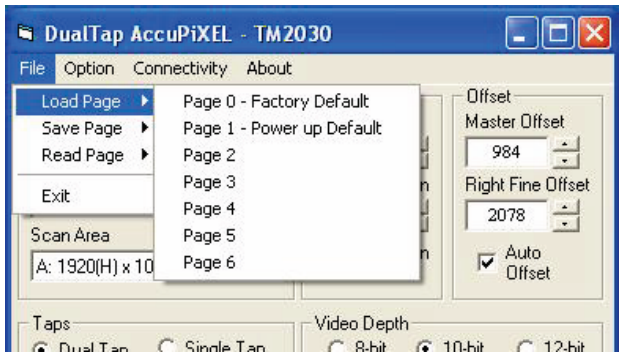
Figure 21. Click “Report” for current software setting information.

2.2 Main Menu: "File"

2.2.1 Load and Save Page

Click on the File menu and choose Load Page to load a saved set of camera parameters. The 1 slot contains the power up default settings.

Figure 22. Load Page

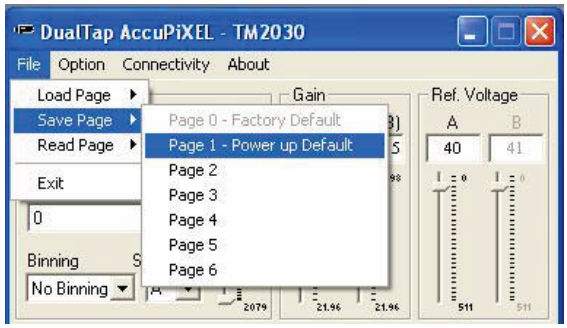


2.2.1 (a) Save Page

Click on the File menu and choose Save Page to change a saved set of camera parameters. The zero slot is used to store factory default settings, and can not be overwritten without supplying a password.

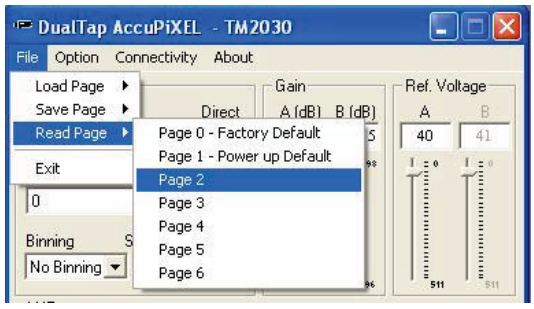
The 1 slot contains the power up default settings, and can be changed to allow different power up defaults. The remaining five pages can be used as desired to save configurations.

Figure 23. Save Page



2.2.1 (b) Read Page

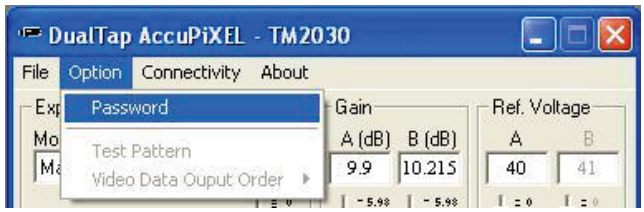
Click on the File menu and choose Read Page to read the EEPROM for a specific page. Using this command does not change the saved configuration.



2.3 Main Menu Option

Click on the "Option" menu and choose "Password" to gain access to load page 0 of the camera parameters. Contact JAI Inc. at 1-800-445-5444 for password access. The password allows access to the EEPROM to rewrite factory default settings.

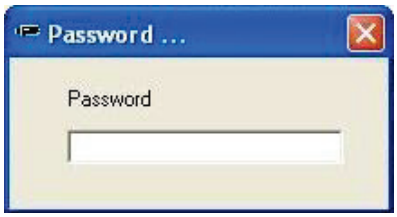
Figure 24. Password Access



2.3.1 Password

Please contact JAI, Inc. for password access.

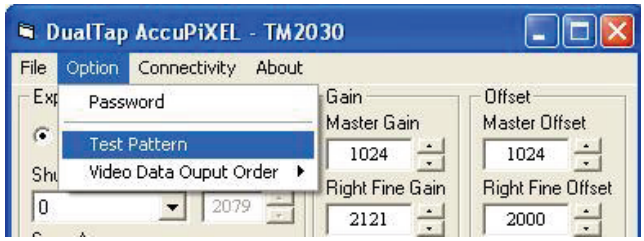
Figure 25. Password Screen



2.3.1 (a) Test Pattern

From the main menu, select "Option" and click 'Test Pattern" to view or disable the test pattern. This menu option is disabled if a monitor is not connected to the camera's video output.

Figure 26. Test Pattern requires a connected camera.



2.3.1 (b) Video Data Output Order

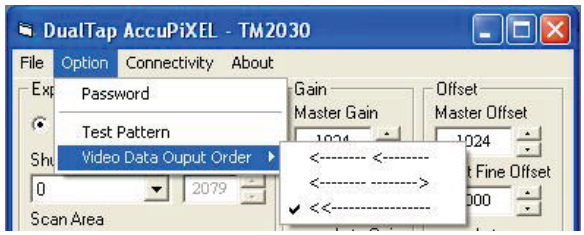
From the main menu, select "Option" and "Video Data Output Order" then choose "<--- <---" or "<--- --->" or "<<------"

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

"<--- --->" = First video data are pixel no. 1 and no. 2848.

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

Figure 27. Video output order



2.3.2 Main Menu "Connectivity"

Click on the "Connectivity" menu to view the buffer size. Some frame grabbers have a small buffer size and require a special communication algorithm. Use the "Receive Buffer Size" menu to set the buffer size. If you have trouble communicating with the camera, then select the "Receive buffer is small" option.

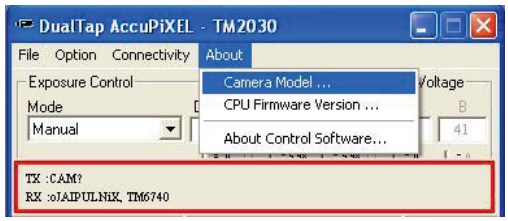
Figure 28. Buffer Size

2.3.3 Main Menu "About"

2.3.3 (a) Camera Model

From the main menu, select "About" and click "Camera Model" to check the camera information. The details display in the information frame near the bottom of the window.

Figure 29. Camera Model



2.3.3 (b) CPU Firmware Version

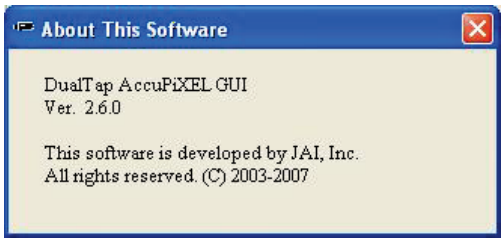
From the main menu, select "About" and click "CPU Firmware Version" to check the CPU firmware information.

Figure 30. CPU Firmware Version

2.3.3 (c) About Control Software

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

Figure 31. Control Software Version



3 Hardware Introduction

3.1 Product Description

The JAI Inc. TM/TMC/RM/RMC-2030CL series[1] is a 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 1/26,000 sec., can be reset asynchronously by external pulse control. The frame rate for a full image is 32 fps. A square imager format with uniform square pixels provides superior image definition in any orientation. On-chip micro lenses provide increased sensitivity to convert 12-bit input to 10-bit or 8-bit output.

The TM-2030CL[2] has a full dynamic range control function, which can be set at externally selectable look-up table (LUT) knee slopes thereby optimizing the CCD's full dynamic range in the normal output signal range. The TM-2030CL has semi-auto-gain balancing functions. The camera does not have a LUT for the 12-bit output.

Applications for the TM-2030CL include machine vision, medical imaging, intelligent transportation systems, high-definition graphics, on-line inspection, gauging, character reading, archiving, and high-security surveillance.

3.2 Features

- Small size and light weight

The printed circuit boards in the TM-2030CL 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 216 grams (7.6 oz.).

- Imager

The TM-2030CL uses a dual-tap progressive scan interline transfer CCD that has the following features:

- Resolution of 1920 x 1080 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 57dB.
- The CCD for the TM-2030CL has a built-in microlens for increased quantum efficiency.

Note: The Kodak KAI-2093 imager used in the TM-2030CL is packaged using a clear coverglass that does not have anti-reflective (AR) coatings. This is because the imager is not available from the manufacturer, Kodak, with AR coating on the coverglass.

The camera will function normally and provide high quality imaging without AR coating. However, in low light applications that are either high magnification or wide field-of-view, reflections between the back of the optics and the coverglass may occur. In low light conditions, portions of these reflections may cause some visible aberrations or ghosting.

- Electronic shutter

The TM-2030CL has a substrate drain-type shutter mechanism which provides superb pictures at various speeds without smearing. For more information, please see Section 5.5 on page 28.

[1] Unless otherwise stated, all information in this manual applies to the TM-2030CL series; the TM-2030CL, TMC-2030CL and their RoHS compliant RM-2030CL and RMC-2030CL.

[2] The TM-2030CL output is available with either 8-bit, 10-bit or 12-bit processing.

- Asynchronous reset

The TM-2030CL 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-2030CL'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-2030CL 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 1/32 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-2030CL has a dual-tap 12-bit/10-bit/8-bit Camera Link output. The analog output is 1.0 Vp-p composite video (75 Ω) on all models.

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

The TM-2030CL, 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.

4 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.

4.1 Getting Started

4.1.1 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.

4.1.2 Components

When you receive your TM-2030CL 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.

4.1.3 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
- CamLink cable 26-CL-02-26 (2m), or 26-CL-05-26 (5m)
- Tripod Mounting Kit: TP-20
  (for dimensions go to: www.jai.com/EN/CameraSolutions/Products/Accessories/Pages/Home.aspx)

4.2 Camera Setup

4.2.1 Heat Dissipation

The TM-2030CL is a compact 1920 by 1080 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.

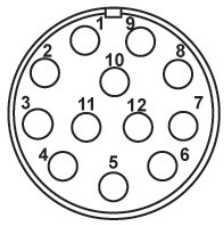
Please contact JAI Inc. at (800) 445-5444 or send an E-mail to imaging@jai.com if you have any questions.

4.2.2 Connector Pin Configurations

4.2.2 (a) 12-Pin Connector

The TM-2030CL has a 12-pin Hirose connector for power input as shown in Figure 32.

Figure 32. 12-Pin Connector Pinouts



Pin #1 is Ground and pin #2 is +12V DC. Table 7 shows the pin-out table.

Table 1 12-Pin Connector

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

4.2.2 (b) Digital I/O Connector

The TM-2030CL has a 26-pin connector on the rear panel to output Camera Link data. The connector pin-out is shown in Table 2 on page 19

Figure 33. 26-pin Camera Link Connector.

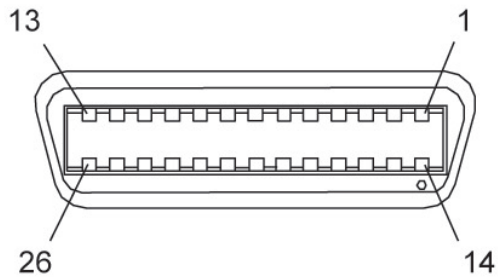


Table 2 Connector and Pin-out Configurations

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

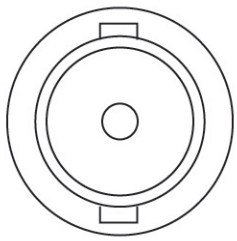
Note: SerTC: Serial To Camera
SerTFG: Serial to Frame Grabber

4.2.2 (c) Analog Output Connector

The TM-2030CL has a BNC connector on the rear panel to output the analog video signal. Analog output is available to drive auto-iris lenses and troubleshooting.

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

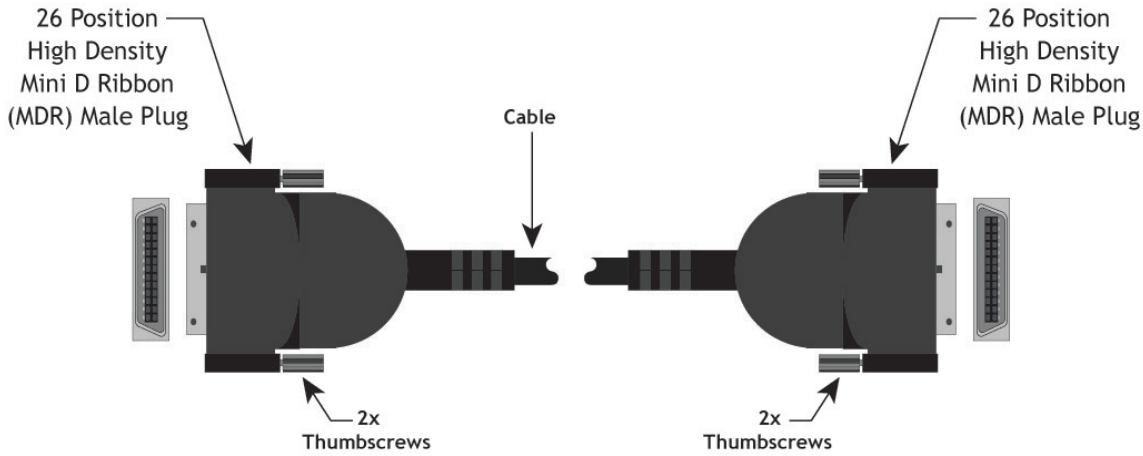
Figure 34. BNC Connector.



4.2.3 Camera Link Cable

The 26CL-02-26 cable assembly has been standardized as the Camera Link cable. This cable has a 26-pin connector on both ends. This is a straight-through cable and the pin-out configuration is shown in Table 2 on page 19. Contact JAI for cable lengths other than 2 meters.

Figure 35. 3M Camera Link Cable



Note: For CL versions, serial communication for camera control is accomplished by means of the Camera Link connector on the rear panel of the camera.

4.2.4 Power Supplies and Power Cable Setup

4.2.4 (a) Power Supplies

The TM-2030CL camera requires 12V DC power that is obtained through the 12-pin connector located on the back panel of the camera. JAI Inc. power supplies feature a 100-240V AC/12V DC 1.2A universal voltage power supply. JAI Inc. recommends the following power supplies:

PD-12UU	No 12-pin connector	US Plug
PD-12UUP	PD-12UU with 12-pin connector	US plug
PD-12UE	PD-12UU no 12-pin connector	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.

4.2.4 (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 pinout diagram below. The cable pin-out diagram is shown in Figure 36. The color-coded leads use Gray for Ground and Yellow for +12V.

Figure 36. 12P-02S Interface Cable (optional)

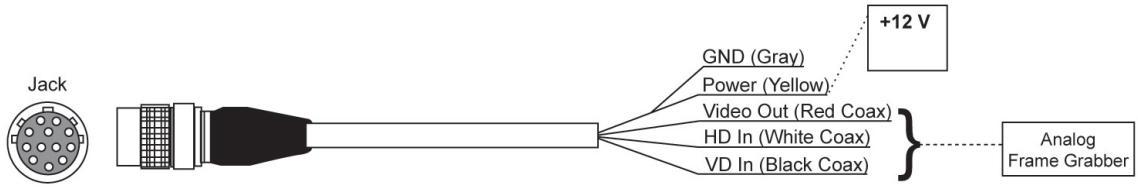


Table 3 12-Pin Interface Pin-Outs

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.

4.2.4 (c) Building Your Own Power Cable

Refer to the 12-pin connector pin-out in Figure 32 on page 18. 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.

4.2.4 (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.

4.2.5 Attaching the Camera Lens

The TM-2030CL camera accepts 1-inch or larger format size C-mount lenses. To attach the C-mount lens[3] 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.

4.2.6 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.

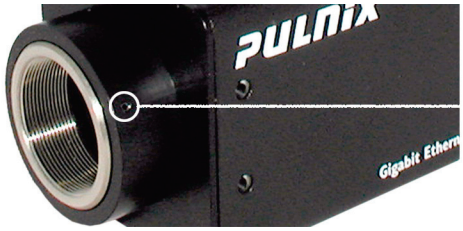
[3] C-mount to F-mount and C-mount to K-mount adapters are available for larger format lenses (35mm). Check with local photography dealers for these lens adapters.

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 37. Back Focus Set-Screw Locations



Loosen the three 2mm screws around the perimeter of the C0mount 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.

5 Operation

5.1 Progressive Scanning

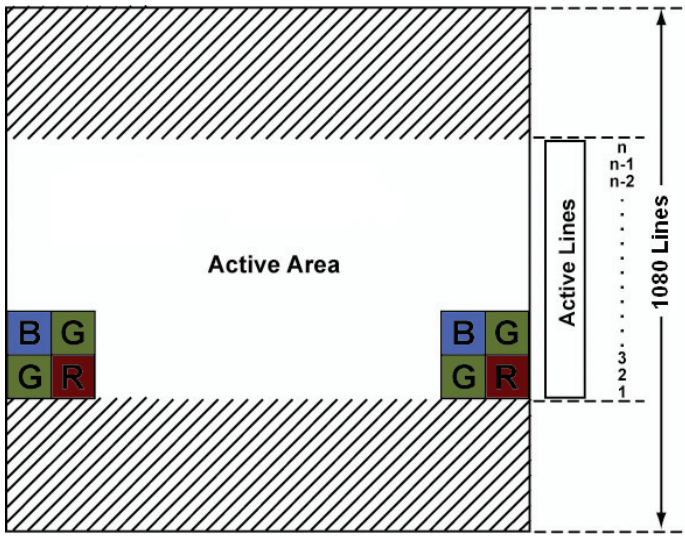
Standard TV-system scanning is 525 lines interlace scanning as specified in the RS-170 protocol. Every other horizontal line (odd lines and even lines) is scanned at a 60Hz rate per field, and the scanning is completed with two fields (one frame) at 30Hz rate. Because of the interlace scanning, the vertical 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-2030CL 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.

5.1.1 Preset Scan Area

TM/TMC-2030CL has full scan mode, all active lines of the CCD sensor, 1080 lines, are transferred out line by line.



5.1.2 Full Scan Area 2x2 Binning

TM/TMC-2030CL has a 2x2 binning of the full scan area. In 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=1 2, ..., 800; j=1,2, ..., 540). In this mode vertical binning makes frame transfer faster than normal scan mode, however, due to the mixture of pixel information, the camera resolution is low in this mode, and the Bayer pattern CCD camera loses color information.

Figure 38. 2x2 Binning

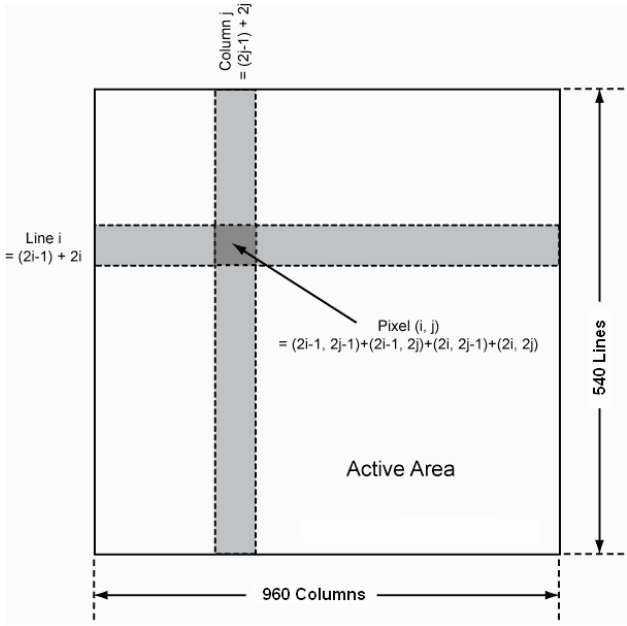


Table 4 Scan Area Start Points

	Scan Area	Start Point (Line)	Effective Area (Lines x Pixels)	Frame Rate (FPS)	
				Dual Tap	Single Tap
A	Full Scan	1	1920 x 1080	32.32	16.16
1	Full Scan 2x2 Binning	1	960 x 540	58.65	30.79

5.2 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 up to 1/26,000 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.

5.2.1 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.

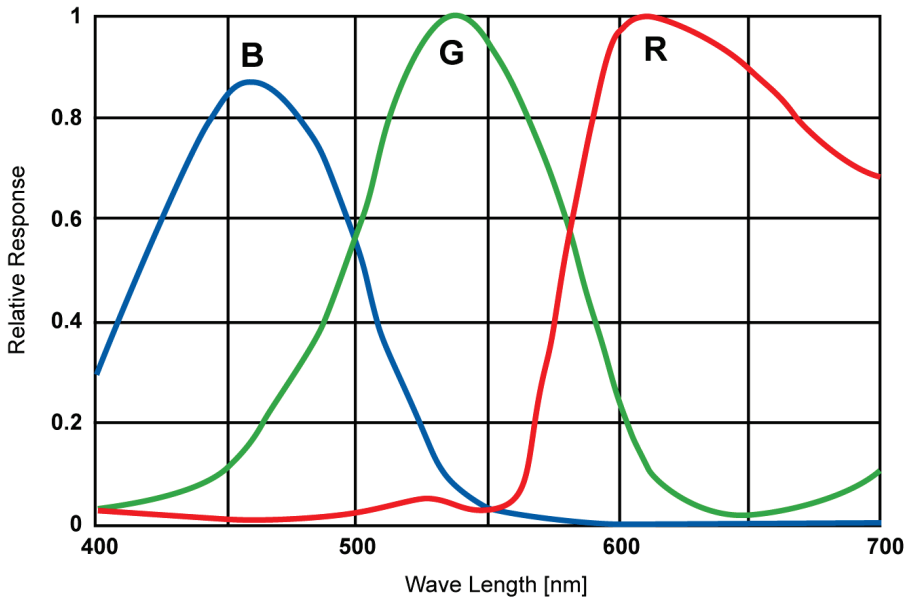
5.2.2 Bayer Color Filter Array (CFA)

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

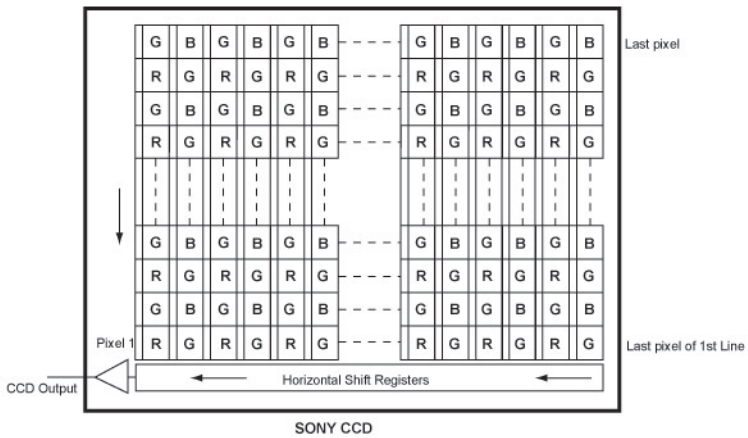
Figure 39. Bayer Color Filter Response.



5.2.3 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 40. Example of Color CCD CFA Pattern



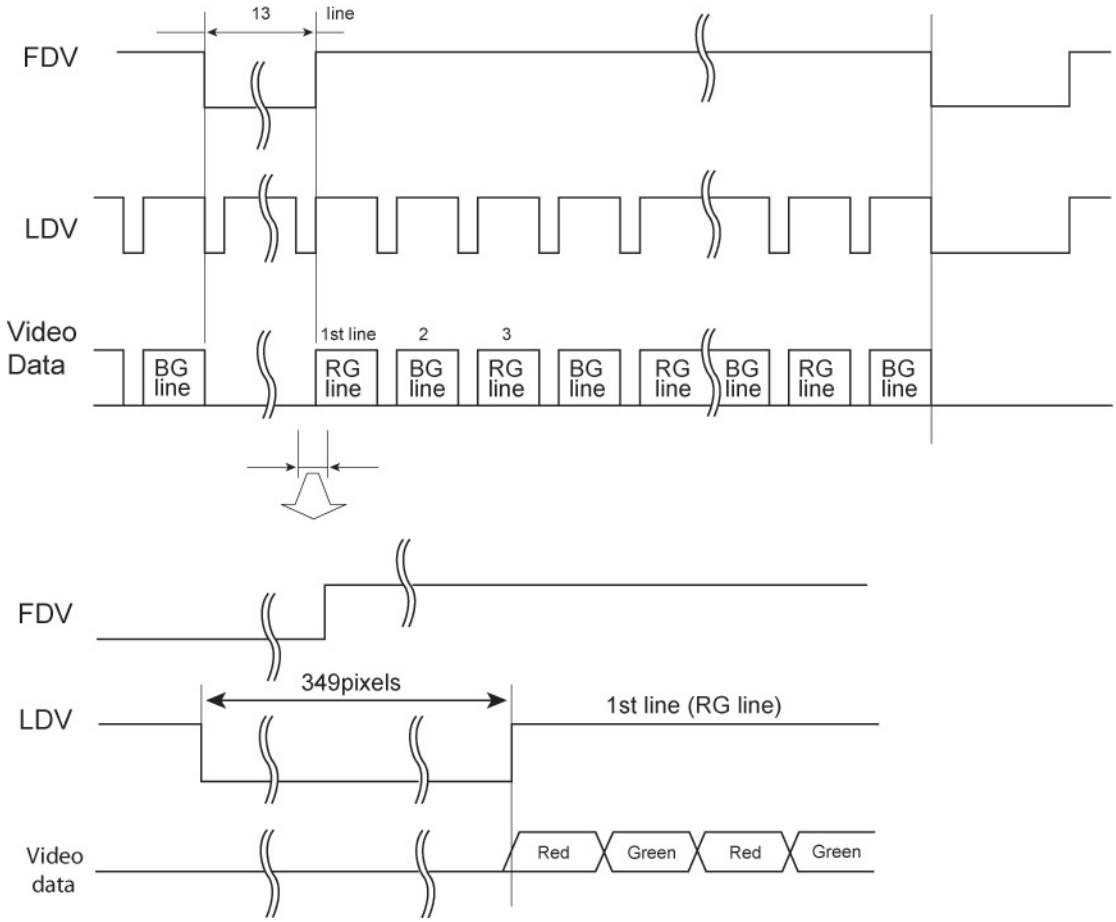
5.2.4 Sync and Data

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-2030CL default mode. FDV and LDV are used internally for the GigE interface.

Figure 41. Example of TMC-2030CL (Same as TM-2030CL)



5.2.5 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.

5.2.6 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.

5.2.7 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).

Figure 42. Color Interpolation Diagram

Green	Red	Green
Blue	Green	Blue
Green	Red	Green

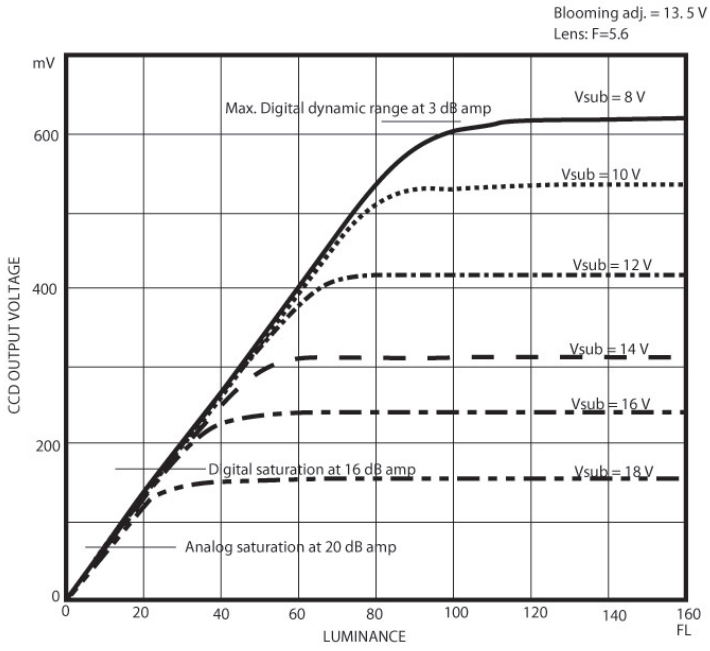
The image quality depends on the camera's own pixel data (including pixel data independency from neighboring pixels, noise and color filter), and interpolation of the software algorithm such as 3 x 3 interpolation, 2 x 2 interpolation, color matrix, white balance capability, and so on.

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.

5.3 Dynamic Range Control

Figure 43. 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-2030CL uses a CCD with 7.4 ?m x 7.4 ?m 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.

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

The TM-2030CL 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.

5.4 External Sync and Pixel Locking

The TM-2030CL 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 = 36.36 KHz ± 2%
fVD = 32.32 Hz ± 2%
(Internal Master clock = 80.00 MHz,
Pixel clock = 40.00 MHz)

5.5 Electronic Shutter

The TM-2030CL has a substrate drain-type shutter mechanism which provides a superb picture at various speeds without smearing.

5.5.1 Programmable Exposure-Continuous Mode

The exposure time of TM/TMC-2030CL 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

$$\textit{Exposure Time} = \begin{cases} (n+1) * 27.5\ \mu s + 15.6\ \mu s & \textit{Dual Tap} \\ (n+1) * 55.0\ \mu s + 15.6\ \mu s & \textit{Single Tap} \end{cases}$$

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

$$\textit{Minimum Exposure Time} = \begin{cases} 43.1\ \mu s\ \textit{(1/23000s)} & \textit{Dual Tap} \\ 70.6\ \mu s\ \text{(1/14000s)} & \textit{Single Tap} \end{cases}$$

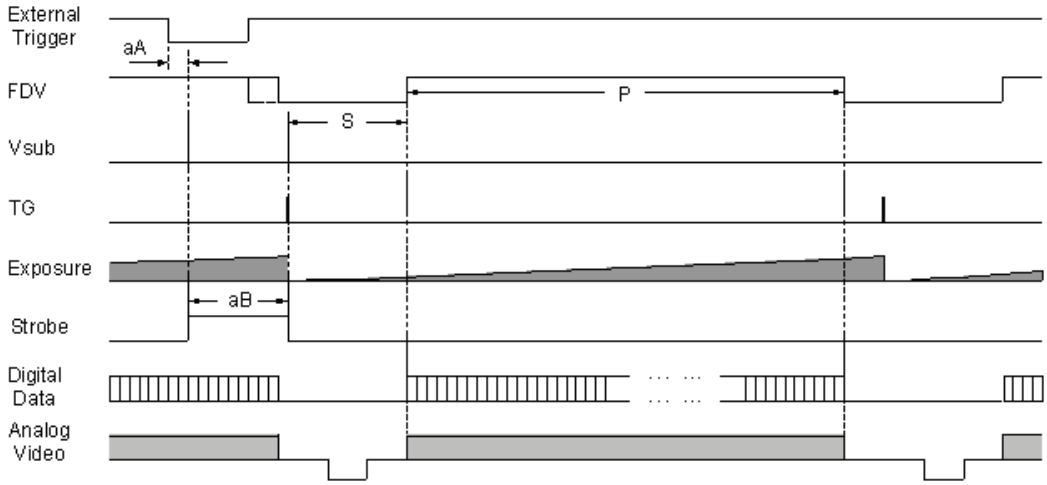
In this mode the maximum exposure time is equal to the setting for one frame. If the user specified exposure time is longer than the time allowed for one frame, it will be ignored by the camera.

5.5.2 Asynchronous No Shutter Mode

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

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

Figure 44. External Trigger Timing.



5.5.3 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:

$$\textit{Exposure Time} = \begin{cases} (n+1) * 27.5\ \mu s + 15.6\ \mu s & \textit{Dual Tap} \\ (n+1) * 55.0\ \mu s + 15.6\ \mu s & \textit{Single Tap} \end{cases} \qquad n = 0,1 \ldots\ldots 1124$$

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

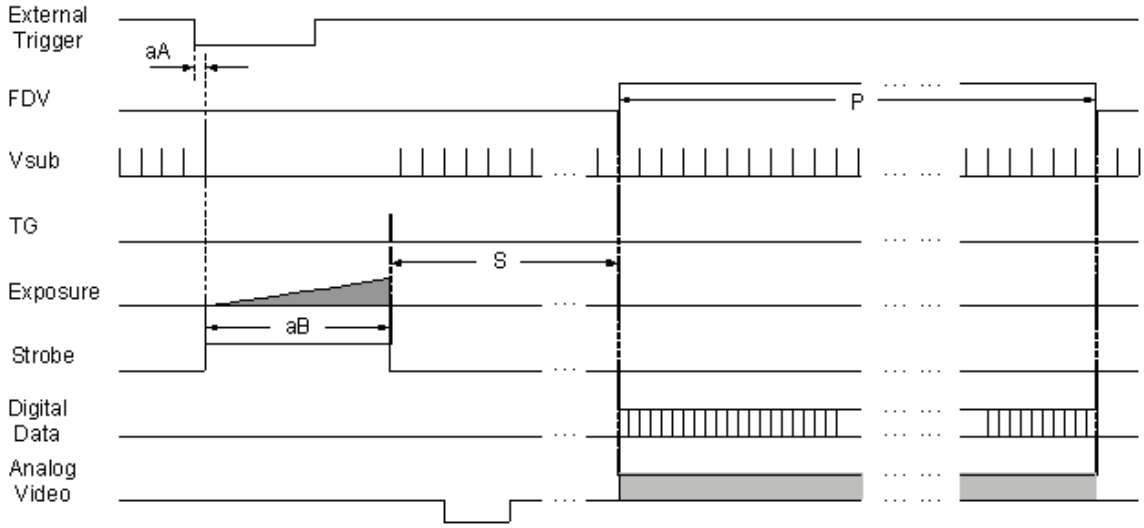
$$\textit{Minimum Exposure Time} = \begin{cases} 43.1\ \mu s\ \textit{(1/23000s)} & \textit{Dual Tap} \\ 70.6\ \mu s\ (1/14000s) & \textit{Single Tap} \end{cases}$$

When n=1124 the exposure time is maximum exposure time. It is equal to:

$$\textit{Maximum Exposure Time} = \begin{cases} 31.25\ \mu s\ \textit{(1/32s)} & \textit{Dual Tap} \\ 62.5\ \mu s\ (1/16s) & \textit{Single Tap} \end{cases}$$

- 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.

Figure 45. Asynchronous Programmable External Trigger



5.5.4 Pulse Width Control Mode

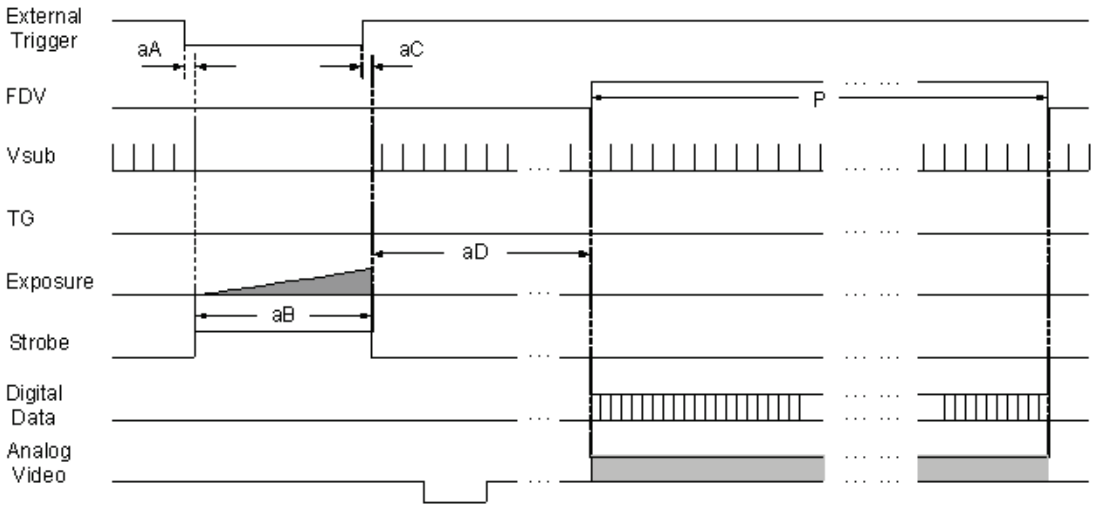
In Pulse Width Control (PWC) Mode, the exposure time is controlled by the external trigger. When an external trigger is applied, one discharge signal (Vsub) is generated right after the active edge of the trigger. The exposure starts when the discharge signal is in the off state. The exposure is off 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 +12.4µs

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 5?s. Theoretically, the maximum active period of the external trigger is unlimited. But, due to the usability of images at 25oC it is recommended the active period of the external trigger be no longer than one second.

Figure 46. Pulse Width Control Trigger

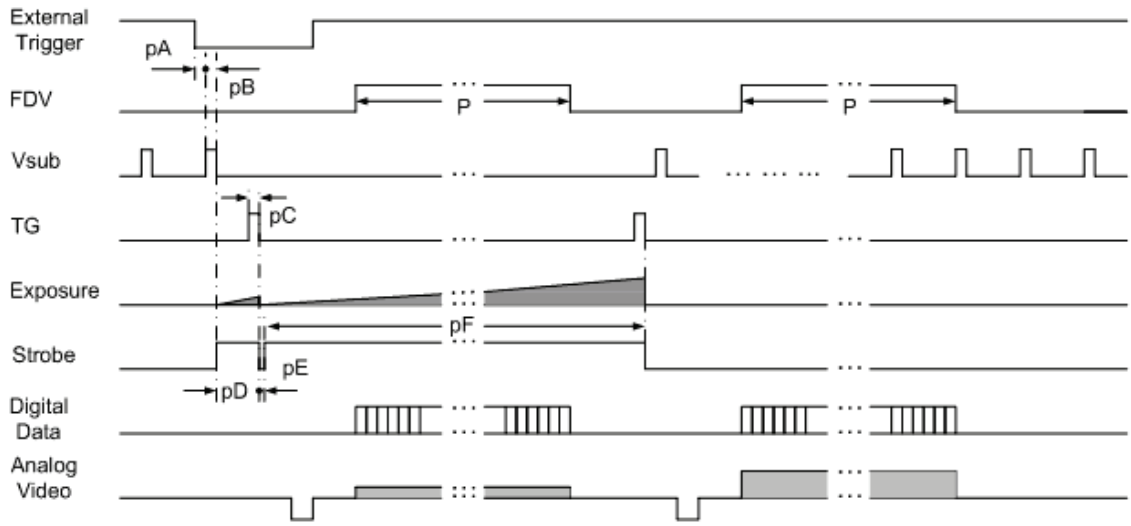


5.5.5 Particle Imaging Velocimetry Fixed Exposure Mode

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 47. PIV Exposure Timing Table



5.5.6 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 48. PWC PIV Timing Table.

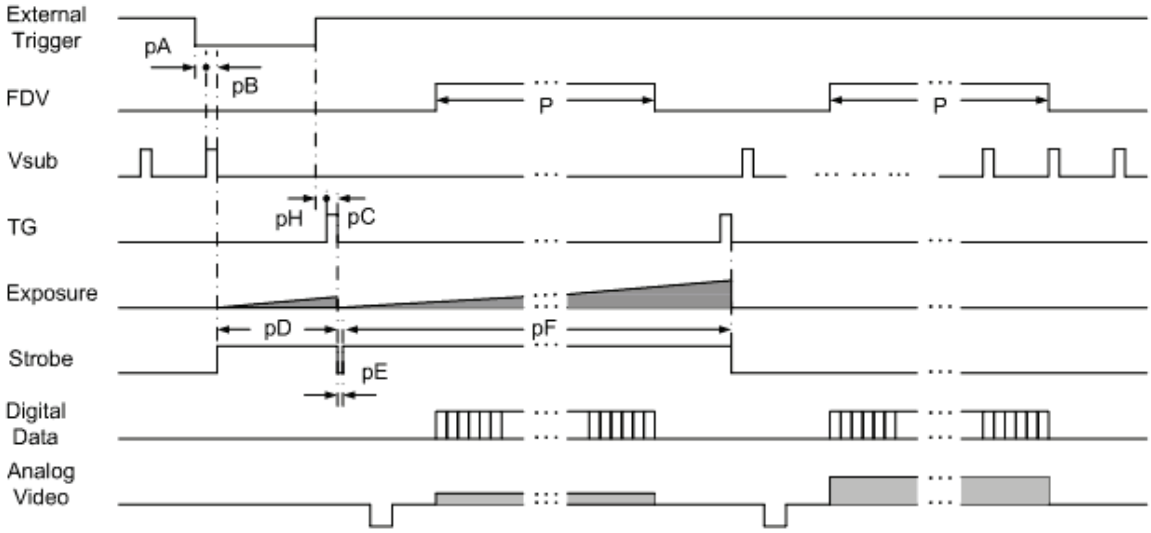


Table 5 Asynchronous Mode Chart

	Asyn No Shutter	Async Preset and Prog. Shutter	PWC
aA	<1 line	<1 line	6 clk
aB	9.5 line	(n+1) lines + 298 clk	Pulse width + 48 clk
aC			48 clk

	PIV Fixe Expo	PIV PWC	Unit
pA	6	6	Pixel
pB	70	70	
pC	200	200	
pD	320	320	
pE	20	20	
pF	1	1	Frame

5.6 Camera Timing Charts

Figure 49. Camera Timing Chart

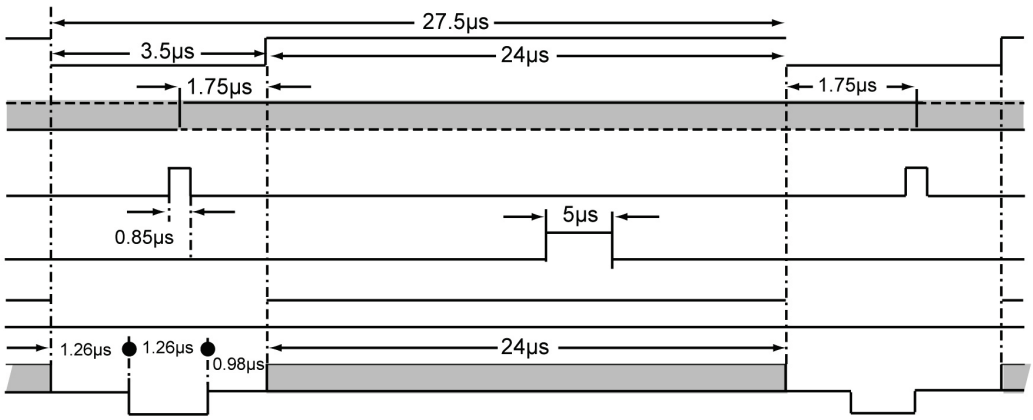


Figure 50. Digital Data Output Order for Configuration

4. Video Output Order

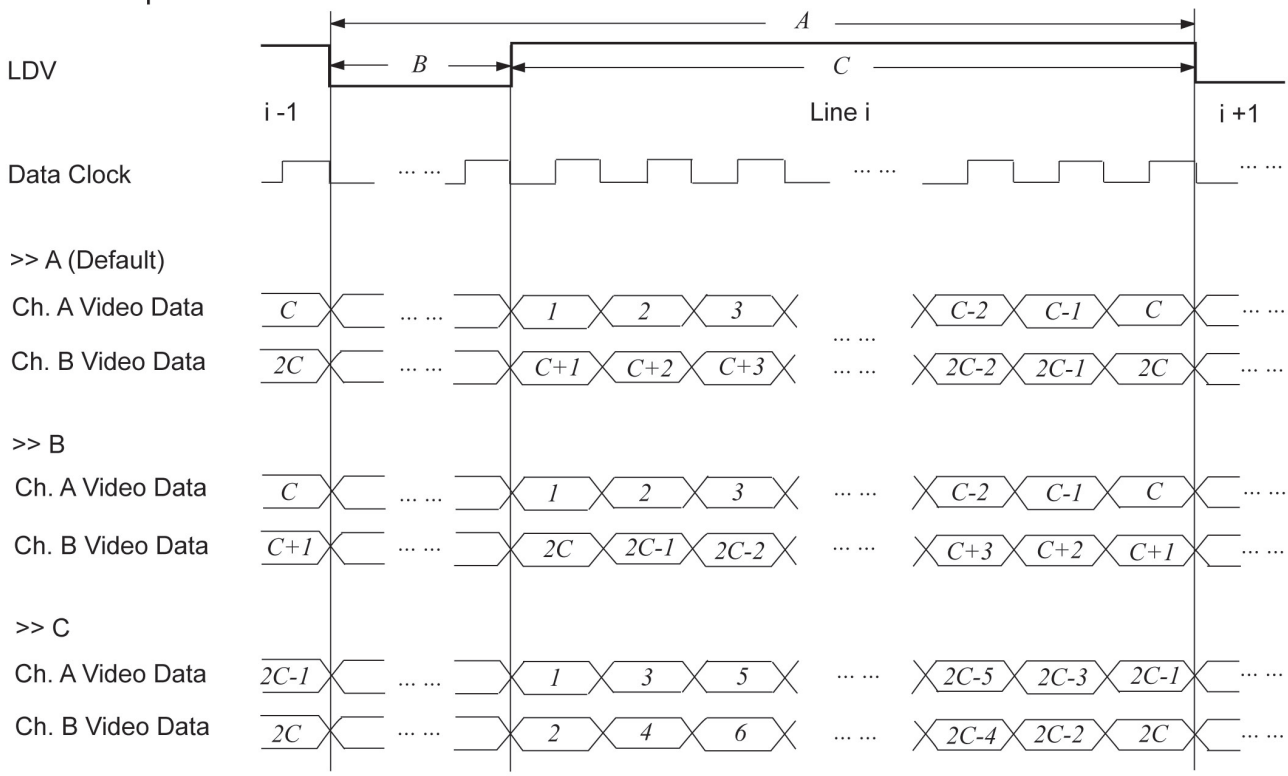
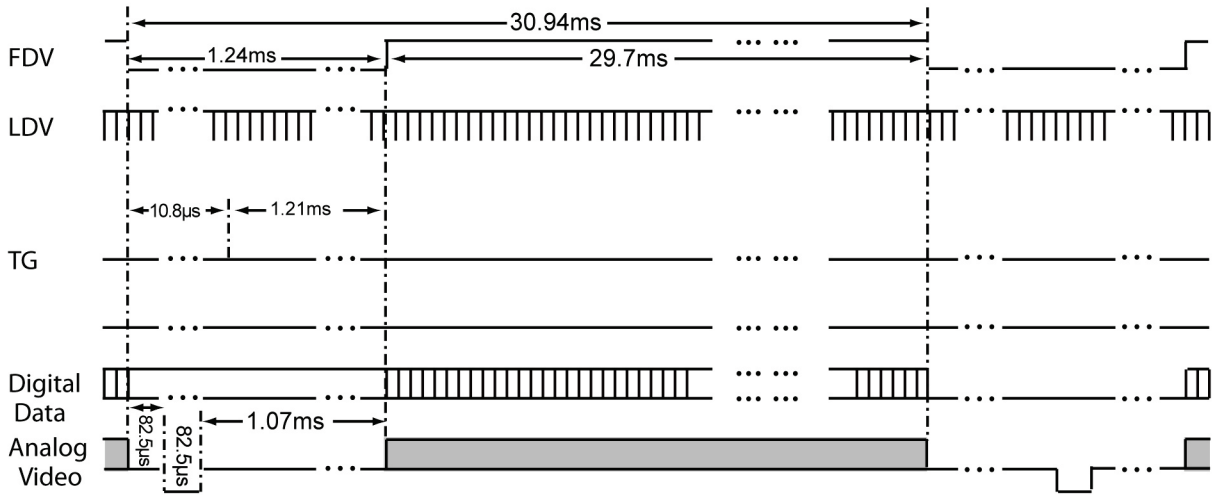


Figure 51. Field Video Timing--Continuous Mode



6 Camera Serial Commands

You can control the C 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 6 lists serial commands that can be used to control the camera.

Table 6 TM/TMC-2030 Command List

Command	Parameter	End of Cmd	Ack. Response	Description
Scan Mode				
Shutter Mode and Shutter Speed				
:MSH=	X	<cr>	:o<cr>	Set Continuous Mode Preset Shutter (X= 0)
: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=9 PWC, X=A Fixed exposure PIV, X=B PWC PIV)
:ADS=	XXX	<cr>	:o<cr>	Set Async Mode Programmable Shutter (XXX=000 - 81F)
:SHR?		<cr>	:o[shtr]<cr>	Inquire current shutter mode
Gain and Offset				
:MGA=	XXX	<cr>	:o<cr>	Set Master Gain (XXX = 000 - FFF)
:MGB=	XXX	<cr>	:o<cr>	Set R channel Fine Gain (XXX = 000 - FFF)
:VRA=	XXX	<cr>	:o<cr>	Set Master Offset (XXX = 000 - FFF)
:VRB=	XXX	<cr>	:o<cr>	Set R channel Fine Offset (XXX = 000 - FFF)
:MGA?		<cr>	:oMG[XXX]<cr>	Inquire Master Gain (XXX = 000 - FFF)
:MGB?		<cr>	:oSG[XXX]<cr>	Inquire R channel Fine Gain (XXX = 000 - FFF)
:VRA?		<cr>	:oMF[XXX]<cr>	Inquire Master Offset (XXX = 000 - FFF)
:VRB?		<cr>	:oSF[XXX]<cr>	Inquire R channel Fine Offset (XXX = 000 - FFF)
Lookup Table				
:LINR		<cr>	:o<cr>	Set linear table
:GM45		<cr>	:o<cr>	Set gamma .45 table
:KNEE=	X1Y1X2Y2	<cr>	:o<cr>	Set knees (X1, Y1, X2, Y2 = 00 - FF)
:NLUT	X	<cr>	:o<cr>	Set Positive Knee or Negative Knee (X = 0 Positive, X = 1 Negative)
:LUT?		<cr>	:o[lut]<cr>	Inquire current LUT setting
Channel Balance				
: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)
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

Command	Parameter	End of Cmd	Ack. Response	Description
Dual Tap Digital Video Output Order				
:VDO	X	<cr>	:o[VD][X]<cr>	Set Dual Tap Digital Video Output Order (X = A, B, C, ?) (A <--<--, B <---->, C <<----, ? Inquire video output order)
Image Pre-processing				
:BLC=	0	<cr>	:o<cr>	Set White Blemish Calibration Flag
:EBL=	X	<cr>	:o[BL][X]<cr>	Enable/Disable Blemish Compensation and Inquire Status (X = 0 Disable, X = 1 Enable, X = ? Inquire Status)
Miscellaneous				
:DUL=	X	<cr>	:o<cr>	Single Tap/Dual Tap Selection (X = 0 Dual Tap, X = 1 Single Tap)
:DDP=	X	<cr>	:o<cr>	Set Output Data Depth (X = 0 8-bit, X = 1 10-bit, x = 2 12-bit)
:CCS=	X	<cr>	:o<cr>	Select Camera Control signals (X = 0 CL Conn, X = 1 Hirose Conn)
:TAH=	X	<cr>	:o<cr>	External Trigger Polarity (X = 1 Active High, X = 0 Active Low)
:TPTN	X	<cr>	:o<cr>	Enable/Disable Test Pattern (X = 1 Enable, X = 0 Disable)
:CAM?		<cr>	:o[model]<cr>	Inquire Camera Model
:VER?		<cr>	:o[version]<cr>	Inquire MPU firmware version

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

Table 7 Command Responses

Command	Parameter	End of Cmd	Description
Byte 1, 2 Byte 3, 4	Master Gain R Channel Fine Gain		Master Gain (H'0000 - H'0FFF: -3dB - +12dB) R Channel Fine Gain (H'0000 - H'0FFF)
Byte 5, 6 Byte 7, 8	Master Offset R Channel Fine Offset		Master Offset (H'0000 - H'0FFF) R Channel Fine Offset (H'0000 - H'0FFF)
Byte 9	Function Flag 0 Bit 0	Rsvd	
	Bit 1 Bit 2	Rsvd Rsvd	
	Bit 3 Bit 4	Rsvd Rsvd	
	Bit 5 Bit 6	Rsvd Pixel Output Order 0	00=<---<--- 01<=<------> 10=<<------
Byte 10	Bit 7 Function Flag 1	Pixel Output Order 1	
	Bit 0 Bit 1	Shutter 0 Shutter 1	Continuous Mode: 0000 Continuous no shutter Trigger mode: 0 = Async no shutter 1001=PWC 1010=PIV Fixed Exposure 1011=PIV PWC
	Bit 2 Bit 3	Shutter 2 Shutter 3	

Command	Parameter	End of Cmd	Description
	Bit 4 Bit 5	Shutter Mode 0 Shutter Mode 1	00=Continuous Preset Shutter 01=Trigger Preset Shutter 10=Trigger Programmable Shutter 11=Continuous Programmable Shutter
	Bit 6	Data Depth 0	00=8bit 01=10bit
Byte 11	Bit 7 Function Flag 2	Data Depth 1	10=12bit
	Bit 0 Bit 1	Look-up table 1	00=Linear 01=Gamma.45 10=User Knee Table
	Bit 2 Bit 3	Rsvd Camera Control Signals	 0=CameraLink Connector 1=Hirose 12pin Connector
	Bit 4 Bit 5	Rsvd Trigger Signal Polarity	 0=Active Low 1=Active High
	Bit 6 Bit 7	Dual / Signal Tap Positive / Negative LUT	0=Dual Tap 1=Single Tap 0=Positive LUT 1=Negative LUT
Byte 12	Function Flag 3 Bit 0	 R Channel Auto Fine Gain	 0=Disable 1=Enable
	 Bit 1 Bit 2	R Channel Auto Fine Offset Rsvd	 0=Disable 1=Enable
	Bit 3 Bit 4	Rsvd Blemish Compensation	 0=Disable 1=Enable
	Bit 5 Bit 6	Rsvd Password	 0=Disable 1=Enable
Byte 13, 14	Bit 7 (X1, Y1)	Test Pattern	0=Disable 1=Enable Coordinate for Knee 1 (X1, Y1=H'00 - H'FF)
Byte 15, 16 Byte 17, 18	(X2, Y2)	 Rsvd	Coordinate for Knee 2 (X2, Y2=H'00 - H'FF)
Byte 19, 20 Byte 21, 22	 Shutter Speed of Programmable Shutter	Rsvd	 Shutter Speed of Programmable Shutter (H'0000 - H'081F)
Byte 23, 24	Vsub Voltage		Vsub Voltage (H'0600 - H'0D00=7.8V - 17V)

7 Troubleshooting

7.1 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.

7.1.1 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

7.1.2 Symptom: Dark Video

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

- Shutter selection
- Iris opening on the lens

7.1.3 Symptom: Non-Synchronized Video

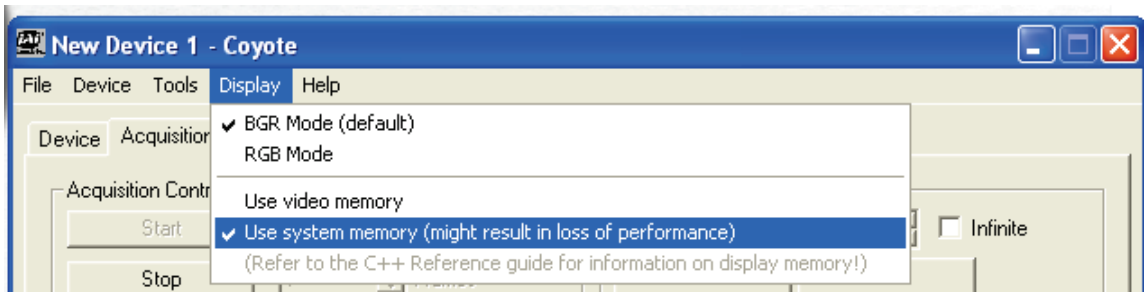
Remedies: Check that the following are properly connected and operational.

- Proper mode output
- Frame grabber software camera selection

7.1.4 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.

Figure 52. Change memory settings.



7.1.5 Symptom: Notebook Computer Driver Installation Problems

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

7.1.6 Information and Support Resources

For further information and support:

North American Technical Support
Phone 408-383-0300
E-Mail: camerasupport@jai.com

European Technical Support
Phone: +45 4457 8916
E-Mail: camerasupport@jai.com

Japan/Asia Technical Support
Phone +81 45 440 0154
E-Mail: tsh@jai.com

Mail:

JAI Inc.
Sales Department
625 River Oaks Parkway
San Jose, CA 95134

ATTN: Video Applications

Web Site: www.jai.com

8 Appendix

8.1 Specifications

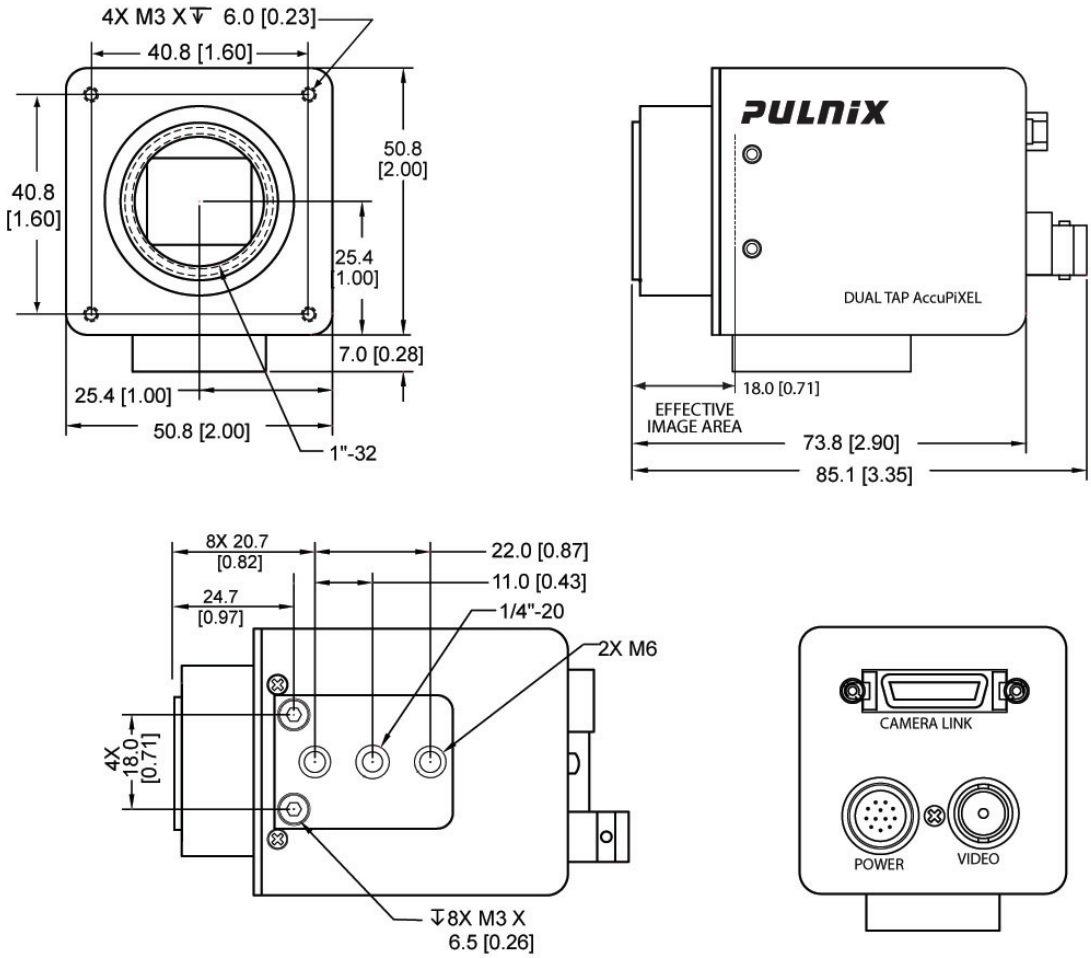
Table 8 TM-2030CL Camera Specifications Table

Feature	TM-2030CL
Sensor	1" progressive scan interline transfer CCD
Active Area	14.2mm x 8.0mm
Active Pixels	1920 (H) x 1080 (V)
Cell Size	7.4µm x 7.4µm
Readout Mode (Active Pixels)	1920 (H) x 1080 (V) @ 32 Hz (dual tap) or 16 Hz (single tap) selectable
Sync	Internal/External auto switch HD/VD, 4.0 Vp-p impedance 4.7 K ohms VD=32.32±2%, non-interlace HD=36.36kHz±2%
Data Clock Output	40.00 MHz
Resolution	Digital: 1920 (H) x 1080 (V), (Analog: over 800 TV lines (H) x 1600 TV lines (V))
S/N Ratio	>57dB min.
Min. Illumination	Monochrome: 0.45 lux. Color: 3.6 lux. f = 1.4 (no shutter) @ 32 fps. Sensitivity: 30uV/e-
Video Output	Digital output: 8-bit / 10-bit /12-bit Gigabit Ethernet (selectable at factory)
Gamma	Programmable LUT (1.0 std.)
Lens Mount	C-mount (use >1" format lenses or larger)
Power Requirement	12V DC, ±10%, 520mA (typical at 25°C)
Operating Temp.	-10°C to 50°C*
Vibration	7 Grams (10Hz to 2000Hz) Random
Shock	70G, 11 ms half sine
Size (W x H x L)	51mm x 51mm x 74mm
Weight	188 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;
Optional Accessories **Power Cable** **Power Supply** **Tripod Mounting Kit**	 12P-02S PD-12UUP series (includes power connector) TP-20

*. Refer to Section 4.2.1 on page 17 for information on camera heat dissipation. Image quality will degrade with increasing temperature.

8.1.1 TM-2030CL Physical Dimensions

Figure 53. Physical Dimensions



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

8.1.2 Spectral Response

Figure 54. Monochrome Response

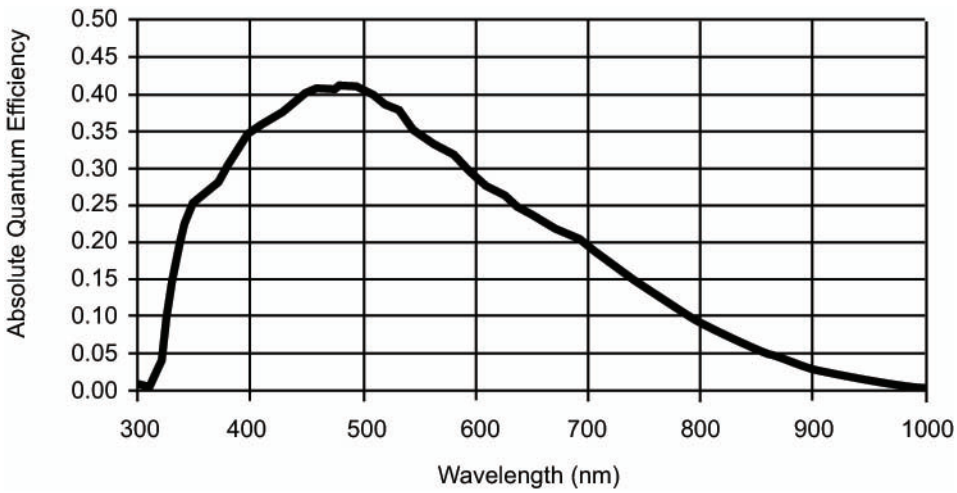
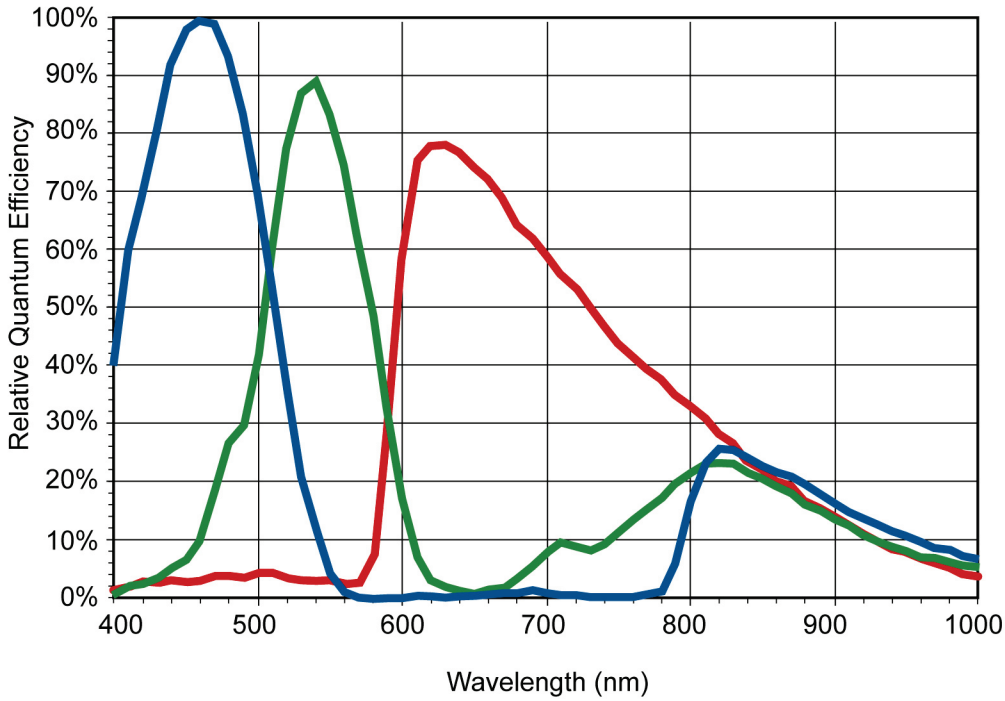


Figure 55. Color Response



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